Annexure 6

- Infrastructure Assessment
  – Kea Consultants Ltd

Infrastructure Assessment Report

Proposed 22 Lot Rural Subdivision

Kapawiti Road

For

Mangawhai Heads Holdings Ltd

SEPTEMBER 2007

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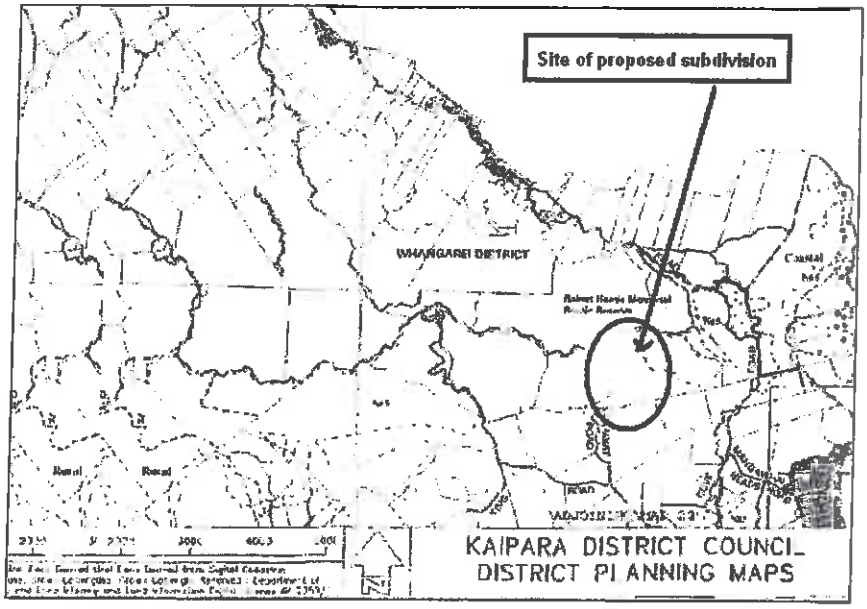
1.0 OVERVIEW

1.1 Introduction

KEA Consultants Ltd have been engaged by Mangawhai Heads Holdings Ltd to detail a proposal to create a 22 lot rural subdivision on the slopes of the Brynderwyns. This document reports on and assesses the effects of stormwater, wastewater disposal, erosion and sediment control.



This report includes the following information:

- Description of the proposed permitted activities.
- Assessment of Environmental Effects (AEE) due to the proposed activities.
- Proposed prevention, avoidance, mitigation measures and consideration of options where appropriate.
- Plans.
- Engineering calculations.

1.2 Site Description

The site is located approximately 4 km from Mangawhai Heads Township in a rural area and is approximately 18 km from State Highway 1 (SH1) via Kaiwaka-Mangawhai Road. The property itself is situated at the very end of Kapawiti Road via a long gravel ROW access. The property extends to the north of this access. The site is situated on the south eastern slopes of the Brynderwyn Range and is generally considered as moderately sloping to very steep. The western section of the development is covered in dense vegetation and has an established and defined watercourse network flowing to the south. The eastern sections are typically hilly slopes covered with a mix of dense vegetation and grassland slopes with minor gulley's draining to the south also. Access through the property to the north west is currently an existing formed farm track access which traverses the entire property from the entrance to the farthest north western boundary. Access to the south east is a partially formed farm track access.

1.3 Existing Stormwater system.

The property is served for stormwater by shedding rainfall into naturally formed gullies draining to the south. Where these are well defined watercourses they typically cross under the existing ROW access or farm track via existing culverts. The existing culverts along this access are proposed to be upgraded to cater for the 100year storm in association with detention, and the existing culverts located along the existing farm tracks are considered adequate and do not require upgrading. A second ROW to serve the south eastern lots will be formed along an existing track also and new culverts are proposed to be installed.

The stormwater catchments are described on plan C144 with catchment flow characteristics and existing/ proposed culverts detailed on plan C140.

