

PREDICTIVE MODEL FOR ARCHAEOLOGY: KĀPITI COAST

A GUIDE FOR DETERMINING THE
LIKELIHOOD OF ENCOUNTERING
ARCHAEOLOGICAL DEPOSITS DURING
EARTHWORKS

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ABSTRACT

Kāpiti Coast District Council has commissioned a predictive model for determining the likelihood of archaeological sites being present in any given area within the district. The predictive model has been prepared as a GIS layer which divides the district into a grid of 20 x 20 metre squares, affording each a value which then allocates it into one of nine classes indicating the likelihood that unrecorded archaeological deposits will be present. A version of this model has been further simplified into four classes to allow its application in a planning context. Recommendations have been made with regard to processes for resource consent applications in each of these classes.

INTRODUCTION

The *Resource Management Act* 1993 requires councils to identify and provide for the protection of the district's historic heritage. This has been echoed by the proposed Regional Policy Statement prepared by the Greater Wellington Regional Council in 2010. Historic heritage includes places of built heritage, archaeological sites and places of significance to tangata whenua. As one of a range of measures undertaken by the Kāpiti Coast District Council to meet this obligation, the Kāpiti Coast District Council have commissioned an archaeological predictive model.

The nature of archaeological deposits means that the archaeological features visible above the ground surface do not always adequately reflect the extent or composition of features below ground. Often significant archaeological deposits do not have any visible manifestation above ground at all.

When determining the nature and extent of archaeological deposits, site specific assessments prepared by consultant archaeologists typically involve a combination of historic research, results of previous archaeological research, geographical indicators, and extant features visible on site at the time of preparation. This model has been prepared for the district taking into account the first three of these variables on a district-wide level, to provide for the protection and recognition of archaeological sites as historic places.

The development of a predictive model provides a useful tool in identifying areas where unrecorded sites are most likely to be present. This is important for two main reasons.

Firstly, it can identify areas where potentially significant archaeological sites might be present. These sites comprise non-renewable repositories of information about the history and pre-history of the Kāpiti Coast, and knowledge of their location plays an important role in their ultimate preservation and protection.

Secondly, because pre-1900 archaeological sites have protection under the *Historic Places Act* whether they are recorded or not, unknown sites represent a significant legal risk to developers. Also by better understanding whether archaeological sites may be present or not, they are better equipped to make informed decisions with regards to the potential costs of development, and can play an active role in the preservation of sites within reserve contributions.

HOW TO USE THIS REPORT

This report has been prepared in conjunction with a GIS overlay prepared by Wild North and enVISION Ltd. The results section of the report contains two plans of the region derived from the GIS overlay.

The first divides the region into nine geographical classes based on the level of likelihood that archaeological remains will be present. This plan provides the most detailed information concerning the likelihood of encountering archaeological deposits in any given area, and can be used to provide a higher level of information for enquiries. The second plan is a simplified version of the plan, divided into four classes to which recommendations concerning planning regulations can be applied. These are outlined in the discussion section of this report.

A flowchart outlining the recommended processes to be followed by planners and consent applicants is provided at the end of this report as Appendix 1. Both of these layers are included in the GIS data supplied to the Kāpiti Coast District Council. To ensure greatest accuracy in relation to individual land parcels and cadastral boundaries, it is recommended that the GIS model is used in preference to the material in printed form for enquiries and consent processing.

LIMITATIONS OF THE DATA

The accuracy of a predictive model has an inverse relationship to the size of the geographical covered. This means that a model covering a larger geographical area will have a greater margin of error than that of a smaller geographical area. This is because the range and diversity of geographical features in a large area is significantly greater than in a small area. Rules that apply to a small area may be localized and not applicable over a larger area. In addition, a smaller study area can allow for more detail to be applied in terms of historic research, and consideration of the effects of subsequent development.

The data contained in this report is a prediction based on current archaeological research and state of knowledge. The nature of the discipline is that methods are constantly evolving and the body of knowledge is constantly increasing. Neither is the archaeological resource static. Natural processes and human development are continuously affecting the preservation of archaeological deposits. These processes are often also responsible for archaeological sites being identified and recorded. The archaeological data from which this model was derived was obtained from the database of the New Zealand Archaeological Association in June 2012. Archaeological sites are constantly being recorded and information in those records is being constantly updated. The NZAA Archsite¹ contains live data on the distribution of archaeological sites in New Zealand, and the data on individual sites can be requested through the site. General enquiries about the data can be directed to the District file keeper.

An area marked as high likelihood in the predictive model does not necessarily equate to the presence of archaeological deposits. Archaeological sites are typically recorded on the basis of tangible evidence. This can be in the form of historical records, but records are usually made on the basis of features that are able to be described, photographed, measured, sampled and analysed. The predictive model makes use of a range of geographical, historical, archaeological, and traditional knowledge, but the data presented represents the *likelihood*, not the *presence* of archaeological deposits.

¹ <http://www.archsite.org.nz>

This model does not assess the significance of archaeological sites in the Kāpiti Coast District. Archaeological sites as defined under the *Historic Places Act* 1993 have blanket protection under the provisions of that Act, and it is unlawful to damage or modify an archaeological site except with the authorisation of the New Zealand Historic Places Trust. The decision on whether to grant or decline an authority based on the activity, and is relative to the significance of the archaeological deposits. Commonly used guidelines for assessing the significance of archaeological sites in New Zealand have been prepared by the Department of Conservation and the New Zealand Historic Places Trust (Walton 1999, NZHPT 2006).

While the predictive model incorporates information from tangata whenua, it is not a predictor of wāhi tapu sites. Wāhi tapu can encompass tangible and intangible values, and are not necessarily predetermined by geographical factors. Information on wāhi tapu values can only be obtained from tangata whenua.

The predictive model contains data sourced from the New Zealand Archaeological Association archaeological site database, Archsite. The New Zealand Archaeological Association Incorporated gives no warranty in relation to the data (including accuracy, reliability, completeness or suitability) and accepts no liability (including, without limitation, liability in negligence) for any loss, damage or costs relating to any use of the data.

BACKGROUND

STATUTORY CONTEXT

There are two main pieces of legislation in New Zealand that control work affecting archaeological sites. These are the *Historic Places Act* 1993 (HPA) and the *Resource Management Act* 1991 (RMA). The New Zealand Historic Places Trust administers the HPA. The HPA contains a consent (authority) process for any work affecting archaeological sites, where an archaeological site is defined as: Any place in New Zealand that:

- (a) Either –
 - (i) was associated with human activity that occurred before 1900; or
 - (ii) is the site of the wreck of any vessel where that wreck occurred before 1900; and
- (b) Is or may be able through investigation by archaeological methods to provide evidence relating to the history of New Zealand (HPA section 2).

Any person who intends carrying out work that may damage, modify or destroy an archaeological site, or to investigate a site using invasive archaeological techniques, must first obtain an authority from the New Zealand Historic Places Trust. The process applies to sites on land of all tenure including public, private and designated land. The HPA contains penalties for unauthorised site damage or destruction.

The archaeological authority process applies to all sites that fit the HPA definition, regardless of whether:

- The site is recorded in the New Zealand Archaeological Association Site Recording Scheme or registered by the Historic Places Trust,
- The site only becomes known about as a result of ground disturbance, and/or
- The activity is permitted under a district or regional plan, or a resource or building consent has been granted.

The RMA requires City, District and Regional Councils to manage the use, development, and protection of natural and physical resources in a way that provides for the wellbeing of today's communities while safeguarding the options of future generations. The protection of historic heritage from inappropriate subdivision, use, and development is identified as a matter of national importance (section 6f).

Historic heritage is defined as those natural and physical resources that contribute to an understanding and appreciation of New Zealand's history and cultures, derived from archaeological, architectural, cultural, historic, scientific, or technological qualities. Historic heritage includes:

- historic sites, structures, places, and areas
- archaeological sites;
- sites of significance to Maori, including wāhi tapu;
- surroundings associated with the natural and physical resources (RMA section 2).

These categories are not mutually exclusive and some archaeological sites may include above-ground structures or may also be places that are of significance to Maori. Where resource consent is required for any activity, the assessment of effects is required to address cultural and historic heritage matters.

DISTRICT PLAN

The operative plan for the Kāpiti Coast District Council presently includes a heritage register comprised of historic buildings, ecological sites, geological sites, significant trees and waahi tapu (currently limited to four cemeteries). There is also a list of 155 archaeological sites for information purposes.

