Waikato Regional Council Technical Report 2017/21

# Regional flood summary: Rainfall event 7 to 12 March 2017

www.waikatoregion.govt.nz
ISSN 2230-4355 (Print)
ISSN 2230-4363 (Online)

Waikato
REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

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March 2017

Document #: 10588909

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Date May 2017

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# Executive summary

The March rainfall event (colloquially known as the Tasman Tempest) was comprised of a series of heavy rainfall bands with the two most significant occurring overnight on 7/8 March and 10/11 March. The northerly, sub-tropical nature of the weather system and the stalling pattern made it very difficult to forecast exact timeframes and rainfall accumulation totals.

The purpose of the report is to:

- summarise the rainfall events, and the observed river flows and water levels that resulted
- describe the response of the Waikato Regional Council (WRC) to these events
- provide the rainfall and flood frequency relationships to inform scheme-specific performance reporting
- capture the chronology of events detailed in the Situation Reports issued by WRC offices during the events

It is not intended to describe or quantify the performance of WRC-managed flood protection schemes and/or land drainage schemes. This will be completed in subsequent level of service reviews and assessments.

The size of the event varied across the affected areas with the largest frequency events being recorded at Mangatangi (<1% annual exceedance probability[1] or AEP, which equates to a greater than a 100 year event) and Pinnacles (3-2% AEP or a 50 to 60 year event). The persistence of the rainfall throughout the week played a significant role in worsening impacts, with short gaps not allowing for full clean-up or any significant channel clearing work.

The Lower Waikato, Waihou/Piako, and Coromandel areas (or WRC catchment zones) were impacted with maximum river flow event frequencies of 20-10% (Mangatawhiri), 10-5% (Kauaeranga), and <2% AEP (Waiwawa) respectively.

The event caused a significant amount of disruption to infrastructure such as roading, power networks and water supplies. A number of communities were isolated throughout the week, particularly on 8 and 11 March after significant overnight rainfall.

Overall, WRC flood protection schemes in the affected areas performed as expected.

**Note:** The March (Tasman Tempest) event was followed by a series of events that occurred 4-14 April 2017 (Ex-Tropical Cyclone Debbie, a Tasman low pressure system, and Ex-Tropical Cyclone Cook). The March event described in this report led to saturated catchments that left the region more vulnerable to the impacts of the April events (described in Doc#10589816).

[1] An Annual Exceedance Probability is the probability of an event occurring in any given year. I.e. a 1% AEP means there is a 1% chance in any given year of the event occurring.

# 1 Overview of Event

The March 2017 rainfall event was caused by a northerly sub-tropical system that first encountered New Zealand on 7 March 2017. The system was laden with moist air and comprised of numerous circulating bands that distributed heavy rainfall (Table 1) and severe winds in an irregular, difficult to forecast pattern. The system stalled over New Zealand because it was trapped between two high-pressure systems (Figure 1). Such events are not uncommon at this time of year, however the length of time that the system remained over a relatively small section of the country (Northland to Waikato) was unusual.

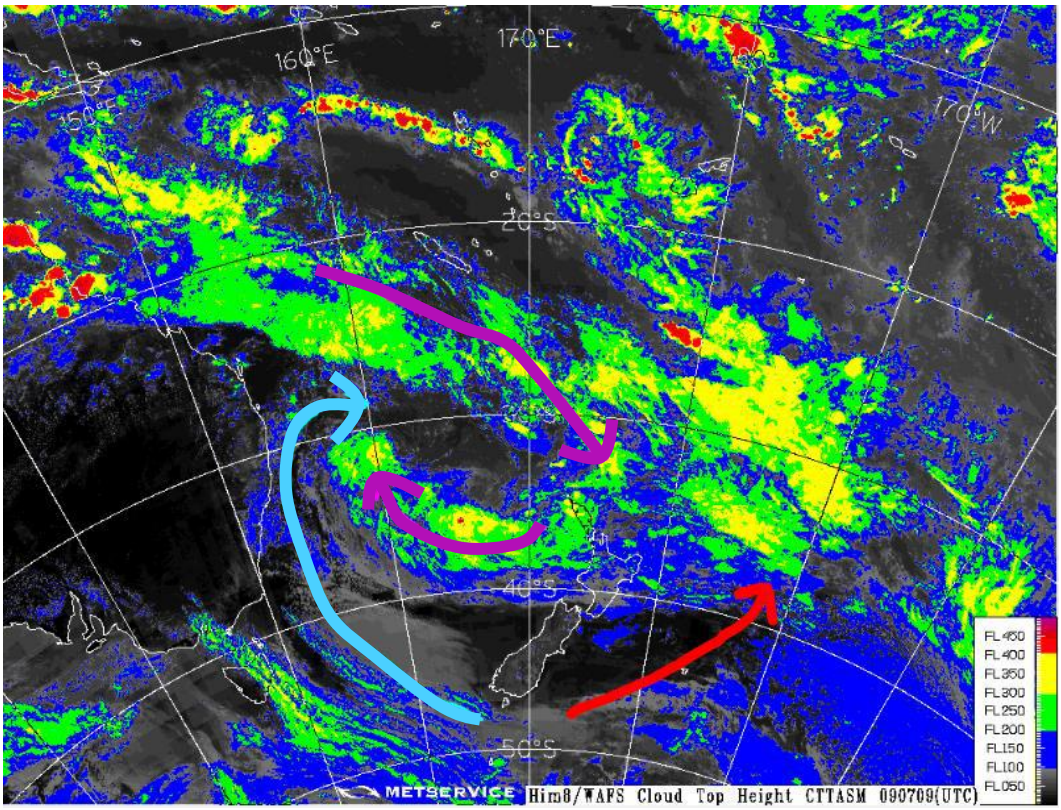



**Figure 1: Satellite imagery from 10 March showing the complex northerly system that stalled over the North Island from 7-11 March. This shows the conveyor belt of tropical air moving down and recirculating for another round (purple arrow); the high pressure system to the SE that is blocking the northerly and causing it to stall over the affected area (red arrow); and the cooler moisture-laden air being dragged up into the northerly system (blue arrow).**

## 1.1 MetService warnings and watches

A summary of associated warnings/watches are summarised in Appendix 1. A series of hazards advisories and updates were released by the WRC Regional Hazards team (which monitors rainfall events as outlined in the Regional Flood Response Management Plan, Section 3), these are also shown in conjunction with the associated MetService alerts in Appendix 1.

## 1.2 Rainfall levels

The weather events over the course of the week occurred as follows:

- Tuesday 7 March: Heavy rainfall warnings for Coromandel Peninsula and Waikato (including Waihou/Piako). Observed low pressure systems travelling across the Tasman picking up

moisture were forecast to drop this on the North Island overnight. Predicted to stall over the North Island and cause heavy rain to continue for the remainder of the week. Peak rainfall intensity overnight exceeded 70 mm per hour (Pinnacles).

- Wednesday 8 March: Rain eased throughout the day, however persistent showers continued. The second band of the northerly low pressure system was observed travelling across the Tasman and predicted to affect later in the week same regions as first main band.
- Thursday 9 March: Intermittent showers, but overall a break in the weather system.
- Friday 10 March: Second major rain band in the system caused heavy rain overnight, although with lower accumulations than the initial event on 7/8 March. Peak intensities reached 42 mm per hour (Pinnacles).
- Saturday 11 March: Periods of heavy rain, particularly in the morning with strong northerly winds. Clearing through the day.
- Sunday 12 March: Further rain throughout the day with heavy rainfall periods in the afternoon. Heaviest rain in the upper Waihou area. Gusty northerlies across the region.

The 12 hour rainfall totals from these events are summarised in Table 1 and the main rainfall events illustrated in Figure 2.