2.0 EXECUTIVE SUMMARY

2.1 Proposed subdivision

The proposal provides for 22 new lots ranging from 0.30 ha to 2.05 ha, with a balance of 23.39 ha. Access for Lots 1-8 and 15-22 will be from a ROW #1. Access for Lots 9-14 will be via ROW #2. The existing native vegetation is proposed to be protected. The proposed ROW's are detailed on plan C100. (note: refer Plan C100 for lot details)

2.2 Stormwater Management

Rainwater Tanks will provide attenuation for roof areas and attenuation credit for paved areas within each Lot. Swale and rock swale drainage systems alongside the private access way provide for practicable stormwater management control and water quality treatment. A substantial vegetated buffer zone existing between the outlets and watercourse will filter runoff.

2.3 Wastewater Management

There is no wastewater reticulation system proposed to serve the land that is being subdivided therefore onsite effluent disposal is proposed. There is enough space within each lot to dispose of high quality effluent by means of pressure compensated dripper lines whilst observing all statutory setbacks.

2.4 Erosion and Sediment Control

Sediment and erosion control management techniques for the construction phase are designed to be in accordance with ARC TP90 design guidelines and will provide an efficient method of management.

3.0 STORMWATER MANAGEMENT

3.1 Strategy

3.1.1 The proposed stormwater management regime has been formulated using principles adopted from the Auckland Regional Council Technical Publications TP10, TP90 and TP 124. The proposal incorporates a suite of devices in series which will ensure that the quality of the water in the receiving environment will not be adversely affected. This approach will minimise piping of stormwater flows and earthworks by

use of retaining or other land stabilisation techniques.

3.1.2 All building sites and driveways are well clear of the streams, gullies and floodplains; refer to stormwater catchment and overland flow path drawing C140.

3.1.3 Properly designed culverts installed or upgraded where ROW's cross the watercourses, refer to drawing C140

3.1.4 The existing culverts are proposed to be upgraded to contain the 100year ARI storm in line with KDC Code of Practice for land subdivision and development year 2000 Section 9 Table 10

3.1.5 The 100 year ARI flood waters backing up behind the culverts has been shown on KEA Consultants sheet C140 and such areas will be required on the titles to be kept free of building and fixed obstructions.

3.1.6 Impervious areas are limited to the minimum practical to be regulated through covenants.

3.1.7 The disposal of runoff from each roof will pass through a rainwater tank that will be drawn upon to supply the residence. They can be used to attenuate flow from the roof areas and if the storage volume is sufficient, 'credit' for the paved area within that lot can be achieved. Peak Flow attenuation for various combinations of roof areas and paved areas are given in Chapter 11 of TP10 and can be utilised at time of residential development of the land.

3.1.8 Runoff from new drives, parking areas and tank overflows is discharged through appropriately designed spreader devices located well away from structures to allow shallow flow over well vegetated slopes. The method of treatment will be the dense vegetated buffer zone that exists between the level spreader and the wetlands / watercourses.

3.1.9 The alignment of the central ROW on plan C140 follows an existing farm track along the ridge line and runoff is directed through stabilised outlets onto the slope typically some 90m from the watercourse. The method of treatment will be the dense vegetated buffer zone that exists between the outlet and the wetlands / watercourses.

3.1.10 The alignment of the secondary ROW following the south east boundary of the site traverses via an existing farm track and three small gullies. A swale drain will collect and treat runoff from the impervious area of roading and discharge into outlets at the gullies.

3.2 Methodology

The following methodology has been adopted.

3.2.1 Data Capture Identification and collation of catchment data necessary to obtain flows and routing details related to the flow through the subdivision. Refer to plan C144 for extent of the catchment and it's sub-catchments.

3.2.2 Modelling The "design rainstorm" is extrapolated from the ARC TP108 Figs A.3 and A.5. The graphical method of estimating stormwater runoff described in TP108 has been adopted, flood events were calculated for the 10, 50 and 100 year ARI and the impacts that these events may potentially have on the proposed development was analysed.

