Duffill Watts
Consulting Group

Tomlinson and Carruthers

Wastewater Treatment and Discharge
Design and Assessment of Effects

Woodlands Road
Carterton

November 2007

Tomlinson and Carruthers
Wastewater Treatment and Discharge
Site Desktop Evaluation and Site Inspection

Woodlands Road
Carterton

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1.0 INTRODUCTION

1.1 Background

Tomlinson and Carruthers (TC) are managing the development of a subdivision on Tiffin Hill, Woodlands Road near Carterton. The owners of the site are proposing to subdivide 48 ha of the property into 17 Lots with residential dwellings being built on 16 of the planned lots. The property is referred to as 'The Site' in this report.

This report is to be used in conjunction with DWG's November 2007 'Tomlinson and Carruthers - *Wastewater Treatment and Discharge Resource Desktop Evaluation and Site Inspection'* which outlines the existing environment surrounding the property as well as providing a soil assessment.

1.2 Purpose

This report describes the design parameters required for a wastewater treatment scheme at the site. These parameters include the volumes of wastewater that the system will be required to handle, recommended loading rates and the likely area resources that each site will require.

Information from the resource review and investigation, combined with design parameters identified, are used to give a total picture of what the likely limiting factor for an on-site wastewater treatment system may be and to present options based on these findings.

2.0 IDENTIFICATION OF DESIGN PARAMETERS

2.1 Location

The Site occupies land to the south of Woodlands Road located to the east of SH 2 (Figure 1, Appendix A). The property is located 5.5km south east of Carterton and consists of two lots. Table 1 below outlines the properties included in the Woodlands Road subdivision proposal.

Table 1: Titles Comprising the Woodlands Drive Subdivision

Section	Survey District/DPS	Area (ha)	Title	Owner
Lot 3	DP 351518	48.6	210952	Dean Richard Brian Schaef and Lesley Robyn Schaef
Pt Lot 15	DP 3680	96.352	21262	Dean Richard Brian Schaef and Lesley Robyn Schaef

The subdivision will consist of 17 Lots; of these 16 will be developed into new dwellings. The proposed layout of the property is shown in Figure 2. The subdivision consists of varying size properties with an average lot size of 3 ha and a minimum lot size of 2 ha.

It should be noted that not all the available area is being used for residential subdivision. Of the 144 ha property detailed in Table 1, only 48ha will contain residential lots for the proposed subdivision.

2.2 Population

The site is currently being designed to accommodate 16 dwellings. The population of the development for the purposes of determining wastewater production has been estimated based on a combination of Census figures for the Carterton Community and by using AS/NZS 1547: 2000. Based on the Census information for Carterton the average household size is 2.5 people. When using AS/NZS 1547: 2000 it has been assumed that on average a four bedroom house will be developed on the site, and based on Table 4.3A1, this gives 6-7 people per house.

The standard provides a guideline for a single household that would need to be designed for if individual onsite systems be installed on each lot. Therefore for the design of the wastewater system the maximum value of 7 people has been used. If a combined wastewater reticulation is used then there may be the opportunity to reduce the number of people per house.

2.3 Design Flows

The wastewater volume generated by the development has been estimated based on the predicted population of the development as described in Section 2.2 above and consideration of the water supply. A nominated flow per person per day of 145 L has been chosen. This flow has been used based on information within AS/NZS 1547: 2000 and DWG's experience.

Additionally this flow value has been chosen based on the information that the dwellings are to use tank water and will not be connected to a reticulated water main. If reticulation of drinking water was to be installed additional wastewater flows should be incorporated into the design.

Table 2 gives projected wastewater volumes for the site.

Table 2: Projected Wastewater Volumes

Facility	People per Lot	Wastewater Rate (L/p/d)	Volume (m^3/d)
Per house hold	7	145	1.015
Cumulative flow	112 (16 Dwellings)	145	16.240

2.4 Raw Wastewater Quality

The characteristics of domestic sewage are well understood and as there are no industrial discharges at the development it has been assumed that the effluent strength will be typical of domestic wastewater. The adopted characteristics of the perceived wastewater are given in Table 3 below.

