7 Description of the Environment

7.1 Ruakaka and Bream Bay – General

7.1.1 General

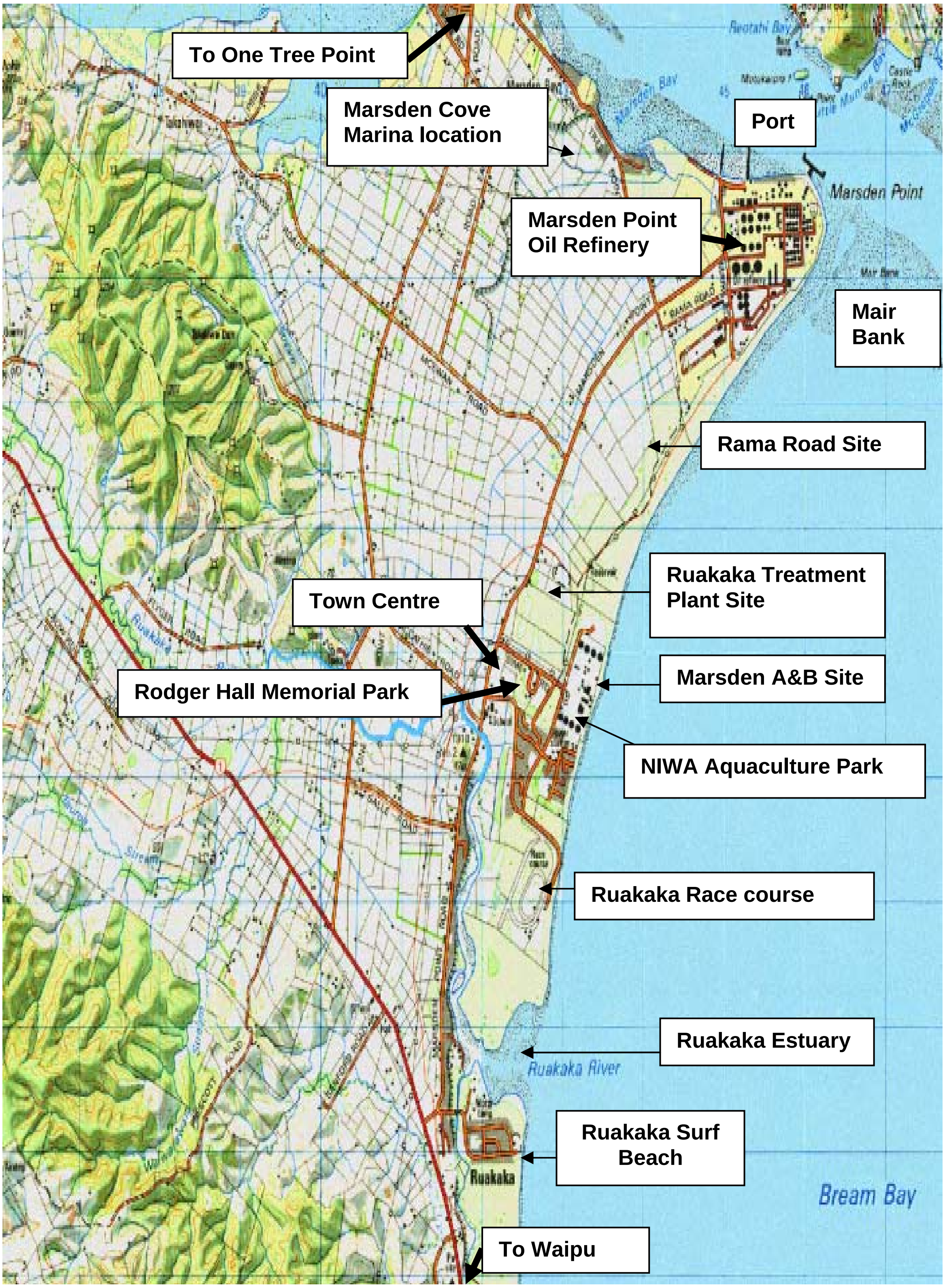
This section provides a description of the wider environment and activates located in the Ruakaka, One Tree Point and Marsden Point areas that will be served by the 'Proposed Scheme. Figure 7.1 shows the location of Ruakaka and surrounding areas. This Section also provides a social, economic and cultural context for the Project.

The Maori meaning for Ruakaka is Rua - two, and kaka - parrot. Ruakaka lies approximately 30km south of Whangarei, and 10km north of the township of Waipu. Bream Bay is located to the south of the entrance to Whangarei Harbour and extends south to Bream Tail.

New Zealand's only oil refinery which is a national strategic asset is located at Marsden Point. The Refinery provides a significant amount of employment to the Ruakaka beachside community.

The existing Ruakaka Wastewater Treatment Plant site is located approximately 2km north from the main Ruakaka Township on Marsden Point Road and is adjacent to the northern end of Ruakaka Beach. Access to the site has traditionally been off Sime Road, and more recently off Marsden Point Road.

Figure 7.1 Location of Ruakaka and Environs



Note: some of the labelling in this diagram has been off-set. This will be corrected in the copy sent with the actual application.

7.1.2 Land Use and Development

In the past, the Ruakaka area has been utilised for dairy farming but over recent years it has gone through quite significant diversification and growth. This change was started with the Marsden Point Oil Refinery which was established during the 1960's and expanded over the 1980's. A timber processing plant has recently been established near the port. The development of the deep water port at Marsden Point provides easy access for timber log and other exports which, in the future, will be able to be shipped around the country via the planned rail system from the main north line.

Land developments and building of commercial and domestic premises abound in the area, including One Tree Point water sections and new housing. A marina is in Stage Two of a multi-staged development at Marsden Bay (adjoining One Tree Point). It currently consists of over 200 waterfront sections and berth fronting many of the sections.

The general area is made up of Ruakaka Beach, Ruakaka South, Ruakaka Township, One Tree Point, Takahiwai and Marsden Point. Further to the south is Waipu, Waipu Cove, Langs Beach and Langs Cove. It is anticipated that these areas will be connected to the Ruakaka Wastewater Plant.

The Marsden Power Station Village was built to support the Marsden Power Stations (A & B) which have since been decommissioned. The area is now promoted as beachside living. Part of the former Marsden 'A' Power Station site is now developed as the NIWA Bream Bay Aquaculture Park, together with OceanNZ Blue paua farm. The NIWA facility is discussed further below.

Extensive industrial parks have recently, and continue to be, developed. They include the following developments:

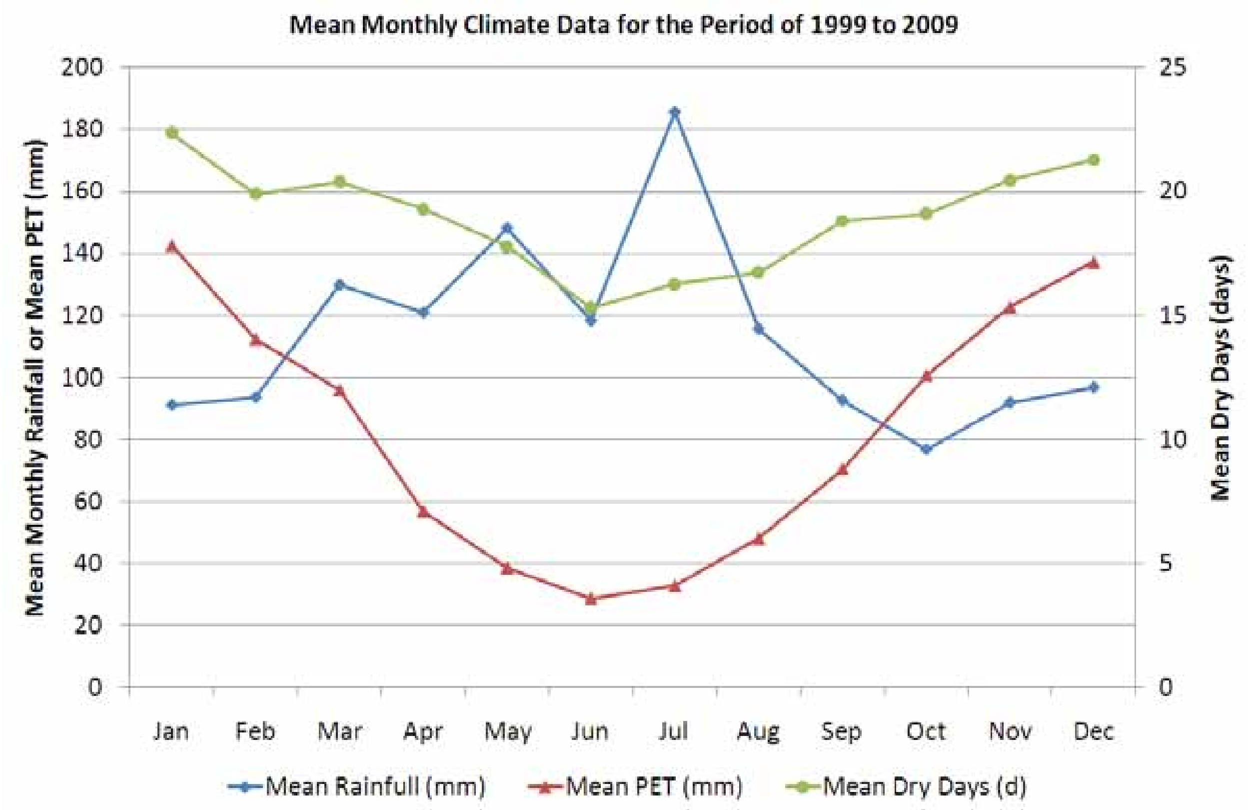
- Northgate;
- Marsden Point Industrial Park;
- Northport;
- Lakeside Business Park; and
- Ruakaka Industrial.

The Ruakaka Wastewater Treatment Plant is surrounded by a small pine plantation, timber processing and manufacturing plants and some remaining farming activities. The Ruakaka Wastewater Treatment Plant site is located approximately 2km from Ruakaka's main township and shopping centre. The nearest house is located approximately 500m to the west of this site.

7.1.3 Climate

Climate data was obtained from the National Climate Database (NIWA) for the nearest comparable climate station to Ruakaka located at Whangarei Airport (Station A54737) and operated by NIWA. The mean data for the last 10 years for rainfall, Potential Evapotranspiration (PET) and dry days are present in Figure 7.2 below.

Figure 7.2 Mean Data for the Last 10 Years for Rainfall, Potential Evapotranspiration (PET) and Dry Days



7.2 Social and Economic Environment

7.2.1 Economic Environment

The Northland Region produces an estimated 4 percent of New Zealand's gross domestic product (GDP) in 2003, based on the New Zealand Statistic's data. The most profitable sectors in the Northland Region with large workforces include agriculture, manufacturing and education, health and community services.

For people aged 15 years and over, the median income (half earn more, and half less, than this amount) in Marsden Point-Ruakaka is $21,700. This compares with a median of $20,900 for all of Northland Region.

There are 46.8 percent of people aged 15 years and over in Marsden Point-Ruakaka have an annual income of $20,000 or less, compared with 48.4 percent of people for Northland Region as a whole.

In Marsden Point-Ruakaka, 16.3 percent of people aged 15 years and over have an annual income of more than $50,000, compared with 13.0 percent of people in Northland Region.

Strategy for the Sustainable Economic Development of Northland
This Strategy – Update 2007-2011 – has been prepared by the four Northland Councils (Northland Regional Council, Whangarei District Council, Kaipara District Council and Far North District Council) in conjunction with a Strategy Steering Group and a Maori Task Group. The Strategy identifies *"What we have in our Region."* It lists the Region's features and advantages, to include:

- *"A subtropical climate which promotes year-round grass growth, as well as a range of foods, crops and forestry species, supporting a range of sectors.*
- *World-renowned tourism destinations.*
- *Unique Maori and European settler history – the birthplace of a nation.*
- *Geology – sands, clays and aggregates.*
- *A diverse population, ranging from Northlanders with a heritage centuries old and possessing all of the inherent knowledge that comes with such a history, to more recent arrivals bringing new skills. In general, Northland's people are innovative, creative and entrepreneurial.*
- *A long-established engineering sector.*
- *Open, uncluttered spaces and undeveloped coastline and harbours on two coasts.*
- *Close proximity to Auckland, New Zealand's biggest market."*

The Strategy's Vision for Northland is:

"A vibrant economy that creates wealth and jobs, and provides choices and opportunities for people to live, work and invest in Northland, while recognising the value of its unique environment for present and future generations."

The Mission is:

"Local government, central government agencies, iwi and key private sector stakeholders will collectively lead Northland to a position of vibrant prosperity. We will use this strategy to focus and shape collaborative and unified actions that drive us towards our agreed vision and outcomes."

The Strategy has three priorities.

- *Priority 1 is "Creating an Effective Growth Platform." This includes, as Strategy 1.1 "Delivering secure infrastructure to Northland." This Strategy 1.1 is a key strategy in terms of the relevance of this Project.*
- *Priority 2 is "Raising Capability."*
- *Priority 3 is "Changing Northland's Economic Profile."*

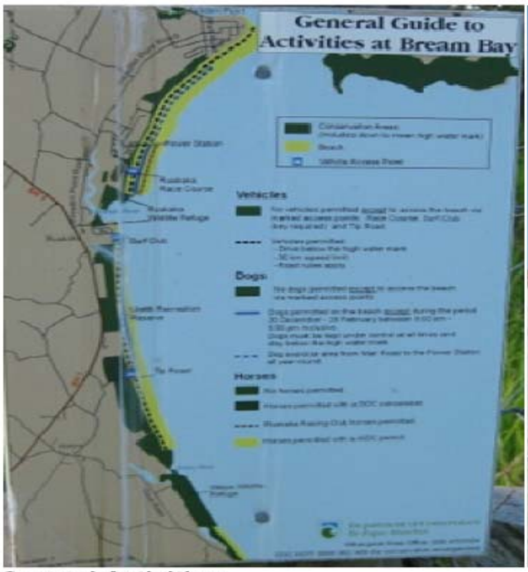
7.2.2 Social Environment

The Ruakaka / One Tree Point area has a growing population with an increase from 2,658 people in 2001 to 2,916 in 2006. This is equated to an increase of 9.7 percent. Marsden Point-Ruakaka has 2.0 percent of Northland Region's population.

The composition of Marsden Point and Ruakaka population is relatively old for the Northland Region. There are 17.8 percent of people aged 65 years and older in the Marsden Point-Ruakaka area, compared with 14.5 percent for all of the Northland Region. While the population is largely European / Pakeha 72.8 percent, the proportion of Maori in the area is 26.4 percent and 12.1 percent of the population is classified as other ethnicity in the 2006 census data.

Ruakaka area and the wide Bream Bay area provides a number of recreational activities utilising the surrounding natural and physical environments which include fishing, shellfish gathering, kayaking, tramping , horse riding, bird watching, passive recreation and cave exploration at the Waipu Caves.

Photograph 7.1 Examples of Recreation, Natural Environment and Development in the Ruakaka Area



General Activities

Ruakaka Surf Beach

Ruakaka Wildlife Refuge

NIWA Buoys

Marsden Cove Marina

Northgate Business Park

7.3 Recreation and Tourism

7.3.1 Ruakaka Surf Life Club

The Ruakaka Surf Lifesaving Club was formed in 1960. Ruakaka Surf Life Saving Patrol's mission statement is to be committed to the training, education of the members and the community for the prevention of incidents and accidents at Ruakaka Beach.

The surf patrol seasons starts at the end of October and finishes at the end of April. During the summer months a series of Junior Surf Fun Days and Carnival events occur at the Ruakaka Beach along with other surf life saving patrols competing from other North Island regions.

7.3.2 Ruakaka Reserve Motor Camp

The Ruakaka Reserve Motor Camp at Ruakaka is run on behalf of the Department of Conservation. The camp is located on 32 acres and is one of the largest camp sites in New Zealand. It contains 180 caravan and campervan sites, 111 tent sites and 8 cabins.