3.3 Primary stormwater disposal

The primary flow and calculations are appended to the report and the catchment definition in the attached plan C140

3.3.1 House Lots. Building sites will attenuate the roof discharge and credit paved areas by installing tanks with storage volume over that required for household purposes and release the overflow through a slow release mechanism to a level spreader into the heavily vegetated buffer zone.

3.3.2 ROW #1 Ch 0-360 The existing accessway shall be crowned shedding the runoff to each side where side drains convey the discharge to upgraded culverts that are located within the natural gullies.

3.3.3 ROW #1 Ch 360-2101 The existing access shall be trimmed with a single crossfall to a side drain that has been sized to contain the ARI 10 discharge (calculations appended to report) The side drain is similar in profile to that shown in KDC/A4/S15. Outlets are placed where appropriate to a culvert that discharge to either a stabilised outlet or scoria trench.

3.3.4 ROW #2 The existing access shall be trimmed and extended to slope with a single crossfall. The swale has been sized to treat the one third of the ARI 2 discharge (calculations appended to report). Outlets are placed where appropriate within the natural gullies to culverts that discharge to a stabilised outlet. It should be noted the discharges will be into an established flowpath.

3.4 Secondary Overland Flowpaths

The secondary flow and calculations are appended to the report and the catchment definition in the attached plan 23219-140

3.4.1 ROW #1 Ch 0-360 The upgraded culverts have been designed to contain the ARI 100 year storm and the pond area that will form in this event has been shown on the plans. This area will be defined on the certificate of title and any construction within it be prohibited.

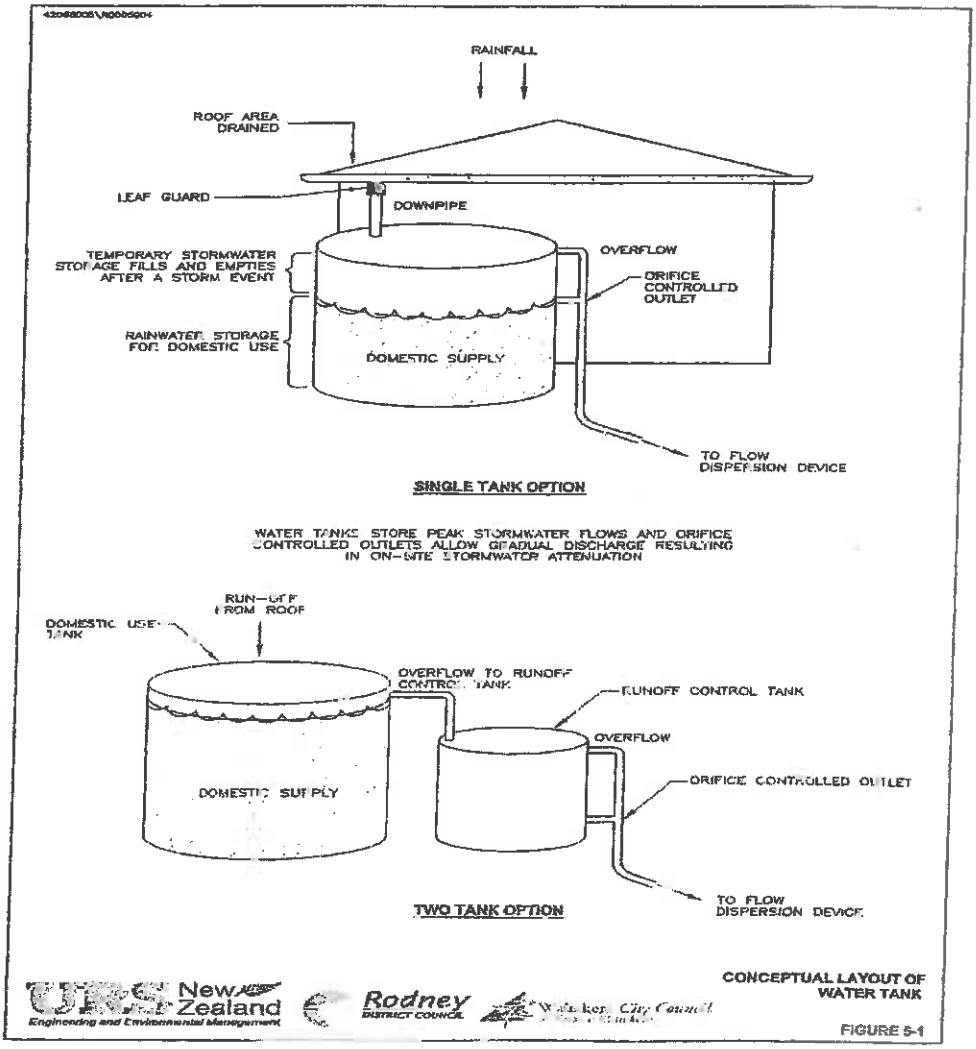
3.4.1 ROW #1 Ch 360-2101 Each of the existing culverts passing under the accessway has been sized to contain the ARI 100 year storm for the catchment above it, (ie to the next upslope outlet) The overland flowpath however has been based on the worst case scenario that each of the culverts is blocked or bypassed during a heavy storm and flows instead to its natural outlet.

