SYNOPSIS This report provides an assessment of potential impacts associated with drainage maintenance works at the Kings Forest site.

REVISION HISTORY

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SUMMARY

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to assess the likely impacts associated with periodic drainage maintenance at the Kings Forest site, New South Wales.

The flood modelling conducted for the site has assumed that only the major east-west drain is maintained. All other drains are modelled as not maintained, so the maintenance of these drains is not required to achieve the modelled level of flood immunity predicted for the developed site.

The main east-west drain will need to be maintained to provide adequate drainage for the site, which is important in the event of flooding. Based on the historical maintenance regime, it is expected that the frequency of disturbance would be low (approximately once every ten years) however, necessary maintenance works could potentially result in the disturbance of acid sulfate soils, water quality impacts, erosion and sedimentation, impacts to flora and fauna.

These potential impacts would be minimised or avoided by strict compliance with the Drainage Maintenance Management Plan (Attachment 2).
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1 Introduction

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to undertake specialist studies and assessments in support of the development of the Stage 1 Project Application for the proposed Kings Forest development at Kings Forest, New South Wales. The site location is shown on Drawing No. 10685.1.1.

This report addresses, in part, the NSW Department of Planning (DoP) Director General’s environmental assessment requirements (DGR) amended on 23 December 2010, specifically:

7.6 Assess the necessity of drains currently in operation across the site and, for those required into the future, assess the impact of any ongoing maintenance required to ensure their effectiveness.

1.1 The project application

The approved Kings Forest Concept Plan proposes the creation of a residential community inclusive of associated educational, social, commercial, sporting and recreational amenities. The development is to be completed in stages. The Kings Forest Stage 1 Project Application seeks approval for a rural retail development in Precinct 1, residential development in Precinct 5 and bulk earthworks within the balance of the site.

The proposed development would include:

- Subdivision to create new lots/land parcels for future development.
- Construction of the entrance road to the site and associated works for the intersection with Tweed Coast Road, as well as a new connecting road to the Tweed Shire Council’s former waste tip.
- Subdivision and associated infrastructure works for the first stage of urban development (Precinct 5).
- Bulk earthworks and planting for the future golf course.
- A rural retail development (commercial site) on the developable land east of Tweed Coast Road.
- Bulk earthworks as required in all precincts.

1.2 Objectives

The aim of the study was to identify and assess the likely impacts of ongoing maintenance of the east-west drain at the Kings Forest site in terms of:

- hydrological impacts
- disturbance of acid sulfate soils
- surface water quality impacts
- erosion and sedimentation
- impacts to flora and fauna.
2 Desktop assessment

2.1 Background

The site is located within the catchment area for Cudgen Creek, and is predominantly drained in an easterly direction by Black's Creek (the 'east-west drain') which traverses the site from west to east. Runoff from the site also enters Cudgen Creek under Old Bogangar Road to the north and via the lowlands adjacent to the southern boundary of the site.

Drainage from the northeastern portion of the site flows into a coastal wetland as defined under ‘State Environmental Planning Policy No. 14 – Coastal Wetlands’ (i.e. a SEPP14 wetland) prior to discharging from the Kings Forest site. There is no statutory definition that can be applied for the classification of a SEPP 14 wetland. Determination of SEPP 14 wetlands was undertaken as a mapping exercise, based primarily upon a set of ‘botanical indicators, which were deemed, for the purposes of the survey, to characterise wetlands’ (Adam et al., 1985, p. 28).

2.2 Previous Investigations

The following previous reports and information were considered as part of this report:

- **Bowler Geotechnical – ‘Acid Sulfate Management Plan’** prepared by (January, 2005)

This assessment also considered the following reports prepared by G&S in 2011:

- **‘Acid Sulfate Soil Assessment, Kings Forest Stage 1 Project Application, Kings Forest, New South Wales’**.
- **‘Site Based Management Plan, Incorporating Golf Course Management Plan, Kings Forest Stage 1 Project Application, Kings Forest, New South Wales’**.
- **‘Groundwater Assessment, Kings Forest Stage 1 Project Application, Kings Forest, New South Wales’**.
- **‘Flooding and Flood Management Assessment Kings Forest Stage 1 Project Application Kings Forest, New South Wales’**.