The camp is bordered by the Ruakaka estuary, and a bird sanctuary.

7.3.3 Ruakaka Wildlife Refuge

The Ruakaka Wildlife Refuge covers an area of 83ha and is located on the low sand spits and vegetated dune areas on either side of the mouth of the Ruakaka River. Up to 45 species of wildlife have been recorded as nesting within this refuge area. These include the New Zealand Dotterel, the Variable Oystercatcher and the Fairy Tern.

7.3.4 Recreational Swimming and Beach Activities

The Bream Bay beaches extend 26kms southward from Marsden Point to Langs Beach / Langs Cove. A recreational survey was undertaken by MWH/WDC during December 2007 and January 2008 and included as Support Document 13. The survey results identified that there is a range of younger and older generations utilising the beaches from Uretiti, Ruakaka Beach to Mair Bank, for variety of activities such as swimming, walking, sunbathing, kayaking, shellfish collection, and surfing.

Many of those who were surveyed identified that they were members of Bream Bay Sliders, a local surf recreational group.

7.3.5 Whangarei Racing Club – Ruakaka Race Course

The Ruakaka Racecourse is located approximately 30km south of Whangarei located at the end of Peter Snell Drive. The Ruakaka Racecourse is the base for the Whangarei Racing Club and they host nine meetings per season. The racing surface is an all weather track and is therefore popular with trainers outside the Ruakaka and Whangarei area who use the track during the winter months.

7.3.6 Recreational Fishing

Bream Bay is a popular spot for recreational fishing. A number of fishing competitions are held during the summer months, such as the Carters Beach & Boat Fishing Competition. The main recreational target species of fish include kahawai, kingfish, snapper, gurnard and John Dory.

Shellfish are taken by recreational fishers along Bream Bay coastline and these include cockles, pipis, tuatua, scallops, various oyster species and lobsters. Cockles and pipis are the most abundant bivalve species found within the Whangarei Harbour, and a number of tuatua beds are located along the Ruakaka Beach between Mair Bank and the mouth of the Ruakaka River.

7.4 Bream Bay Aquaculture Park

The Bream Bay Aquaculture Park at Ruakaka provides NIWA a centre to undertake research into a variety of fish and shellfish species and will provide important information to existing and new aquaculture operators, and to help them to create a sustainable industry.

The aquaculture park is a warm-water facility which allows the rearing and growth of a range of seafood species, with research programmes leading to commercial-scale culture. The facility aims to help New Zealand meet a growing demand for seafood, by providing aquaculture operators with the knowledge needed to expand and set up new aquaculture industries, including marine fin-fish. As of 2010 the facility reared 21 species of fish, 14 species of mollusc, 6 species of crustacean, 4 species of sponge and numerous species of algae.

The Bream Bay Aquaculture Park has four separate buildings that cover an area of 3000m^2. This includes a hatchery, nursery, conference room, accommodation, wet and dry laboratories, and a workshop and storage area.

NIWA's main aim for the Bream Bay Aquaculture Park is to reduce the gap between small-scale research techniques and commercial-scale production of high quality products.

Section 8.3.8 discusses the NIWA Aquaculture Park from an environmental effects viewpoint as it relates to the proposed offshore ocean outfall discharge.

7.5 Commercial Fishing and Shellfish Collection

The Bream Bay coastline is known to be an important commercial fishing area; with the main commercial fish stocks include snapper, trevally, grey mullet, kahawai, John Dory and terakihi.

Commercial collection of shellfish includes cockles which are taken exclusively from Snake Bank. With the commercial gathering of pipi occurring predominantly on the seaward and northern side of Mair Bank, and commercial harvesting of scallops in the Bream Bay area - Sections 8.3.8, 8.3.9, 8.6.7, 8.6.15 and 8.6.16 further discuss commercial fishing and shellfish matters including those associated with the NIWA Bream Bay Aquaculture Park.

7.6 Marsden Point Oil Refinery

The Marsden Point Oil Refinery is located at Marsden Point and is the only oil refinery in New Zealand, making the refinery one of New Zealand's national strategic infrastructural assets. The oil refinery location was chosen due to the deep water at Marsden Point, low risk of earthquakes, flat topography of the site and close proximity to large residential populations in the North Island.

Construction first started in 1962, and the refinery was first opened in 1964. In 1979-1981 an expansion of the refinery occurred with a hydrocracker, and a 170km pipeline to Wiri, South Auckland being constructed. In 1985 the refinery was also shut down for five months of maintenance work on the old refinery and was reopened in 1986. In 2005 the refinery undertook an expansion to allow for the desulphurising of diesel and removing of benzene from petrol to occur on site.

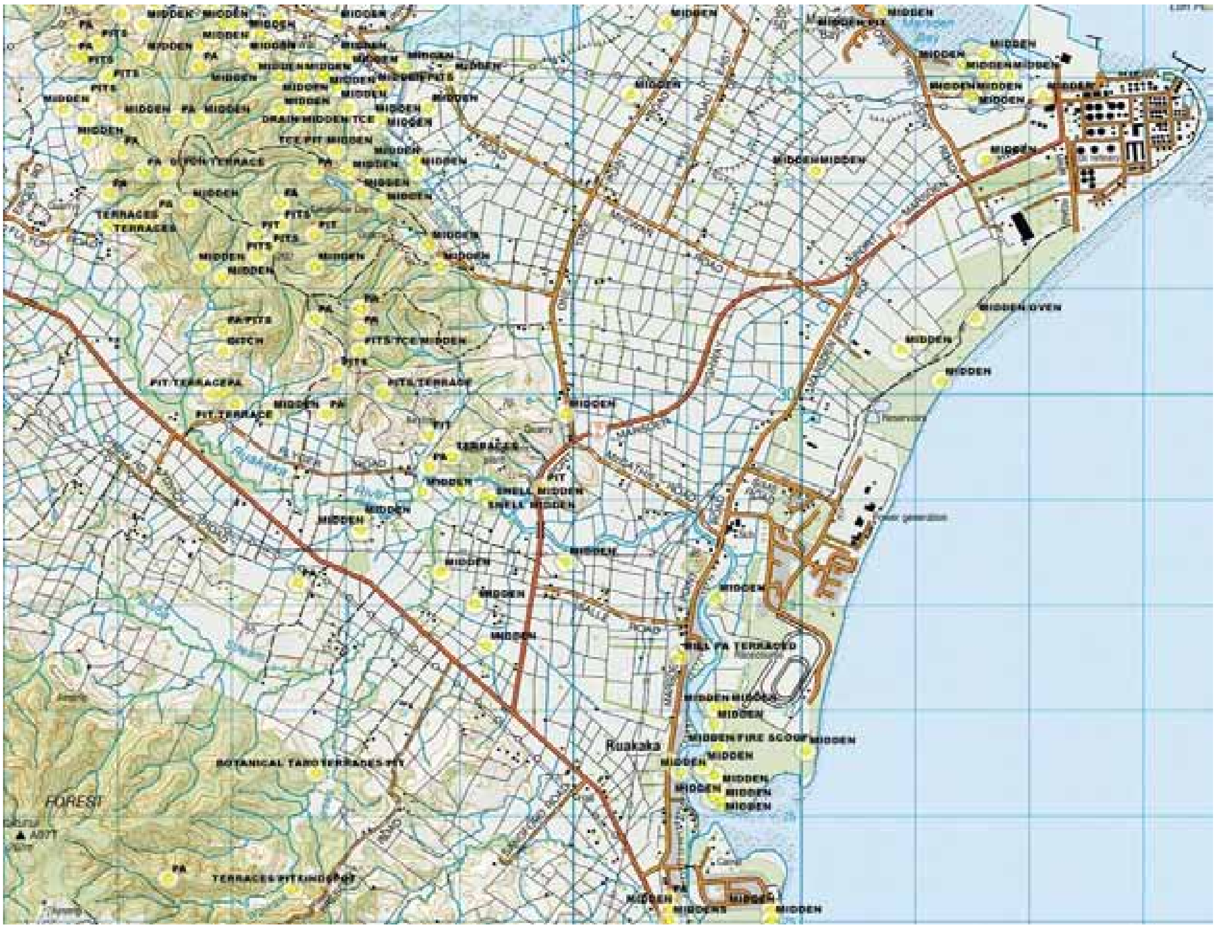
In 1984, the Marsden Point Oil Refinery assets were transferred to the New Zealand Refining Company Limited, which was listed on the New Zealand stock exchange. The four major companies who are shareholders and customers include BP, Chevron, Mobil and Aotea Energy Limited.

In July 2010 the Marsden Point Oil Refinery helped New Zealand become more self reliant on fuel products due to another expansion of the refinery which increases the refinery's capacity by 15% which equates to approximately 135,000 barrels per day. The expansion allows the refinery to produce up to 80% of all fuel products in New Zealand, and improves the reliability of New Zealand's transport fuel supply of diesel, petrol and jet fuel.

7.7 Archaeological Elements in Bream Bay

The proposed wastewater management system exists within an area of high cultural value. There are numerous recorded and unrecorded archaeological sites relating to both prehistoric and early historic settlement in Te Poupouwhenua. Numerous archaeological sites have been recorded above the coastal escarpment and along the coastal dune which include burial grounds, pa, midden and artefact finds. Ground disturbance associated with the proposed construction of the new treatment facility and ocean outfall pipe will include excavation for the installation of new structures and pipes within proximity to recorded archaeological sites. It should be noted that whilst there are no recorded sites within the footprint of the proposed new treatment facility or and path of the outfall pipe the risk of an accidental discovery is considered medium to high.

Figure 7.3 Recorded Archaeological Sites - Ruakaka (NZAA Site Recording Scheme 2008)



7.8 Tangata Whenua Context and Cultural Values

7.8.1 The Cultural Landscape – Te Poupouwhenua

There are a series of specific water bodies, sites and landscape features that are of particular cultural heritage significance to iwi with a vested cultural interest in Te Poupouwhenua/Marsden Point. These places are interconnected through a long history of association of people traversing and settling in the immediate area. These sites and places include wahi ingoa/maunga/pa/kainga/mahinga kai/wahi taonga and wahi tapu.

Te Poupouwhenua/Marsden Point in pre-European times was a landscape abundant in natural resources. Te Poupouwhenua was cloaked in forest vegetation and at this time was dominated by rimu, with toatoa, manuka, totara, rushes (wiwi), and mamaku. The riparian margins were covered by water-edged plants providing a natural habitat and food source for many native aquatic and avian species. Kauri was also prolific in the area, and the coast and the bush were rich in native bird life, there were tuna and fresh water prawns in the creeks and rivers, the inter-tidal sandy areas, rivers and river mouths and estuaries were rich in marine life such as flat fish, pipi, tuatua, scallops and cockles, and the bay was teeming with fish.

7.8.2 Patuharakeke Settlement in Te Poupouwhenua – Marsden Point

In the fourteenth century migrations of the famous ancestral canoes waka had begun to arrive in Northland from East Polynesia. These new migrants immediately established settlements and instituted indigenous rights of occupation particularly in areas rich in natural resources. Te Poupouwhenua was settled by the epytemous ancestor of the Patuharakeke, Manaia, Captain of the *Mahuhu-ki-te-rangi* or *Ruakaramea* canoe. Decent through Manaia represents one of the oldest whakapapa lineages in Taitokerau.

Patuharakeke are one of numerous iwi that descend from the tipuna Manaia. Manaia's settlement and occupation in Te Taitokerau established tribal mana whenua and manamoana from the coast of Whangarei south to Whangaparaoa.

There were various iwi settlements in Te Poupouwhenua some of which were permanent places of occupation and other temporary kainga/fishing villages. The permanent settlements were located especially around the Takahiwai hills, where there is evidence of pa, villages, mara/cultivations, coastal midden and a variety of archaeological find sites. Burial sites were established in the caves on the foreshore at the western end of Takahiwai. One of the better known pa in this region is Mangawhai which was constructed and occupied by Patuharakeke iwi.

Patuharakeke have maintained their mana whenua status in Te Poupouwhenua through the continued practice of ahi kai. Ahi kaa is an indigenous custom for exercising occupation rights requiring the uninterrupted occupation of a territory supported by the use and enjoyment of its natural resources. Traditionally, Patuharakeke enjoyed an unlimited supply of fish and shellfish from the harbour, birds and timber from the bush, and kumara, taro and hue from the fertile flat land below the Takahiwai hills.

7.8.2.1 The Naming of Takahiwai

As per Tai Tokerau – Sixth Printing August 2005 Copyright (owned by the Keene Family), the following is stated:

"Many years ago Takahiwai, situated about three miles up the Whangarei Harbour from Marsden Point, was a thickly populated Maori settlement. How this place and the tribe were named makes a most unusual story. At the time in question, the chief of the tribe was the noble Whakariki whose wisdom and prowess as a warrior had resulted in his living to a venerable old age. His successor on the other hand, was still a baby. This situation created its own problems for in times of danger the little chieftain had to be protected at all costs. When fighting broke out between the Parawhau tribes at Whangarei and those at Takahiwai, Whakariki's first thought was for the safety of the baby chieftain, and he made a quick

decision. He asked that the little boy be brought to him. He gazed at the baby and raised his hand as if in blessing and said, "Farewell, little chief, if I should die, you are my successor. May the gods protect you." Away in the distance the Parawhau warriors were approaching so he ordered seven of his most trusted men to take the little boy to the Kaipara and put him under the care of the Ngati Whatua. The warriors, taking turns to carry the baby, set off at a smart pace. Then the brave old Whakariki and his followers stood their ground in an endeavour to halt the attackers. They took their stand behind some flax bushes, which were very plentiful in that area. With his mere held firmly in his hand Whakariki stood up with chiefly dignity and authority and said, "Fight, my warriors, fight to the last man. I am old and may die but do not slacken your efforts. Fight on, fight on. On no account must the Parawhau be allowed to capture my successor." Unfortunately, Whakariki's taua was greatly outnumbered and although they fought desperately and bravely, many of them were killed. The aim of all attacking parties was to capture or kill the chief but no chief would dream of allowing himself to be taken alive, which to him would be worse than a hundred deaths, for it would strip him of his mana, his most prized possession. Whakariki fought valiantly but eventually force of numbers prevailed and he was cut down by a blow from an enemy's mere. With a last cry of rage he died and fell among the flax bushes. From that time onwards, his tribe took the name of Patuharakeke, which means failing dead among the flax."

Today the people of Patuharakeke continue to occupy Te Poupouwhenua; within the small settlement is the marae which carries the name, Takahiwai. At the central heart of the marae is the wharehui, Rangiora named after the ancestral mountain located to the rear of the marae. The whare is also a memorial hall to the servicemen and women that served in the First and Second World Wars. 'The leading light in this development was the late Harold Williams (Nga Tai/Whakatohea). Harold was known as 'Dad' Williams and Harry Williams. His photograph holds a place of prominence and remembrance in the Hall'[3].

7.8.2.2 European Settlement in Te Poupouwhenua – Marsden Point

In November 1769, Captain Cook arrived off the coast of Whangarei. Cook described his observations in ship ships log as follows;

"*low and wooden in tufts, and between the sea and the firm land are white sand banks, we saw no inhabitants. However, during the night fires were seen inland".*

Cook's arrival in Whangarei was followed by successive waves of European migrants into the area. This was then followed by permanent settlement and cohabitation with tangata whenua. Initially the relationship between iwi and Pakeha was amicable, trade occurred and the local Maori economy flourished. However, by the 1850's Maori land ownership was under pressure by the demands of Pakeha settlers for land for settlement and commercial pursuits. This placed a significant amount of pressure on Maori land owners and subsequent sales were forced upon the iwi leading to a state of disenfranchisement and discontent.

Te Poupouwhenua has undergone significant changes over the past 170 years, the extensive forests and wetlands that once provided a variety of food resources have been cleared and drained, only small vestiges of natural heritage remain.