3.4.3 ROW #2 The extension of this access will include earthworks across the existing gullies along the alignment. Culverts have been designed to contain the ARI 100 year storm and the pond area that will form in this event has been shown on the plans. This area will be defined on the certificate of title and any construction within it be prohibited.

3.5 Stormwater Runoff Control and Quality Devices

A Low Impact design approach has been adopted and the following outlines the range of control and quality devices that may be used to minimise the impact of the construction.

3.5.1 Rainwater Tanks These can be used to attenuate flow from the roof areas and if the storage volume is sufficient, 'credit' for the paved area within that lot can be achieved. Peak Flow attenuation for various combinations of roof areas and paved areas are given at Fig 11-5 Chapter 11 of TP10 and can be utilised at time of residential development of the land. Fig 5-1 Conceptual layout of water tank taken from Countryside and Foothills SW Management Code of Practice illustrates the principle to be adopted. The tanks shall be designed at the time of the Building Consent application and a consent notice on the title shall enforce the condition.

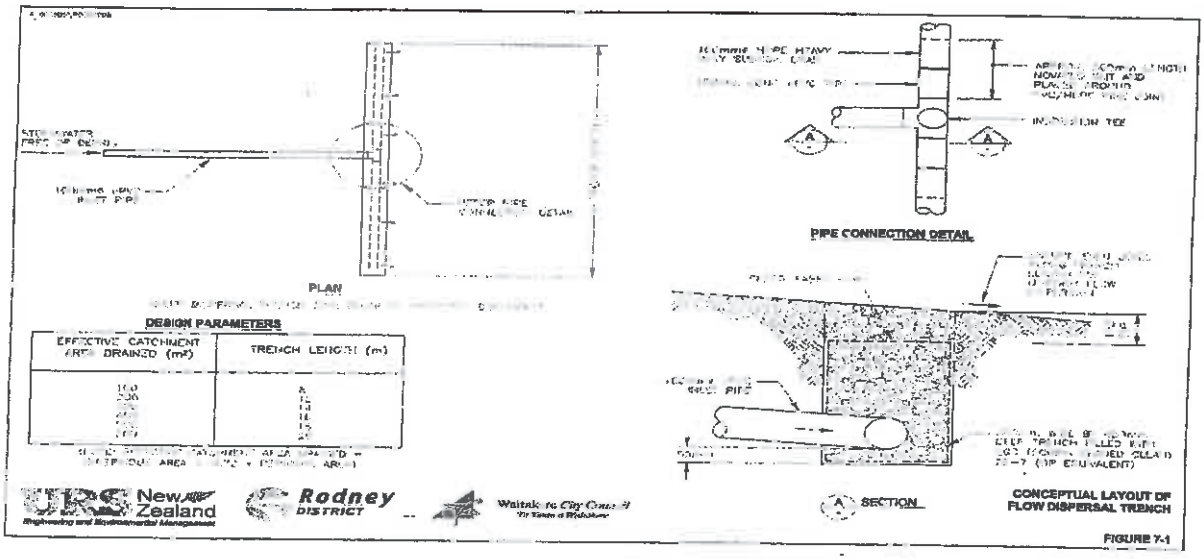


3.5.2 Rain Gardens Rain gardens are constructed depressions containing filter materials such as sand, aggregate, and filter fabric to prevent the migration of the fine materials; and a layer of mulch and plant soil. The area is then planted and landscaped. Approximately 5% to 10% of the size of the impervious area is required in rain garden to achieve the 75% sediment removal. The main issue with their long term performance is the assurance of adequate maintenance. Rain gardens can be used to achieve the level of treatment required by the ARC and can contribute towards securing hydraulic neutrality. They may be used on this site to treat runoff from the lots subject to a Geotechnical Engineer's site specific approval.

3.5.3 Permeable Surfaces Permeable pavements have the potential to act as a pollutant sink and as a stormwater quality device. The permeable pavement typically comprises of a layer of concrete blocks at the surface laid upon 50 mm layer of 5-10 mm washed pea gravel, separated from the underlying sub-base stone layer of geotextile. The sub-base is 20-50 mm washed crushed granite with a depth of 600 mm. Permeable pavements are typically more expensive than normal pavement. Permeable pavements for on site access driveways could be used to reduce the amount of runoff from each lot.