The District is divided into eight zones with respect to land use activities. These are: residential, rural, commercial/retail, Paraparaumu town centre, industrial/service, open space, river corridor, and conservation. Land use activities are then identified and divided into permitted, controlled, discretionary, non-complying and prohibited. The majority of zones identified in the District Plan have an allowance for earthworks of 50m³, with a maximum depth of 2 metres. This amount of earthworks unchecked can seriously impact on archaeological deposits, and in some cases destroy them completely.

When making decisions on a resource consent for a discretionary activity under the current plan, the Kāpiti Coast District Council has the ability to consider the impact on Maori ancestral lands, water, sites, wāhi tapu and other taonga, but this does not necessarily extend to archaeological deposits, and archaeological deposits are not presently included in the list of definitions.

REGIONAL CONTEXT

LOCATION AND GEOGRAPHY

The Kāpiti Coast District encompasses a diverse geographical area that extends from Paekakariki to Otaki, and encompasses some 732 square kilometres. It includes Kāpiti Island, and the southern end of a dune belt that extends up the west coast as far north as Patea, in South Taranaki District. The eastern part of the Kāpiti Coast District is dominated by the Tararua mountain range, which rises to around 1500 metres above sea level.

The main rivers through the District include the Otaki and Waikanae Rivers. Smaller rivers and streams include the Wainui, Whareroa, Wharemauku, Tikotu, Mangaone, and Waitohu. Over time the courses of rivers and streams in the western part of the district have undergone marked changes,

and many have been redirected both as a result of natural processes and human intervention. There are five active faults in the Kāpiti Coast District, the Ohariu, Northern Ohariu, Gibbs, Otaki Forks and Southeast Reikorangi (Van Dissen & Heron 2003). State Highway One and the North Island Main Trunk Line traverse the western part of the District, running parallel with the coast, some 2-4 kilometres inland. The majority of the population is concentrated along the coast, west of State Highway One.

The geology of the Kāpiti Coast District is dominated by Wellington belt Torlesse period formations, Rakaia terrane grey sandstone-mudstone sequences and poorly bedded sandstone which form the backbone of the Tararua ranges. Towards the coast and in river gullies, this gives way to steep fan gravel deposits (Begg & Johnston 2000:20-21, 35-37, Stevens 1988:7-27). To the west of the Tararuas are Aeolian series dunes, comprising Foxton dunes (6500-900 BP) to the east, Motuiti dunes (900-400 BP), Older Waitarere (400-150 BP), and Younger Waitarere dunes (150 BP to present) along the coastal strip (McFadgen 1997:8-11).

HISTORICAL OVERVIEW

The exact date of the arrival of Māori on the Kāpiti Coast is unknown, but it is likely that the first arrivals were some time prior to the fourteenth century AD. It is now generally accepted that people arrived in New Zealand during the thirteenth century and rapidly dispersed across the country (Higham and Jones 2004:232). To date, the earliest radiocarbon dates obtained from archaeological deposits on the Kāpiti Coast have been those from a site at the southern end of Paekakariki. Samples obtained from beneath the Old Waitarere dune formation in this location returned a calibrated age of 300 to 400 years BP (McFadgen 1997:9-10).

At the beginning of the nineteenth century the Kāpiti area was settled by the Muaupoko, Ngati Ira and Ngati Apa people, who occupied much of the area between the Horowhenua and Porirua. Muaupoko, Ngai Tara and the closely related Rangitane of the Manawatu, were descendants of those who arrived on the Kurahaupo canoe which landed at Hawke's Bay. Many of the names of earlier origin in the Kāpiti District, including Paraparaumu and Waikanae, are said to have been bestowed by their common ancestor Hau, who travelled through the area in search of his wife, Wairaka (Davidson 1988:32). According to Carkeek, a boundary running from the southern tip of Kāpiti Island to the east coast, known as Te Waewae Kāpiti o Tara raua ko Rangitane, separated the descendants of Tara and Rangitane (Carkeek 1967:2).

From 1822, the Kāpiti District was settled by groups of Taranaki and Waikato origin. Having first seen the Kāpiti area while accompanying an earlier expedition, Te Rauparaha determined to leave an increasingly untenable position in the Kawhia area to settle in Kāpiti (Ballara 2003:303). The subsequent migration of Ngati Toa, accompanied by their allies Ngati Raukawa, Te Ati Awa, Ngati Maru, Ngati Tama and Ngati Mutunga occurred in several waves from 1822. Interactions between the migrant groups and resident Ngati Apa and Muaupoko were initially peaceful, but a failed attempt to assassinate Te Rauparaha at Lake Papaitonga led to war between Muaupoko and Ngati Toa. A successful expedition to Kāpiti Island led by Te Pehi Kupe saw Ngati Toa establish themselves there. The decisive engagement occurred in 1824 at Waiorua on Kāpiti Island. A large force of Muaupoko, Ngati Apa and Rangitane gathered to attack Ngati Toa and Te Ati Awa, who successfully repelled the attack. Soon afterwards, another heke, referred to as Nihoputa, arrived in the Kāpiti district and these people were apportioned land formerly occupied by Ngati Apa and Muaupoko.

European settlement on the Kāpiti Coast began in the 1820s. Initially Europeans joined existing Maori settlements. By 1830 there were an estimated 30 Europeans living permanently on the island. Bay whaling in New Zealand waters began in New Zealand with the visit of the *William and Ann* in

1791, and the earliest recorded whaling at Kāpiti was that carried out by the *William Stoveld* and the *Hind* in May 1830 (McNab 1913:5). Visiting ships were predominantly American and British vessels, and by the mid-1830s a number of shore whaling stations had been established on Kāpiti Island.

Relations eventually frayed between former allies Te Ati Awa and Ngati Raukawa, and by 1834 had erupted into open hostilities with the battle of Haowhenua. The present-day boundaries between iwi were largely determined in 1839, when another significant battle occurred when Ngati Raukawa attacked Te Ati Awa at Waimeha pa on the north side of the Waikanae River. The battle of Kuititanga, as it was known, resulted in heavy losses on both sides but was ultimately a victory for Te Ati Awa, and Ngati Raukawa were forced back north to Otaki (Maclean 2010:29).

In 1839 the Kāpiti Deed of purchase was negotiated and signed between Ngati Toa and the New Zealand Company representative Lieutenant-Colonel William Wakefield. The intention of the New Zealand Company was to acquire land between Taranaki and the Kāpiti Coast, although this was later a matter of dispute, when Te Rauparaha insisted that he had only agreed to the sale of land in Nelson and Golden Bay. The methods of purchase being used by the New Zealand Company soon aroused the suspicions of the Crown, and in 1841 commissioner William Spain was instructed to oversee an enquiry into land purchase in the Wellington Region. The enquiry held that a number of purchases including those on the Kāpiti Coast, had no legal effect.

In 1840 the Treaty of Waitangi arrived in the Kāpiti area, and signing took place at Otaki, Waikanae and Kāpiti. The Treaty initially brought a measure of security to the area and many Ngati Toa moved back to the mainland from Kāpiti Island (Maclean 1999:151). The whaling stations had largely ceased operating by the end of the 1840s. Many of the whalers at this time moved to the mainland with their Maori wives and set up hospitality and trading businesses. An overland mail service was started in 1842.

The first missionary to arrive on the Kāpiti Coast was Octavius Hadfield, who came at the invitation of Te Rauparaha in 1843. Hadfield built churches at Otaki and Kenakena, although the latter was destroyed in the earthquakes of 1848.

Growing opposition to land sales in the 1840s created tensions between Maori and European settlers which came to a head in 1846 with an attack on European troops at Boulcott's farm in the Hutt Valley. Governor George Grey sent the HMS *Driver* to arrest Te Rauparaha. Te Rauparaha was finally released to Otaki in 1848. 1848 was also the year many of the Te Ati Awa living at Waikanae returned to Taranaki to take up land at Waitara under Wi Kingi. At its height, the land around the Waikanae Estuary had been occupied by three pa containing approximately 1000 people. Two years later Charlotte Godley described the area as deserted (Maclean 2010:40).

Transport links between principal New Zealand Company settlements at Wanganui and Wellington were via a road that traversed the Paekakariki Hill from the Hutt Valley, then along the beach. A river port had been established at Foxton to service the timber and flax industries in 1868, and this, combined with the coach route along the beach, provided additional access for settlers in the District. It was the completion of the Wellington-Manawatu railway in 1886 that provided the main boost to the development of the Kāpiti District.