The Patuharakeke iwi regard such changes as irrevocable and an unfortunate consequence of human interruption of natural processes. According to the Patuharakeke Te Iwi Trust Board (Inc) Environmental Plan dated 7 March 2007, Patuharakeke feel that the presence of people and their activities have impacted adversely on the traditional food 'basket'; and the harbour and its waterways is a diminishing source of healthy, mouth-watering seafood and curative waters. Places once covered in native bush, then cleared for Kauri logs and gum, have been planted in grass while native bush clings to the hills called Pukekauri and Takahiwai.

[3] Patuharakeke Environmental Management Plan – 7 March 2007

7.8.2.3 Wahi ingoa – Traditional Place Names

Patuharakeke association with Te Poupouwhenua is founded on relationships formed out of migration and settlement of the ancestral cultural landscape spanning generations of occupation. The genesis of this ancient relationship proceeded through the creation of Te Poupouwhenua by the primordial ancestors of Patuharakeke that transcends through mythological, spiritual, cultural, and traditional realms. Te Poupouwhenua is the traditional name for Te Poupouwhenua and Marsden Point generally.

Wahi ingoa (place names) is a significant symbol of the Patuharakeke relationship with the landscape as they are usually associated with important people, events, physical features and natural flora and fauna. Traditional place names are tangible reminders of the Patuharakeke history associated with a particular place. There are numerous traditional iwi place names associated with Te Poupouwhenua the following list includes some of the traditional names and places:

Te Poupouwhenua – Marsden Point

Te Poupouwhenua is the traditional name for the settlement of Ruakaka.

Takahiwai

Takahiwai is the traditional name for the settlement of Ruakaka.

Te Rerenga Paraoa - Whangarei Harbour

The name is in fact derived from the surfacing and submerging of Rangi Korero and Kauika (Whanga) and the expulsion of water and air (rei), floating of the foam (tere-nga-paraoa).

Tai Hoe nga Tamahine - Bream Bay

The traditional name for Bream Bay is Tai Hoe Nga Tamahine.

Kaione - Bream Head

This name refers to the foam (paraoa) drifting on to the onepu (sand). This was collected along the seashore by our ancestors, and used for medicinal purposes.

Marotere Islands Taranga Island - Hen and Chicken Islands

The names of these islands refer to the sons of Taranga cast adrift on her loincloth because of their disruptive behaviour.

7.8.3 Schedule of Significant Sites – Te Poupouwhenua

The places of cultural heritage significance in particular (wahi tapu) are described by Patuharakeke as:

- Te Kopuawaiwaha
- Toe Toe
- Onemana
- Motu Pomana
- Mangawhati
- Waitaharoa
- Kuramakanoa
- Ngatiti
- Te Hopua
- Takahiwai

- Motu Papa
- Ruakaka
- Te Tai Hoe a nga Tamahine[4]

These sites and places within Te Poupouwhenua are regarded as spiritually important to the iwi of Patuharakeke. As such the iwi promote the protection of the cultural values ascribed of these sites (wahi tapu, wahi taonga, mauri) and the sustainable and collective management for future generations.

7.8.4 Tangata Whenua View of the Environment

Tangata whenua view of the local environment

Ko Whangarei Te Rerenga Paraoa Te Moana

Whangarei Te Rerenga Paraoa is the sacred waterway

For Patuharakeke iwi the god of the sea is Tangaroa, and the ocean is inseparable from the land. From the Patuharakeke iwi perspective the sea is the giver of life and has curative powers for treating illness, as stated in the Patuharakeke Te Iwi Trust Board (Inc) Environmental Plan dated 7 March 2007.

Because of the importance of the sea to the Patuharakeke iwi people (its health is thought to be a synonym for the well-being of the people i.e. the mauri (life force) of the sea is the mauri of the people), their view of their environment has the Bream Bay sea at its centre and anything that impacts the sea is said to have an impact on the people.

The people are therefore obligated to care for of their god or exercise kaitiakitanga or guardianship and the life source to ensure that this taonga is passed on to their descendants in good health.

That responsibility took on a new dimension in the latter part of the 20th Century as deterioration in the environment of the seas from discharges of industrial and other wastes, over-fishing, and associated habitat destruction. These environmental factors affecting the aspects of the sea are deemed to be culturally, spiritually and environmentally offensive.

The entire infrastructure supporting the proposed Project is centred at Ruakaka WWTP, with land application proposed at Rama Road Block and Roger Hall Memorial Park, reuse at the Refinery and a future offshore ocean outfall discharging high quality treated wastewater into the sea. From a cultural perspective it is understood that the land and sea sits within the acknowledged rohe of the Patuharakeke iwi.

7.8.5 Cultural Values

Understanding the tangata whenua view of the environment is the first step towards gaining an appreciation of the associated cultural values. Those values are often encompassed in relevant whakatauki; proverbs or sayings that are record of the history of the people and their links to the natural world.

The main cultural value linking tangata whenua to the environment is '*kaitiakitanga*' which is defined in the Resource Management Act as being:

> *"the exercise of guardianship by the tangata whenua of an area in accordance with tikanga Maori in relation to natural and physical resources; and includes the ethic of stewardship."*

[4] Patuharakeke Environmental Management Plan – 7 March 2007

It is the exercise of this cultural value against the historical and traditional background of the Patuharakeke iwi in respect of the Bream Bay that lies behind a number of the specific issues addressed in this assessment document.

8 Assessment of Effects of the Discharge of Treated Wastewater to Bream Bay

8.1 Introduction

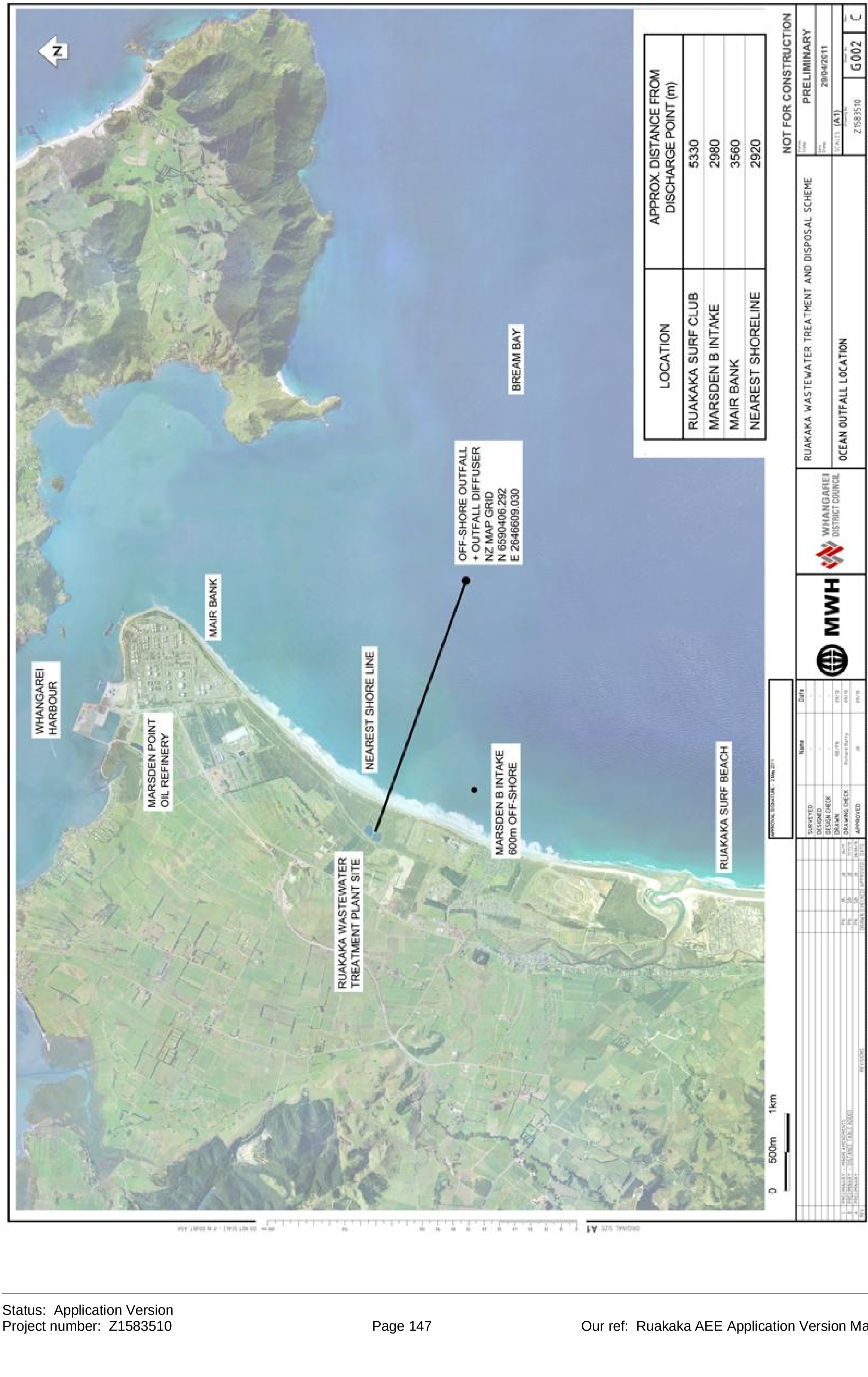
The proposed treated wastewater discharge to Bream Bay is the outcome of investigations, evaluations and consultation processes which the Whangarei District Council has undertaken over the last three years. The reasons and rationale why this particular proposal is the adopted option, following and evaluation of alternatives, are set out in Section 4.11. The immediate receiving waters for the proposed Ruakaka WWTP discharge are managed under the RCP as a 'Marine 2 Management Area'. The relevant water quality classes are described in Section 8.4.1.

8.2 Characterisation of the Treated Wastewater Discharge

8.2.1 Location

Treated wastewater would discharge continuously into Bream Bay through a proposed offshore outfall located approximately 2,980m (rounded to 3 km) offshore (east south-east) of the existing Ruakaka WWTP. The outfall location is identified at Point 22 in the DHI modelling reports (DHI 2010a and 2010b) (Support Documents 29, 30 and 31). The outfall will terminate in a multiport diffuser at a water depth of 8.4m MSL approximately 2,980m (rounded to 3km). The discharge point would be approximately 5,330m north east of the Ruakaka Surf Club, 2,980m east of the NIWA water intake and 3,560m south of the southern edge of Mair Bank. These three locations have been decided on as the three key sensitive sites and accordingly included in the DHI modelling as summarised later in this Section of the AEE. These distances are taken from Table 2.1 of the DHI Phase 2 Report (Support Document 33).

Figure 8-1 Location of Offshore Ocean Outfall



8.2.2 Rate of Discharge

The projected ADWF for year 2047 is 15,895 m^3/day (rounded to 16,000 m^3 /day) or an average 185 L/s, increasing to a peak wet weather flow (2047 PWWF) of 740 L/s. Information on population and wastewater flow and load estimates is given in Section 4.2. As with all municipal wastewater system flows, rates vary over the daily cycle.

8.2.3 Quality of Discharge

This section describes the proposed quality of the wastewater after it has been treated at the proposed Ruakaka WWTP, prior to its discharge through the ocean outfall.

WDC has made the decision to achieve a high standard of treated wastewater which will meet the criteria specified in Table 8.1. These values have formed the design basis for the proposed new Ruakaka WWTP. The reasons and rationale for WDC deciding on this high standard of treated wastewater are included in the WDC's Officers' Paper to Council dated 30 July 2008, included as Appendix A to this AEE, and also discussed in Section 4.11

Table 8.1 Ruakaka Proposed Treated Wastewater Quality (based on 52 samples per quarter, i.e. 4 samples per week collected over a 13 week compliance period)

Constituent	*Unit*	*Median*	*95-Percentile*
$cBOD_5$	mg/l	5	20
Suspended solids	mg/l	5	30
Total nitrogen	mg/l	10	30
Faecal coliforms	cfu/100ml	10	1,000

The predicted concentration of metals in Ruakaka treated wastewater is based on a review of monitoring results obtained from comparable WWTP plants in New Zealand, these being Hutt City, Hamilton City and Tauranga City WWTPs. Treated wastewater from these WWTPs has higher suspended solids content than proposed for Ruakaka, and are likely to have higher metal concentrations from trade wastes. Accordingly it is anticipated that the metal content of the proposed Ruakaka discharge will be no higher, and probably less than the values given in Table 8.2.

Table 8.2 Concentrations of Metals and Other Constituents (µg/l) in Treated Wastewater from Seaview, Hamilton and Tauranga WWTPs (combined data, 2001 to 2009)

Constituents	*N samples*	*Median*	*95-Percentile*
Total Arsenic	70	2.00	17.7
Total Cadmium	34	0.08	0.37
Total Copper	71	8.3	20
Total Chromium	70	1.5	9.3
Total Nickel	71	4.0	15
Total Lead	71	2.0	12
Total Mercury	70	<0.30	0.61
Total Zinc	70	46	175
Phenol	46	<10	138
PCP	8	0.07	0.16

Organic compounds are generally not detected in treated municipal wastewater or are detected at very low concentrations. Annual monitoring of PAHs, organochlorine pesticides, PCBs, and phenols in Hamilton municipal wastewater between 2001 and 2005 returned nearly 100% of results at less than the detection limit. Limited data available for phenol concentrations in Hutt wastewater and for PCP in Hamilton wastewater are included in Table 8.2.

8.3 Nature of Coastal Receiving Environment

8.3.1 Coastal Character

Bream Bay is an open embayment at the entrance to Whangarei Harbour on the northeast coast of Northland. Seaward, the Bay faces out to the Pacific Ocean with the Hen and Chicken Islands offshore. It measures some 30km from Bream Head at the northern end to Bream Tail at the south. The coastline is largely composed of clean exposed beach with up to 5m high foredunes accreting and eroding in response to storm events. Bream Bay has a wide (80m) mid to low tide platform seaward of a relatively narrow (9m) mid to high tide rise to an upper beach platform.

8.3.2 Hydrodynamics

Bream Bay is influenced by tidal flows from Whangarei Harbour as well as from the wider Hauraki Gulf. The tidal compartment for Whangarei Harbour is calculated at 1.64 x 10^6 m^3 for a spring tide (Heath 1975). An analysis of the hydrodynamics of Bream Bay indicates that tidally driven currents within the Bay have a peak magnitude of approximately 0.05 to 0.1 m/s, however strong onshore winds can increase current speeds significantly to greater than 0.2 m/s (DHI 2010) (Support Documents 31, 32, and 33). The prevailing winds are 'north westerly' which occur 27% of the time, and 'south westerly' for 23% of the time. Easterly winds occur 15% and calm conditions 6% of the time. A full discussion of the wind data is given in DHI (2010).

Bream Bay receives freshwater inflows from the Ruakaka and Waipu Rivers and from rivers discharging to the upper Whangarei Harbour. Calculated freshwater inflows based on NRC data are summarised in Table 8.3.

Table 8.3 Freshwater Inputs to Bream Bay (calculated from NRC data in DHI 2010)

Freshwater Inputs to Bream Bay	Average return interval (ARI) Peak Flow (m^3/s)					
	2 year	5 year	10 year	20 year	50 year	100 year
Ruakaka River	103	156	191	224	268	299
Upper Whangarei Harbour	134	230	301	372	459	532
Waipu River	228	305	346	381	421	451

8.3.3 Water Quality of Bream Bay

Field sampling was undertaken by Northland Regional Council staff for WDC at 9 sites in Bream Bay, Whangarei Harbour entrance and Ruakaka River over the period June 2008 to May 2009. Surface water samples were collected on 7 occasions, including ebb and flood tides, and dry and wet weather (refer Figure 8.1). Additional samples were collected at depth at selected locations. The methods employed and results of monitoring are described in MWH (2009) (Support Document 30). A summary is given in the following sections.