2.3 Flood modelling

The flood modelling conducted for the site by G&S (2011) has assumed that only the major east-west drain is maintained. All other drains are modelled as not maintained.

The resolution of the model is such that the drainage function of the minor drains has been disregarded by the model, so the maintenance of these drains is not required to achieve the modelled level of flood immunity predicted for the developed site.

The main east-west drain will need to be maintained to provide adequate drainage for the site, which is important in the event of flooding.
3 Impact Assessment

A cleared track adjacent to the east-west drain currently provides access for maintenance vehicles (see Drawing No. 10685.1.2, attached).

In 2005, G&S conducted an assessment of the likely soil and hydrological impacts, specifically pertaining to the SEPP 14 wetlands, of drainage maintenance conducted within the north-south drain at the Kings Forest site. The soil types through which the north-south drain was constructed are similar to those present in the vicinity of the east-west drain. Accordingly, the findings of the 2005 G&S assessment and other relevant reports referenced below, are considered applicable to the east-west drain.

3.1 Hydrological impacts

The findings of the hydrological assessment can be summarised as follows:

- The water quality results suggest that water contained in the drainage line (on 19.05.2005) was predominantly surface water runoff.
- The surveyed surface water and groundwater level results suggested that an apparent hydraulic gradient (approximately 3%) toward the drainage line may exist, with the zone of drawdown influence extending approximately 20m from the edge of the drain. It is considered likely that the drainage line would collect some groundwater during normal operation.
- It is considered unlikely that the observed ‘cone of depression’ would deleteriously impact upon the SEPP14 wetland communities due to low in situ permeability, groundwater from adjoining lands ‘replacing’ lost groundwater, the localised nature of the cone of depression and the influence of the drain on groundwater drawdown being within the ‘normal’ range of seasonal variation.

Similar soil types to those present in the vicinity of the north-south drain are found along the east-west drain and no dewatering will be required during the maintenance works.

The key objective of drain maintenance is to minimise hydraulic friction (roughness) to facilitate efficient drainage and conveyance. This will be achieved by removing excessive vegetation growth, obstructions to the flow (snags etc.) and deposited sediment. Maintenance will not increase the depth of the drain and therefore will not result in groundwater drawdown.

3.2 Acid sulfate soil assessment

The findings of the G&S acid sulfate soil assessment can be summarised as follows:

- The screening results were comparable to those results of the investigation conducted by Bowler Geotechnical (January, 2005).
- The ‘Acid Sulfate Management Plan’ prepared by Bowler Geotechnical (January, 2005) recommends treatment with lime at a rate of 5kg/m² of materials exhibiting nil sulfidic acidity. Impacts on local ecosystems are likely to have been avoided if the provisions of the Management Plan (Bowler Geotechnical, 2005), including recommendations and management strategies, were implemented.

3.3 Surface water quality impacts

Drain maintenance works may result in the displacement of sediment and soil from drains, temporarily increasing turbidity. The degradation of water quality has the potential to cause fish kills downstream of works.

To minimise the degradation of surface water quality, sediment and erosion control measures will be implemented in accordance with Section 4.3 and the Kings Forest Stage 1 Project Application Erosion and Sediment Control Plan Report (G&S 2011). All surface water downstream of sediment and erosion control measures (floating silt curtains) will comply with the criteria defined in Table 4.4 of the DMMP.