3.5.4 Side Drains Stormwater table drains will be constructed along the private accessway as per drawing C145 and 146. These will act as stormwater quality devices and will convey stormwater runoff from the proposed accessway and be discharged/dispersed into the natural overland flowpath. The principal function of the drain will be to attenuate the discharge from the proposed accessway. This will provide the most practicable form of stormwater management control and storm water quality treatment.

3.5.5 Aggregate Trenches. Aggregate trenches are trenches filled with layers of aggregate and sand underlying with a filter fabric to avoid the migration of the material. They are similar to rain gardens in principle except that they do not have to be a depression. The surface can be covered with mulch and plant soil and landscaped with other plants or grass. Aggregate trenches could be successfully incorporated in this development.



They are cost effective to construct and to maintain. They are not designed to infiltrate water back into the ground but rather sheet flow stormwater across the surface. Aggregate trenches can also play an important role in treating runoff from the hard surfaces within the lots. Fig 7.1 Conceptual layout of flow dispersal trench taken from Countryside and Foothills SW Management Code of Practice illustrates the principle

3.5.6 Vegetated filter strips and buffers. These are zones of vegetation, either existing or planted, which are used to receive runoff in the form of sheet flow from upslope. Strips may include vegetation ranging from grasses to forested areas. Vegetated filter strips may use existing vegetation or be planted during the course of development. Filter strips must include some form of level spreading device to ensure an even distribution across the vegetated area. If filter strips can be integrated into design criteria so that small storms are controlled and properly distributed, with larger storms being redirected, the technique has excellent water quality benefits

3.6 Maintenance of Stormwater Quality Devices

3.6.1 Rainwater Tanks. Rainwater tanks will be privately owned and operated by the lot owners and proper operation and regular maintenance of the rainwater tank system is necessary to achieve the design objectives.