Table 3: Domestic Wastewater Characteristics

Constituent	Raw effluent (g/m^3)	After Sedimentation (g/m^3)
BOD_5	210 – 530	140 - 200
SS	237 – 600	50 – 90
TN	35 – 80	25 – 60
NH_3-N	7 – 40	20 - 60
TP	10 – 30	10 - 30
FC (MPN/100mL)	$10^6 – 10^{10}$	$10^3 – 10^6$

From Metcalf and Eddy, Wastewater Engineering, third edition (year). (Conservative as coarse filtration of effluent after sedimentation not taken into account).

2.5 Relevant Legislation

Discharges from on-site wastewater treatment systems are covered under the Regional Plan for Discharges to Land for the Wellington Region. The following rule is specific to on-site sewage treatment and discharge;

Rule 7 On-site sewage treatment and disposal

The discharge into or onto land of any water or contaminants other than septage, from on-site sewage treatment and disposal systems is a Permitted Activity if:

EITHER

1. *the system is already in use at the time this Rule comes into force; and*
2. *the discharge does not exceed 1300 litres per day (calculated as a weekly average);*

Provided

a) *the discharge shall consist only of contaminants normally associated with domestic sewage;*
b) *no stormwater shall be allowed to enter the system;*
c) *there shall be no direct discharge from the system to groundwater, surface water, or above the soil surface;*
d) *the system shall be maintained on a regular basis;*

e) the discharge is more than 50 metres from any surface water body, farm drain, or water supply race in any catchment being managed for water supply in the Regional Freshwater Plan (see Appendix 6 of the Regional Freshwater Plan); and
f) the discharge is more than 20 metres from any surface water body, farm drain, water supply race, or the coastal marine area in all other areas.

OR

3. *the system is a new or upgraded system;*
4. *the discharge does not exceed 1300 litres per day (calculated as a weekly average);*
5. *the system shall be installed on the same property as the premises to which the system is connected; and*
6. *there shall be no direct discharge above the soil surface.*

provided that conditions (a)-(f) above and the following conditions are complied with:

g) a site investigation shall be carried out. The matters to be addressed in a site investigation are set out in Appendix 5 of this Plan;
h) the system shall be designed, constructed and operated to meet the following performance criteria:

(i) the system shall be designed with sufficient effluent retention time to enable adequate treatment in relation to any constraints identified in the site investigation;
(ii) the effluent shall be evenly distributed to the entire filtration surface of the disposal field;
(iii) the bottom of the effluent disposal system shall be sufficiently above the groundwater at its highest level, in relation to any constraints identified in the site investigation, to prevent any contamination of groundwater; and
(iv) *the area available for treatment shall be appropriate for the volume of the discharge and any constraints identified in the site investigation*

This report's intent is to demonstrate the ability of on-site wastewater facilities to operate successfully at the Woodlands Road development. It will also demonstrate compliance with **Permitted Activity** conditions as listed above.

3.0 ASSESSMENT OF ALTERNATIVES

The following provides a summary of the options considered for wastewater treatment for the site.

3.1 Option 1 - On-site

Advances in wastewater technology have resulted in more on-site treatment plants capable of producing high quality effluent. Treatment plants can vary from primary treatment to high secondary to tertiary standard. The options for treatment are discussed below:

3.1.1 Primary Treatment and Discharge

Primary treatment option involves on-site septic tanks that generally remove the solids and floatable material from the wastewater within the retention unit. The sedimentation of solids reduces the TSS emitted from the wastewater treatment system. The treatment water quality can be improved through the addition of an outlet filter.

The system requirements for primary treatment are as follows:

- Sufficient land area within the lot to provide for the wastewater treatment and disposal fields; and
- Discharge could be via mounds or Low Pressure Effluent Dosing (LPED) systems.