8.3.3.1 Suspended solids and turbidity

Suspended solids levels were elevated in Ruakaka River but generally low at the harbour entrance and in offshore sites, although some variability is evident at most locations. Background levels in the Bream Bay were typically in the order of 6 mg/l. During a heavy rainfall event of 16 June 2009, high suspended solids concentrations were recorded in the Ruakaka River and in the Bream Bay offshore and south of the river mouth. On that occasion, on the ebb tide, a clearly visible coloured and turbid plume extended from the river mouth out into the Bream Bay and to the south. That plume would be expected to migrate to the north on the flood tide. Turbidity values were mostly less than 2 NTU in the Bream Bay and ranged from <2 NTU to 70 NTU in the lower river.

8.3.3.2 Salinity/Conductivity

Salinity ranged between <0.5 and 34.5 mg/l in the Ruakaka River but remained between 34 and 36 at all other locations most of the time. A notable exception was a low salinity result offshore and south of the river mouth during the June rainfall event, confirming the influence of the Ruakaka River well out into the Bream Bay during high flow events.

8.3.3.3 Temperature

Temperature measurements in Bream Bay ranged between 13.3^{o} C in winter and 20.1 degrees C in summer. The Auckland University Research unit at Leigh has a continuous temperature record which indicates summer peaks between 20 and 23^{o}C, which is the likely peak range in Bream Bay. This is confirmed by NRC bathing beach monitoring at Ruakaka Beach (Table 8.4). There was evidence of slight stratification in the December survey when surface temperatures were up to 1 ^{o}C warmer than at 8m depth. During the December survey, water leaving Whangarei Harbour on the afternoon ebb tide was more than 2 ^{o}C degrees warmer than water that entered the harbour on the morning flood tide of the same day.

8.3.3.4 Dissolved oxygen

Dissolved oxygen levels were typically in the range 7.5 to 8.5 mg/l throughout Bream Bay, but were lower following the June rainfall event.

8.3.3.5 Dissolved reactive phosphorus

Concentrations of dissolved reactive phosphorus (DRP) varied seasonally with low concentrations occurring during the summer period and higher concentrations recorded in winter and following wet weather. The highest concentrations occurred in the Ruakaka River following the June rainfall event. On that occasion runoff from land evidently also caused elevated DRP levels in Bream Bay and at the harbour entrance.

A comprehensive water quality monitoring programme undertaken by Environment Bay of Plenty (EBOP) offshore of Pukehina, Whakatane and Opotiki (Park 2005) found a similar seasonal pattern to that described above. The influence of terrestrial freshwater inputs and associated nutrients was found to be highest in the winter near the coast, often forming very large surface plumes during the larger river fresh or flood events. Park also reported that DRP concentrations were consistently high in the bottom waters at the edge of the continental shell (around 0.025 mg/l at 200m depth), which points to replenishment from either sediments or from deep oceanic up-welling.

8.3.3.6 Dissolved inorganic nitrogen

Concentrations of dissolved inorganic nitrogen (DIN) closely mirrored DRP, with a seasonal pattern of depletion in summer and abundance in winter and after wet weather. The highest concentrations occurred in Ruakaka River and in the parts of the Bay affected by the Ruakaka River.

The EBOP study found that concentrations of oxidised nitrogen in the Bay of Plenty were consistently high near the edge of the coastal shelf, pointing to sediment regeneration and oceanic up-welling as important sources of replenishment (Park 2005).

8.3.3.7 Recreational Water Quality

WDC monitoring in 2008 and 2009 indicates that concentrations of *Enterococci* and faecal coliform bacteria are high in Ruakaka River after rain (faecal coliforms up to 15,000 cfu/100ml) and moderately elevated in the Ruakaka River in dry weather (faecal coliforms from 2 to 3400 cfu/100ml). Those parts of Bream Bay that are affected by the River discharge plume in wet weather, including waters over the NIWA intake pipeline to the north and at least 1.5 km to the south and 2km offshore, all showed elevated indicator bacteria concentrations following a significant rainfall event (faecal coliforms up to 2100 cfu/100ml, 2km offshore). Indicator bacteria concentrations were consistently low throughout Bream Bay in dry weather (faecal coliforms mostly <2 cfu/100ml) when the influence of terrestrial freshwater inputs was reduced (refer MWH 2009).

NRC bathing beach monitoring results for Ruakaka Beach near the surf club (south of river mouth) and at Urquharts Bay near the Whangarei Harbour entrance are summarised in Table 8.4 and Table 8.5. The samples were collected over the period December to February in the years 2004 to 2007. The results show that indicator bacteria levels are normally low, but occasionally elevated levels have been recorded at both locations. According to the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE 2003), both bathing beaches would have a Microbiological Assessment Category (MAC) grade of B for contact recreation, based on the 95 percentile enterococci values. Grades range from A to D, with A indicating a low risk of gastrointestinal illness and D indicating a high risk. With regard to recreational shellfish gathering, the MfE guidelines indicate that the 90% faecal coliform value should not exceed 43/100ml. This guideline is met at Ruakaka Beach but is marginally exceeded at Urquharts Bay Beach.

Table 8.4 Summary of Water Quality Results for Ruakaka Beach (near Surf Club)

	N Samples	Median	90%ile	95%ile	Maximum
Temperature (^oC)	33	19.1	21.2	22.1	22.7
Salinity g/L	33	35	35.4	35	36
Enterococci (n/100ml)	34	<10	113	111	306
Faecal coliforms (cfu/100ml)	34	<2	22	133	416

Table 8.5 Summary of Water Quality Results for Urquharts Bay at Beach (Harbour Entrance)

	N Samples	Median	90%ile	95%ile	Maximum
Temperature (^oC)	35	20.4	21.6	22.6	24.7
Salinity g/L	35	35	35.9	36	36
Enterococci (n/100ml)	35	<10	61	79	531
Faecal coliforms (cfu/100ml)	35	<2	52	172	604

Figure 8.1 Bream Bay Water Quality Sampling Locations (Sites 1-9)

8.3.4 Marine Sediment Quality

Bream Bay is a sand dominated environment. Sediments along the proposed ocean outfall alignment and parallel to the shore are very homogenous, dominated by fine sand and contain only a small proportion of mud. Black (1983) described the seabed off Ruakaka as featureless, with megaripples evident further offshore. Sediment transport occurs in a northerly direction in Bream Bay towards Mair Bank then out of Whangarei Harbour via the main channel.

Reporting on a study of the sediment quality and benthic ecology at the proposed location of the Ruakaka ocean outfall, Golder Associates (2010) (Support Document 35) observed that currents in Bream Bay are sufficient at times to disturb the seabed and mobilise fine sands. They concluded that the seabed environment around the outfall is not depositional as is evident from the small proportion of fine sediment. The authors concluded that:

> "*Sediments were dominated by fine sand, small amounts of mud and shell fragments. The sediments contain very little organic carbon reflecting the sandy nature of the sediments. As a result of the fine sandy nature of the sediment and the mineralogical characteristics, concentrations of trace elements were low and some non-detectable. Typically, variation in trace element concentrations between site samples was small and what differences were observed between sites (geographically) appears to be attributable to the variation in sediment texture."*

8.3.5 Marine Ecology Values

The Regional Coastal Plan (RCP) for Northland identifies the coastal region of the Ruakaka River mouth and the Waipu River mouth as 'Marine 1 (Protection) Management Area', which are considered to have important conservation values and are required to be managed in such a manner that the conservation values (coastal wetlands, marine mammals, birds, ecosystems and habitat values) of the areas are protected.

The majority of the Whangarei Harbour was zoned as 'Marine 2 (Conservation) Management Area' which recognises existing conservation values, but still allows for broad use and development. There is a current re-zoning exercise (Plan Change 2 – processing stage) which means many areas around Whangarei Harbour will now fall under Marine 1 Management areas. This includes the outer harbour sandbanks: Mair Bank, Snake Bank, Calliope Bank and McDonald Bank (RCP change 2).

Following an investigation of Bream Bay in the vicinity of the proposed outfall for WDC, Golder Associates (2010) (Support Document 35) noted that the intertidal environment of Bream Bay is that of a clean, sand dominated, exposed beach. Shellfish found in the intertidal zone include tuatua as well as several polychaete worms and common crustaceans such as isopods, amphipods, shrimps and the New Zealand paddle crab. There are no persistent marine floral species recorded from the intertidal zone of the Bay. With regard to the deeper sub tidal region of the Bream Bay the authors concluded that:

> "*The epi-benthic community through the study area was dominated by sand dollars (F. Zelandica), urchins (Pagurus sp.) and the gastropod Amalda depressa. The epibenthic and infaunal community found in the vicinity of the proposed outfall and throughout the wider Bream Bay area is typical of exposed (and sheltered) high salinity waters over fine, sand substrates. Similar assemblages dominated by F. Zelandica and Pagurus sp. and the polycaete worms as infauna have been recorded elsewhere along New Zealand's coastline; for instance in the Manukau and Kaipara Harbours. In general, this epibenthic community is of relatively low diversity and abundance (with the exception of F. Zelandica at 2,000 m from the outfall). There were no marine benthic communities found within the footprint of the proposed outfall that are unusual, rare or of high ecological significance."*

8.3.6 Marine Ecology Values

Golder Associates (2010) notes that the variability in benthic infauna community composition has implications for the development of monitoring plans. Other studies indicate that in the past there have been large natural changes in the benthic fauna of Bream Bay which may be driven by changes in sediment grades (i.e., Lukens 1976, Ritchie 1987).

8.3.7 Marine Mammals

A large proportion of the 34 species of cetacean known to frequent New Zealand waters have been sighted along the north-eastern coastline of the North Island. Several of these species are known to be semi-residents, frequent transients and/or seasonal transients of the coastal waters surrounding Bream Bay. The more common species occurring along the Whangarei coastline include bottlenose dolphins (*Tursiops truncatus*), common dolphins (*Delphinus delphis*), orca (*Orcinus orca*) and Bryde's whale (*Balaenoptera edeni*). Both southern right and humpback whales are known to seasonally transit through Whangarei waters. More detailed information on these species is given in Cawthron (2009) (Support Document 27).

8.3.8 Recreational and Commercial Fishing

The Bream Bay coastline is known to be an important recreational and commercial fishing area, with the main recreational target species including kahawai, kingfish, snapper, gurnard and John Dory. Blue mackerel, jack mackerel, other mackeral, koheru, yellow-eyed mullet, grey mullet and trevally are also caught along the coast and within Whangarei Harbour. Commercially important stocks include snapper, trevally, grey mullet, kahawai, John Dory and tarakihi (Cawthron 2009) (Support Document 27).

Shellfish are taken by recreational fishers along Bream Bay coastline, in estuaries and within the Whangarei Harbour (Oldman et al 2004). These stocks include cockles, pipis, tuatua, scallops, various oyster species and lobsters. Cockles are one of the most abundant bivalve species found within the Whangarei Harbour. Within the Harbour, Snake Bank and McDonald Bank and the northern shores are important areas. Commercial collection of cockles (COC 1A) is undertaken exclusively on Snake Bank. The total commercial catch for the Whangarei cockle fishery during the last three seasons ending September 2008, 2009 and 2010 was reported as 151 t, 88 t, and 92.8 t respectively, which is well below the total allowable catch of for this area set at 346 t (http://fs.fish.govt.nz). Cockles are also gathered by recreational fishers in the Ruakaka and Waipu Estuaries (Shaw and Maingay 1990).

Pipis are present throughout Whangarei Harbour and in sheltered areas nearby including One Tree Point, Marsden Point, Mair Bank and Snake Bank (Venus 1984). The commercial gathering of pipi (PPI 1A) occurs predominantly on the seaward and northern side of Mair Bank. The total commercial catch for Whangarei pipi fishery during the last three seasons ending September 2008, 2009 and 2010 reported as 141.6 t, 131 t and 135.5 t respectively, which is below the total allowable catch for this area set at 200 t (http://fs.fish.govt.nz). Pipi are also gathered by recreational fishers in the Ruakaka and Waipu estuaries (Shaw & Maingay 1990).

Scallop beds occur near the harbour entrance and there is an offshore fishery throughout Bream Bay to a depth of 30 m (Oldman et al 2004). Despite the commercial harvest of scallops in the area Golder Associates (2010) found no scallops in any of the epibenthic dredge tows undertaken in close proximity to the proposed outfall location nor at the control site further north. The reported commercial catch for the Northland scallop fishery (SCA1) for the last six seasons ending March 2006, 2007, 2008, 2009, 2010 and 2011 were 69.1 t, 53 t, 32.7 t, 24.6 t, 10.4 t and 1.1 t (http://fs.fish.govt.nz). In recent years the majority of the scallops in Bream Bay have been located offshore and south of the Ruakaka River, at a depth of 14 to 25 metres.

Golder Associates (2010) (Support Document 35) collected samples of tuatua from a series of five intertidal sites in Bream Bay and a sample of pipi from Mair Bank for microbiological testing. All shellfish samples collected contained less than 230 faecal coliforms per 100g which is the acceptable level for unprocessed, harvested shellfish (NZ National Shellfish Sanitation Programme) as given in the Microbiological Reference Criteria for Food (October 1995).

8.3.9 Bream Bay Aquaculture Park

NIWA operates an aquaculture production and research facility known as the Bream Bay Aquaculture Park (the aquaculture park) at Ruakaka. Discussion on the Aquaculture Park is included in Section 7.4 of the AEE.

The aquaculture park, which includes the OceaNZ Blue paua farming operation, is a warm-water facility which allows the rearing and growth of a range of seafood species, with research programmes leading to commercial-scale culture. The facility aims to help New Zealand meet a growing demand for seafood, by providing aquaculture operators with the knowledge needed to expand and set up new aquaculture industries, including marine fin-fish. As of 2010 the facility rears 21 species of fish, 14 species of mollusc, 6 species of crustacean, 4 species of sponge and numerous species of algae.

The Aquaculture Park takes seawater from Bream Bay to sustain its aquaculture operations, currently at a rate of around 250 L/s. Seawater is taken through the NIWA pipeline located 605 m offshore in a water depth of about 8 metres. The intake is approximately 2 metres above the seabed. NIWA holds a resource consent to discharge up to 1000 L/s of seawater and stormwater from the aquaculture park to Bream Bay via the Marsden A cooling water outfall pipe. This discharge is approximately 750m out from the shoreline.

Figure 4.7 shows the NIWA intake and pipeline.

8.3.10 Avifauna

Important areas for bird life in Whangarei Harbour are located on the southern coast from Mangapai River through Takahiwai to Blacksmiths Creek and Marsden Point. The harbour provides feeding grounds and isolated roosting areas for approximately 81 species of birds, including migratory species (Northland Harbour Board 1989). In the vicinity of the harbour entrance at the northern extent of Bream Bay, the deep channels of clean open water and shell banks provide habitats for bird species such as shags, gannets, petrels and shearwaters (Northland Harbour Board 1989).

The coastal dunes, estuaries, freshwater wetlands and river margins provide habitats for a variety of threatened bird species. Eleven of the 12 threatened species recorded utilise the Ruakaka estuary area for feeding and two of them (New Zealand dotterel and banded rail) also breed in the estuary. Variable oyster catchers (formerly classed a threatened species) feed in the estuary in moderately high numbers and many also nest there. New Zealand fairy terns visit the estuary occasionally. Banded rails utilise habitat beyond the vicinity of the river mouth and are also present throughout much of the mangrove margin of the estuary (Shaw & Maingay 1990).

8.4 Assessment Criteria

8.4.1 Water Quality

The Regional Coastal Plan (RCP) defines the CMA within the Ruakaka River and the area extending outside the river mouth into Bream Bay as ‘Marine 1 (Protection) Management Area’, and all other nearshore waters of Bream Bay as ‘Marine 2 (Conservation) Management Area’. The proposed offshore ocean outfall would discharge into the Marine 2 management area.

Method 13.5.3(b) (ii) indicates that, for Marine 2 management areas, the RMA Third Schedule Classes AE, CR, A, C and SG would apply after reasonable mixing. These are:

Class AE Water (being water managed for aquatic ecosystem purposes)

(1) The natural temperature of the water shall not be changed by more than 3 ^{o} C.