The township of Parata was established at modern Waikanae at this time, when Wiremu Parata relocated the Te Ati Awa settlement from the northern side of the Waikanae estuary. The railway link also allowed farming and timber industries to flourish during the last decade of the nineteenth century, and communities had established with schools at Waikanae, Reikorangi, Paraparaumu and Paekakariki opening by 1896. The inland road link between Paekakariki and Otaki was completed

between 1900 and 1906, with bridges over the Waikanae and Otaki Rivers constructed in 1901 and 1902. Communities were established at Rangiruru in 1896, and Raumati Beach in 1908.

The centennial highway between Pukerua Bay and Paekakariki was completed in 1939. The Paraparaumu airport was also opened around this time in 1940, and 1942 saw the establishment of large military camps for US Marines at Paekakariki, Camp Russell and Mackays Crossing.

ARCHAEOLOGICAL BACKGROUND

Archaeological recording on the Kāpiti Coast has largely been the result of sporadic and opportunistic recording, with few large scale surveys. Exceptions include the survey of Kāpiti Island carried out by P Barton (1974), and the survey of midden sites in the Waikanae area by Colin Smart (1962).

The formal recording of archaeological information in a national database by the New Zealand Archaeological Association was started in 1957. Until that time, research which included archaeological data had been published in a variety of journals. One of the earliest descriptions of archaeological deposits was by Henry Field (1891), who noted that dune movement and erosion was exposing large shell midden along the coast. In 1918, Elsdon Best described archaeological deposits south of Paekakariki at Te Paripari (Best 1918). In 1957, a number of pa sites, since lost to development were documented around the Paraparaumu area by Peter Beckett (1957).

In 1983, the legislation providing protection for Historic Places was amended to afford blanket protection for archaeological sites. Requirements under the new legislation led to localised surveys of areas being carried out prior to development, and the systematic recording of features uncovered by earthworks. This has greatly increased the number of archaeological sites recorded in the district, but introduced a bias in their distribution. Larger archaeological surveys in the Kāpiti Coast District since that time have been carried out for the Western Link Road (O’Keeffe 1999, SPAR 2009), and also as a result of various works along the North Island Main Trunk Line (McFadgen 2005, Grouden 2009, O’Keeffe 2010).

Regional syntheses of ethnographical and archaeological information collected from the Kāpiti Coast include the work by Wakahuia Carkeek (1967), Janet Davidson (1988) and Bruce McFadgen (1997). The work of Carkeek is of particular importance as it contains details and locations of a large number of places of significance to tangata whenua that have not been recorded in the New Zealand Archaeological Association site recording scheme.

In 1999, it was acknowledged that much of the condition and location data for archaeological sites was dated and there were issues with the accuracy. A nationwide project to upgrade the information in the New Zealand Archaeological Association was initiated to rectify the problem. Work in the Kāpiti District was undertaken between 2005 and 2006 by Karen Greig and Nicola Molloy (2007).

SITE DISTRIBUTION

Archaeological sites in the Kāpiti Coast are predominantly recorded on Kāpiti Island and along the coast west of State Highway One (Figure 1). Exceptions are a Muaupoko refuge pa near Reikorangi (R26/285), those associated with 1930s forestry and farming in the Otaki Forks area (S26/6-10), and an obsidian find on the ridgeline that forms the eastern boundary of the District (S26/1). On first appearances this distribution suggests that archaeological sites have been under-recorded north of Peka Peka and around Otaki.



Figure 1: Archsite map showing distribution of recorded archaeological sites in the Kāpiti Coast District (Sept 2012)

SITE TYPES

Recorded archaeological sites on the Kāpiti Coast are predominantly of Māori association, accounting for approximately 85% of sites recorded to date in the New Zealand Archaeological Association Site Recording Scheme (Figure 2). Of these sites the majority comprise midden/oven sites (72%), with the remainder made up of pit/terrace sites (14%), and burial sites (8%), artefact finds (4%) and pa (2%).

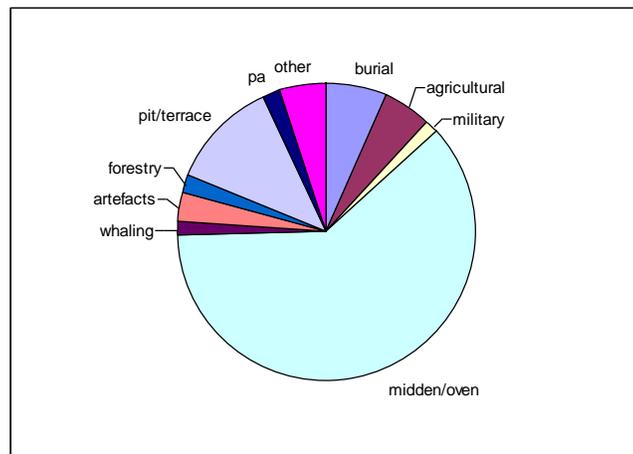


Figure 2: Recorded archaeological site types in the Kāpiti District.

The remaining 15% of sites are largely of European or mixed cultural origin, and can be categorised into groups according to various industries. Of these, agricultural sites make up the largest proportion (33%) followed by whaling sites (14%), forestry (14%) and military sites (13%). A significant portion fall into other categories (26%).

Archaeological sites from the post-1840 historic period appear to be significantly under represented in the Site Recording Scheme. Missing sites are likely to be associated with early farmsteads and businesses such as hotels. A number of town sections in Otaki, Waikanae, Paraparaumu and Paekakariki were developed by the end of the nineteenth century, and a number of buildings from this era are still in existence, but not recorded in the Site Recording Scheme.

PREVIOUS ARCHAEOLOGICAL PREDICTIVE MODELS

The idea of using predictive modeling to ascertain the likelihood of archaeological remains being present in a given area is not new. When attempting a survey and assessment of a large geographical area, archaeologists typically employ a sampling strategy based on their previous knowledge and experience. Instead of inspecting every square metre of a block of land, a more efficient and practical approach is usually to identify the most productive areas, and focus the survey effort on those places.

Areas discounted might be those where there has been erosion down to bedrock, or where the slope is such that there is effectively no usable land. Put another way, there is usually little to be gained from closely inspecting an area where the researcher is confident there will be no visible traces of archaeological deposits. Depending on the outcome it may be necessary to revise the approach and consider a wider or more selective area, but the results of this sampling can be generally indicative of what is likely to be present on the larger block of land. This type of archaeological predictive modeling is carried out frequently during routine assessments, and while it is often documented in the methods section of an archaeological report, it is seldom applied uniformly over a large area.

Regional thematic studies for archaeological sites can also form the basis for predictive models by describing the range of archaeological site types in a region. An archaeological regional thematic study has been carried out for Kāpiti-Horowhenua by the Department of Conservation Science and Research Unit (McFadgen 1997), and the maps of dune sequences contained in this publication have been routinely used in subsequent archaeological assessments in the Kāpiti and Horowhenua Districts.

Large scale predictive models relevant to the Kāpiti Coast District have been attempted on a variety of levels ranging from those prepared on a national scale to those carried out on a more localised scale.

An example of an archaeological predictive model on a national scale was carried out by Landcare Research on contract to the Department of Conservation (Leathwick 2000). The model looked at the correlation between 11,251 Maori pit and pa sites and environmental variables including temperature, seasonality, rainfall, and soil types. The study showed a high correlation between the presence of archaeological site types and environmental variables, and demonstrated that it was possible to predict sites on the basis of those variables. It also demonstrated that climate and landform, along with close proximity to water bodies, were important in determining the likelihood of sites being present (Leathwick 2000:12).

In 2009 an archaeological assessment prepared by South Pacific Archaeological Research for the Kāpiti Coast District Council's Western Link Road included an archaeological predictive model for sites along the alignment (SPAR 2009:31-35). Environmental variables considered in this model included dune series, slope, elevation, distance from coastal and freshwater resources and proximity

to other recorded sites. These were considered in relation to various site types and given a ranking against each type; the scores were then combined along the proposed road corridor to identify areas of high, medium and low probability that archaeological sites would be encountered.

More recently, a predictive model for archaeology in the Wellington Region was commissioned by the Greater Wellington Regional and New Zealand Historic Places Trust. This model was prepared by Wild North Ltd and enVISION Ltd with input from the author, in a former role as the New Zealand Historic Places Trust Central Region Archaeologist. The current model for the Kāpiti Coast District builds on the data of the previous model prepared for the Wellington Region, but allows considerably better definition and consideration of localised environmental factors.