Regular maintenance includes:

- Inspection of the tank (at least annually), clean-out of dead storage and repairs as necessary
- Inspection of the orifice outlet and pipework (no greater than annually) and repairs as necessary.
- Inspection of the overflow pipework (at least annually) and repairs as necessary.
- Inspection for erosion damage of areas receiving flow from the orifice and overflow where applicable, and repairs as necessary (after unusually severe storms)
- Water supply pumps and associated electrical work maintenance as per manufacturer's requirements
- Inspection of the backflow preventer by a certified inspector and repairs as necessary every 5 years
- Maintenance and replacement of the filters as per instruction manual
- Inspection of first flush device at least annually and repairs as necessary, along with cleaning of screens in gutters and downspouts

3.6.2 Side Drains. Sediment may also impede effective performance by clogging inlets and preventing the entry of design storms into the practice. If stormwater backs up into the upstream drainage area, it may overflow to an area not intended to accept additional flow and may cause erosion and site instability. As with other practices, debris removal is an ongoing maintenance need for all swales and filter strips. Debris, such as vegetative cuttings or garden/yard dumpings, if not removed can block inlets or outlets, cause flow to become concentrated and can be unsightly. Inspection and removal of debris should be done on a monthly basis, but debris removed whenever it is observed on site.

3.6.3 Swale Drains. Swales are mainly susceptible to impaired performance from excess sediment smothering vegetation. Because the effectiveness of swales and filter strips depends on vegetative filtering of dispersed flow, as well as on infiltration of runoff into underlying soils, their maintenance focuses on:

- Maintaining dispersed flow through the swale or filter strip
- Maintaining a thick growth of vegetation
- Preventing undesired overgrowth vegetation from taking over the site
- Removal of accumulated sediments
- Debris removal

3.7 Operation of Stormwater Quality Devices.

It is proposed that stormwater quality devices be managed by the residents society on behalf of the lot owners. The land occupied by the devices will be subject to maintenance obligations and each title will be subject to a consent notice addressing the maintenance matters discussed above. A draft consent notice will be supplied by the applicant as part of the conditions required to allow for application for the 224(c) certificate of completion.

3.8 Recommendations and Proposal

3.8.1 Roof runoff shall be discharged to a rainwater tank for household supply and the attenuated overflow from that tank and shall pass through an aggregate trench constructed along the contour to spread the flow into the natural vegetation (a vegetated filter strip) and away from the house platform and common accessways.

3.8.2 Any paved areas constructed within the lot shall be credited with attenuation from the extra storage in the rainwater tanks (TP10 Chapter 11 applies) They should be designed to minimise the impervious areas and sheet flow the runoff into the bush rather than concentrate it to a point.

3.8.3 The impervious area created for the common accessway shall pass through side drains as described above and shown on plan C145-146

3.8.4 Side drains shall discharge through an inlet similar to that shown on plan -C145 and 146 into a culvert.

3.8.5 A level spreader below shall be located a convenient distance from any structure to create a sheet flow that can pass though the densely vegetated buffer zone. Final positions for the spreaders are best determined on site, the locations shown are indicative. The positions must take into account steep slopes and the potential for dispersed flows to re-concentrate downslope.

3.9 Consents Required

As the proposed stormwater discharge and runoff retention meets the criteria of a permitted activity under the relevant plan, a Stormwater Discharge Consent is considered unnecessary.

4.0 WASTEWATER MANAGEMENT

4.1 Predicted Flows

A preliminary assessment of wastewater flows and characteristics has been made based on information from ARC Technical Publication No. 58, 2005.
The volume of wastewater has been assessed on the basis of 6 persons in each proposed household (4 Brm) with an average of 180 l/p/d for the dwelling. It is further recommended that water conservation fixtures are utilised. Therefore, the design discharge is estimated to be 858 l/d/dwelling.

Dwelling Residential	Occupancy	Design Flow Allowance (litres/person/day)	Design Flow
4 Brm	6	180	**1080**

Table 1 Wastewater Production

4.2 Water Conservation

It is recommended that the dwelling connected to the wastewater treatment system should contain wastewater reducing fixtures to reduce actual wastewater production. Installation of wastewater reduction fixtures can provide water consumption savings of up to 20 %. Wastewater reducing fixtures include:

- Low flush dual flush (6/3 litre) toilet cisterns
- Low flow shower heads (9 l/min)
- Low water use dishwashers
- Aerated tap faucets (6-9 l/min)
- Front loading washing machines

For the purposes of this analysis a reduction factor of wastewater generation has been taken into account for the installation of the above water conservation fixtures. This has been calculated in accordance to Table 6.3, "Flow Allowance Reduction Calculations for Household Fixtures", P56, ARC TP58 2004.