(2) The following shall not be allowed if they have an adverse effect on aquatic life:

- *(a) Any pH change*
- *(b) Any increase in the deposition of matter on the bed of the water body or coastal water*
- *(c) Any discharge of a contaminant into water*

(3) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(4) There shall be no undesirable biological growths as a result of any discharge of a contaminant in the water.

Class CR Water (being water managed for contact recreation purposes)

- *The visual clarity shall not be so low as to be unsuitable for bathing.*
- *The water shall not be rendered unsuitable for bathing by the presence of contaminants*
- *There shall be no undesirable biological growths as result of any discharge of a contaminant into water.*

Class A Water (being managed for aesthetic purposes)

The quality of water shall not be altered in those characteristics which have a direct bearing upon the specified aesthetic values.

Class C Water (being managed for cultural purposes)

The quality of the water shall not be altered in those characteristics which have a direct bearing upon the specified cultural or spiritual values.

Class SG (being water managed for the gathering or cultivating of shellfish for human consumption)

(1) The natural temperature of the water shall not be changed by more than 3^{o} Celsius.

(2) The concentration of dissolved oxygen shall exceed 80% of saturation concentration.

(3) Aquatic organisms shall not be rendered unsuitable for human consumption by the presence of contaminants.

The general performance standard in 31.4.13(c), which incorporates the standards on section 107(1) of the RMA, would also apply:

Discharges to water shall, after reasonable mixing, comply with the relevant receiving water standards and shall not contain any contaminants which could cause:

(i) the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.

(ii) any conspicuous change in the colour or visual clarity of the receiving waters.

(iii) any emission of objectionable odour.

(iv) accumulation of debris on the foreshore or seabed underlying or adjacent to the discharge point.

(v) any significant adverse effects on aquatic life or public health

As these receiving water standards are largely narrative, the approach taken here is to refer to widely accepted or national guidelines such as ANZECC (2000) and MfE (2003) to provide numeric limits or performance criteria.

8.4.2 Reasonable Mixing

The RMA requires that any standards imposed through classification of waters or under Section 107 of the RMA should be met "*after reasonable mixing*". This implies the existence of a zone in which the underlying standards need not be met. However, the RMA stops short of giving clear guidance about what constitutes reasonable mixing. It may be implied that the area of water required for "*reasonable* *mixing*" should be minimised and any adverse effects within the "*reasonable mixing zone*" should not frustrate the management objectives for the waters.

The RCP touches briefly on reasonable mixing in the general assessment criteria (above) but does not provide any further guidance.

8.5 Dilution and Dispersion

8.5.1 Investigations

Whangarei District Council commissioned NIWA in March 2008 (Support Document 8) to undertake oceanographic data collection to supplement data already available. In December 2008, DHI (Support Documents 31, 32 and 33) were commissioned to carry out a modelling assessment of the dilution and dispersion characteristics of a proposed ocean outfall discharge in Bream Bay to facilitate the selection of the appropriate location for the outfall and to assess the potential effects of the discharge from the selected outfall location. DHI developed a MIKE 3 advection dispersion model for Bream Bay to undertake the assessment. The study, which was undertaken in two phases, focused on likely dilutions at three sensitive site locations:

- Ruakaka Surf Club;
- NIWA Aquaculture Park water intake; and
- Mair Bank.

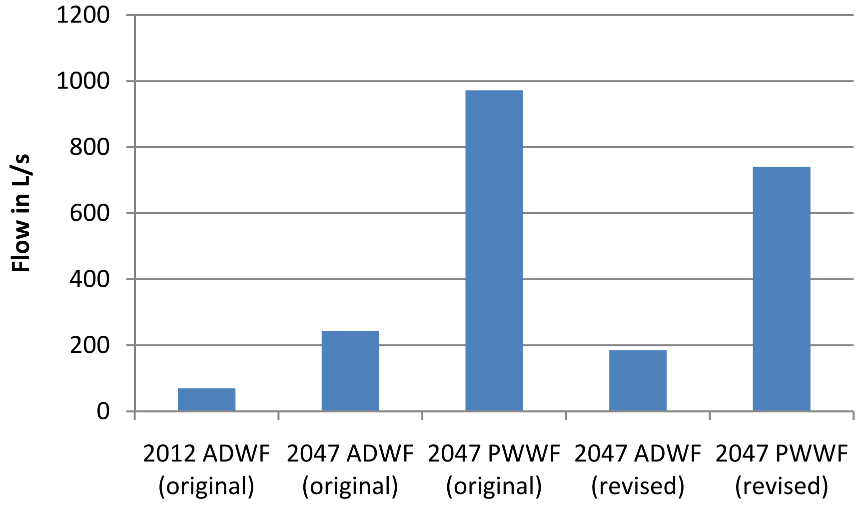
Phase One was a comparative assessment of 22 potential outfall locations based on seven selected hydrological scenarios. These sites are shown in Figure 6.1 in Section 6 of this AEE. Phase Two included a more detailed assessment of the two best performing outfall locations, and then, after selection of a preferred outfall location, comprehensive assessment of the preferred location. This included a detailed assessment based on 3 wastewater flows and seven selected scenarios. In also included a year-long simulation to predict dilutions for two wastewater flows. The year-long simulation included a full range of wind conditions that occur in Bream Bay.

The assessment was based the following wastewater flow projections which allow for population growth. Section 4.2 covers this assessment. The majority of the modelling was performed on the projections which were provided by WDC at the beginning of the project of:

- 2047 ADWF = 244 L/s (21,081 m^3/day).
- 2047 PWWF = 972 L/s (21,081 m^3/day x 4).

More recent flow projections (WDC 2010) indicate that these figures substantially overestimate the wastewater flows likely to occur within the next 35 years. The revised flows are:

- 2047 ADWF = 185 L/s (15,895 m^3/day) – rounded up to 16,000 m^3 /day.
- 2047 PWWF = 740 L/s (15,895 m^3/day x 4) – rounded to 64,000 m^3 /day.



The original flows were used for the scenario modelling however the year long simulations were run for both the original and the revised 2047 ADWF.

Based on the WDC 2010 projections, an ADWF of 70 L/s and 244 L/s is likely to be reached by approximately 2025 and 2060, respectively. The PWWF of 972 L/s is not likely to occur until year 2060. Therefore, given that dilution reduces as wastewater flow increases, the wastewater flows used in the majority of the modelling will result in a conservative (i.e. lower) predicted dilutions than would be achieved during the consent time frame.

8.5.2 Initial Dilution

A near field mixing assessment for the proposed outfall was carried out using the CORMIX modelling system. A preliminary diffuser design was assumed based on 32 ports spaced nominally at 2m, with a diffuser length of 62m. In the vicinity of the outfall 'near field' mixing processes dominate. In terms of the initial dilution achievable in the near field area, the key factors are the current velocity flowing across the diffuser, the water depth and the wastewater discharge rate. Initial dilutions are lowest at slack water at the turn of the tide and are substantially higher at other times.

The predicted minimum initial dilutions (as predicted at slack tide) at three wastewater flows are summarised in Table 8.6. The zone of initial dilution (ZID) only includes the initial mixing of the wastewater plumes from the diffusers up until they level out near the water surface, with longer ZIDs occurring when the current velocity is highest (but dilution is correspondingly higher). The modelling predicted that the ZID occurs within about 50m of the diffuser, but may vary from a few metres wide upwards. Also included in the table are predicted dilutions at the edge of a 100m radius circular mixing zone.

Table 8.6 Predicted Minimum Plume Dilutions at Edge of Initial Mixing and 100m Mixing Zones

	Minimum initial dilution range	Minimum dilution range at edge of 100m radius mixing zone
ADWF of 70L/s	57 -1434	514 - 1542
ADWF of 244L/s*	26 - 419	289 - 476
PWWF of 972L/s*	14 - 110	86 - 129

*The higher wastewater flows on which the predicted dilutions are based are now considered unlikely to occur before year 2060. They substantially over estimate the flows likely to occur within the maximum 35-year term of a resource consent. The above assessment, being based on flows 30% higher than those likely to occur, is conservative.

We consider that the zone of 'reasonable mixing' as provided in the RMA, should be defined as a cigar shaped area extending 100m in all directions from the from the edge of the diffuser.

8.5.3 Far Field Dilution

Following the initial dilution phase, a reasonably coherent surface plume moves away from the discharge site under the impetus of the coastal current. As it moves it continues to spread and dilute, but at a slower pace than in the initial dilution phase. In order to characterise the far field dilution DHI ran the MIKE 3 model for 7 scenarios selected to represent the expected range of weather conditions. DHI also ran a year-long simulation which included a full range of wind conditions that occur in Bream Bay. The results for these two separate modelling exercises are summarised in this section.

The minimum dilutions for ADWF and PWWF at the 3 sensitive sites for the scenario based assessment are given in Table 8.7. The authors noted that:

- For an ADWF of 70 L/s, the predicted dilutions are never less than 4,900-fold at the sensitive sites.
- For an ADWF 244 L/s, the predicted dilutions are never less than 1,400-fold at the sensitive sites.
- For a PWWF of 972 L/s, the predicted dilutions are never less than 380-fold at the sensitive sites.

Table 8.7 Predicted Minimum Plume Dilutions from the Scenario Assessment at Sensitive Receptor Sites in Bream Bay (DHI 2010)

Flow Rate	Minimum Dilution (fold)			
	Surf Club	NIWA Intake Surface	NIWA Intake 2m above the bed	Mair Bank
ADWF of 70L/s	6,220	5,810	5,780	4,930
ADWF of 244L/s*	1,810	1,680	1,685	1,415
PWWF of 972L/s*	425	410	405	385

*The higher wastewater flows on which the predicted dilutions are based are now considered unlikely to occur before year 2060. They substantially over estimate the flows likely to occur within the maximum 35-year term of a resource consent. The above assessment, being based on flows 30% higher than those likely to occur, is conservative.

The predicted minimum dilutions for ADWF at the three sensitive sites for the typical year simulation are shown in Table 8.8. It is also noted that:

- For the original 2047 ADWF (244 L/s), predicted dilutions are never less than 1000-fold at the sensitive sites and are less than 2000-fold for no more than 1.3% of the time.
- For the revised 2047 ADWF (185 L/s), predicted dilutions are never less than 1300-fold at the sensitive sites and are less than 2000-fold for no more than 0.2% of the time.

Table 8.8 Predicted Minimum Plume Dilutions from the Year-Long Simulation at Sensitive Receptor Sites at Bream Bay (DHI 2010)

Flow Rate	Minimum Dilution (fold)		
	Surf Club	NIWA Intake Surface	Mair Bank
2047 ADWF (244L/s) **original**	1,785	1,405	1,090
2047 ADWF (185L/s) **revised**	2,350	1,820	1,365

The dispersion modelling shows that the 'worst case' conditions can be expected during an onshore (easterly) wind. The dilutions at the sensitive receiver sites that have been used in the following assessment of potential effects are:

- predicted 2047 ADWF minimum dilutions range from 1365-fold to 2350-fold based on the **revised** wastewater flows and the year-long simulation (from Table 8.8) and

- predicted 2047 PWWF minimum dilutions range between 385-fold and 425-fold based on the **original** wastewater flows and the scenario assessment (from Table 8.7), which are unlikely to occur within the consent term and hence represents a conservative approach.

8.6 Potential Effects

8.6.1 Background

This section outlines the potential effects of the proposed discharge. The assessment is based on the proposed treated wastewater quality from a new wastewater treatment plant, projected increases in wastewater flows over the next 35 years in response to population growth, and dilution and dispersion modelling of the discharge plume in Bream Bay.

8.6.2 Effects on Suspended Solids, Colour and Clarity

The RCP defines the waters around the proposed outfall diffuser as a Marine 2 Management Area. The relevant water quality criteria, which apply after reasonable mixing, include:

- *The visual clarity shall not be so low as to be unsuitable for bathing.*
- *The quality of water shall not be altered in those characteristics which have a direct bearing upon the specified aesthetic values.*

Discharges to water shall, after reasonable mixing, comply with the relevant receiving water standards and shall not contain any contaminants which could cause:

- *the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.*
- *any conspicuous change in the colour or visual clarity of the receiving waters.*
- *accumulation of debris on the foreshore or seabed underlying or adjacent to the discharge point.*

The effects of the proposed treated wastewater discharge on receiving water total suspended solids levels (TSS) can be calculated by a balance on mass loads. The receiving water contaminant concentration (C_x) at any location x is given by equation 1:

$$C_x = \frac{(C_o - C_b)}{TD} + C_b \quad (1)$$

Where C_o = the wastewater concentration of the contaminant; C_b = the background concentration in the ocean; and *TD* = the total dilution.

The assessment in Table 8.9 is based on a background median TSS concentration of 6 mg/l, a median treated wastewater TSS concentration of 5 mg/l and a minimum dilution of 289:1 at an ADWF of 244 L/s. The proposed discharge typically has a similar suspended solids concentration to the receiving sea water in which case it will not increase seawater concentrations.

A projected PWWF of 972 L/s with a TSS concentration of 30 mg/l, rather than 5 mg/l as is expected for the typical discharge, may cause a 5% increase in TSS at 100m but no change at any of the three sensitive sites included in this assessment. (These being Mair Bank, the NIWA Aquaculture Park water intake and the Ruakaka Surf Club). Wastewater flows approaching the PWWF occur in response to sustained heavy rainfall, typically for a period of less than one day.

Table 8.9 Predicted Total Suspended Solids Concentrations (mg/l) in Bream Bay Receiving Waters

Wastewater flow	Waste-water conc.	Predicted Minimum dilutions				Background coastal water conc.	Predicted receiving water conc. 100m from outfall	Predicted receiving water conc. at Mair Bank	Predicted receiving water conc. at NIWA intake	Predicted receiving water conc. at Ruakaka Surf Club
		100 m	Mair Bank	NIWA Intake	Surf Club					
ADWF of 70 L/s	5	514	4930	5780	6220	6	6	6	6	6
ADWF of 185 L/s	5	289	1365	1820	2350	6	6	6	6	6
PWWF of 972 L/s	30	86	385	405	425	6	6.3	6.06	6.06	6.06

MWH conclude that a 5% increase in suspended solids concentrations, which may occur for a brief period during a sustained rainfall event, would have the following consequences on colour and clarity:

- an approximate 5% reduction in water clarity due to increased scattering;
- less than 5% reduction in light penetration, because light penetration is largely a function of water colour rather than water clarity (MfE 2004);
- imperceptible change in water colour or in brightness due to light reflection. Although it is difficult to predict exactly the extent of change to water colour without information on the optical properties of the suspended material, MfE guidelines (MfE, 1994) suggest that if clarity guidelines are observed, there is little likelihood that colour guidelines would not also be observed.

Bream Bay in the vicinity of the proposed outfall diffuser is an erosional rather than depositional environment. Therefore, given the very low suspended solids content of the discharge, which is at most times lower than that of Bream Bay receiving waters, the discharge would not contribute to an accumulation of debris on the seabed near the point of discharge.

8.6.3 Effects on Oil and Grease

The RCP requires that discharges to Marine 2 Management Areas shall, after reasonable mixing, not contain any contaminants which could cause:

"the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials."

Oil and grease are a group of thousands of chemicals with varying physical, chemical and toxicological properties. Oil and grease are the primary component of surface slicks, and can cause a variety of environmental effects.

The development of surface slicks is dependent upon the concentration of oil and grease in the treated wastewater and the dilution available in the receiving water.

In this case the oil and grease concentrations contained within the raw wastewater are largely removed by the treatment processes and concentrations in the treated wastewater are expected to be low. Given this it is expected the formation of a conspicuous oil or grease film following discharge will not occur.

8.6.4 Objectionable Odour

The RCP requires that discharges to Marine 2 Management Areas shall, after reasonable mixing, not contain any contaminants which could cause:

"any emission of objectionable odour."