The advantages of theses systems are as follows:

- Simple system with less likelihood of failure;
- Low maintenance requirements; and
- No reticulation of sewage is required within the development.

The disadvantages of theses systems are as follows:

- Low output quality of effluent;
- Suitable only for trench disposal methods; and
- Need to make allowance for reserve areas.

3.1.2 Secondary Treatment

There are numerous options available for secondary treatment systems within New Zealand.

These technologies produce varying qualities of effluent depending upon the manufacturer's specifications. However most systems are capable of producing effluent which is of an acceptable environmental quality, cost effective, and their operation and management requirements are envisaged to suit the needs of the development.

The system requirements for this type of system are as follows:

- Sufficient land area within the lot to provide for the wastewater treatment and discharge fields.

The advantages of theses systems are as follows:

- If appropriately designed, such systems are generally endorsed by regional councils as being a sustainable method of effluent discharge to land. This could result in a more efficient (and quicker) consenting/approval process;
- The effluent can easily be used to irrigate gardens and other open spaces, keeping them lush and green;

- The low rates, if applied to the subsurface, are highly unlikely to break through to the surface; and
- No reticulation of sewage is required within the development.

The disadvantages of theses systems are as follows:

- Low rates require proportionally the highest amount of area of any land treatment system;
- Each lot is required for the installation and maintenance of an on-site effluent treatment system;
- Individual systems are likely to be relatively more expensive than decentralised or fully reticulated options; and
- There are concerns relating to the cumulative effects of individual systems in such developments and also regarding their ability to be managed.

3.2 Decentralised/Communal

Another option is to reticulate the wastewater from each property to a decentralised/communal treatment plant and discharge field. This option allows the wastewater produced from the subdivision to be dealt with at one location and can also take the responsibility away from the individual lot owners to organise the running and maintenance of the treatment plants and discharge fields.

It does, however, have the drawback of requiring wastewater reticulation to be installed within the subdivision. Additionally it requires the organisation of a body corporate or residents association to manage and take responsibility for the site.

A scaled up single lot treatment plant can be installed to service all the individual properties. The requirements for this type of system are as follows:

- Land area at least large enough to accept effluent irrigation from all dwellings. In the case of decentralised/communal systems the irrigated land is usually reserve/amenity areas and not necessary onto individual lots; and
- Reticulation of wastewater from the individual houses to the treatment facility is required, possibly needing easements to be established.

The advantages of theses systems are as follows:

- Councils often have a preference for one larger treatment system than many smaller treatment plants, especially in terms of ease of management;
- The effluent can easily be used to irrigate gardens, reserves, and other open spaces, keeping them lush and green;
- The low rates, if applied to the subsurface, are highly unlikely to break through to the surface;
- Decentralised/communal treatment plants allow the wastewater produced from the subdivision to be dealt with at one location, assisting with management; and
- A decentralised/communal system can take the responsibility away from the individual lot owner for the running and maintenance of the treatment plant and discharge fields.

The disadvantages of theses systems are as follows:

- Low rates require a proportionally larger area for the discharge system;

- Reticulation of wastewater from the individual houses to the treatment facility is required; and
- There can be issues regarding ownership/management of the treatment plant. Body Corporate or similar systems governing agreements are likely to be required.

3.3 Reticulation to existing Carterton Treatment Plant

A further option that may be available to the subdivision is to reticulate the wastewater produced to the existing Carterton sewage system. The reticulated network does not currently extend along Woodlands Road.

This option would have the benefit of both the treatment and discharge of wastewater being off-site. There would be minimal maintenance requirements for the development, having only a sewage pumping station to maintain. It would be expected that there would, however, be a connection / contribution fee to the Carterton system and then ongoing fees for the treatment and discharge of wastewater (possibly rates for individual lots).

The appropriateness of this system may be questionable given the distance to Carterton and the costs involved.