**Table 1: 12 hour rainfall totals throughout event.**

| Rainfall Station | Tues 7 | Wednesday 8 | | Thursday 9 | | Friday 10 | | Saturday 11 | | Sunday 12 | | Event Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12:00-00:00 | 00:00-12:00 | 12:00-00:00 | 00:00-12:00 | 12:00-00:00 | 00:00-12:00 | 12:00-00:00 | 00:00-12:00 | 12:00-00:00 | 00:00-12:00 | 12:00-00:00 | |
| Castle Rock | 71.0 | 88.0 | 20.5 | 10.5 | 10.0 | 0.5 | 90.5 | 57.5 | 2.5 | 20.0 | 16.0 | 387 |
| Pinnacles | 99.0 | 333.5 | 61.5 | 51.0 | 58.5 | 12.5 | 135.0 | 60.0 | 8.0 | 10.0 | 26.5 | 855.5 |
| Golden Cross | 22.0 | 114.5 | 28.0 | 2.5 | 14.0 | 11.5 | 129.0 | 40.0 | 1.0 | 13.0 | 36.5 | 412 |
| Queens Head | 26.0 | 88.5 | 23.0 | 0.5 | 3.5 | 10.0 | 81.0 | 30.0 | 0.0 | 14.5 | 20.0 | 297 |
| Te Aroha | 14.5 | 59.5 | 6.0 | 0.0 | 0.0 | 2.0 | 52.0 | 24.5 | 0.0 | 2.5 | 44.5 | 205.5 |
| Maunga-kawa | 2.5 | 0.0 | 3.5 | 0.0 | 0.0 | 0.0 | 78.5 | 44.5 | 2.0 | 1.0 | 5.0 | 137 |
| Ruakura | 31.4 | 35.8 | 6.8 | 0.2 | 0.0 | 0.0 | 45.0 | 36.8 | 0.4 | 0.8 | 9.6 | 166.8 |
| Control Structure | 56.0 | 74.0 | 1.0 | 0.5 | 0.0 | 0.0 | 48.5 | 44.0 | 0.0 | 0.0 | 34.0 | 258 |
| Manga-tangi | 50.5 | 156.5 | 2.5 | 0.0 | 0.0 | 1.5 | 68.0 | 45.0 | 0.0 | 18.0 | 17.0 | 359 |

The heaviest rainfalls recorded in the event were in the Hunua area. These levels reached over 1% AEP (annual exceedance probability) which is equivalent to a 100-year ARI (average recurrence interval) for 6, 12, and 24 hour time intervals (Figure 3). The method of estimating rainfall frequencies is presented in Appendix 2.

NIWA confirmed that the peak rainfall intensity at Whangamata township ranged between 5 and 10 year return period for events of 1 to 24 hours (Chris Brandolino, Pers. Comm. 21/03/2017). It is possible that in some higher elevation surrounding catchments, where no data is available, rainfall was more intense, which would account for the severity of the flooding in the area.

Northern Coromandel received much lower rainfall totals than forecast. This led to relatively few issues in this area.