Experience at existing ocean outfalls around New Zealand suggests that odour is unlikely to ever be discernable in the immediate vicinity of the outfall, especially given the high standard of treatment proposed for this discharge.

8.6.5 RCP Contact Recreation and Shellfish Gathering Criteria

8.6.5.1 Contact Recreation

For water managed for contact recreation, the RCP requires that:

- *The visual clarity shall not be so low as to be unsuitable for bathing.*
- *The water shall not be rendered unsuitable for bathing by the presence of contaminants*
- *There shall be no undesirable biological growths as result of any discharge of a contaminant into water. (refer Section 8.6.11)*

Visual clarity has been discussed in Section 8.6.2 above. The predicted worst case reduction in visual clarity at any point 100m from the discharge is 5%. A change of this order would be barely perceptible and unlikely to affect the suitability of these waters for bathing. Visual clarity at the many bathing beaches in Bream Bay, the nearest of which is some 2.9 km from the proposed discharge point, will not be affected by the proposed discharge.

The principal contaminants of concern for contact recreational waters are microbiological contaminants, which are addressed by *The Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas* published by the Ministry for the Environment and the Ministry of Health (MfE 2003). The guidelines for contact recreation in marine waters are based on keeping the illness risks to less than about 2%, which is indicated by:

- *"No single sample greater than 140 enterococci per 100ml",* as determined by regular weekly monitoring.

The proposed Ruakaka WWTP will be designed to achieve a median faecal coliform concentration of 10 per 100ml. A median enterococci concentration of the same value is assumed.[5] At projected 2047 ADWF this would cause a background enterococci concentration of 1 per 100ml to increase to 1.03 per 100ml at the edge of a 100m mixing zone, i.e. no measurable increase.

At times of peak wet weather flow (PWWF) the raw wastewater may be diluted 3 or 4-fold by rainwater which has infiltrated or inflow into the reticulation. This typically results in lower contaminant concentrations in the inflow to the plant. However, the higher wastewater flows may cause some loss of treatment efficiency. The net result is typically a moderate increase in suspended solids content in the discharge, and in the worst case a larger increase in indicator bacteria concentrations due to reduced effectiveness of UV disinfection. For the purpose of this assessment, it is assumed that the enterococci concentration in the discharge increases by two orders of magnitude, from 10 to 1000/100ml at times of peak flow. At the projected 2047 PWWF this would cause a background enterococci concentration of 1/100ml to increase to 13/100ml at the edge of a 100m radius mixing zone. However, the new treatment plant proposes to use the existing oxidation ponds to buffer out extremely high storm flows so that the plant's treatment capacity would not be compromised.

Such an increase would not cause the MfE Contact Recreation trigger value of 140 *enterococci* per 100ml to be exceeded; indeed it would amount to less than 10% of the trigger value. Microbiological water quality at the many bathing beaches in Bream Bay, the nearest of which is some 2.9 km from the proposed discharge point, would not be affected by the proposed discharge.

[5] Enterococci concentrations would typically be 30-60% lower than faecal coliforms in treated wastewater but for the purpose of this assessment equality is assumed.

8.6.5.2 Shellfish Gathering Waters

For waters managed for the gathering or cultivation of shellfish for human consumption the RCP requires that:

- *The natural temperature of the water shall not be changed by more than 3 ^{o}C.*
- *The concentration of dissolved oxygen shall exceed 80% of saturation concentration.*
- *Aquatic organisms shall not be rendered unsuitable for human consumption by the presence of contaminants.*

Effects on temperature and dissolved oxygen are negligible as discussed in the following sections. The primary contaminants of concern are the microbiological contaminants, which are addressed by the MfE (2003) guideline for shellfish gathering waters. The guideline states:

"*The median faecal coliform content of samples taken over a shellfish-gathering season shall not exceed a Most Probable Number (MPN) of 14/100ml and not more than 10% of samples should exceed an MPN of 43/100ml*"

At the projected 2047 ADWF, the proposed treated wastewater discharge, with a median faecal coliform content not to exceed 10 FC per 100ml would not cause any measurable increase in the faecal coliform content of seawater at the edge of a 100m mixing zone or beyond.

As already discussed, in the worst case some reduction in treatment efficiency may occur at times of peak wet weather flow, which could increase the microbiological content of the discharge. For the purpose of this assessment it is assumed that the faecal coliform content may increase by two orders of magnitude, from 10 to 1000/100ml at times of peak flow. At the projected 2047 PWWF this would cause a background receiving water concentration of 1/100ml to increase to 13/100ml at the edge of a 100m radius mixing zone. As PWWF events occur only occasional and usually for less than one day they will not cause an exceedance of the guideline for shellfish gathering waters at or beyond 100m from the outfall.

8.6.6 Microbiological Risk Assessment

A microbial public health risk assessment (MRA) (Quantitative Public Health Risk Assessment, MWH, August 2010) (Support Document 36) was undertaken in recognition of the requirements of the microbiological guidelines for marine waters inherent with the "*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Area"* published by the Ministry for the Environment and the Ministry of Health (2003).

The guidelines state that they *"**cannot be directly used to determine water quality criteria for wastewater discharges**"* and that they "***should not be directly applied to assess the microbiological quality of water that is impacted by a nearby point source discharge of treated effluent without first confirming that they are appropriate***".

The MRA was undertaken to determine the potential risk of infection relating to impacts associated with the discharge of treated wastewater from the planned Ruakaka wastewater treatment plant. It considered exposure from enteric viruses that typically cause gastro-intestinal infection, i.e. the infections that result in illnesses that have been commonly used to define water quality standards. The risk assessment:

- identified the possible concentration of pathogenic micro-organism in the treated wastewater discharge,
- established the fate of these pathogenic micro-organism in the environment,
- determined the risk of infection derived from contact recreation activities at and consumption of shellfish from three locations along the coastline, namely Mair Bank, Ruakaka Surf Club and the NIWA intake and at the edge of the zone of initial dilution.

The MRA did not consider the potential public health risks associated with protozoa (oocysts of Cryptosporidium spp. and cysts of Giardia spp.) and bacterial pathogens (Salmonella spp. and thermophilic Campylobacter spp.).

Potential public health risks associated with protozoa and bacterial pathogens were not considered in the study as the risks associated with these pathogens are significantly lower than that associated with culturable human enteric viruses. This results from the increased sensitivity of protozoa and bacterial pathogens to UV irradiation which is the disinfection process proposed for the planned WWTP (i.e. a substantially greater reduction of these pathogens would be expected relative to viruses) and the greater dose required to induce infection (i.e. they are also considerably 'less infectious' relative to most viruses). Further the concentration of protozoa and bacterial pathogens in the raw wastewater is lower than the virus concentration.

The MRA was based on a Monte Carlo simulation analysis to reflect the likely wide range of concentrations of enteric viruses at the points of exposure and the range of exposures that can occur. The assumptions of the model are as follows:

- The model was based on the average dry weather flow in 2047 of 185 L/s;
- An influent virus concentration statistical distribution was defined for raw wastewater based upon a review of data collected from the Mangere WWTP over the period 2002 to 2010;
- Contact recreation was assessed at three locations along the coastline and in close proximity to the outfall itself;
- Shellfish consumption was assessed at three locations along the coastline for the range of dilutions which the locations would be subject to from the one year modelling of the dispersion of the plume. Also, it was assumed that there was no further die off/decay of the viruses in the environment after discharge;
- In determining the concentration of viruses in the shellfish flesh, a bioaccumulation rate of 50:1 was assumed. The plume will not be continually present at the shellfish beds, which will allow the shellfish to remove viruses from their system. Therefore, the assumption of a rate of 50:1 is considered conservative;
- Exposure scenarios considered have included possible ranges of exposure being the ingestion of a median of 50 ml and a maximum of 100 ml of seawater for contact recreation and the consumption of a median meal of 60 grams and maximum of 80 grams of uncooked shellfish per meal. The median weight of shellfish is equivalent to a large meal of cockles or a small meal of oysters.

Further, it was assumed that:

- Risks of infection were derived using a highly responsive infectivity model as a precautionary approach;
- The risks given in the assessment are for infection, rather than illness. The rate of development of illness from infection varies depending on the virus considered, and for enteric viruses, as used in the assessment, can vary from 1% to 97% depending upon the virus and age of the subject. The risks inherent in the MfE Guidelines against which the modelled risks are assessed are risks of illness from epidemiological surveys, rather than risks of infection. The inherent risks of infection in the MfE Guidelines would be higher.

The modelled risks of **infection** are assessed against the inherent risks of **illness** in the MfE Guidelines for Recreational Waters, 2003 being:

- a no observed adverse effect level (NOAEL) of < 1%;
- a detectable increase in risk level above the threshold level for reported illness (LOAEL) of 5%, which would be considered generally acceptable;
- a substantial elevation in the probability of reported illness (Substantial risk) of 10%.

The key conclusions of this assessment, with respect to **infection** are that:

- *For contact recreation:*
  - The risk of infection is less than one swimmer for every 10,000 swimming exposures (i.e. 0.01%) at all times at the locations on the coastline.
  - In close proximity to the outfall, the risk of infection was less than one swimmer for every 1,000 swimming exposures (0.1%) for 95% of the time. The risk of infection never exceeded one swimmer for every 100 swimmers (1%), which is the NOAEL level associated with a Grade A beach.
- *For shellfish consumption*:
  - The risk of infection is less than one for every 1,000 meals (0.1%) consumed from shellfish gathered at the NIWA intake and the Ruakaka Surf Club sites for 99.9% of the time and at Mair Bank for 99.8% of the time.
  - The predicted risk of infection is less than 0.5% (i.e. 5 infections per 1,000 meals consumed) at all times at these locations and hence is less than the no observed adverse effects level from the Contact Recreation Guidelines of 1% at all times.

8.6.7 NZFA Specifications for Bivalve Molluscan Shellfish

The New Zealand Food Safety Authority specifications for Bivalve Molluscan Shellfish (2006) provide standards that apply to the commercial harvest of bivalve molluscan shellfish (BMS) on marine farms, in land based aquaculture facilities and in the wild. Section 29 (Prohibited Classification) prohibits the harvest of BMS from growing areas adjacent to a point source discharge. Section 19(4)(c) states:

"*For major point source discharges, such as a sewage outfall, a minimum prohibited area of 500m must be established in the growing area*."

It is likely that this prohibition would apply to the proposed treated wastewater discharge to Bream Bay, and that commercial harvesting of shellfish would not be permitted within 500m of the point of discharge.

Section 19(4)(d) and (e) provides a set of criteria and type of computer modelling required for determining of the size of the prohibited area. In the case of the proposed discharge to Bream Bay the investigation methodology underpinning the consent application, including treated wastewater characterisation, dispersion modelling and culminating in the microbiological risk assessment (MRA) are all consistent with these criteria. The computer software used by DHI Water and Environment Ltd in the dilution and dispersion studies have a higher level of sophistication than the USEPA model referred to in the specifications. Modelling software used has been discussed with the regional shellfish specialist.

The analysis indicates the prohibited area need be no larger than 500m and in fact could be smaller from an effects basis, as discussed below.

For shellfish growing areas outside of the prohibited area, the following standard would apply for commercial harvest (which is consistent with the MfE (2003) recreational water quality guidelines):

"*14 Standard for approved growing areas affected by point source discharges*
The growing area water and BMS must meet the following bacteriological standards at every sampling station in the growing area when the area is in open status:

(a) the faecal coliform median MPN of the water samples must not exceed 14/100ml and no more the 10% of the samples must exceed an MPN of 43/100ml.

(b) the E coli median MPN of the BMS samples must not exceed 230 E coli per 100g and not more than 10% of the samples must exceed an MPN of 700/100 grams at each sample station."

The assessment given above in Section 8.6.5.2 for shellfish gathering waters indicates that this standard would be comfortably complied with, indeed 14(a) would be met within 100m of the outfall diffuser. The preliminary outfall design is for the diffuser to be located over the last (seaward) 62m length of the outfall.

Scallops are commercially harvested from Bream Bay, mostly offshore and south of the Ruakaka River. However, some scallops may occur within 500m of the proposed outfall, potentially in an area from which commercial harvest might be prohibited. Pipi and cockles are commercially harvested at Mair Bank and Snake Bank respectively, both at least 3.5km from the outfall, well outside the area where a prohibition might apply.

8.6.8 Effects on Recreational Values

The treated wastewater is to be discharged through an ocean outfall some 2.9 km from the nearest shoreline and 5.3 km from the Ruakaka Surf Club beach. As such it is well removed from the bathing beaches where the majority of recreational activities occur. It is recognised that other activities such as sailing and fishing may take place closer to the outfall and this is addressed by the high standard of treatment proposed.

The potential adverse effects on recreational activities will thus be avoided or mitigated by a combined approach utilising both a long ocean outfall and a high level of wastewater treatment (refer microbial risk assessment above).

8.6.9 Effects on Temperature

The RCP water quality criteria, which apply after reasonable mixing, include:

> *The natural temperature of the water shall not be changed by more than 3 ^{o}C.*

Wastewater will be retained for some hours during conveyance to and treatment at the wastewater treatment plant. It will then receive rapid dilution on discharge to Bream Bay via the ocean outfall. Based on temperature measurements from the Hamilton WWTP, and coastal water temperatures at Leigh, the wastewater is normally 3 to 5 ^{o}C warmer than seawater.

Taking a worst case example with wastewater at 25 ^{o}C and seawater at 20 ^{o}C, and assuming a worst case 86-fold dilution at the edge of the 100m mixing zone (at the projected 2047 PWWF), the discharge would cause sea water temperature to increase to 25.1 at the edge of the mixing zone. This 0.1 degree increment is just 3.3% of the 3 ^{o}C change permitted by the RCP criteria. Therefore, the RCP criteria will be complied with.

8.6.10 Effects on Dissolved Oxygen

The RCP water quality criteria, which apply after reasonable mixing, include:

> *"The concentration of dissolved oxygen shall exceed 80% of saturation concentration."*

Low dissolved oxygen (DO) concentration has an adverse effect on many aquatic organisms which depend on oxygen dissolved in the water for efficient functioning. It can also cause reducing conditions in sediments, so the sediments release previously bound nutrients and toxicants to the water column (ANZECC 2000).

The dissolved oxygen content of the treated wastewater may be below 100% saturation and may draw off oxygen from surrounding seawater as initial mixing takes place near the diffuser. However, Bream Bay coastal waters are well oxygenated and given the large dilution available, no significant DO depletion is anticipated as the discharge plume reaches the surface. Further, no significant oxygen depletion is anticipated in marine sediments near the outfall because of the low suspended solids content of the discharge and the erosive or dispersive character of the Bream Bay receiving environment.

8.6.11 Effects on pH

The RCP includes a requirement that changes in pH:

> *"...shall not be allowed if they have an adverse effect on aquatic life"*

Treated municipal wastewater will typically have a pH around 7.2 compared with the more alkaline seawater of Bream Bay which normally has a pH around 8.1. Seawater is heavily buffered by dissolved salts which render it relatively resistant to change and unlikely to be influenced by the proposed treated wastewater discharge after reasonable mixing.

Baseline monitoring indicates that water pH in the parts of Bream Bay affected by the Ruakaka River discharge plume can range between 7.2 and 8.1. A change of this order occurs after a heavy rainfall event when the flooded river delivers large volumes of freshwater to the Bay forming a freshwater plume overlaying the seawater. Proposed peak wastewater discharge volumes are approximately equal to 0.1% of the river inputs to Bream Bay in a 2 year ARI storm and are not capable of causing changes on the scale of these natural occurrences.

Therefore, any change in pH as a result of the discharge shall be minimal and will not result in any adverse effects especially beyond the zone of reasonable mixing.