3.4 Erosion and sedimentation

Drainage maintenance works have the potential to result in the degradation of drain stability. The installation of sediment and erosion control measures downstream of drain maintenance works in accordance with Table 4.3 of the DMMP will contain sediment during drain maintenance and minimise soil loss offsite.
STAGE 1 DEVELOPMENT
AREA
STAGE 1 BULK EARTHWORKS
IN THE CUDGEN PADDOCK
FOR GOLF COURSE
CONSTRUCTION

SITE BOUNDARY
EAST - WEST DRAIN
ACCESSIBLE
EAST- WEST DRAIN
LIMITED ACCESS
STAGE 1 DEVELOPMENT
AREA
STAGE 1 BULK EARTHWORKS
IN THE CUDGEN PADDOCK
FOR GOLF COURSE
CONSTRUCTION

SOURCES
Google Earth Pro 2011

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AGRICULTURE WATER ENVIRONMENT

KINGS FOREST - STAGE 1
PROJECT 28 PTY LTD

DATE 22/06/2011
DRAWN AJ S
PROJECT NO 1088

SCALE 1:20 000
CHECKED HLF
DRAWING NO 10881.12
3.5 Impacts to flora and fauna

A report by Geoff Sainty (2007) found the clearing of drains downstream of intensive farming activities can be beneficial to freshwater wetlands due to the removal of sediment and accumulated nutrients and pesticides. The report recommends the mechanical removal of sediment where the deposition of silt is greater than 20cm deep. In addition, plant growth should be managed to prevent the drainage system from blocking up.

The east-west drain’s exposure to upstream agricultural activities is less than the north-south drain and it is estimated that maintenance to the east-west drain will only be required once every ten years.

Tidal saline water limits the growth of Para Grass and other invasive weeds within the east-west drain however, maintenance to control salt-tolerant species may still be required.

Herbicide should be applied following the manufacturer’s instructions and recommendations and a visual inspection of flora and fauna conducted within 48 hours of herbicide application to ensure no adverse impacts have resulted from the application.
4 Conclusions

Periodic maintenance works in the east-west drain are necessary to ensure the correct function of the drainage and flooding conveyance regimes at the Kings Forest site. Maintenance works in the north-south drain are not required for flood conveyance and no regular maintenance works are proposed.

Drainage maintenance events in the east-west drain are proposed to occur only once per decade. On these occasions, the works may result in hydrological impacts, disturbance of acid sulfate soils, water quality impacts, erosion and sedimentation and impacts to flora and fauna. Previous studies indicate these impacts may be characterised as minor and the proposed frequency of drainage maintenance (i.e. once a decade) means the impacts are likely to be experienced only in the short-term.

To ensure that the identified potential impacts are avoided (where possible), minimised and/or managed in accordance with proven techniques, strict compliance with the DMMP (Attachment 2) is proposed.
5 Limitations of reporting

Gilbert & Sutherland Pty Ltd has made every effort to ensure that the information contained in this report is accurate. The interpretation of scientific data, however, often involves both professional and subjective judgments and as such is open to error.

In recognising the potential for errors in scientific interpretation, Gilbert & Sutherland Pty Ltd does not guarantee that the information is totally accurate or complete and clients are advised not to rely solely on this information when making commercial decisions. Any representation, statement, opinion or advice, expressed or implied is made in good faith and on the basis that the authors, Gilbert & Sutherland Pty Ltd, their agents or employees are not liable (whether by reason of lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to above.

Furthermore, this information should not be relied upon by any persons other than the client or the relevant statutory authority determining the client’s application, for whom it has been compiled. This information reflects the specific brief and the budget of the client concerned, who enjoys an individual tolerance of risk.
6  Attachment 1 – Sainty report (2007)
Sainty and Associates

Report on:

KINGS FOREST DRAINS

Prepared for:
Project 28 Pty Ltd
Level 1
46 Cavill Avenue
SURFERS PARADISE QLD 4217

Prepared by:
Geoff Sainty

Sainty and Associates

March 2007
Maintaining Kings Forest Drains

Purpose

This report has been prepared to assess (a) the importance of adequate drainage within the Kings Forest property and (b) the impact of drains on SEPP 14 wetlands within the Kings Forest property.

Issue Identification

The owner of the Kings Forest property, Project 28 Pty Ltd, seeks to determine the need to maintain the drains, and the appropriate method and frequency of such maintenance.

Background

The Kings Forest land forms part of the Cudgen system which is an important natural remnant on the Tweed coast.

The site comprises flat or gently undulating land with low-lying areas supporting permanent wetlands. The site has been significantly altered by agricultural enterprises especially clearing and slash pine plantations. Large drains have been constructed for internal drainage to enable water to drain from land to the north outside the property.