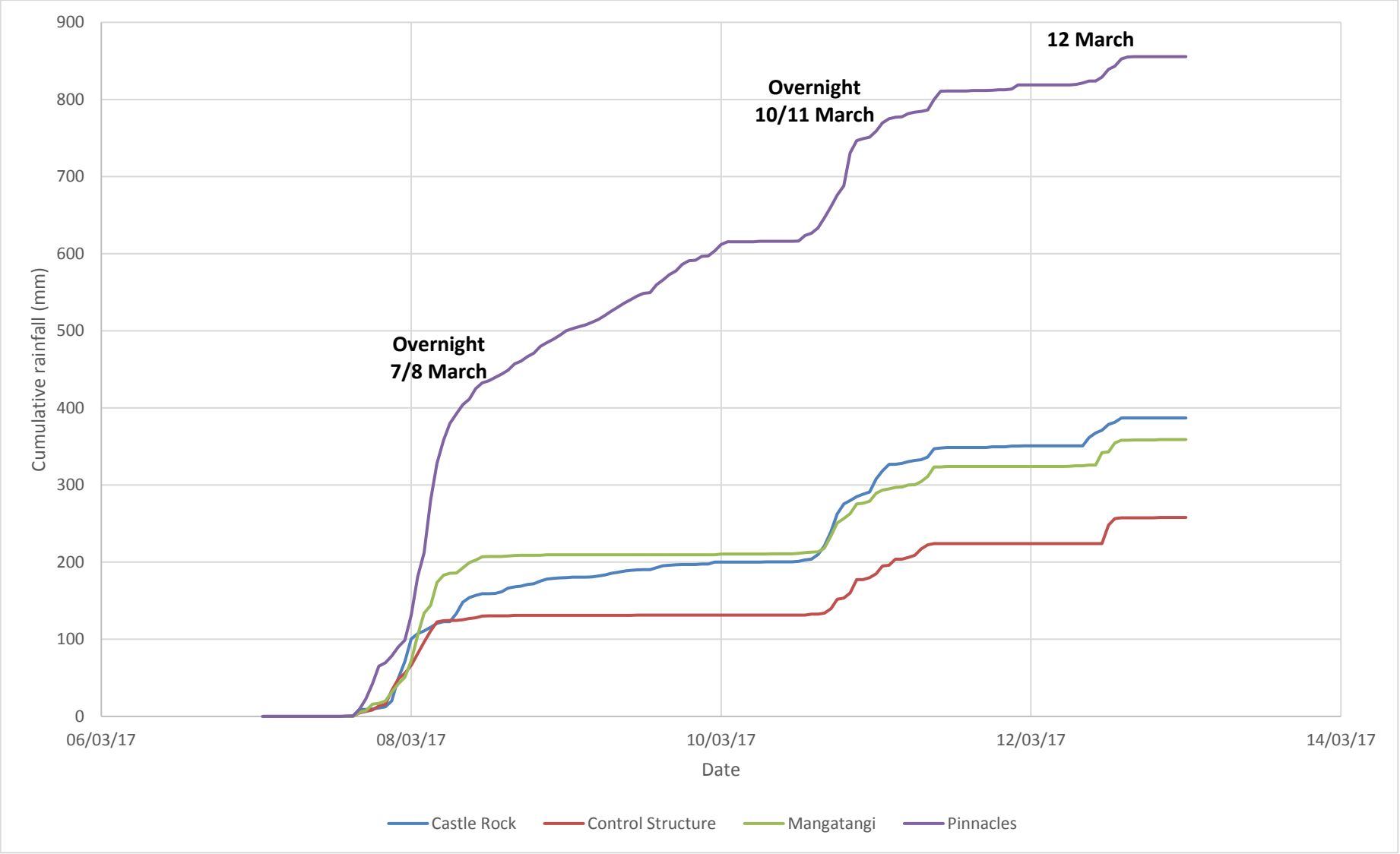
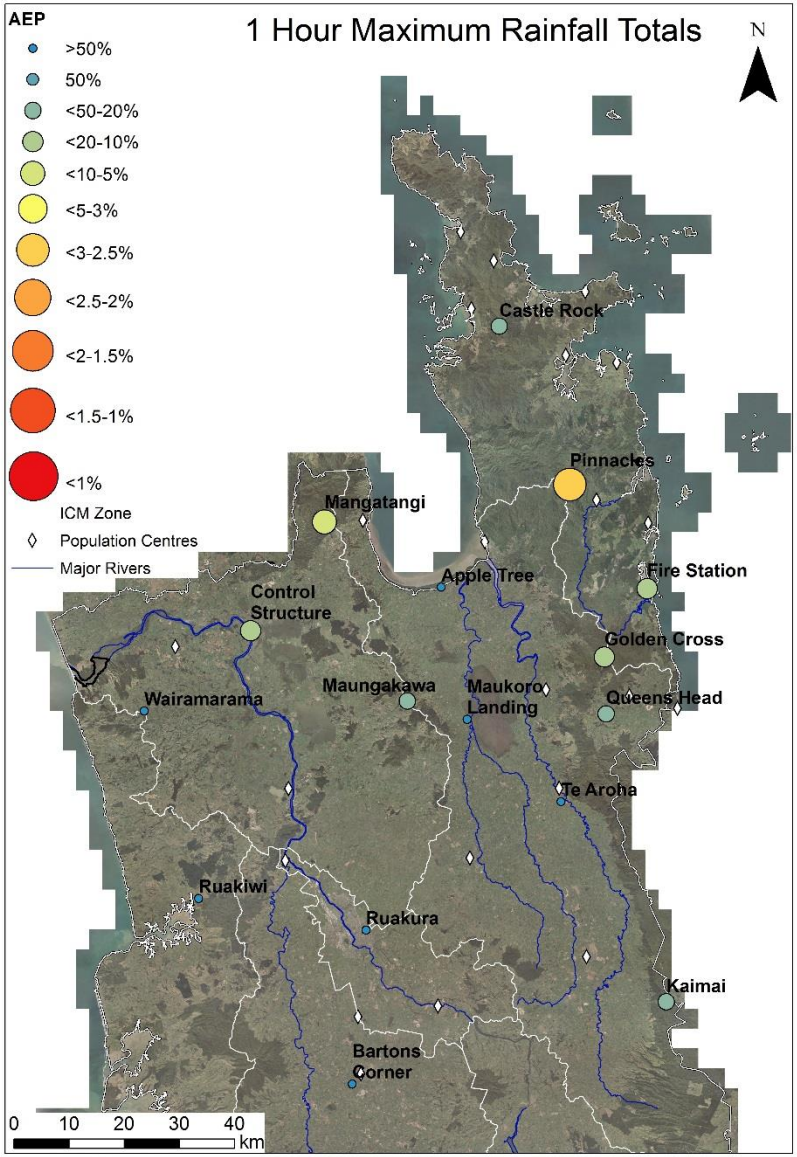
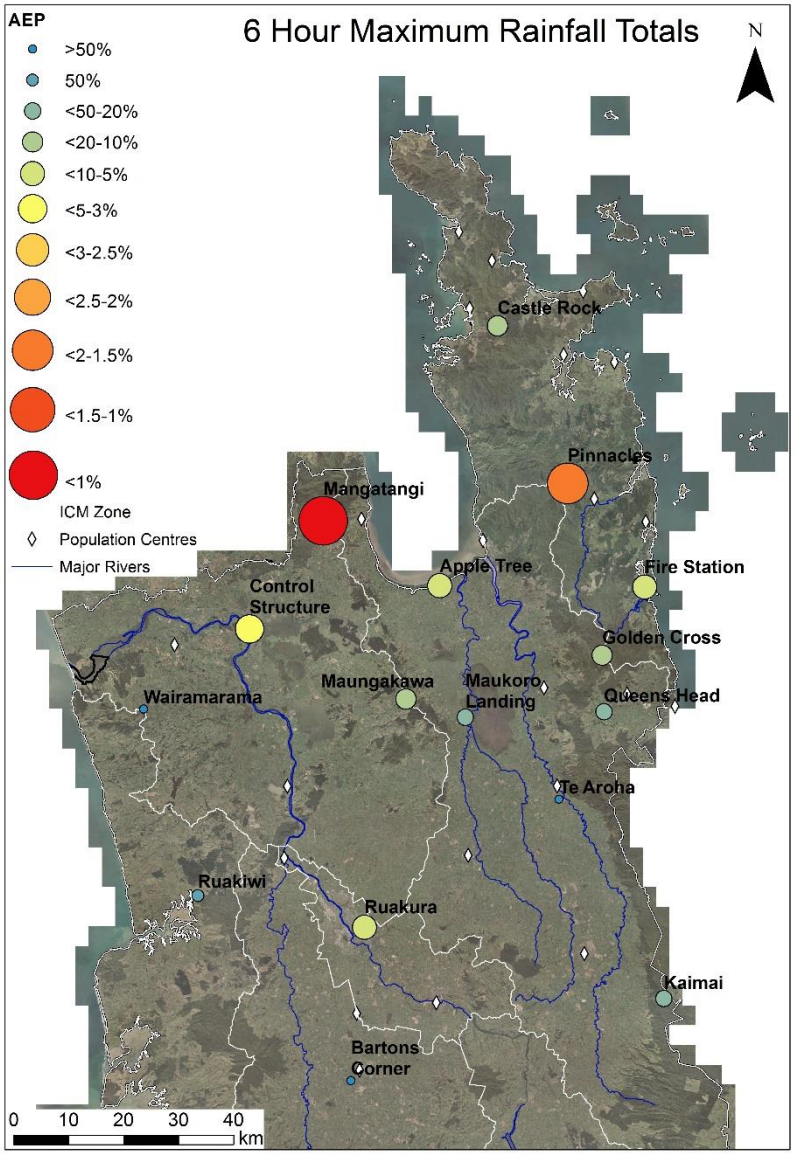
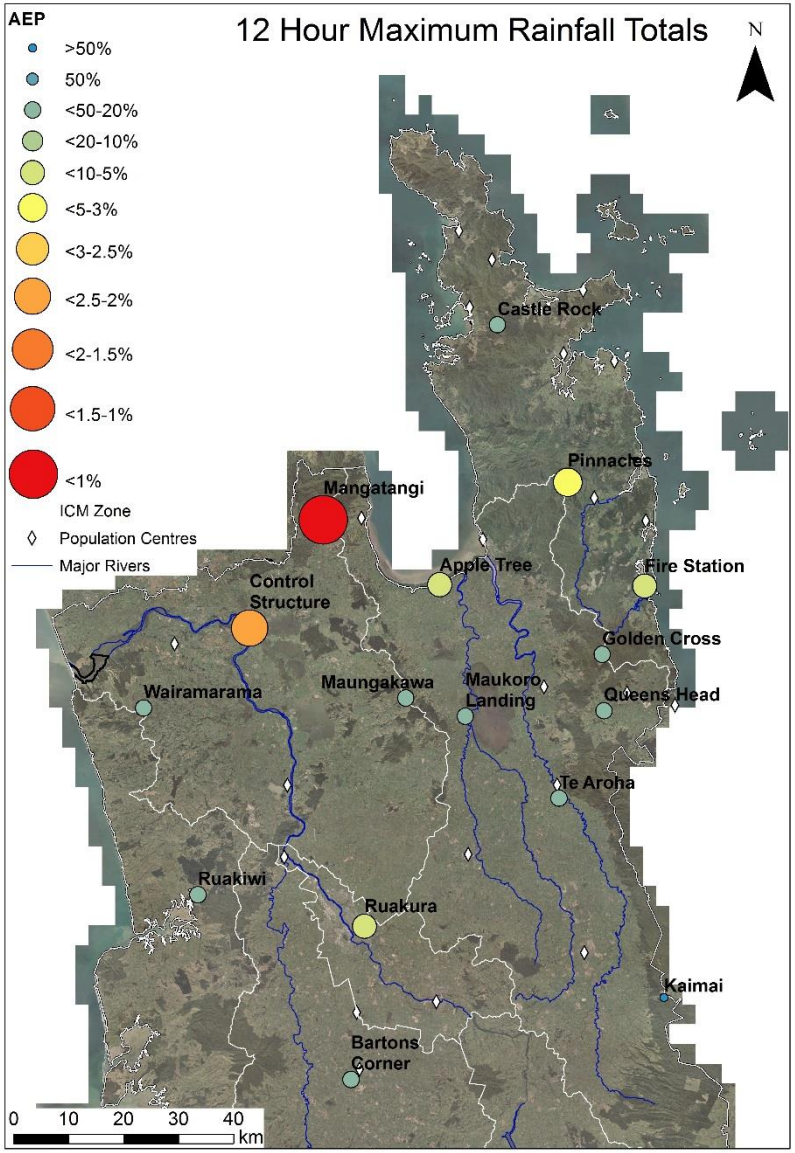