METHODS

DATA

Data on 300 recorded archaeological sites in the Kāpiti Coast District was obtained from the New Zealand Archaeological Association Site Recording Scheme in May 2012. Information for each site relevant to the predictive model included NZAA_ID, description, period (pre-contact, proto-historic, colonial, modern), site type, and NZTM coordinates. Additional locations for unrecorded sites was obtained by converting sites shown on maps supplied in Carkeek (1967:227-237), Adkins (1941:232-238) and Beckett (1957:357-364) into point data.

Consultation with representatives from the three principal mana whenua iwi, Ngati Raukawa, Te Ati Awa and Ngati Toa, supplied information on 256 sites of known significance in the region, and these were collated with the sites from the NZAA and published data. Additional polygon data was prepared for waahi tapu with researched extents.

Nineteenth century Deposited (DP) Plans, Maori Land (ML) Plans and Survey Office (SO) Plans provided information on extents of the nineteenth century town centres. The 1886 railway alignment was also included both as an arterial route through the district along which early development was facilitated, and as a pre-1900 archaeological feature in its own right.

Environmental data incorporated in the modeling included slope, proximity to coast, soil type, river zones, ridges in the 35-70 metre zone, and elevation. Digital elevation models at five metre intervals (DEM5m) were used for elevation data. Soil classes were obtained from online information supplied by Land Information New Zealand, and comprised sixteen different types based on particle size, grading from loams and sands to silts and clay soils. The density of archaeological sites was determined by using a 200 x 200 metre grid and calculating the number of recorded archaeological site in each square. This allowed for clustering of sites to be considered.

Lastly, a current urban extent layer with a negative weighting allowed for correction of the data in terms of twentieth century development, which is likely to have removed or modified archaeological deposits in certain areas.

Compilation of the different data sets, principally NZAA and iwi data, was carried out to eliminate duplicate entries. Grid coordinates from the New Zealand Archaeological Association derived from original CINZAS (Central Index of New Zealand Archaeological Sites) data were corrected to provide consistency across data in terms of precision. This was required because the data carried across to the Archsite from CINZAS comprised points that fall in the southwest corner of a 100 x 100 metre square, and indicate that the recorded archaeological site falls somewhere within

that square. Site locations from CINZAS were corrected by moving the grid reference to the centre of the square and applying a 50-metre buffer.

ANALYSIS

The statistical relationship between environmental data and the position of recorded sites was explored using the Ordinary Least Squares regression tool to determine if any factors could be discounted. During this process it was noted that the proximity to rivers and ridgelines, which are both often strong indicators elsewhere in New Zealand, had low statistical correlation with the archaeological data.

A Geographically Weighted Regression tool was then used for each of the environmental variables, which allowed the weighting of these factors to be considered relative to the statistical relationship of those variables with the locations of known archaeological sites. This tool could also be varied with input from heritage specialists to correct for under-represented sites.

Four sets of data were given paramount ranking as high alert areas. These included point data with 50 metre buffers for recorded archaeological sites, the 1886 railway corridor with a 50 metre buffer, wāhi tapu areas defined as polygons, and the nineteenth century town extents defined as polygons. For these sites it was felt that there was sufficient historical evidence to consider the areas as having a high likelihood of archaeological sites being present. It was also felt that inclusion of the historic period site data in the geographically weighted regression would make it a less effective tool for predicting prehistoric and traditional settlement sites which have a better correlation with environmental variables. The paramount ranking means these sites and areas automatically show up red in the final model.

The final model gave a weighting of 80% environmental data and 20% human factors. Because recorded archaeological sites, locations provided by iwi, nineteenth century town centres and the railway corridor were already given paramount importance, the more important variables in predicting unknown sites were deemed to be environmental factors. A number of the environmental factors also demonstrated a high statistical correlation with the distribution of recorded sites.

When preparing the GIS raster layers and maps, the district was divided using a grid projection of 10m² squares. Individual squares were given a weighted scoring which could then be allocated into nine or twelve classes to give a graded plan of the region. A full description of the analysis is included as Appendix 2.

RESULTS

A sample of recorded sites were selected to test the statistical correlation between environmental variables and site location. Sites selected for this purpose were those for which GPS data was used to obtain grid coordinates, as it was deemed that these would provide the more reliable and accurate locations.

The results of the statistical modeling showed a high correlation for some variables and negative correlation of others. Slope and elevation were fairly strong indicators, with the recorded sites predisposed towards gently sloping ground at lower elevations. Proximity to coast and soil types were also strong indicators, although while the soil data was able to differentiate between sandy and clay soils it did not differentiate between dune phases. With the majority of recorded archaeological sites occurring in the coastal band, the predisposition towards sandy soils is perhaps not surprising.

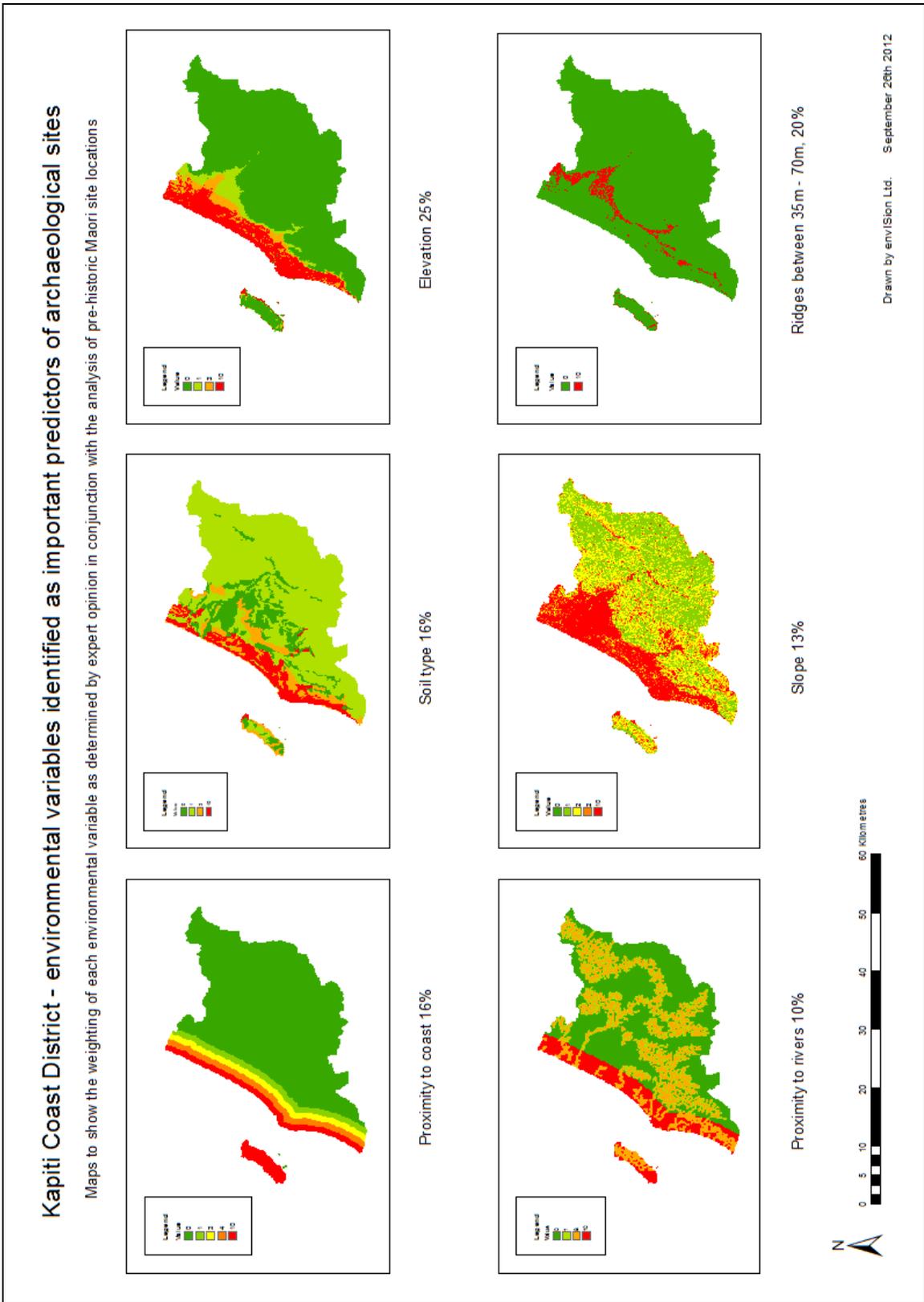
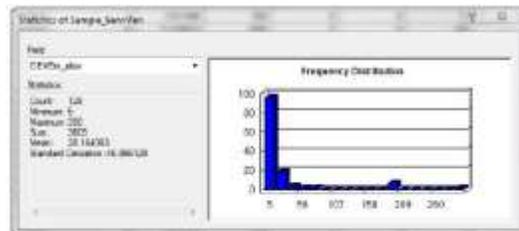
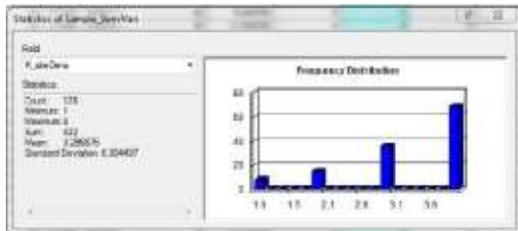