The Kings Forest site has been used for various agricultural activities since the early 1900s (Gilbert and Sutherland 2005). This has required the construction of drains for internal water management and to allow water to drain from agricultural lands upstream.

Intensive agriculture has been carried out in catchments that drain into the Kings Forest property, including sugar cane production, tree fruits, row crops, dairying and beef cattle. In the low lying areas it is essential that adequate drainage be installed, as intensive crop production cannot operate economically unless water can be drained from the area. The Tweed River area noted for its high agricultural production, and good drainage is as important as the availability of water for the crops.

The identification of wetlands within the Kings Forest land has been a focus for many years. More recently SEPP 14 wetlands and Endangered Ecological Communities have been delineated by James Warren and Associates (2003) and Sainty and Associates (2006). The boundaries of these wetlands have been accepted by NSW Department of Planning.

Gilbert and Sutherland (2005) undertook a study of the impact of drain maintenance on adjacent wetlands within the Kings Forest property.
Site description

Kings Forest has an area of approximately 849 ha and is located a few kilometres inland between the coastal towns of Kingscliff and Bogangar on the Tweed coast. It is positioned immediately north of Cudgen Lake. The site is generally low lying and of low relief (<9m) with a large proportion composed of beach ridge plain. The beach ridge plain is composed of Pleistocene sands (Gilbert and Sutherland 2005).

Catchment Area

The entire property is within the Cudgen Creek catchment area and is predominately drained in a southerly (initially) and easterly direction by Blacks Creek, a drain that traverses the property from west to east and discharges into the tidal Cudgen Creek. Kings Forest drains provide a conduit for drainage from more than 300 hectares of intensive agricultural land to the north and north west of the property.
Existing drainage system

The drainage of the site is described by Gilbert and Sutherland (2005) (drawing GJO350.2.2) and for further details of drainage in Kings Forest that study should be read in conjunction with this report.

Phillip Bell and Partners (Kings Forest Stormwater Management Plan 2001) have prepared a drainage classification system for the Kings Forest land. Seven classes were described ranging from Class 1, a largely unmodified creek, to a Class 7 that caters for overland flow. The main drains within Kings Forest are Class 3 which are 6 to 12 m wide.

Gilbert and Sutherland (2005) and Aspect North (2005) reviewed aerial photographs taken in 1962 and compared them with recent photos. They concluded that there had been no reduction in the size of wetlands on Kings Forest property since that time.
Main drains: Kings Forest
Kings Forest north-west sector showing poor drainage, November 2006

Kings Forest showing west-east drain (Blacks Creek), November 2006
Historical presence of Kings Forest drains

Intensive agricultural activities require appropriate drainage. The existing drainage system has been in operation since the early 1900s and has been necessary from the commencement of farming in this catchment. The drains have been constructed in or adjacent to the natural wetlands (now SEPP 14 wetlands and endangered ecological communities) as this land has the lowest elevation.

Maintenance of existing drains

In the past the drainage system was sufficient to drain Kings Forest and to accept water draining from the catchment outside the property. Recently, some maintenance has been carried out. No action has taken place since then to control obstructive aquatic plant growth. The aerial photograph taken in November 2006 shows macrophytes obstructing flow in parts of the north-south drain. Closer examination shows growth of grass, including the highly invasive exotic Para Grass (*Urochloa mutica*) infesting the system.
Impact of cleaning the north south drain on adjacent wetlands

Gilbert and Sutherland in 2005 established through detailed series of measurements that the ‘cone of depression’ (the drawing of water into the cleaned but not deepened drain) would be unlikely to adversely impact on the adjacent wetland communities, although they did identify the potential for some drawdown influence extending for approximately 20 m from the drainage line. They further identified the soils along the north-south drain were clayey and had low permeability and this would limit significant groundwater movement from the wetlands to the drain.

Noting also that the drains had not been increased in depth beyond that originally excavated, Gilbert and Sutherland concluded that the maintenance had not significantly impacted on the wetlands.