8.6.12 Nutrients

The RCP water quality criteria do not refer specifically to nutrients but more generally require that:

> "*There shall be no undesirable biological growths as a result of any discharge of a contaminant into water."*

Nutrients, especially nitrogen and phosphorus, are vital to the coastal marine ecosystem and both generally become depleted in shallow coastal waters during the spring and summer period. Baseline monitoring in Bream Bay shows that ambient dissolved reactive phosphorus (DRP) concentrations in the Bay range from 0.015 mg/l in winter to around 0.005 mg/l in summer. Ambient dissolved inorganic nitrogen (DIN) is around 0.06 mg/l in winter reducing to less than 0.01 mg/l in summer. The principal cause of nutrient depletion is uptake by phytoplankton, which typically reach their highest concentration in spring. Three sources of nutrient replenishment are identified, these being recycling from the seafloor, inputs from deep oceanic upwelling and inputs from terrestrial sources following high flows in the Ruakaka River and other watercourses.

The potential effects of the proposed wastewater discharge on nutrients concentrations of Bream Bay have been assessed by running a hydrodynamic model of Bream Bay (DHI 2010) (Support Document 39) supported by monitoring data for Bream Bay (MWH 2009) and coastal shelf water quality data collected in the Bay of Plenty by Environment Bay of Plenty (Longdill 2005). This model does not account for nutrient depletion by phytoplankton uptake and thus can be expected to overestimate concentrations of dissolved nutrients in Bream Bay derived from the proposed discharge.

Monitoring, and subsequent modelling, has confirmed that the Ruakaka River has a significant influence on Bream Bay water quality at times of flood, with DRP and DIN reaching 0.049 and 0.25 mg/l, respectively, 2.5km south east of the river mouth (MWH 2009, DHI 2010). This represents an over 200% increase for DRP over winter ambient levels and an over 300% increase for DIN. Watercourses discharging to the upper Whangarei Harbour cause a similar increase in nutrient levels in the Harbour in wet conditions. While flood events can have a major effect on nutrient concentrations in Whangarei Harbour and Bream Bay, such events are intermittent and seldom sustained for more than 2 or 3 days at a time.

Oceanic upwelling of cold nutrient rich water is a recognised phenomenon on Northland's east coast during periods of sustained north westerly winds, which occur most frequently during an El Nino phase.

Modelling indicates that oceanic upwelling can cause more than an 80% increase in summer DRP concentrations from 0.006 to 0.011 mg/l and an almost 500% increase in summer DIN from 0.01 to 0.057 mg/l throughout Bream Bay and further afield (Table 8.10 and Table 8.11). Although strong north westerly winds seldom occur continuously for long periods, they can be the predominant wind for many weeks or even months, causing relatively high nutrient levels in the Bream Bay over an extended period.

This assessment indicates the projected wastewater discharge may increase average ambient summer DRP and DIN concentration in the wider Bream Bay area by up to 0.001 mg/l (Table 8.10). An increase of this order is effectively undetectable by standard water quality monitoring methods. While predicted average increments are higher close to the outfall, up to 0.003 mg/l for both DRP and DIN at a distance of 1000m from the outfall, the area of water in which nutrients are likely to be significantly elevated above background levels is limited to the vicinity of the outfall (Table 8.11).

Table 8.10 Predicted Mean Nutrient Concentrations in Wider Bream Bay (mg/l) – ADWF 244 L/s (from DHI 2010) (Support Document 37)

	Ambient		*Flood event*		*Upwelling*		*Range*
	Summer	*Winter*	*Summer*	*Winter*	*Summer*	*Winter*	
DRP - no discharge	0.006	0.015	0.010	0.019	0.011	0.018	0.006-0.018
DRP - with discharge	0.006	0.015	0.011	0.019	0.012	0.019	0.006-0.019
%increase due to wastewater discharge	*6%*	*2%*	*3%*	*2%*	*9%*	*5%*	
DIN - no discharge	0.010	0.062	0.025	0.067	0.057	0.096	0.010-0.096
DIN - with discharge	0.010	0.062	0.025	0.067	0.058	0.097	0.010-0.097
%increase due to wastewater discharge	*3%*	*0%*	*2%*	*1%*	*2%*	*1%*	

Table 8.11 Predicted Mean Nutrient Concentrations 1 km from the Outfall Diffuser (mg/l) – ADWF 244 L/s (from DHI 2010)

	Ambient		*Flood event*		*Upwelling*		*Range*
	Summer	*Winter*	*Summer*	*Winter*	*Summer*	*Winter*	
DRP - no discharge	0.006	0.015	0.011	0.020	0.011	0.018	0.006-0.020
DRP - with discharge	0.009	0.017	0.014	0.022	0.013	0.020	0.009-0.022
%increase due to wastewater discharge	*42%*	*12%*	*24%*	*14%*	*15%*	*10%*	
DIN - no discharge	0.010	0.061	0.023	0.065	0.056	0.095	0.010-0.095
DIN - with discharge	0.013	0.063	0.026	0.068	0.058	0.096	0.013-0.096
%increase due to wastewater discharge	*25%*	*3.0%*	*12%*	*4%*	*3%*	*2%*	

The ANZECC 2000 guidelines do not provide a trigger value for nutrients in marine systems in New Zealand. One of the concerns in relation to the discharge of nitrogen and phosphorus to coastal waters is the potential for settlement of nutrient rich particulate material into the seabed, leading to sediment enrichment and adverse effects on the benthic biota. In this case however the proposed treated wastewater contains very low concentrations of particulate material and the discharge is to an erosional rather than depositional receiving environment. The risk of accumulation on the seabed is therefore low.

A second area of concern is the potential for creating appropriate conditions in the water column for nuisance algae blooms. The availability of dissolved nutrients (DRP and DIN) and balance between nutrients (the N:P ratio) are key factors in this regard. Phytoplankton utilise N and P in a ratio typically of the order of 16:1 which often results in the availability of DIN becoming the limiting factors during periods of phytoplankton growth.

Phytoplankton will respond to increased concentrations of DIN and DRP in coastal waters by increasing biomass, provided the nutrient increase occurs over a wide area for a sustained period (days or weeks rather than hours). The predicted 3% summer average increase in DIN concentration in Bream Bay associated with the projected 2047 treated wastewater discharge might be expected to cause a similar increase in phytoplankton biomass in the Bay. This compares with a predicted 500% increase in summer DIN which can be maintained over a large part of the Hauraki Gulf for long periods by oceanic upwelling associated with El Nino conditions. In this context the predicted increases in nutrient concentrations associated with the proposed treated wastewater discharge are minor in both extent and magnitude compared with those which already occur naturally during periods of north westerly wind stress.

There is now ample evidence that very extensive algae blooms might be directly related to physical forcing experienced along the north eastern coast of New Zealand (i.e. Chang et al 2007). The circulation of Hauraki Gulf is highly responsive to wind; upwelling and downwelling over the adjacent continental shelf in the region are favoured by north-westerly and south easterly along-shelf winds, respectively, which in turn cause variations in nutrient supply and phytoplankton standing stock (Chang et al 2003; Zeldis et a*l* 2005; Chang et al 2007). A harmful algae bloom that occurred in the Hauraki Gulf during 2002 was preceded by prevailing north-westerly wind conditions during winter and spring which forced cold nutrient rich shelf-water to the upper column along the shelf, which was transported into Hauraki Gulf by the predominant southward flows. Chang et al (2007) hypothesize that the 2002 bloom was initiated when the dinoflagellate Karenia Concordia, originating in warm subtropical water from offshore, was then introduced as seed stock during an incursion into the nutrient-rich waters in the Gulf.

The evidence is that occasional harmful algae blooms in this area are caused by large scale climatic conditions, and are primarily driven by El Nino/Southern Oscillation events which generate prevailing north-westerly winds. The small scale, localised nutrient inputs predicted for the proposed scheme are unlikely to have any significant influence on these extensive algae blooms.

The discharge shall be a significant distance off shore and hence not located close to any shoreline features which could result in localised concentration of nutrients. Therefore, the discharge is also unlikely to lead to small scale localised blooms.

8.6.13 Effects on Aquatic Ecology

8.6.13.1 Introduction

This section assesses the environmental risk associated with contaminants potentially discharged with the treated wastewater. The RCP requires that:

"*The following shall not be allowed if they have an adverse effect on aquatic life:*

(a) Any pH change

(b) Any increase in the deposition of matter on the bed of the water body or coastal water

(c) Any discharge of a contaminant into water"

The general performance standard of the RCP also requires that discharges to water shall, after reasonable mixing, not contain any contaminants which could cause:

"...*any significant adverse effects on aquatic life."*

The risks associated with pH variation have been addressed earlier in Section 8.6.10. The risk of increased sediment organic content leading to eutrophication has been addressed in Section 8.6.11. The remaining issue is the discharge of a contaminant which has an adverse or toxic effect on aquatic organisms in the water column or in marine sediments. Wastewater toxicity can be measured in terms of the toxicity of individual toxicants or toxicity of the wastewater as whole. In this instance, as the proposed new Ruakaka WWTP has yet to be constructed, the treated wastewater characterisation is based on data from comparable wastewater treatment plants elsewhere in New Zealand.

Toxicity effects can result from either short term (acute toxicity), or long-term (chronic toxicity) exposure, relative to the life span of the organism. Generally, short term exposure effects occur at higher concentrations than long-term effects. Also, toxicity can occur from the accumulation of toxicants from the water or sediments either directly or through consumption of food containing the toxicants (bioaccumulation).

8.6.13.2 Chemical Specific Toxicity

The majority of toxicants carried in Ruakaka wastewater will be removed by the proposed treatment process hence concentrations are expected to be low. Predicted concentrations of toxicants in the discharge plume as it mixes with receiving waters 100m from the diffuser are given in Table 8.12.

This analysis indicates that, at projected dry weather and wet weather wastewater flow rates, receiving water concentrations of toxicants at the edge of a 100m mixing zone will remain well below ANZECC (2000) trigger values for "*slightly-moderately disturbed systems*". The risk of toxicity occurring in the water column beyond a 100 metre mixing zone is low. The potential for adverse effects occurring within seabed sediments in the vicinity of the diffuser is also considered to be low because of the very low suspended solids content of the discharge and the dispersive character of the Bream Bay environment, i.e. wastewater derived sediments are unlikely to accumulate on the seabed near the outfall.

Table 8.12 Predicted Toxicant and EDC Concentrations in Receiving Water at Edge of 100m Mixing Zone and at NIWA Intake

Wastewater constituent	Unit	Treated wastewater concentration (95%ile)[1, 2]	Bream Bay background water Concentration[3]	'Worst Case' receiving water concentrations 100m from diffuser at three wastewater flows			Worst Case receiving water concentrations at NIWA intake for predicted 2047 flows		*Proposed PNECs (Young et al 2002; Calwell et al 2008) and LOECs (Gadd 2009)[5]*	*NIWA (Clearwater 2009) Site specific trigger values for Aquaculture Park species*	*ANZECC (2000) Marine Water Quality Guideline[6]*
				ADWF 70 L/s (dil^{n} 513:1)	ADWF 244 L/s (dil^{n} 288:1)	PWWF 972 L/s (dil^{n} 85:1)	ADWF 185 L/s (dil^{n} 1820:1)	PWWF 972 L/s (dil^{n} 405:1)			
Total Arsenic	ug/l	17.7	1.5	1.531	1.556	1.688	1.509	1.540			2.3
Total Cadmium	ug/l	0.37	0.006	0.007	0.007	0.010	0.006	0.007			0.2
Total Copper	ug/l	20	0.056	0.094	0.123	0.282	0.067	0.102		0.2	1.3
Total Chromium	ug/l	9.3	0.160	0.178	0.192	0.266	0.165	0.183			4.4
Total Nickel	ug/l	15	0.330	0.359	0.382	0.506	0.338	0.367			7.0
Total Lead	ug/l	12	0.003	0.026	0.045	0.143	0.010	0.033			4.4
Total Mercury	ug/l	0.61	0.0006	0.0018	0.0027	0.008	0.0009	0.002			0.1
Total Zinc	ug/l	175	0.078	0.418	0.683	2.113	0.174	0.510		5	15
Ammonia-N	ug/l	10,000	5	29	45	126	15	35			910
Phenol	ug/l	138	0.0	0.27	0.48	1.60	0.0759	0.3399		286	270
PCP	ug/l	0.16	0.0	0.0003	0.0006	0.002	0.00009	0.00039		7	11
Benzene	ug/l	<0.5	0.0	<0.0010	<0.0017	<0.0058	<0.0003	<0.0012			500
Naphthalene	ug/l	<0.3	0.0	<0.0006	<0.0010	<0.0035	<0.0002	<0.0007			50
SDS	ug/l	700	0.0	1.36	2.42	8.14	0.38	1.72		80	
DDT	ug/l	<3	0.0	<0.01	<0.01	<0.03	<0.1	<0.1			0.4
Endrin	ug/l	<3	0.0	<0.01	<0.01	<0.03	<0.1	<0.1			4
17β-estradiol	ug/l	6.2	0.0	0.012	0.021	0.072	0.0034	0.015	1 (PNEC)		
Estrone	ng/l	39	0.0	0.076	0.135	0.045	0.021	0.096	3-5 (PNEC)		
17α-ethinylestradiol	ng/l	1.3	0.0	0.003	0.004	0.015	0.0007	0.0032	0.35 (PNEC)		
Octylphenol	ng/l	240	0.0	0.467	0.830	2.79	0.132	0.59	35 (LOEC)		
Nonylphenol	ng/l	2900	0.0	5.64	10.03	33.72	1.59	7.14	100 (LOEC)		
Bisphenol A	ng/l	143	0.0	0.278	0.49	1.66	0.07	0.35	Not available		

Notes: 1. Expected concentrations of metals, phenol and PCP in treated wastewater are based on the upper 95th percentile value of monitoring results obtained from Hutt (Seaview), Hamilton and Tauranga wastewater treatment plants over the period 2001 to 2009 (refer Table 8.2).
2. Treated wastewater concentrations of other organic compounds are typically below detection limits, but indicative of values are included here.
3. Treated wastewater concentrations of EDCs are from a review by Gadd (2009)
4. Background concentrations are sourced from MBARI (http://www.mbari.org/), WDC, and Roper, D; Chiaroni, L; Hartill, B.; Hickey, C; Macaskill, B.; Morrison, M.; Parsons, D.; Walker, J.; Williams, J. (2006). The marine environment of Whangarei Harbour and Bream Bay. NIWA Report No. HAM2006-126. 103 p; and assumed effectively zero for organic contaminants and EDCs
5. PNEC = predicted no effects concentration; LOEC = lowest observed effects concentration.
6. ANZECC (2000) trigger values for 99% protection are given for bio-accumulative compounds (bold), otherwise 95% protection values are given

8.6.13.3 Potential Effects on Seabed Ecology

Golder Associates was commissioned by WDC to review existing information on the general ecology of Bream Bay and to undertake investigations into the sediment quality, benthic ecology and edible shellfish of Bream Bay in the vicinity the proposed outfall and diffuser. Their report (Golder Associates 2010) describes sediment characteristics, sediment chemistry, the intertidal ecology and the subtidal benthic ecology of the study area. The authors concluded that:

> "*There were no marine benthic communities found within the footprint of the proposed outfall that are unusual, rare or of high ecological significance*."

Given the high quality of the proposed treated wastewater discharge with the low level of toxicants, the clean sandy character of the seabed near the proposed outfall, and the low risk of accumulation of particulate material on the seabed near the proposed outfall, it is concluded that the discharge is unlikely to cause any discernable adverse effects on the benthic biota or sediments.

8.6.13.4 Bioaccumulation

Some chemicals can pose indirect risks associated with their longer-term concentration in organisms and hence the potential for secondary poisoning of other animals or humans through consumption of these contaminated organisms. The main criteria for determining whether the discharge could lead to significant bio-accumulation of contaminants in organisms are:

- substantial concentrations of bio-accumulative substances in treated wastewater;
- evidence of plume impacting upon food gathering areas for higher order organisms; or
- evidence of sediment accumulation near the outfall.