**Figure 2**: **Graph showing cumulative rainfall totals for telemetry sites over the week. This shows the main rainfall events that the weather systems caused.**


1 Hour Maximum Rainfall Totals
AEP
>50%
50%
<50-20%
<20-10%
<10-5%
<5-3%
<3-2.5%
<2.5-2%
<2-1.5%
<1.5-1%
<1%
ICM Zone
Population Centres
Major Rivers
N
Castle Rock
Pinnacles
Mangatangi
Apple Tree
Fire Station
Control Structure
Golden Cross
Wairamarama
Maungakawa
Maukoro Landing
Queens Head
Te Aroha
Ruakiwi
Ruakura
Kaimai
Bartons Corner
0 10 20 30 40
km


6 Hour Maximum Rainfall Totals
AEP
>50%
50%
<50-20%
<20-10%
<10-5%
<5-3%
<3-2.5%
<2.5-2%
<2-1.5%
<1.5-1%
<1%
ICM Zone
Population Centres
Major Rivers
N
Castle Rock
Pinnacles
Mangatangi
Apple Tree
Fire Station
Control Structure
Golden Cross
Wairamarama
Maungakawa
Maukoro Landing
Queens Head
Te Aroha
Ruakiwi
Ruakura
Kaimai
Bartons Corner
0 10 20 30 40
km


12 Hour Maximum Rainfall Totals
N
AEP
>50%
50%
<50-20%
<20-10%
<10-5%
<5-3%
<3-2.5%
<2.5-2%
<2-1.5%
<1.5-1%
<1%
ICM Zone
Population Centres
Major Rivers
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Apple Tree
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Wairamarama
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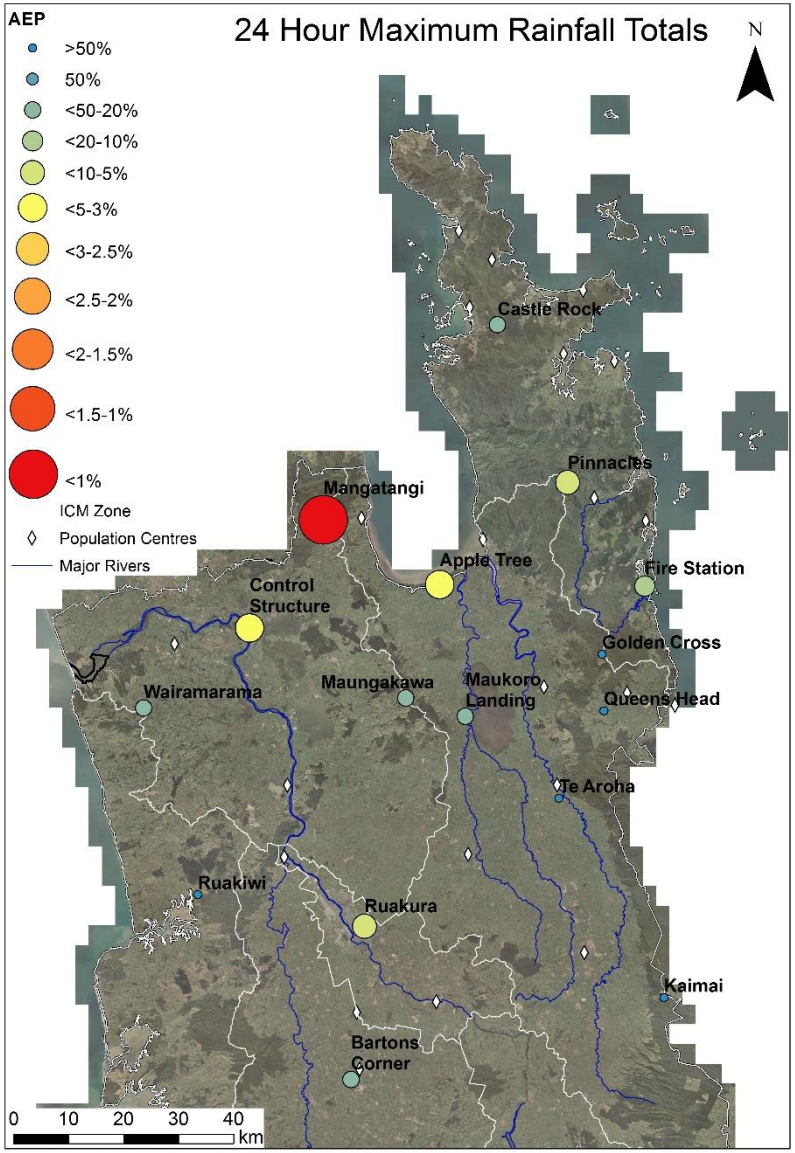
Maukoro Landing
Queens Head
Te Aroha
Ruakiwi
Ruakura
Kaimai
Bartons Corner
0 10 20 30 40
km


24 Hour Maximum Rainfall Totals
N
AEP
>50%
50%
<50-20%
<20-10%
<10-5%
<5-3%
<3-2.5%
<2.5-2%
<2-1.5%
<1.5-1%
<1%
ICM Zone
Population Centres
Major Rivers
Castle Rock
Pinnaches
Mangatangi
Apple Tree
Fire Station
Control Structure
Golden Cross
Wairamarama
Maungakawa
Maukoro Landing
Queens Head
Te Aroha
Ruakiwi
Ruakura
Kaimai
Bartons Corner
0 10 20 30 40
km

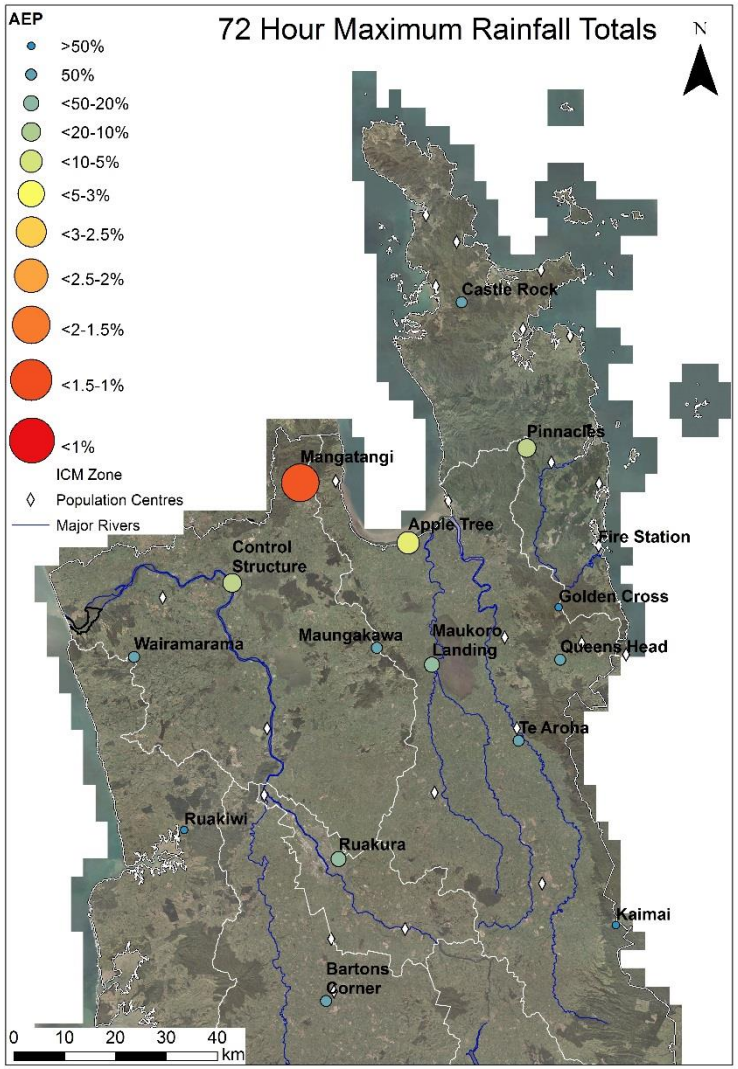



**Figure 3: Maps showing the annual exceedance probabilities for maximum rainfall accumulations over various timeframes (1hour, 6 hours, 12 hours, 24 hours, and 72 hours).**

## 1.3 River levels

Peak river levels for sites monitored in affected areas of the Waikato region are listed in Table 2 and their locations shown in Figure 4.