Changed run-off patterns and water regimes

Changing land use from the original densely forested Kings Forest has caused major changes on run-off volumes and peaks. There is evidence in some wet sections of Kings Forest that Slash Pine has caused previously ‘wet’ wetlands to become drier.

Other examples of changed landuse noted in the Kings Forest catchment include: short, grazed grasslands which significantly increase runoff, and sugar cane which is not wet tolerant, and requires the establishment of drains to keep the land at appropriate moisture levels.

Steep fallow land commonly evident in the intensively farmed land to the north of Kings Forest has resulted in significant erosion some of which is deposited in the main north-south drain.

In short, the volume and peaks of water that runs through Kings Forest has changed and will continue to change from the original landscape. There is no possibility of turning drainage volumes and peaks to that which originally occurred.

Contaminants

Nutrients and pesticides from the intensive farming upstream inevitably finds its way into the drainage systems. These contaminants arrive in pulses, tied to significant rainfall events and the time of the year the rain falls. If the drainage system is allowed to block up these contaminants have the potential to enter the SEPP 14 wetlands.

Recommended maintenance in the drains

When there is significant silt deposition i.e. beds of silt more than 20 cm deep, mechanical removal of the sediment should be undertaken. Plant growth is best managed by the use of glyphosate, using the formulation that has a label specifying use in water. Application should strictly follow label recommendations. In the first year three treatment may be necessary, subsequently reducing to two applications a year.

Altering drain cross section

In the light of the Gilbert and Sutherland 2005 report on groundwater infiltration it is not recommended that the drains be deepened unless there are blockages in specific localities. If the cross section of the drain proves insufficient to carry the flow, an investigation should determine if a one or two metre wide bench could be constructed in the drain, the bench to be set at 50 cm above
the current bed level to eliminate significant ground water movement from the adjacent wetland. This action may allow a greater flow in the drain during periods of sustained high rainfall.

**Weed Control**

A major problem in the drainage system is Para Grass. Currently it is patchy and if left uncontrolled will overtake the whole system except where the tidal saline water limits growth. This weed should be controlled as a **matter of urgency**.

![Contours showing catchment to Kings Forest drains](image)

**Conclusion**

Effective drains are essential to the Kings Forest development for the conservation of the existing wetlands and for the benefit of some of the farming land to the north of the property.

1. The drains at Kings Forest have long been in place, some for more than 100 years. The influence of these drains on the adjacent wetlands is not fully known but the current wetland mix in Kings Forest is in excellent condition and indicates that it is receiving adequate moisture despite the fact that there has been drier than average periods in the last decade. Photos taken in 1962 and compared with 2005 show no observable changes in wetland area.
2. Wetlands that maintain healthy Swamp Mahogany *Eucalyptus robusta* are generally well drained. If excessively wetted Swamp Mahogany loses vigour and in continually saturated conditions will die. Failure to maintain the drains and allow drainage water to flow unrestricted across the adjacent wetlands may lead to the loss of health of this important habitat tree in some sections of the property.

3. Aquatic weeds are a major threat to the 150 ha of wetland in Kings Forest. An unmaintained drainage system enables weeds to get a foothold. Para Grass, a major invasive weed, has spread from a section of drain adjacent to the east west drainage line and will continue to spread into open marsh areas unless control measures are implemented.

4. Land used for intensive agriculture uses significant amounts of nutrients and pesticides. Significant quantities of these contaminants are inevitably washed into the Kings Forest drainage system. If that system is allowed to block and the contaminants allowed to wash into the wetlands there will be changes to the current biota in the wetlands.

**Action**

- A programme of occasional sediment removal, but not excavation below the current bed level, is recommended when sediment deposition exceeds 20 cm.

- A programme of herbicide treatment is recommended using glyphosate at label rates two or three times each year, commencing in mid spring (October) each year.

- If the cross section of the drain proves insufficient to carry the flow, an investigation should be carried out to determine if a one or two metre wide bench could be constructed inside the drain; the bench to be set at 50 cm above the current bed level to eliminate significant ground water movement from the adjacent wetland.

Geoff Sainty

March 2007
Attachment 2 – Drainage Maintenance Management Plan