3.4 Preferred Option

Primary treated effluent would not be suitable to allow for the use of drip irrigation. Additionally extending the Carterton Wastewater treatment system to Woodlands Road is not seen as a viable alternative given the small number of lots proposed for the development and the distance.

It is proposed that the effluent produced should be discharged via subsurface drip irrigation. Drip irrigation is recommended as it provides a way of achieving an even distribution of effluent over a nominated area and is generally considered best practice for the discharge of highly treated effluent and low permeability soils (see Site Evaluation report). The use of drip irrigation warrants the use of secondary treatment.

Both communal/decentralised and on-site system could be used. Given the separation between the lots, it is recommended that individual on-lot systems be used.

4.0 PROPOSED SYSTEM DESCRIPTION

4.1 Preferred Reticulation and Discharge Option

The preferred option is described above in the previous section and is individual on-lot treatment and discharge systems. Occupants could be at their own discretion to choose a wastewater treatment system for each lot. However, calculations for this report are based around a Standard Secondary Treatment (SST) system. As a result any system that is installed on the site should meet the design criteria used below.

Table 5 below outlines the typical performance data from these systems. It should be noted that this is typical design data and does not necessary constitute maximum design standards.

Table 4: Typical Performance Data

Parameter	Secondary Treatment* (g/m^3)
BOD_5	< 10
TSS	< 10
Total Nitrogen	25-40
Total Phosphorous	7
Faecal coliform (MPN/100ml)	$< 10^4$

- Auckland Regional Council Technical Publication No 58 Secondary treatment plus an Intermittent Sand filter

4.2 Land Treatment and Discharge via Subsurface Drip Irrigation

Drip irrigation fields will need to be established on each lot. DWG recommend a pressure compensating emitter system be used. This allows for installation over slightly undulating land which does not necessarily have to follow the land contour. Low application rates allow for good final treatment of effluent within the soil matrix.

4.3 Treatment Plant Location

Each lot will comprise an on-site wastewater treatment plant and an associated discharge field. Treatment plants should be installed in accordance with manufacturer's specifications.

4.4 Land Discharge Location

All discharge locations must be installed on the same property as the premises to which the system is connected. The location of these discharge fields will need to be in accordance with Rule 7 On-site sewage treatment and disposal of Greater Wellingtons Discharges to Land for the Wellington Region (WRC, 1999)

The driplines will discharge wastewater evenly into the soil, buried at a depth of 150 mm below the surface to minimise surface pooling of discharge. Alternatively the driplines can be placed on the surface providing access to the area is restricted or a cover of at least 100 mm of mulch is maintained.

4.5 Hydraulic Loading

Hydraulic loading is determined by the rate at which the effluent can be infiltrated into the soil. A recommended loading rate has been determined based on work by DWG's site investigation as detailed in their previous report ''*Wastewater Treatment and Discharge Resource Desktop Evaluation and Site Inspection"*. The report outlined that that the soils on site consisted of clay soils with some mottling and classified the soil as Category 5- Light Clays (AS/NZS 1547:2000).

DWG undertook sampling to determine the near saturated water conductivity capacities of the soil (meso-pore flow based on a matrix potential of K_{-40mm}). The goal of the soil hydraulic conductivity tests for wastewater irrigation is to determine the rate at which the soil has the capacity to accept water in order to minimise ponding, runoff, excessive wetness and excessive flow through the macro-pores (preferential flow). The data varied according to the site, with the most conservative results indicated that the soil has the capacity to accept 5 mm/hr of clean water.

To accommodate the effects of wastewater (TSS and ionic conductivity) as well and the effects of prolonged loading on a section of soil, 10 % of this value is believed to be representative of the soil's potential for receiving wastewater on a long term basis. As a result the sampling indicated that the soils have the capacity to absorb 0.5 mm/hr or 12 mm/day.