Figure 3: Underlying GIS environmental layers used to produce the final model

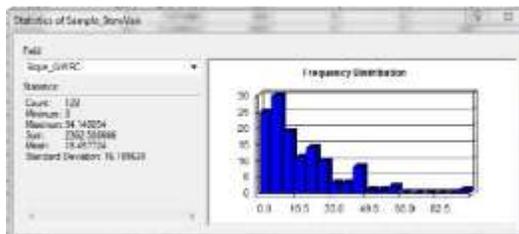
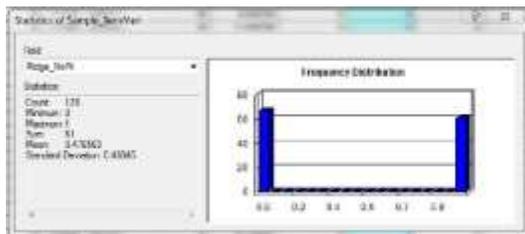
Proximity to streams, swamps and lake margins was not a significant factor in predicting archaeological sites on the Kāpiti Coast. This is also not altogether unexpected. The mobile nature of the dunes and subsequent human intervention in draining swamps for farmland and redirecting streams means that the location of streams today is likely to be markedly different to that 200, 400 or 600 years ago. The larger Otaki and Waikanae rivers are also not static in their courses, and many of the archaeological deposits along the banks either side are likely to have eroded as the rivers changed their courses through time (Easter 1991).

Also evident was that sites were clustered in relation to each other, with a significant number of sites with six or more other sites within 500 metres.



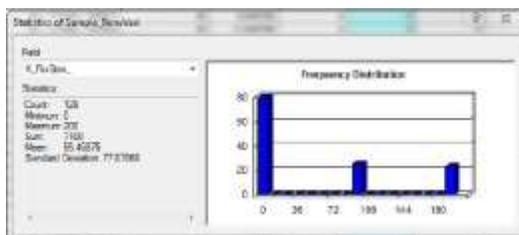
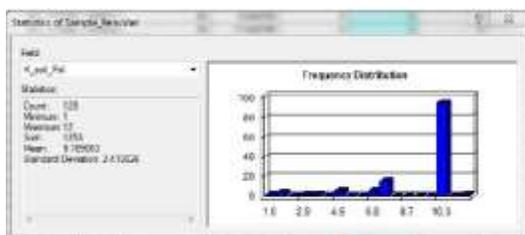
Clustering with other sites – many sites are located with six or more other sites within 500m