Dwelling Residential	Occupancy	Design Flow Allowance (litres/person/day)	Reduction Factor of 20% gives	Design Flow (litres/day)
4 Brm	6	180	143	858 Litres/day

Table 2 Wastewater production post conservation

4.3 Wastewater Treatment

The wastewater from each dwelling will be derived from residential uses, and hence is expected to have characteristics similar to domestic wastewater typical around New Zealand.

The outlet of the septic tank (concrete and/or fiberglass) will be fitted with an Orenco Biotube® effluent filter designed to retain in the septic tanks solids of more than 3 mm diameter. Retention of solids prevents the carryover of biological material to the

secondary/tertiary treatment stages and to the land application system. The installation of the Orenco Biotube® significantly improves effluent quality, resulting in average suspended solids of less than 30 mg/l in the effluent entering the secondary treatment stages.

Flow modulating devices built into the Biotube® regulate peak flows within the system preventing peak discharges into the secondary treatment stage. This feature improves the performance of the treatment plant and results in a more consistent treatment process.

The septic tank will be constructed in an excavated hole on-site; it will be watertight and will contain a sealed PVC riser and lockable fiberglass lid. The effluent having passed through the septic tank shall be dose loaded over an intermittent Orenco sand filter, collected through an underdrain into a pump chamber and then pressurised through the shallow wastewater irrigation lines.
In order to utilise the recommended shallow irrigation system it is required that the wastewater entering the irrigation lines be treated to a high standard. By utilising the sand filter, total suspended solids can be reduced to less than 10 g/m3. Therefore, allowing wastewater to be discharged through the shallow irrigation lines via pressure compensating drippers.

4.4 Wastewater Irrigation

It is proposed to discharge highly treated effluent to a land application system comprising pressure compensating drip irrigation lines laid in the topsoil horizon and spaced at 1 metre centres. The advantages of the irrigation system are:

- Low areal loading rates to minimise the potential for ground saturation.
- Evapo-transpiration is maximised, especially with proposed revegetation.
- Final renovation through the soil is maximised by use of large areas for better assimilation by soil, bacteria and vegetation.
- Ideally suited over uneven terrain.

The wastewater having been discharged through the septic tank through the sand filter would then be pressurized and disposed through Ramm Light (or similar) subsurface pressure compensating drippers. The advantage of this is the ability for a low hydraulic design loading rate and the ability to utilise the upper oxygenated soil profile to further treat wastewater.

4.5 Wastewater Irrigation Area Requirements

Based on wastewater generation from the dwelling of 858 l/d/dwelling and a design loading rate as shown above, the minimum irrigation area requirement for the dwelling is shown in the Table below. These area requirements are achievable within the 1000m² footprint designated on the scheme plan C140 for each of the Lots with the required set back from boundaries.

Total Design Flow	Application Method	Lot No.	Loading Rate	Land Treatment Area	Lineal Length Required
0.86m³/day	Subsurface Drip Irrigation	1-22	2 mm/day	430 m²	430 m

Table 3 Wastewater Irrigation Area.

4.6 Stormwater

Stormwater cut-off drains are required to be constructed above the waste water irrigation areas.

4.7 Minimum Setback Distances

The land application system will be setback from property boundaries by a minimum of 1.5m. Also, a minimum setback of 3.0 m will be maintained from each of the dwellings. Refer to KEA Consultants Plan 23087-SP1.

4.8 Reserve Land Application Area

A portion in each of the sites is to be set aside as a reserve land application area for wastewater. This area represents 33% of the primary area, recognising a conservative design loading rate of 2mm/m²/day. This is better defined at the time of building consent when the location of each dwelling and associated landscaping is defined refer KEA Consultants plans and note defined areas allow for that. Also note that covenanted bush will allow for discharge within those areas as additional reserve factor.