However, given the mottling found in the soil at a depth of 200-350 mm, which indicates that the soil at this depth has exposure to the high water table as a result of drainage restrictions, DWG believes that a conservative value is appropriate. As a result a loading rate **of 2 mm/day** is considered to be appropriate. This is comparable, but slightly less, than the rate recommended in AS/NZS 1547:2000 for Category 5 soils (Table 4.2A4), which recommends a maximum loading rate of 20 mm/week or 2.8 mm/day.

Using the hydraulic loading rate prescribed above, and the flows described in Section 2.2, a discharge area for each lot will be 510 m^2. Additionally DWG recommends incorporating a 25% reserve area. This reserve area is not to be used for replacing poorly performing areas, rather to be set aside for further extension of the property at a later date.

Table 5: Size of Land Discharge Area

Stage of development	Required (m^2)	Required area including reserve area (m^2)
Each Lot	510	635

4.6 Nutrient Loading

Nutrients in the treated wastewater have the potential to limit the application rate and consequently the land area required for discharge. The key nutrient of concern is nitrogen. Typically, nitrogen should be applied at a rate which avoids the potential to generate excessive leaching. This rate should be comparable to nitrogen removed in crop foliage, or that which can be lost in various gaseous forms. The amount of nutrient loading would depend upon the type of treatment system deemed appropriate for the site.

DWG notes that it is the cumulative effects of subdivisions that typically have the impact on the receiving environment and therefore seeks to examine the nutrient loading rate of the subdivision. In order to calculate these nutrient loading rates per hectare over a year DWG has undertaken calculation based on 5 people per household. This is seen as a conservative approach due to the average number of people / house hold in Carterton averages at 2.5 people (Section 2.2).

Based on a nitrogen concentration leaving the wastewater system of 40 g/m^3 and a loading of 2.0 mm/day over 365 days, the nitrogen loading is calculated at up to 292 kg/ha/yr.

A nitrogen loading rate of 292 kg/ha/yr is not high compared to many intensive land use operations. However, this area should not be grazed or cropped. It could be mown which may result in some nitrogen removal.

Despite the relatively high loading rate given possible land uses, it is unlikely there will be leaching to groundwater given the soils, and when averaged over the proposed lots, ranging in size 2 to 3 ha, the effects of the proposed loading will be minor.

4.6.1 Phosphorus Loading

Phosphorus is another nutrient that is important to consider when developing land application areas for effluent. This is especially true where there may be leaching to freshwater bodies as phosphorus is often the limiting nutrient for eutrophication. Based on a phosphorus concentration of 8 g/m^3 in the effluent from the treatment plant and at a loading of 2 mm/day, the phosphorus loading rate is calculated to be approximately 58 kg/ha/yr over the treatment area. This rate is slightly higher than typical agronomic application rates for the corresponding land use, but the effects are unlikely to be detected.

5.0 Construction and Commissioning

The following outlines the construction and commissioning requirements of both the sewerage treatment plant as well as the discharge fields.

5.1 Sewage Treatment Plant

5.1.1 Construction Requirements

The specific requirements for the sewage treatment plant construction include:

- Installation of the treatment system in accordance with the recommended design or approved variation;
- The work shall be carried out according to NZ standards (that is civil construction, mechanical and electrical installations, etc);
- The Contractor shall follow site safety and traffic control regulations as appropriate;
- The works shall be carried out in a manner that causes minimum disruption to the local residents and the public;
- The works shall be carried out in a manner that causes minimum disruption to the surrounding environment, that is minimal dust, noise, visual impacts, and disruption to the natural habitat;
- Restoration of all works area/services disrupted during the installation works;
- The Contractor shall provide 'As Built' drawings to the system owners and district council;
- A Certificate of Completion shall be provided to the system owners and district council; and
- The providing of the necessary service manuals and design drawings to the system owners and district council.

5.1.2 Commissioning Requirements

The Contractor shall undertake erection/installation, testing, trial runs and commissioning of the wastewater treatment plant including all equipment and accessories, interconnecting pipeworks, all civil/structural works, all electrics and instrumentation supports etc. as required within the limit of design.