Peak river levels in the Orere River at Point Road Bridge reached between 2% and 1% AEP (50 to 100 year ARI) levels, which corresponds with where the highest rainfall event occurred. Note that the Orere River monitoring site is outside the WRC boundary as shown in Figure 4.

The site at Smiths in the Kauaeranga River recorded a 10% to 5% AEP (10 to 20 ARI) event immediately after the initial heavy rainfall band (8 March 05:45). This corresponds with the first time the spillway operated during the event (see Section 4.2.1.1). The second time the spillway operated (10 March 23:25) the levels corresponded with a similar sized rainfall event.

River levels were elevated compared to normal March levels over much of the northern part of the Waikato Region (including the Lower Waikato Zone). This was due to heavy rainfall throughout the catchment. The need to create storage in the upper Waikato catchment meant that Taupo and Karapiro outflows (controlled by Mercury in discussion with WRC during flood events) were maintained at an upper level, causing elevated levels in the Lower Waikato compared to March averages. However, despite this levels and flow remained below annual flood levels.

Many smaller rivers and streams in the Coromandel may have had river levels that reached higher return period estimates. However, data is not available to accurately calculate and identify these. The methodology to determine river level frequencies is contained in Appendix 2.

Scheme specific design flow calculations are in progress for the Piako River and will be incorporated into the upcoming level of service review (scheduled late 2017).

**Table 2: Timing of peak river levels shown on map below (Figure 4).**

| Telemetry Location | Waterway | Zone | Time of peak level | Peak level (m RL) | Return Period (years) | AEP (%) |
|---|---|---|---|---|---|---|
| Rangihau Road | Waiwawa | Coromandel | Gauging station damaged by debris (estimated RL 5.57 m from debris line) | | Est. >50 | <2 |
| Orere Point Road Bridge | Orere | Waihou/Piako | 8/3/2017 01:50 | 2.151 | 50 to 100 | 2-1 |
| Smiths | Kauaeranga | Waihou/Piako | 8/3/2017 05:45 | 11.418 | 10 to 20 | 10-5 |
| Adams Farm Bridge | Wharekawa | Coromandel | 8/3/2017 05:25 | 3.546 | 5 to 10 | 20-10 |
| SH2 | Mangatawhiri | Lower Waikato | 8/3/2017 05:45 | 7.648 | 5 to 10 | 20-10 |
| Broken Hills | Tairua | Coromandel | 10/3/2017 22:45 | 5.129 | 5 to 10 | 20-10 |
| SH2 | Mangatangi | Waihou/Piako | 8/3/2017 09:30 | 13.121 | 2 to 5 | 50-20 |
| Karangahake | Ohinemuri | Waihou/Piako | 10/3/2017 23:50 | 15.818 | 2 to 5 | 50-20 |
| Jefferis | Mangawara | Lower Waikato | 11/3/2017 02:50 | 20.482 | 2 to 5 | 50-20 |
| Tapu-Coroglen Road | Tapu | Coromandel | 8/3/2017 06:25 | 2.093 | 2 | 50 |
| Queens Head | Ohinemuri | Waihou/Piako | 8/3/2017 10:40 | 4.762 | 2 | 50 |
| Awaroa Confluence | Opitonui | Coromandel | 11/3/2017 01:25 | 3.01 | <2 | >50 |
| Kiwitahi | Piako | Waihou/Piako | 11/3/2017 19:30 | 2.385 | <2 | >50 |
| Paeroa-Tahuna Road | Piako | Waihou/Piako | 12/3/2017 13:40 | 4.974 | <2 | >50 |
| Okauia | Waihou | Waihou/Piako | 12/3/2017 22:25 | 29.12 | <2 | >50 |
| Waharoa | Waitoa | Waihou/Piako | 13/3/2017 01:00 | 46.962 | <2 | >50 |
| Pinedale | Oraka | Waihou/Piako | 13/3/2017 03:30 | 2.073 | <2 | >50 |
| Te Aroha | Waihou | Waihou/Piako | 13/3/2017 19:35 | 10.159 | <2 | >50 |
| Waitoa | Mellon Road | Waihou/Piako | 16/3/2017 06:26 | 7.269 | <2 | >50 |

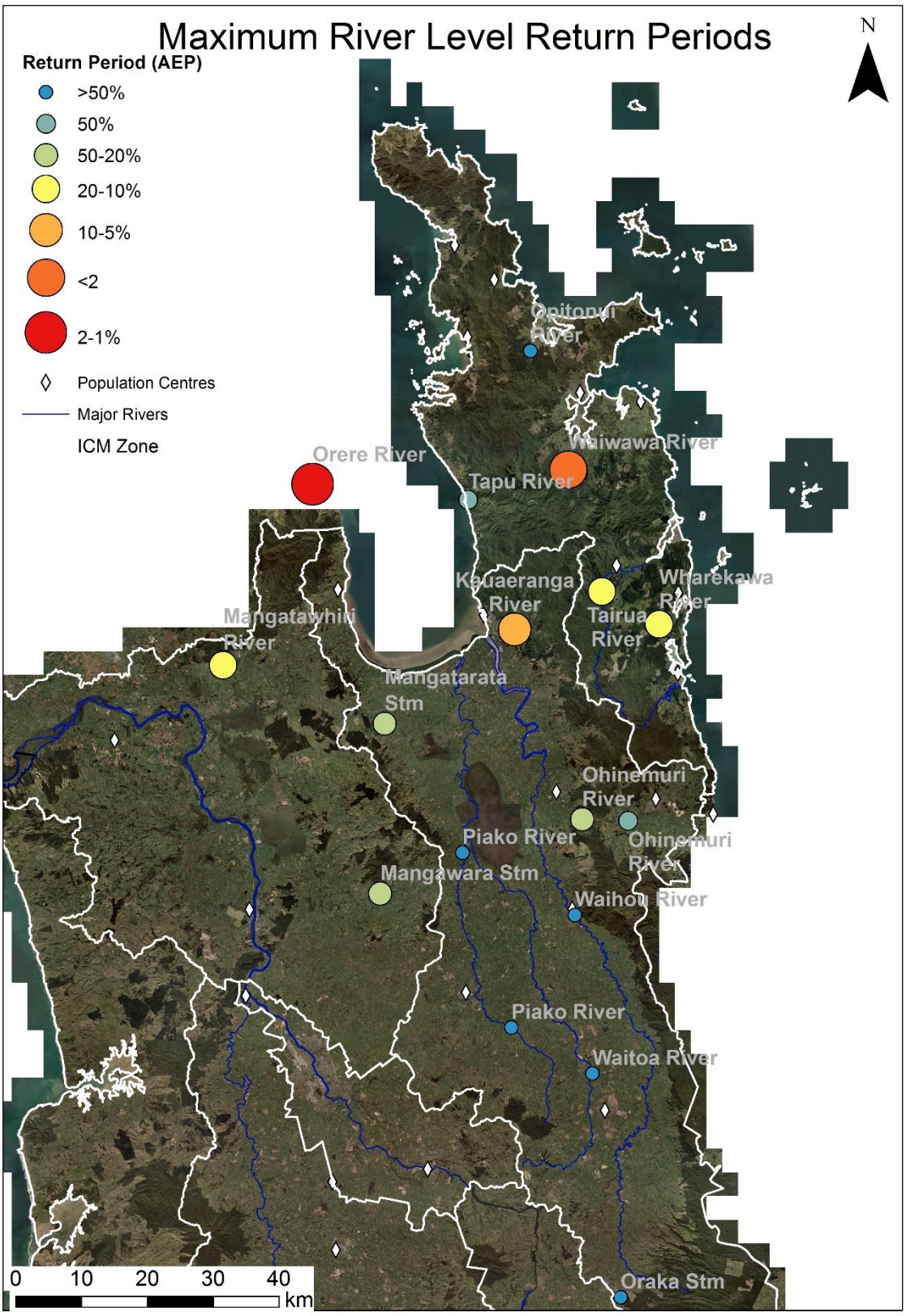



**Figure 4: Maximum river levels over the event showing distribution of the return periods reached.**

# 2 Relevant WRC flood protection schemes

## 2.1 Coromandel Zone

Flood protection in the Coromandel Zone is made up of numerous smaller schemes protecting individual catchments (Morris et al. 2012). The main works are at:

- Grahams Creek (Tairua) - channel contouring, stopbank and floodgate designed to alleviate flooding to a 2% (left bank) and 1% AEP (right bank) levels (Grant 2014).
- Karaka Stream and a small section of the Whangarahi near the retirement village (Coromandel town) – These relatively short sections of stopbanks were designed to a 1% AEP standard, however this does not include a climate change component.
- Te Puru Stream (Te Puru) - 144 m of stopbanks and ~950 m of floodwall that has a design standard of 1% AEP (only ~150m of floodwalls account for 0.5 m of future sea level rise, other sections do not include a sea level rise component in their design level).
- Waiomu Stream (Waiomu) – Stopbanks and floodwalls (100m and 20m in length respectively) that protect the holiday park are designed to 1% AEP levels with 0.5m sea level rise incorporated. The smaller section of stopbanking further upstream is designed to a 2% AEP level.
- Tararu Stream (Tararu) –

## 2.2 Waihou/Piako Zone

The Waihou Valley Flood Protection Scheme was built in the 1980's to 1990's and comprises 175 km of works including stopbanks, 20 pumpstations, 75 floodgates and drainage control works. The purpose of the scheme is to protect agricultural land in the zone between Te Aroha and the Firth of Thames, stabilise channels in the area from Te Aroha south, and provide protection to urban areas of Thames, Paeroa, and Te Aroha (Basheer 2002).

The Waihou flood protection begins at Te Aroha where the western bank provides 1% AEP level protection, in order to prevent the Waihou flowing across the plains and joining with the Piako River. Immediately downstream of Te Aroha there are stopbanks on both sides of the river providing a lower standard of protection (mostly 10% AEP design standard). At the southern outskirts of Paeroa the protection levels increase back to 1% AEP levels along the Waihou and the confluence of the Ohinemuri River. Numerous other tributaries are stopbanked at a 10% AEP standard, with the exception of the Hikutaia and Kirikiri Streams which are at 2% due to nearby urban areas requiring protection. This protection continues until the Waihou drains into the Firth of Thames (Peploe et al. 2011).

The Piako River Scheme was primarily built in the 1960's and 1970's, with some single components built prior to this and later incorporated into the scheme. It is comprised of 166 km of stopbanks, 59 floodgates, and 32 pumpstations (Peploe et al. 2011).

The Piako flood protection is more complex than the Waihou, owing to its relationship with the Kopuatai peat dome and its emergency ponding areas. The protection begins at Paeroa Tahuna Road and runs along both sides of the river to the Waitoa River confluence. Here, the stopbanking ends on the eastern side (true right bank) but continues to the west (left bank) until the Elstow canal joins the Piako on the eastern side. Between the Waitoa River and the Elstow Canal are a series of ponding zones running along the western side of the Kopuatai peat dome. These ponding zones are shown in Figure 5 and can be divided into four main types: 1) uncontrolled ponding areas where water can freely pond immediately alongside the peat dome; 2) an initial ponding area that is flooded relatively frequently; 3) the first emergency ponding zone that will be inundated when flows approach 10% AEP levels and the stopbanks in this area begin to spill; and 4) the second emergency ponding zone which will have water spill into it when flows approach 5% AEP levels.

The flood protection assets to the north of the ponding zones provide 1% AEP level protection for both Piako River flood flows and tide levels. Foreshore stopbanks bounding the Firth of Thames are all designed to 1% AEP levels. Flood protection scheme components across the Waihou/Piako Zone are shown in Figure 5.

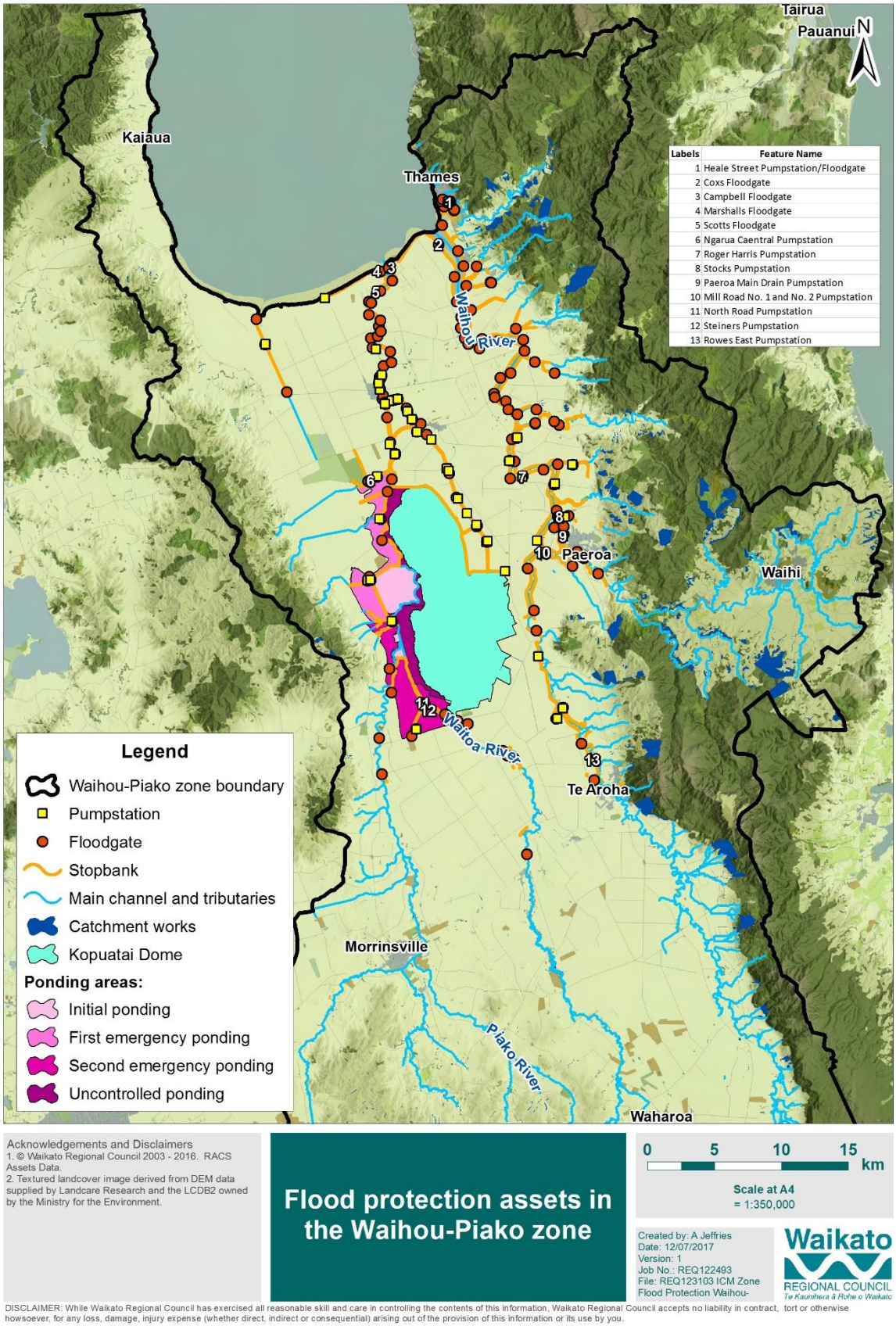



**Figure 5: Flood protection scheme components discussed in Waihou/Piako Zone April event observations.**

The other major flood protection scheme in the Zone, is the Kauaeranga River Scheme. This protects 13,000 hectares of land with 190 metres of stopbanks. It is designed to provide protection in a 1% AEP river flood event and protect against sea inundation to 3 metres above current mean sea level (WRC leaflet July 2016, #5031). One of the major management issues in a flood event in this zone is the Thames-Kauaeranga Bridge where a spillway operates. The

spillway is located immediately upstream of State Highway 25 at the southern entry to Thames. It allows flood waters to be safely discharged from the Kauaeranga River into the Firth of Thames, protecting the town from higher peak flood flows (Figure 6).