The potential for bioaccumulation of substances derived from the proposed Ruakaka WWTP discharge is assessed as low because:

- The concentrations of suspected bio-accumulative compounds in the treated wastewater are expected to be low;
- The proposed ocean outfall and diffuser will achieve rapid and effective mixing thereby reducing contaminant concentrations to within ANZECC (2000) trigger levels; and
- The outfall discharges into a dispersive (non-depositional) environment preventing the accumulation of sediment or contaminants on the seabed around the outfall.

8.6.13.5 Endocrine Disrupting Compounds

The presence of endocrine disrupting compounds (EDCs) in the environment has been generally identified as a concern in recent years, and is the subject of considerable international research effort. EDCs are compounds which disrupt endocrine systems, which are common to animals, birds and fish.

Endocrine systems co-ordinate and regulate communication between cells and regulate a number of biological functions, including growth, embryonic development and reproduction. Therefore, chemicals which disrupt these systems can result in effects on both exposed individuals and their progeny. A wide range of chemicals, both natural and synthetic, have been found to have an endocrine disrupting effect.

The most important EDC's in municipal wastewater include natural hormones excreted from human and animal sources (such as 17β-estradiol, estrone, estriol, and testosterone) and synthetic hormones (such as 17α-ethinylestradiol which is used in birth control pills). Other EDC's common in municipal wastewater include alkylphenols (including nonyphenol and octylphenol), plasticisers (including Bisphenol A) and flame retardants such as PBDEs (Gadd 2009; Conwell and Clement 2009).

Investigations into the removal of EDCs in WWTPs in NZ, Australia and internationally show concentrations of most EDCs and estrogenic activity are greatly reduced by wastewater treatment processes. Activated sludge treatment (AST), which is proposed for Ruakaka in an SBR (Sequencing Batch Reactor) or Continuous Flow Activated Sludge Plant, is acknowledged as the most important step (Gadd 2009). Activated sludge typically reduces steroid estrogen concentrations by 80-100% (Auriol et al 2006, Baronti et al 2000). EDCs are removed to a greater extent by AST plants with longer hydraulic retention times and sludge retention times (Langford & Lester 2003).

Predicted EDC concentrations in treated wastewater from the proposed Ruakaka WWTP with AST and UV treatment (from Gadd 2009) are listed in Table 8.13.

The limited information available on predicted EDC concentrations in Ruakaka treated wastewater and predicted no effects concentrations (PNEC) in Bream Bay as assessed by NIWA (Gadd 2009), indicate that up to a 30-fold dilution may be required to ensure no effects on marine biota. As indicated in Table 8.6 predicted initial dilutions (as the plume discharges from diffuser ports and rises towards the water surface) are higher than 30-fold at most times. Initial dilutions less that 30-fold are predicted to occur occasionally during 2047 peak wet weather flows, typically only during slack water at the turn of the tide and well within the proposed 100m mixing zone. Predicted dilutions beyond a 100m radius mixing zone are no less than 89-fold at all times, even for peak wet weather flows at slack water at the 2047 design horizon.

This analysis indicates that the risk of endocrine disrupting effects will probably be limited to organisms resident in the immediate vicinity of the outfall diffuser, for instance encrusting organisms attached to the diffuser port, which are continuously exposed to an undiluted or nearly undiluted discharge plume.

Table 8.13 Predicted EDC Concentrations (mg/l) in Treated Wastewater from the Proposed Ruakaka WWTP and Available Information on the 'no observed effects concentration' (NOEC), 'lowest observed effects concentration' (LOEC) and 'predicted no effects concentration' (PNEC) (from Gadd 2009, Young et al 2002 & Caldwell *et al* 2008)

Compound	*Predicted concentration in Ruakaka treated wastewater*	*NOEC/LOEC or PNECs available for EDCs, for marine species*	*Dilution (fold) required for no effect*
17β-estradiol	<1- 6.2	1 (PNEC Young *et al* 2002)	6.2
Estrone	<1 – 39	3 – 5 (PNEC Young *et al* 2002)	13
17α-ethinylestradiol	<0.11 – 1.3	0.35 (PNEC Caldwell *et al* 2008)	3.7
Octylphenol	<10 – 240	35 (LOEC Echinoderm)	7
Nonyphenol	<10 – 2900	100 (LOEC pacific oyster)	29
Bisphenol A	<10 - 143	Not available	Not known

The potential effects of EDC's on organisms raised at the Bream Bay Aquaculture Park are addressed in Section 8.6.15.

8.6.14 Effects on Marine Mammals

As discussed in Section 8.3.7, several marine mammals including bottlenose dolphins, common dolphins, orca and Bryde's whale are frequent transients or seasonal transients in the coastal waters surrounding Bream Bay. Bottlenosed and common dolphins frequent inshore waters and may occasionally pass near the proposed outfall location. Conwell and Clement (2009) considered the risk to these species which may arise due the EDC and pathogen content of the proposed treated wastewater discharge. They note that even as semi residents, these generalist feeders potentially range and forage over 400 km of coastline. As a result, an individual animal would be expected to forage on prey fish that have been exposed the proposed wastewater discharge infrequently. They concluded that:

> "...*given the size of Bream Bay and the generally wide distribution of both the fish and marine mammal species that frequent these waters, their overall risk of EDC and/or pathogen bioaccumulation from the Ruakaka outfall discharge is expected to be low. Additional factors that*

help to reduce the chances of fish and mammal exposure to contaminants include the secondary and tertiary treatment of Ruakaka sewage, the relatively low levels of EDCs in New Zealand wastewater compared with Northern Hemisphere studies (especially PCBs), and the predicted scale of dilution and dispersion into Bream Bay coastal waters."

That conclusion is supported by the analysis given in Section 8.6.13 which indicates that the risk of toxicity effects relating to the proposed discharge is very low for transient species which pass near the outfall diffuser from time to time.

8.6.15 Effects on Commercial Aquaculture

NIWA's Bream Bay Aquaculture Park, which includes the OceaNZ Blue paua farm at Ruakaka, is a commercial aquaculture and research facility that could potentially be affected by an ocean outfall discharge into Bream Bay. Seawater needed to sustain the aquaculture operations is taken from Bream Bay via a pipeline extending 605 m offshore. The intake is approximately 2 metres above the seabed and approximately 6 metres from the surface (MSL).

NIWA raised concerns early with WDC about potential risks to the Aquaculture Park, which have subsequently been a key focus of the investigations programme. The dilution and dispersion modelling study (DHI 2010) included the NIWA intake as one of the 'sensitive sites' so that the outfall selection process could take account of potential effects on the Aquaculture Park seawater supply. NIWA were commissioned to undertake two technical reports, these being "*Ecotoxicity information on species cultured at NIWA Bream Aquaculture Park*" (Clearwater 2009) and "*Review of potential effects of endocrine disrupting compounds on marine species at Bream Bay Aquaculture Park"* (Gadd 2009). The output from these studies was considered by WDC prior to it reaching a decision on the proposed outfall location.

The NIWA intake is located approximately 3 km west-south-west of the proposed Ruakaka outfall diffuser. Modelling investigations based on a year-long model simulation predict that at the revised 2047 ADWF, the wastewater plume could move in the direction of the NIWA intake and receive a dilution at the intake of less than 5,000-fold for around 8.9% of the time. The predicted minimum dilution at the intake is 1,820-fold at 2047 ADWF, reducing to 405-fold for short periods at 2047 PWWF (refer section 8.5.3). The latter value is very conservative because, as already discussed, the modelled PWWF is now not expected to occur until after year 2060.

The review of ecotoxicity information (Clearwater 2009) highlighted the paucity of toxicity data for the 57 marine species being reared at the Aquaculture Park. Similarly, the review of potential effects of EDCs (Gadd 2009) found that there is very little information regarding the potential effects of EDCs on these species. This lack of information leaves some uncertainty around the risks presented to the Aquaculture Park by the proposed Ruakaka WWTP discharge. In response to this concern WDC has proposed both a high quality treated wastewater and a long ocean outfall which would ensure the discharge has low contaminant levels and is well removed from the NIWA water intake.

The information that is available indicates that toxicants and endocrine disrupting compounds, at the concentrations likely to be present in Ruakaka treated wastewater, will be sufficiently diluted after discharge to Bream Bay and having dispersed across nearly 3 km of coastal water to the Aquaculture Park water intake, as to present minimal risk to marine species reared at the Aquaculture Park. The assessment in Table 8.12 indicates that even during the 8.9% of the time when the discharge plume may disperse towards the NIWA intake, none of the available guidelines or trigger values is likely to be exceeded in water at the intake, even for the projected future worst case scenario (2047 PWWF).

The predicted effects of the proposed discharge on indicator bacteria (faecal coliform) content of coastal waters at the NIWA water intake are summarised in Table 8.14. In dry weather conditions the ADWF is not expected to cause any measurable change in the background faecal coliform content of water near the NIWA intake, which is typically less than 1/100ml. This is the case even during the 9% of the time when the WWTP discharge plume is pushed towards the intake by onshore winds.

During periods of sustained heavy rainfall, the Ruakaka River at high flow or flood can cause a significant but temporary increase in faecal coliform numbers in nearshore coastal waters around the NIWA intake. In these conditions the proposed PWWF discharge, in the worst case, is predicted to cause a further minor increase in faecal coliform numbers from 35/100ml to 37/100ml.

The proposed discharge will not cause the MfE (2003) guidelines for shellfish gathering waters to be exceeded in the vicinity of the NIWA intake.

Table 8.14 Predicted Worst Case Faecal Coliform Content (MPN/100ml) at NIWA Intake

Wastewater flow	*Waste-water concentration*	*Predicted Minimum dilutions At NIWA intake*	*Background coastal water concentration*	*Predicted receiving water conc. at NIWA intake*	*Guideline for shellfish gathering waters (MfE 2003)*
ADWF of 70 L/s	10	5780	<1.00	<1.00	median <14; 90% <43
ADWF of 244 L/s	10	1685	<1.00	<1.00	
PWWF of 972 L/s	1000	405	35	37	

8.6.16 Tangata Whenua Effects

The Whangarei District Council is acutely aware of the social and cultural concerns regarding the discharge of treated wastewater into the marine environment. Of particular concern to local iwi are the effects that wastewater can have on aquatic and marine life. This concern is shared by NIWA who own and operate the Aquaculture Park (NIWA Aquaculture Park) situated in Bream Bay.

The proposed treated wastewater median standard is described as a 5:5:10:10 standard, the values representing the respective concentrations of BOD, TSS, TN and FC. The Assessment of Environmental Effects (AEE) further elaborates on this high standard and compares it to ocean outfalls elsewhere in New Zealand, noting that it is a higher standard than any other existing or proposed ocean outfalls as far as WDC is aware.

Iwi are satisfied that treatment is of a higher than usual standard but have repeated their concerns about the impacts on the mauri, spiritual integrity of the water in Bream Bay, Te Tai Hoe a nga Tamahine. A higher standard of treatment does not necessarily address these issues.

To mitigate the effects on the mauri of Bream Bay, Te Tai Hoe a nga Tamahine it is proposed to implement a comprehensive cultural coastal health monitoring programme. This model will be based on the standard cultural health index models (CHI) developed around the country. The programme, in coordination with Patuharakeke Te Iwi Trust Board (PTB), will be initiated and funded by the applicant. The monitoring methodology will look to combine western science with matauranga Maori.

8.6.17 Cumulative Effects

It is recognized in New Zealand and elsewhere that while the effects of a particular activity on its own may be environmentally acceptable, the cumulative effects over time of many activities may not be acceptable. Section 17.8 of this AEE discusses cumulative effects generally. This section specifically refers to potential cumulative effects associated with consented discharges into Bream Bay. These consented discharges currently include:

- Mighty River Power discharge of stormwater and cooling water from the Marsden A power station site to Bream Bay via the existing Marsden A outfall pipeline extending some 610m offshore;
- Mighty River Power discharge of cooling water from the Marsden B power station site to Bream Bay via the existing Marsden B outfall pipeline extending some 860m offshore;
- NIWA discharge of seawater and stormwater from the Bream Bay Aquaculture Park to Bream Bay via the existing Marsden B outfall pipeline extending some 860m offshore;

- Marsden Point Oil Refinery discharge of seawater, treated wastewater, stormwater and groundwater to Whangarei Harbour entrance via an existing outfall.

There are also various point-source and diffuse discharges to the upper Whangarei Harbour and to the Ruakaka River which may influence the water quality in Bream Bay from time to time.

While the monitoring undertaken in Bream Bay by WDC as part of this application, and by NRC from a regional perspective, show some effects on water quality particularly from non point source discharges, these are mostly localised and minor, or are associated with high rainfall events where stormwater runoff from the land carries contaminants either directly into the Bay or via the Ruakaka River or the Whangarei Harbour. There is no evidence of significant adverse effects on the water quality or aquatic ecology of the wider area and indeed the overall environmental state of Bream Bay appears to very good.

One of the benefits of the proposed long ocean outfall, in conjunction with the high standard of treatment to be provided, is that, not only does it ensure the discharge would be well removed from sensitive recreational and commercial sites in Bream Bay but it also removes it from the vicinity of other discharges to the Bay and so minimises the risk that the combined effects of a these discharges might reach an unacceptable threshold level.

8.6.18 Mitigation

The 'Proposed Scheme', as described in Section 4, includes the following measures to avoid or mitigate adverse effects:

Construction and operation of a new, state of the art wastewater treatment plant at Ruakaka designed and operated to achieve a high standard of treated wastewater.

Construction of a long offshore ocean outfall and multiport diffuser extending approximately 3,000m offshore, ensuring the discharge is well removed from sensitive areas such as bathing beaches, shellfish gathering waters and the NIWA Aquaculture Park.

Flow management for utilising the existing oxidation ponds as contingency storage ponds at Ruakaka for storage of wastewater if required, thus avoiding or minimising the risk of having to discharge untreated or partially treated wastewater at times of peak wet weather flow or plant outage.

Extensive treated wastewater and receiving environment monitoring programme encompassed in the suggested resource consent conditions.

Use of review conditions in the consent to address new matters that may arise.

Pre-implementation / pre-construction reviews of key components of Proposed Scheme technology reviews to enable technology and management upgrades, where appropriate. Along with assessment of growth against projections and capacity of the Scheme at that time.

On-going involvement with tangata whenua and other stakeholders groups as included for in the suggested resource consent conditions.

8.6.19 Summary of Effects

This evaluation of potential effects of the proposed discharge of wastewater to Bream Bay through approximately 3,000m offshore outfall identifies a number of adverse effects on the receiving environment. These effects are no more than minor flows up to those projected to 2047. The magnitude and extent of these effects, taking into account the mitigation measures outlined in the previous section, are summarised below.

Table 8-15 Summary of Effects of Proposed Discharge of Wastewater

Adverse Effect	*Magnitude and Extent of Effect*	*Relevant Section of this AEE*
Water Quality: S107 • Visual & aesthetic • Effects on aquatic life (water temp, DO, pH, toxicity, EDCs, bio-accumulation)	Minor at edge of 100m mixing zone Minor at edge of 100m mixing zone	S8.6.2 - S8.6.4 S8.6.8 - S8.6.14
Contact Recreation • Microbiological Water Quality • Undesirable biological growths	Minor at edge of 100m mixing zone Minor in Bream Bay	S8.6.5 - S8.6.6 S8.6.11
Shellfish Gathering	Minor at Mair Bank	S8.6.5 – S8.6.6
Commercial Aquaculture	Minor at aquaculture park water intake	S8.6.14
Recreational & Amenity Effects	Minor at edge of 100m mixing zone	S8.6.6 – S8.6.7
Maori Cultural and Spiritual Effects	Although partly minimised and mitigated adverse effects still exist with the discharged of treated wastewater into the coastal marine environment.	S16

Positive Effect	*Magnitude and Extent of Effect*	*Relevant Section of this AEE*
Overall positive effect of having a safe water borne wastewater scheme.	Considerable positive effects.	Section 17.1