The objective of this exercise is to demonstrate to the system owner that the plant and equipment installed will perform consistently to the specified duty parameters. All instruments required for performance testing shall be duly calibrated and the same shall be arranged by the successful Contractor.

The effluent from the wastewater treatment system immediately prior to discharge to the land discharge field shall comply with or exceed (better than) the parameters of performance outlined in Table 5.

All equipment shall operate satisfactorily and performance and efficiencies of the equipment shall not be less than the respective guaranteed value. The above guarantee should be valid for a period of twelve (12) months from the date of issue of Certificate of Completion or such extended period as provided for.

The Contractor shall provide on-site training to the system owners. At the same time they shall be supplied with an operation manual, which details servicing requirements and contingencies should problems arise with the system.

5.2 Discharge Field

5.2.1 Construction Requirements

The specific deliverables for this component of the works include:

- Installation of the discharge system in accordance with the recommended design or approved variation;
- Testing and commissioning of the system and its components including the pumps and their associated control and valves etc;
- Restoration of all works areas/services disrupted during the installation works;
- Provision of operating and maintenance manuals and requirements;
- The Contractor shall provide 'As Built' drawings; and
- A Certificate of Completion shall be provided.

5.2.2 Commissioning Requirements

The successful Contractor shall undertake erection/installation, testing, trial runs and commissioning of the discharge system, including all equipment and accessories, interconnecting pipeworks, all civil/structural works, all electrics and instrumentation supports etc. as required within the limit of design.

The objective of this exercise is to demonstrate to the system owner that the plant and equipment installed will perform consistently to the specified duty and/or design parameters. All instruments required for performance testing should be duly calibrated.

All equipment shall operate satisfactorily and performance and efficiencies of the equipment shall not be less than the respective guaranteed value. The above guarantee shall be valid for a period of twelve (12) months from the date of issue of Certificate of Completion or such extended period as provided for.

The Contractor shall provide on-site training to the system owners. At the same time they shall be supplied with an operation manual, which details servicing requirements and contingencies should problems arise with the system.

6.0 Management

It is recommended that the successful Contractor shall undertake or organise a maintenance contract for a period of 5-years following date of issue of the Certificate of Completion of both the sewage treatment plant and discharge field. This contract will involve 12 monthly programmed maintenance and servicing of the treatment plant and discharge field.

The specific deliverables from this component of the works include:

- Checking and modification of treatment plant effluent recirculation rates;
- Visual inspection of effluent clarity;
- Cleaning if necessary of the treatment plant filters;
- Tank solids levels monitoring and disposal if necessary;
- 12 monthly visual inspection of the treatment plant and discharge field to check for breakages, leaks, ponding and abnormal system operation; and
- Checking appropriate pressures are maintained in piping for the discharge system.

In compliance with the requirements of this contract, the Contractor is to provide the system owner the names and contact telephone numbers of two persons for the purposes of after hours contact (including Saturday and Sunday and Public Holidays). One person must always be able to be contacted and available to respond immediately (or arrange an immediate response) to any work relating to:

- Loss of pressure;
- Ponding of effluent runoff over ground surface;
- All alarms ;
- Spill;
- Failure of the monitoring equipment; and/or
- Any complaints and/or malfunction of the system or part of the system.

It is recommended that after the initial 5-years maintenance contract has expired a further maintenance contract is established and is held for the life of the system.

7.0 SUMMARY

Tomlinson and Carruthers (TC) are managing the development of a subdivision on Tiffin Hill, Woodlands Road near Carterton. The owners of the site are proposing to subdivide 48 ha of the property into 17 Lots with residential dwellings being built on 16 of the planned lots. The property is referred to as 'The Site' in this report.

Wastewater treatment and discharge facilities are required for the site. Tomlinson and Carruthers have engaged Duffill Watts Consultant Group (DWG) to identify wastewater characteristics, treatment requirements and discharge options. In particular DWG have been requested to identify the likely wastewater systems and their effects.