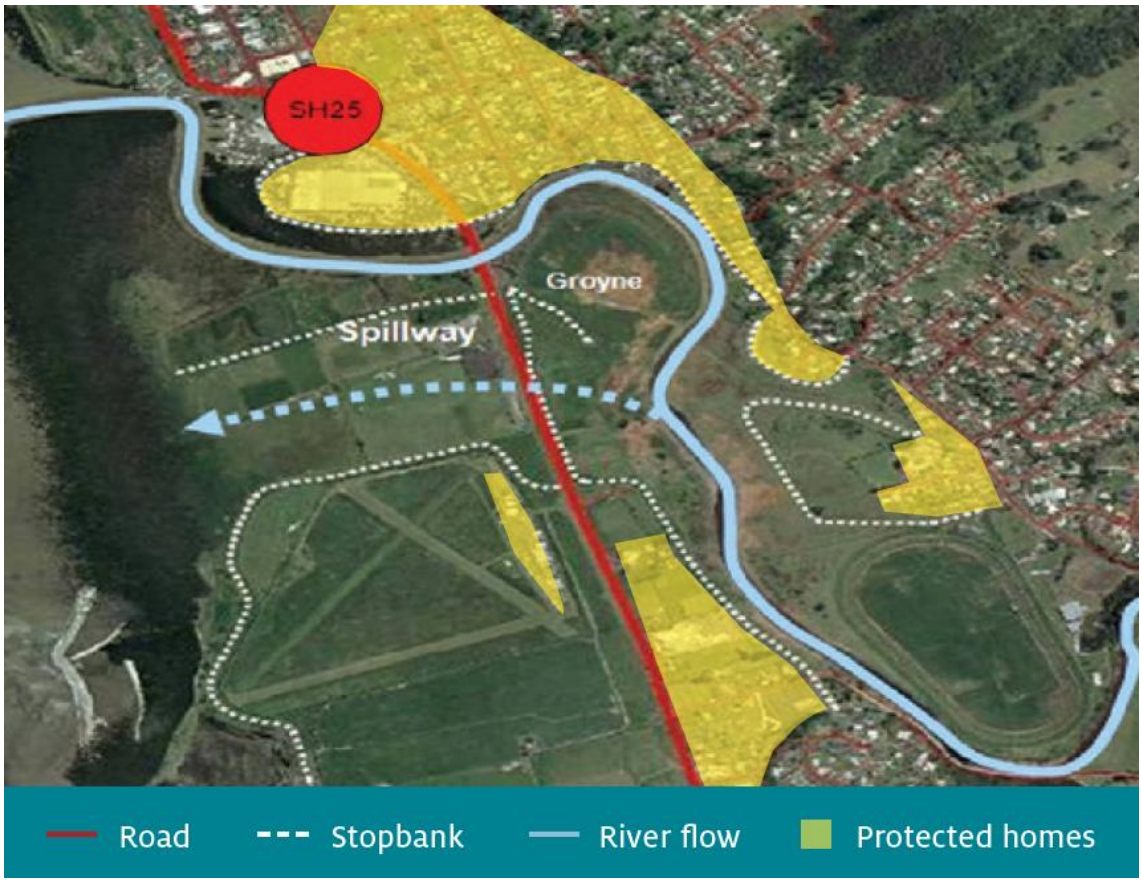



**Figure 6: Diagram showing the Kauaeranga River flood protection infrastructure and spillway at the southern end of Thames.**

## 2.3 Lower Waikato Zone

River flood flows in the Lower Waikato Zone are dependent on flows from the Upper Waikato (partially managed by the nine hydro-dams that are part of the Waikato Hydro Scheme) and the Waipa River (uncontrolled, low gradient, confluence at Ngaruawahia). The Lower Waikato flood protection works are comprised of 250 km of stopbanks, 63 pumpstations, 247 floodgates, and numerous other river works (Figure 7).

Stopbanks along the main Waikato River channel south of Rangiriri are of a 1% AEP design standard, with 600 mm freeboard through Huntly and 300 mm freeboard between Huntly and Rangiriri. Protection on both sides of the river between Rangiriri and Te Kohanga is at 5% AEP level with 600 mm freeboard. At Te Kohanga on the southern side (left bank) and part of Aka Aka on the northern side (right bank) is designed to provide 1% AEP protection with 300 mm freeboard.

There are also flood protection structure outside of the main Waikato River channel. These range from 1% AEP design (Lake Waikare and Whangamarino from Waikato River), 2% AEP design (Mangawara River), and 5% AEP design (Ruawaro and Deroles from Lake Whangape; Mangatawhiri River downstream of SH2), and 14% AEP (Mangatawhiri River upstream of SH2) (Peploe et al. 2011b).

Numerous drainage compartments are also in place across the Lower Waikato Zone. These provide land drainage for agriculturally productive land and most are designed to allow for the drainage of ponded water after a 10% AEP rainfall event within three days (Figure 7).