Elevation – preference for lower elevation sites



Ridge – evenly distributed not statistically relevant

Slope – graded preference for less steep slopes



Soil type – sites more likely in sandy soils

Proximity to streams – sites not recorded in close proximity to streams

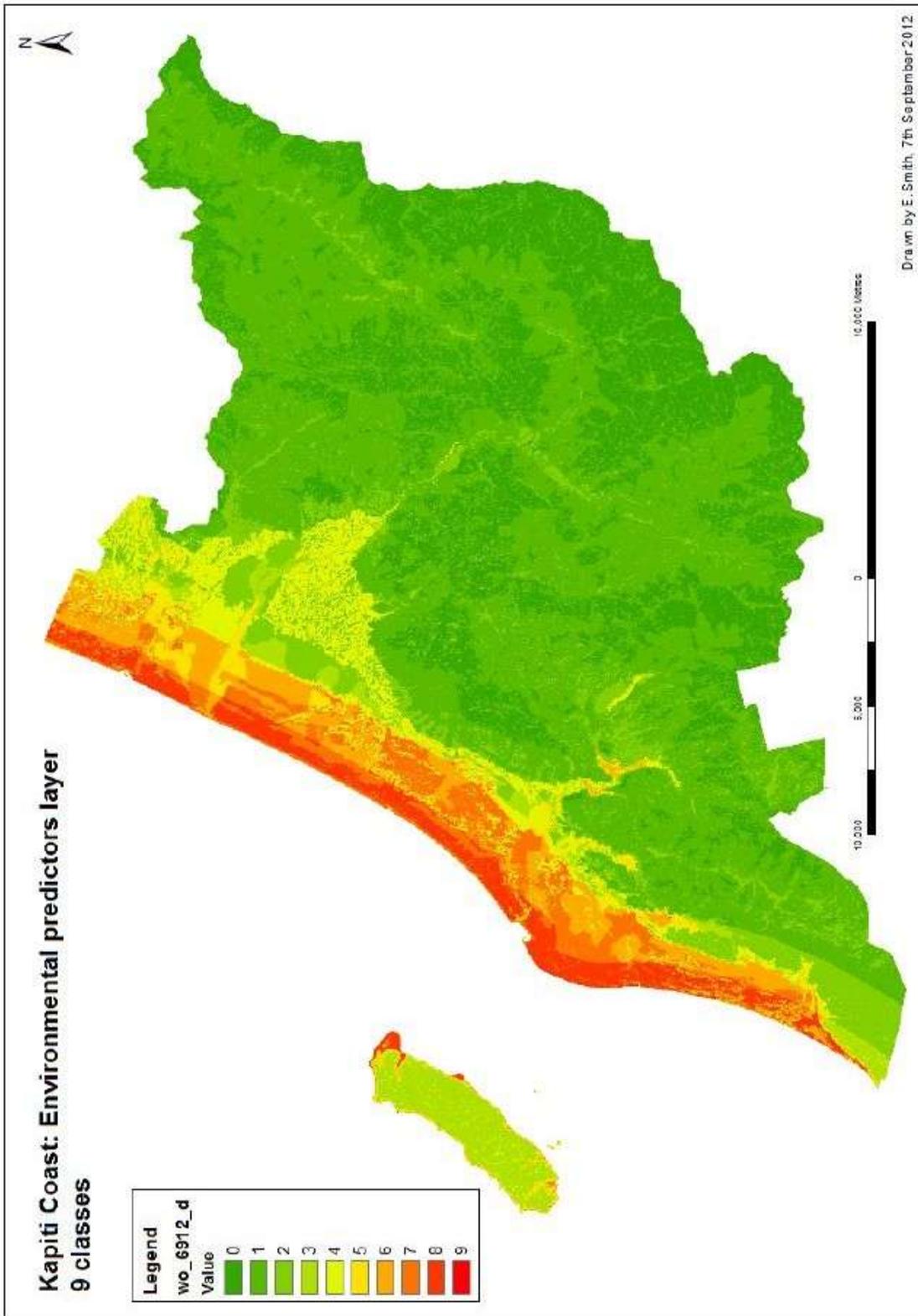


Figure 4: GIS archaeological predictive layer using nine site classes

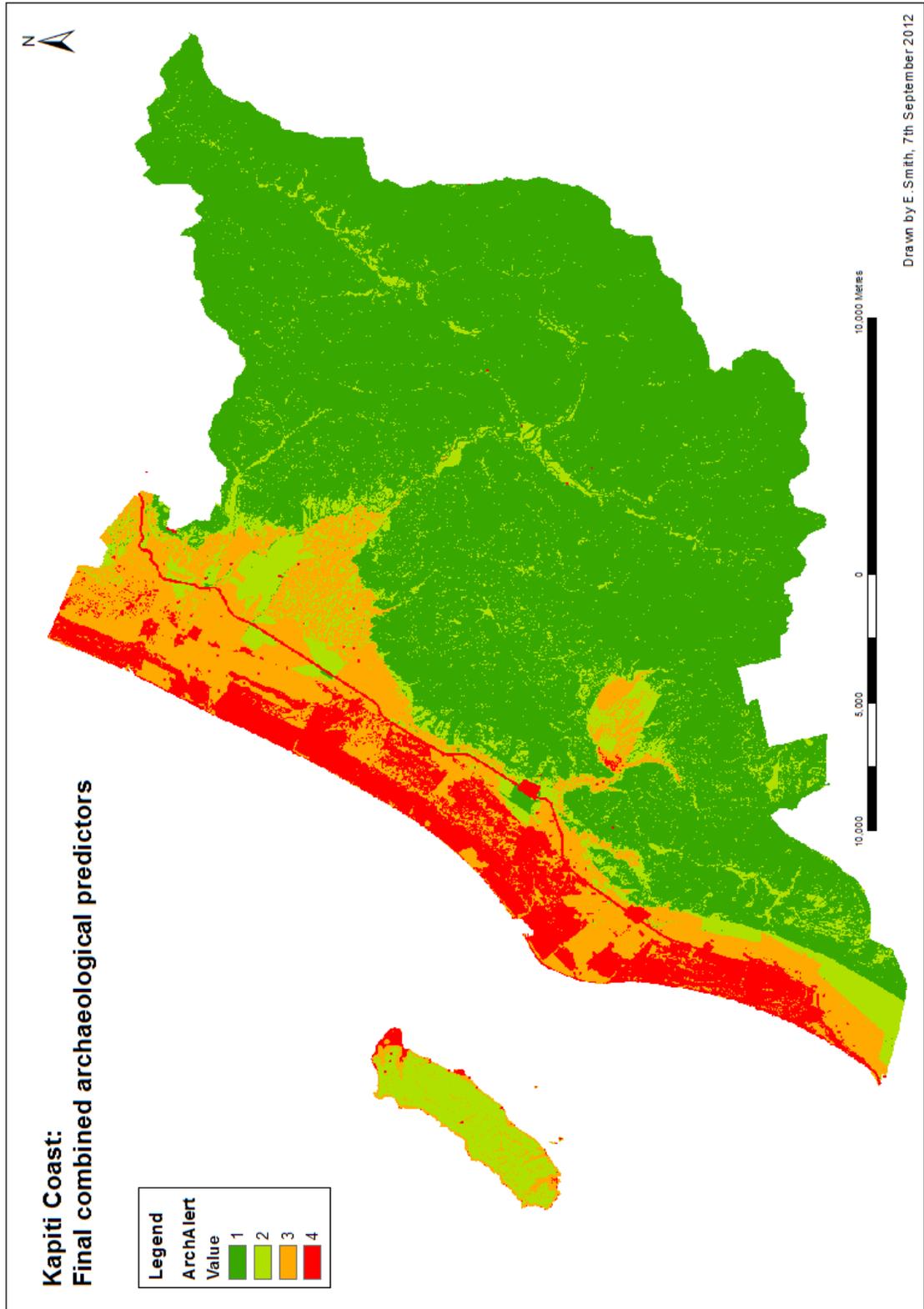


Figure 5: Simplified zones for application of predictive model in district plan

CONCLUSION

Prior to the preparation of the predictive model a number of trends regarding archaeological sites on the Kāpiti Coast were already apparent. For example, there was a clear correlation between archaeological sites and proximity to the coast. With most of the sites occurring in the dune system or in river valleys, there also appeared to be a correlation between archaeological sites and elevation above sea level.

Predictive modeling carried out in other locations around New Zealand has suggested correlations between proximity to waterways, ridgelines, particular soil types, and other known archaeological sites (eg. Leathwick 2000, SPAR 2009). Māori food production was focused on horticulture, as well as hunting and gathering resources that were located in specific environments. Fish and shellfish were obtained from the coastal environment. Eels, freshwater fish species, and water fowl could be harvested from around streams, lagoons and swamps. Conventional wisdom therefore suggested that occupation sites would be located closer to mahinga kai or resource gathering areas.

These assumptions were able to be tested within the predictive model. The use of GIS allowed for the relationship between the location of various site types and environmental factors to be tested to determine if it was statistically significant.

It was anticipated that the mobile nature of the Waitarere series dunes throughout the period of human occupation along the Kāpiti Coast would make predicting archaeological site locations difficult. Shifting dunes expose and rebury archaeological deposits, and alter the course of streams and drainage of swamps. Modern interventions for farming aside, the location of swamps and streams today is likely to be markedly different from that 300 to 400 years ago. Furthermore, the courses of the larger Waikanae and Otaki Rivers as they near the coast have also changed significantly. The beds of these rivers have shifted course resulting in considerable erosion which is likely to have affected the preservation of archaeological deposits in these areas.

These points were borne out by the GIS analysis, which showed a poor statistical relationship between archaeological occupation sites and proximity to rivers and waterways, while confirming the correlation between site locations in terms of elevation and distance to the coast. Soil types also had a strong statistical correlation with Maori occupation.

PROPOSED APPLICATION OF PREDICTIVE MODEL

The final predictive model divides the District into 4 classes signifying likelihood of archaeological deposits. In order of likelihood from lowest to highest these are coloured: (1) dark green; (2) pale green; (3) orange; and (4) red. It is recommended that the Kāpiti Coast District Council adopt the following information requirements for consent applications which are likely to affect archaeological sites. The level of notification should be determined in consultation with the New Zealand Historic Places Trust and tangata whenua. The process set out for notification below maybe modified as a result of those discussions.

CONSENTS INVOLVING EARTHWORKS OR SUBDIVISION

Earthworks and subdivisions have a significant impact on archaeological sites in the Kāpiti Coast District. Activities requiring earthworks may include road construction, fencing, landscaping, or preparation of building platforms. Subdivisions which do not involve earthworks at the time of consenting also have a significant impact on the preservation of archaeological deposits. While the actual damage to the archaeological sites is not carried out by the consent applicant, the opportunity to identify and protect archaeological sites is effectively lost if it is not considered at the planning stage. Even a relatively small amount of earthworks can have a significant impact on archaeological sites and destroy valuable and irreplaceable archaeological information. Archaeological sites and wāhi tapu can be protected in reserve contributions if they are identified at an early stage, and matters of compliance are greatly simplified if prospective buyers of subdivided lots receive information on the archaeological potential of those lots from the vendor.

For some types of subdivisions the effects on archaeological sites will be lower, and it may not be necessary to require formal archaeological assessments or notification for all subdivisions. The most critical subdivisions will be those that involve an intensification of use, or change in land-use zones. Consent applications for subdivisions that involve earthworks or increase the threshold of permitted earthworks should also be considered in terms of their impact on archaeological values.

Boundary adjustments and in-fill subdivisions in already developed residential areas could be excluded from the requirement to obtain and submit archaeological assessments. In the case of in-fill subdivisions it is recommended that this exclusion only apply to applications where a single additional lot is to be created from a parent lot of less than 3000m². This would impose a less onerous consent process where the activity is in keeping with the existing residential land-use activities. In such instances it should be stressed that there is no limit for earthworks contained in the *Historic Places Act*, and the onus falls on the person undertaking the work to ensure they are not in breach of the archaeological provisions of the *Historic Places Act* and have obtained an authority if required.

For subdivisions not excluded above, and consents involving earthworks, it is proposed that the following information requirements and processes be adopted for consents involving earthworks or subdivision.

Red. Consent applications for earthworks or subdivision should be accompanied by an archaeological assessment and cultural values assessment. The Kāpiti Coast District Council should notify tangata whenua and the New Zealand Historic Places Trust that the application has been received. The notification should note that the proposed works include earthworks and/or subdivision in an area zoned red in the Kāpiti Coast Archaeological Predictive Model. Standard advice notes concerning archaeology should be appended to any consents granted by the Kāpiti Coast District Council in this area.

Orange. Consent applications for earthworks or subdivisions should be accompanied by (a) copies of correspondence showing they have consulted the NZAA Archsite with regards to the affected property, and (b) an Archaeological Discovery Protocol. The Kāpiti Coast District Council should notify tangata whenua and the New Zealand Historic Places Trust that the application has been received. The notification should note that the proposed works include earthworks and/or subdivision in an area zoned orange in the Kāpiti Coast Archaeological Predictive Model. It will be up to the New Zealand Historic Places Trust to indicate to the applicant if they require an archaeological assessment to be completed. Standard advice notes concerning archaeology should be appended to any consents granted by the Kāpiti Coast District Council in this area.