A previous report prepared by DWG in October 2007 '*Wastewater Treatment and Discharge Resource Desktop Evaluation and Site Inspection*' outlines the soil characteristics found on site as well as undertaking a desktop study of the surrounding environment.

An assessment of options has indicated that onsite site treatment of wastewater rather than reticulated sewerage treatment is the preferred option for the site. The system provides clear ownership and management of the wastewater treatment system and removes the need for a body corporate or residents association to be created for the development.

The design flow is for each lot is likely peak at 1.015 m^3 per dwelling and wastewater systems and discharge areas have been designed to withstand this maximum or peak flow. This flow rate is based on 145 L/person/day that for properties that use onsite roof water. This flow rate is below Wellingtons Regional councils 1.3m^3 which is allowed as a permitted activity.

Discharge of secondary treated effluent to land via drip irrigation within each lot is proposed. This option provides good nutrient and pathogen reduction, and in the right setting can provide reuse/irrigation benefits. It is proposed that the drip-line will be laid 150 mm below ground.

The previous report undertook a soil analysis on the site. The investigation note that the main limitation to drainage would be a layer of silty clay located 200-350mm below the surface. As a result the infiltration rates have been designed to reflect this limiting layer. A maximum design irrigation rate of 2 mm/day or 14 mm/week is considered appropriate for the site.

Given the above information DWG believes that on-site systems can meet requirements outlined in Rule 7 outlined in the Regional Plan for Discharges to Land for the Wellington Region; and as a result can be regarded as a **Permitted activity.**

8.0 REFERENCES

Australian and New Zealand Standards (2000) *AS/NZS 1547:2000 On site Domestic Wastewater Management*

Wellington Regional Council 1999 *Regional Plan for Discharges to Land for the Wellington Region*

APPENDIX A

Figures

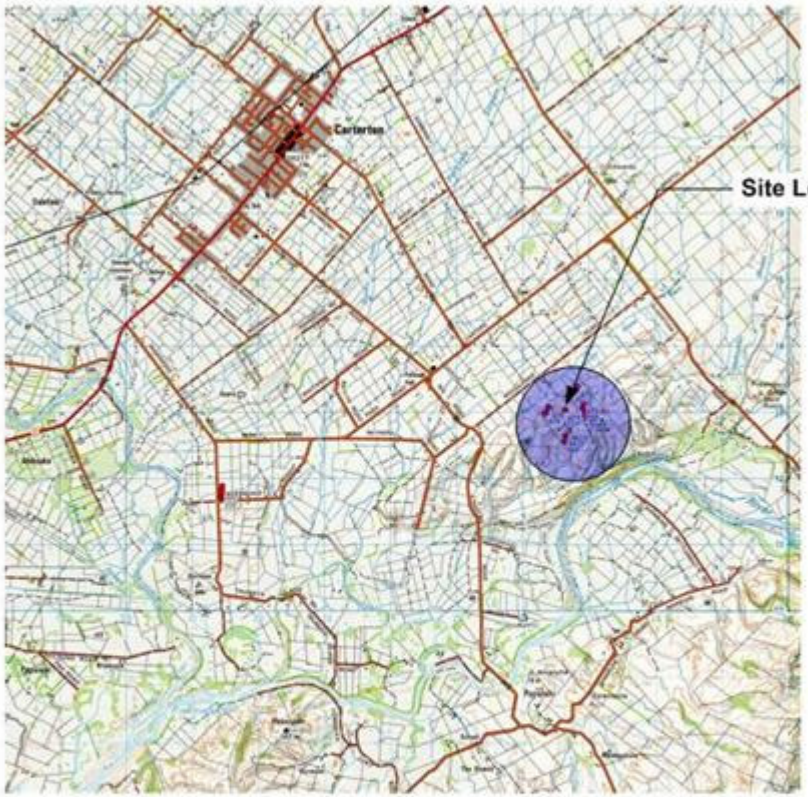

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Figure 1: Site Location and Topography

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