4.9 Consents

Onsite wastewater disposal is a permitted activity when the wastewater production is less than 2m³/day and the ratio of lot area (m²) to wastewater production (Litres) is less than 1.5 This subdivision will satisfy those criteria so the activity is permitted and consent not required.

4.10 Conclusion.

The proposal meets the following general criteria for a wastewater disposal system

- Each site has sufficient capacity to dispose of treated effluent allowing for setbacks to adjacent properties and watercourses.
- The geotechnical Report from Peters and Cheung confirm a system designed in accordance with TP58 will not cause any land instability.

It can be concluded that there will be no more than minor adverse environmental effects arising from future wastewater treatment and disposal aspects of the subdivision proposal.

5.0 Earthworks and Sediment control

Earthworks associated with the development are considered minor. Earthworks for the development are detailed on planC110 and are as follows:

a) ROW #1 – trimming of existing surfaces for shaping, installation of culverts and minor excavation associated with embankment slopes in the upper reaches. Estimated earthworks cut/ volume 5370m3.
b) ROW #2 – trimming existing surfaces for shapping, installation of culverts and

minor excavation associated with embankment slopes, plus forming of access along eastern section, estimated earthworks cut volume 980m3.

The total proposed impervious area associated with the proposed subdivision, i.e. access is approximately 10,000m2, which is approximately 2% of the total area of the subdivision. In addition ARCTP90 has been referenced for managing stormwater runoff and erosion and sediment control during the construction phase. The total area that will be affected by siteworks is approximately 45,000m2 which is greater than the NRC limit of 5000 m2. The slope of some areas of the earthworks is greater than 15 degrees, which means the site is prone to erosion. Sediment control measures need to be taken to reduce the sediment that otherwise will go into the stormwater that will affect the receiving environments adversely.

Silt fences are to be installed along the lower side of the road earthworks because the main source of the sediment is the road area. Earth bund will be built to divert clean water to culverts without mixing with the sediment laden water.

With the proposed measures in place the effects of the project earthworks will be no more than minor in terms of sediment increase.

6. Right of Way Construction

The access to serve each lot within the proposed development is via 2 formed and paved "Rights of Way" described on Plan C110, C133 and C134. The width of each ROW varies based on the number of lots being served. The main access section located from chainage 0 to 300m is proposed as 5.5m in width and gravel. The grade of this section is minimal. The alignment is proposed to follow the existing access with widening for compliance for width and upgrading of culverts for stormwater control. The remaining section of ROW 1 varies from 5.5m to 3.0m and is an upgrade to the existing formed track. Generally, the grades are compliant to the maximum and a high friction surface finish is proposed for this second section. Proposed ROW 2 varies in width from 3.5m to 3.0m and is proposed as gravel for grades under 1 in 8 and concrete for the remaining. The grade is considered as undulating. Each access has been designed in accordance with the KDC Subdivision Code of Practice and where necessary incorporating passing bays, corner widening and high friction surfaces on steep sections.

7. Conclusion

The proposed development is located within the Kaipara District Council ward area of Mangawhai. Mangawhai Heads Holdings Ltd has proposed to subdivide the existing 2 titles into a new development containing 22 rural lots. The property is located on the south eastern slopes of the Brynderwyn Range and is predominantly steep sloping and covered with heavy vegetation. The site is served by an existing formed access that extends to the northern extents of the property and stormwater sheds from the property via steep to rolling slopes to watercourses in defined areas.

The proposal is to complete minimal earthworks only associated with the construction or upgrading of the existing access or to extend the existing access and to install stormwater controls to manage stormwater runoff and prevent erosion.

The proposal details on-site stormwater and wastewater management and disposal for each lot in terms of acceptable and established guidelines.

The proposal is considered to mitigate for effects for earthworks, stormwater and wastewater disposal and that the effects as proposed shall be less than minor.