Pale Green. Consent applications for earthworks or subdivisions should be accompanied by (a) copies of correspondence showing they have consulted the NZAA Archsite with regards to the affected property; and (b) an Archaeological Discovery Protocol. The Kāpiti Coast District Council does not need to notify tangata whenua or New Zealand Historic Places Trust that an application has been received unless the supporting documents show that additional sites have been recorded on the property since the development of this model. Standard advice notes concerning archaeology should be appended to any consents granted by the Kāpiti Coast District Council in this area.

Dark Green. Consent applications earthworks or subdivisions need not be accompanied by supporting documentation pertaining to archaeology and Kāpiti Coast District Council does not need to notify tangata whenua or the New Zealand Historic Places Trust that an application has been received. Standard advice notes concerning archaeology should be appended to any consents granted by the Kāpiti Coast District Council in this area.

CONSENTS INVOLVING FORESTRY OPERATIONS

Typically, forestry operations affect large areas of land, and involve substantial earthworks for roads and placement of skids. Additional damage can be cause by compaction from heavily machinery and the felling of trees onto archaeological features. Trees planted directly into archaeological deposits cause damage to the subsurface stratigraphy as a result of root penetration, and impede the ability to recover meaningful information from any surviving deposits. Once an area is planted, there is only limited capacity to mitigate against damage to archaeological features. The best means of preserving archaeological sites within forestry blocks is to mark out and exclude them, prior to planting. The *Historic Places Act* 1993 makes it unlawful to plant in areas where archaeological sites are present without first obtaining authorisation from the Historic Places Trust, but in the Kāpiti Coast District there is presently no requirement to obtain a resource consent at the planting stage. This means that many sites are already damaged or compromised by forestry operations before any mitigation measures are considered. The following process is proposed for forestry operations:

Red. Consent applications for forestry operations and large-scale infrastructure should be accompanied by an archaeological assessment and cultural values assessment. The Kāpiti Coast District Council should notify tangata whenua and the New Zealand Historic Places Trust that the application has been received. The notification should note that the proposed works include forestry operations or large-scale infrastructure in an area zoned red in the Kāpiti Coast Archaeological Predictive Model. Standard advice notes concerning archaeology should be appended to any consents granted by the Kāpiti Coast District Council in this area.

Orange. Consent applications for forestry operations and large-scale infrastructure should be accompanied by an archaeological assessment and cultural values assessment. The Kāpiti Coast District Council should notify tangata whenua and the New Zealand Historic Places Trust that the application has been received. The notification should note that the proposed works include forestry operations or large-scale infrastructure in an area zoned orange in the Kāpiti Coast Archaeological Predictive Model. Standard advice notes concerning archaeology should be appended to any consents granted by the Kāpiti Coast District Council in this area.

Pale Green. Consent applications for forestry operations and large-scale infrastructure should be accompanied by (a) copies of correspondence showing they have consulted the NZAA Archsite with regards to the affected property, and (b) an Archaeological Discovery Protocol. The Kāpiti Coast District Council should notify tangata whenua and the New Zealand Historic Places Trust that the application has been received. The notification should note that the proposed works include forestry operations or large-scale infrastructure in an area zoned pale green in the Kāpiti Coast Archaeological Predictive Model. It will be up to the New Zealand Historic Places Trust to indicate to the applicant if they require an archaeological assessment to be completed. Standard advice notes concerning

archaeology should be appended to any consents granted by the Kāpiti Coast District Council in this area.

Dark Green. Consent applications for forestry operations and large-scale infrastructure should be accompanied by (a) copies of correspondence showing they have consulted the NZAA Archsite with regards to the affected property, and (b) an Archaeological Discovery Protocol. The Kaptiti Coast District Council does not need to notify tangata whenua or the New Zealand Historic Places Trust that an application has been received unless the supporting documents show that additional sites have been recorded on the property since the development of this model. Standard advice notes concerning archaeology should be appended to any consents granted by the Kāpiti Coast District Council in this area.

OTHER ACTIVITIES

Some presently permitted activities such as the use of explosives for seismic testing or military training can have a significant impact on archaeological deposits. However negative effects can be effectively mitigated against by ensuring that people engaged in such activities know the location of archaeological features and conducting their activities away from sensitive areas. It is not anticipated that the council make such activities discretionary or controlled, but in instances where resource consents are required for activities that will also involve the use of explosives is recommended that council planners consider the impact on archaeological features in the consent process and ensure that applications are accompanied by evidence that the applicant has obtained an appropriate level of advice pertaining to the presence of both recorded and unrecorded archaeological sites and the effects of their proposed activities.

Other permitted activities such as native revegetation programmes can also impact on the preservation of archaeological deposits. In addition to modification caused by the physical act of planting, deeper rooting vegetation established on archaeological deposits will disrupt archaeological stratigraphy, and make it harder to recover information from the site in a meaningful way. Mixing of layers will result in the loss of archaeological context, and affect the potential for recovery of archaeological information. As with the use of explosives, it is not anticipated that native revegetation programmes should require resource consent, but in instances where resource consents are required for proposals that will involve revegetation it is recommended that council planners consider the impact on archaeological features in the consent process.

Other activities that can affect the preservation of archaeological sites include the inundation of large areas, such as for dam construction, or draining of swamps and wetlands. Changes in the water table will affect soil chemistry and anaerobic conditions that might have otherwise preserved organic archaeological fabric (Gumbley Johns and Law 2005:35-40). Flooding of large areas means that the sites within that footprint become less accessible for investigation. Typically these activities require earthworks which would necessitate a resource consent, so it is recommended that proposals for such activities be subject to the same process for considering effects on archaeological values as for earthworks and subdivisions. However, council planners will also need to ensure that impact on archaeological features, beyond that directly resulting from the earthworks, is considered during the consent process.

RECOMMENDATIONS

1. That the following be added to the assessment criteria for discretionary activities in section D-6:2
 - The impact of the proposal on archaeological sites
2. That the following definition for archaeological site be adopted and added to the list in section Q
 - **Archaeological site** means a site as defined in the *Historic Places Act* 1993, or as defined in any subsequent legislation that repeals that Act.
3. That the clause in the contract for earthworks required under D1.2 be amended to read

“Should a wāhi tapu, archaeological site or other cultural site be unearthed during earthworks the operator and/or owner shall:
 - (a) Cease operations;
 - (b) Inform local iwi;
 - (c) Inform the NZ Historic Places Trust (NZHPT) and apply for an appropriate authority if required
 - (d) Take appropriate action, after discussion with NZHPT, Council and Tangata Whenua, to remedy damage and/or restore the site.
4. It is recommended that for an activity to be permitted in any area zoned red in the archaeological predictive model the maximum allowable earthworks is reduced to 20m³.
5. It is recommended that planting for forestry operations be made a discretionary activity in any are zoned red or orange in the archaeological predictive model.
6. It is recommended that KCDC use this report as a basis for consultation with the New Zealand Historic Places Trust, and tangata whenua representatives, to determine the preferred level of notification to those parties for resource consents involving earthworks in areas where unrecorded archaeological sites are likely to be present.

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APPENDIX 1

INFORMATION TO BE INCLUDED WITH RESOURCE CONSENT APPLICATIONS

Information on archaeological sites and values submitted with a resource consent application should be prepared by a qualified archaeologist. To avoid duplication of effort, it is recommended that when advising an applicant of the requirement to obtain an archaeological assessment, they are encouraged to commission an assessment that meets the requirements of an application for resource consent and any requirements of the New Zealand Historic Places Trust.

Archaeological assessments

- Prepared by a qualified archaeologist
- Show known or predicted locations and extents of archaeological deposits within the affected area.
- Contain information about the significance of the sites identified above
- Include recommendations about the mitigation of negative effects

Cultural values assessments

- Must be prepared by appropriately mandated mana whenua
- Appropriate level of detail to be determined by mana whenua

Material supplied by NZAA Archsite

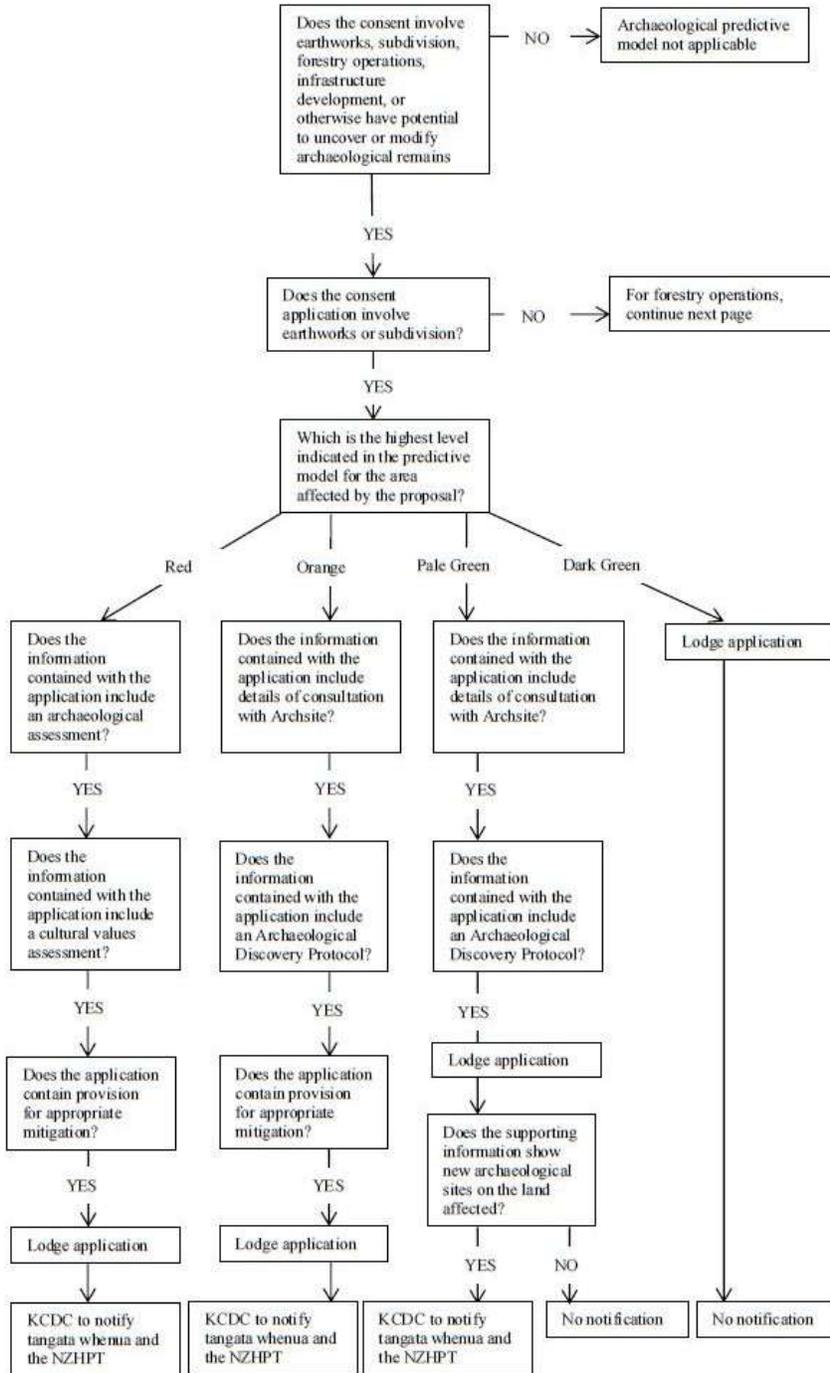
- Copies of NZAA Archsite records
- Copy of email from Archsite administrator that shows the date of the request and details the area of land for which records have been requested
- Summary of data if a large number of records are attached

APPENDIX 2

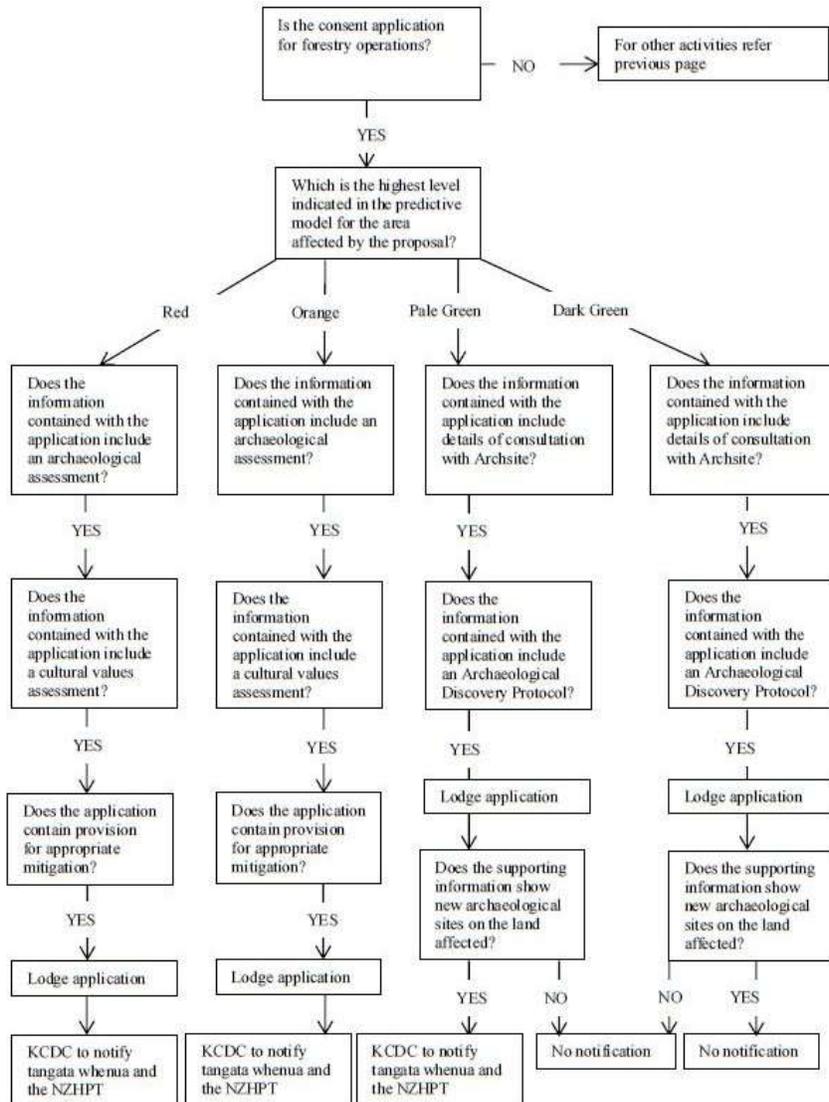
TECHNICAL REPORT ON PREDICTIVE MODEL

APPENDIX 3

PROPOSED ARCHAEOLOGY FLOWCHART FOR CONSENT PLANNERS²



² Threshold proposed for notification is starting point for further discussion and should ultimately be determined in consultation with tangata whenua and NZHPT



APPENDIX 4

EXAMPLES OF ADVICE NOTES

Standard Archaeological Advice Note

This consent does not constitute authorisation to modify archaeological deposits. In accordance with the *Historic Places Act* 1993, where an archaeological site is present (or uncovered) an authority from the NZ Historic Places Trust is required if the site is to be modified in any way. This applies to archaeological sites irrespective of whether they are recorded or not. It is the responsibility of the applicant to ensure that they are informed with regards to the requirements pertaining to archaeological sites, and seek qualified advice as appropriate.

Archaeological advice notes for consents involving the use of explosives

This consent does not constitute authorisation to modify archaeological deposits. Archaeological sites have protection under the Historic Places Act 1993 and it is unlawful to modify them in any way except with the authorisation of the NZ Historic Places Trust. It is recommended that information on the location of any recorded sites in the areas where explosives are to be used is first obtained from the New Zealand Archaeological Association, and that these areas are excluded from use.

APPENDIX 5

INFORMATION TO BE INCLUDED IN AN ARCHAEOLOGICAL DISCOVERY PROTOCOL

- Detail on who will be instructed as to the use of the protocol, eg. owner, site foreman, machinery operator
- Procedure to be followed in the event of finding koiwi/human remains. The minimum legal requirements are that work is to cease in the immediate area, and that mana whenua, NZHPT Regional Archaeologist, and NZ Police are contacted.
- Procedure to be followed in the event of disturbing archaeological features. The minimum legal requirements are that work is ceased in the immediate area, and that the NZHPT Regional Archaeologist is contacted.
- May include provision for seeking advice from a qualified consultant archaeologist prior to notification of other parties to determine if remains are archaeological.
- Contact details for mana whenua representative
- Contact details for NZHPT Regional Archaeologist
- Contact details for NZ Police (if koiwi/human remains)