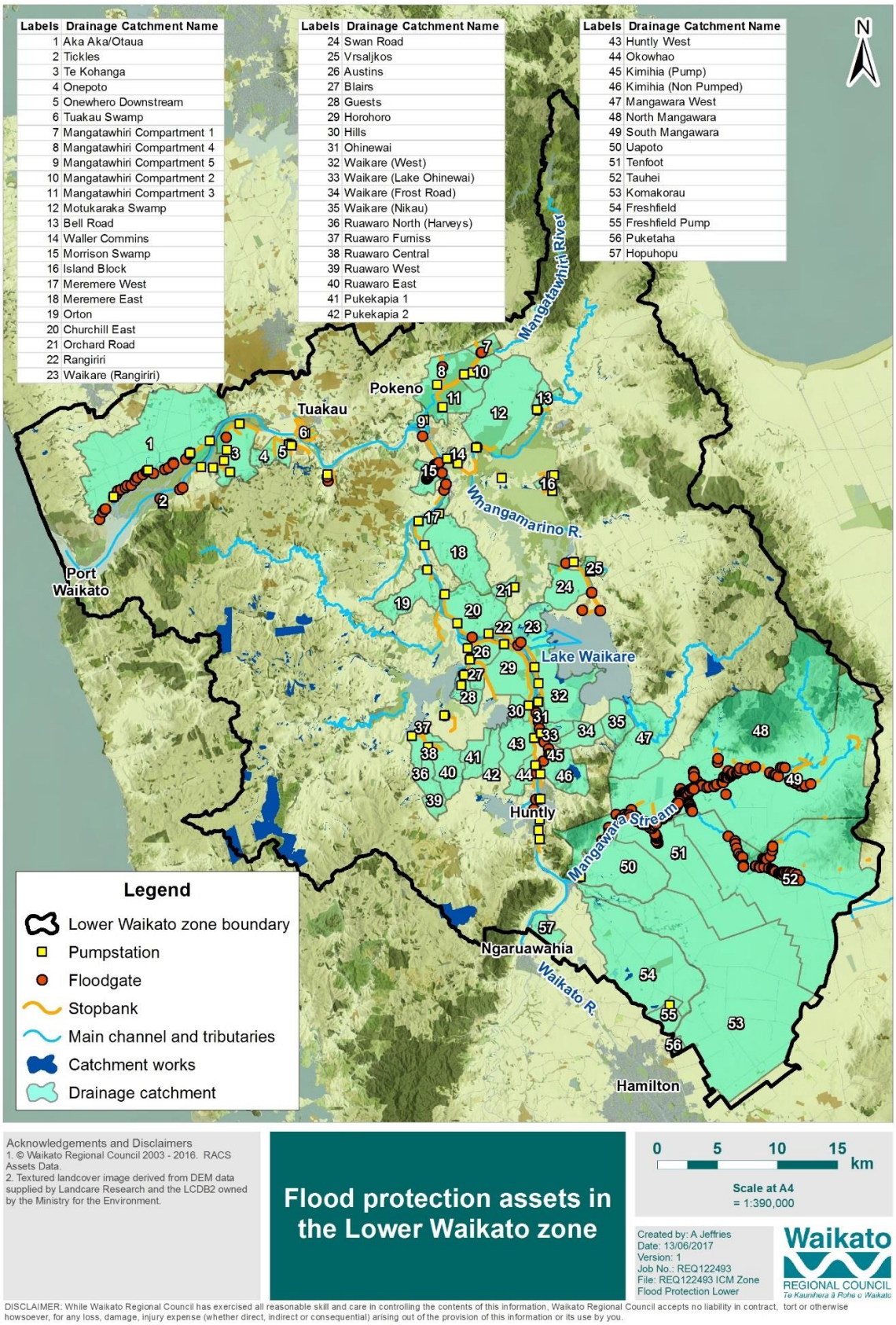



**Figure 7: Flood protection scheme components and drainage schemes discussed in Lower Waikato Zone April event observations.**

The Lower Waikato Control Scheme (Figure 8) offers protection to the Lower Waikato Zone downstream of Rangiriri. The scheme diverts water from the Waikato River into Lake Waikare and the Whangamarino Wetlands during times of high flow. The scheme provides storage when Waikato River flow exceeds 2% AEP levels. The level of Lake Waikare is regulated through an outlet canal with gates allowing drainage into the Whangamarino Wetland. Control structures

at the Rangiriri spillway between the Waikato River and Lake Waikare ensure that during non-flood events the lake level remains slightly below where it naturally would be. Then during times of high flow water uses the spillway to flow into the lake. As Lake Waikare fills there is less pressure on stopbanks along the Waikato River, further reducing the chance of substantial flooding in the northern part of the Lower Waikato Zone.

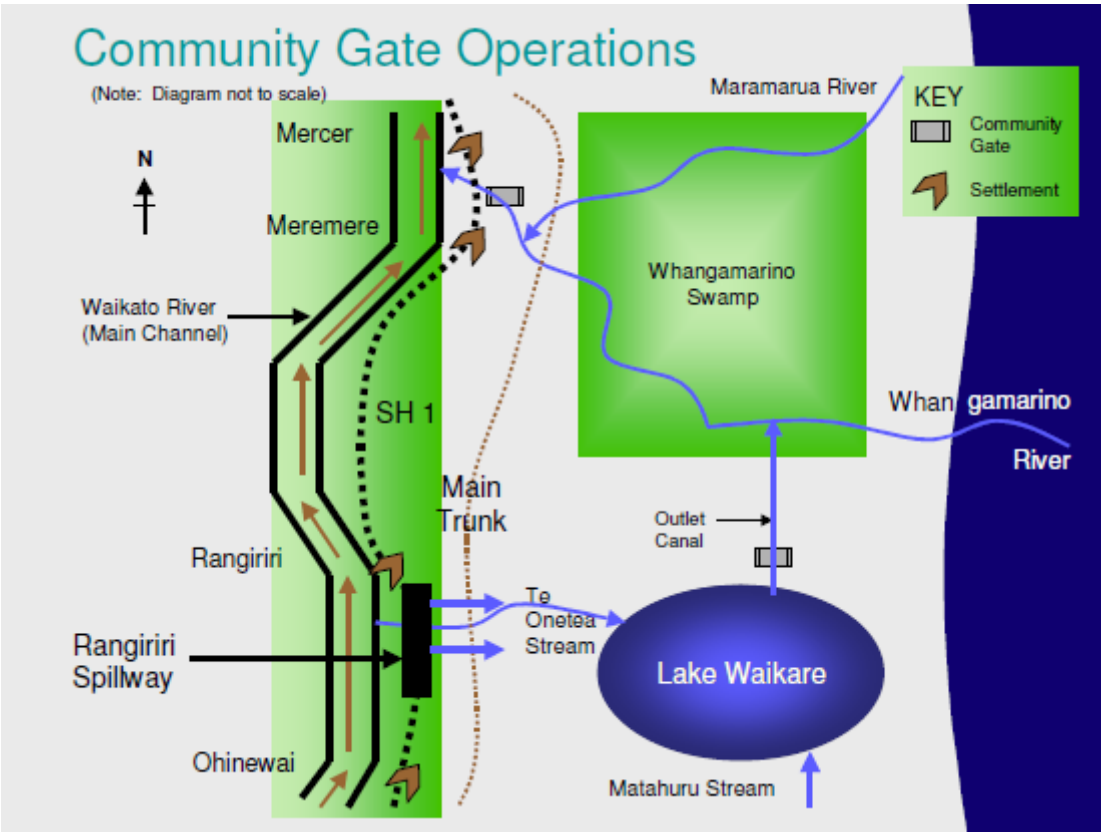



**Figure 8: Conceptual diagram of the Lower Waikato Control Scheme.**

# 3 Regional Flood Response

## 3.1 Regional Flood Response Management Plan

The Regional Flood Response Management Plan (RFRMP) is a document that informs and directs the management and coordination of WRC staff responding to a flood event. It sets out the roles and responsibilities for staff, transition steps moving into response and through to remediation, trigger points for determining the scale of the event (Section 2.2), and the flood debrief and reporting process.

One of the key functions described is the interaction between the Local Coordinators (Zone or Section Manager), and the Regional Flood Response team (involving key rostered staff). Figure 9 shows how these roles interface with each other, Civil Defence, the WRC Governance Group, and WRC local office operations staff (based in Whitianga, Paeroa, Te Aroha, Gordonton, and Taupō).

## 3.2 Determination of flood scale and severity

Determining the scale of a flood event is a key part of the critical path for matching resourcing and providing structure as part of response. The likely event and flood response scale is formally declared at the beginning of a response to give time for planning and operational response, and to allow WRC to communicate on the likely extent and severity of the event. Scale is also relevant to forward planning for remediation activities.

The council operates a three tier system based on geographic spread to define the scale of the flood response required and the likely resourcing that is likely to be required. A summary of each scale is as follows, with further detail in Table 3:

1. Event can be dealt with within existing resources of local office team (regional team monitoring and on standby), developing situation coordinated locally.
2. Capacity and capability of local office team starts to become stretched but event is still managed locally with regional response team oversight (i.e. regional team is activated in support, opens "flood room" to monitor event and liaise with local offices and stakeholders).
3. Flood event extends beyond capacity of the local response team/office and event is now fully coordinated/managed by the regional flood response team.

**Table 3: Flood event scale indicators**

| Scale | Type of event | Area offices directly involved in flood response | Resource requirements | Example funding thresholds (indicative) |
|---|---|---|---|---|
| **1** | Local event | One area office | Low | Absorbed into existing operational budget<br>1 in 20yr flood |
| **2** | Subregional event | Two area offices | Medium | Regional Fund<br>1 in 20-50yr flood |
| **3** | Regional event | Two or more areas offices | High | National Fund<br>1 in 100yr flood |

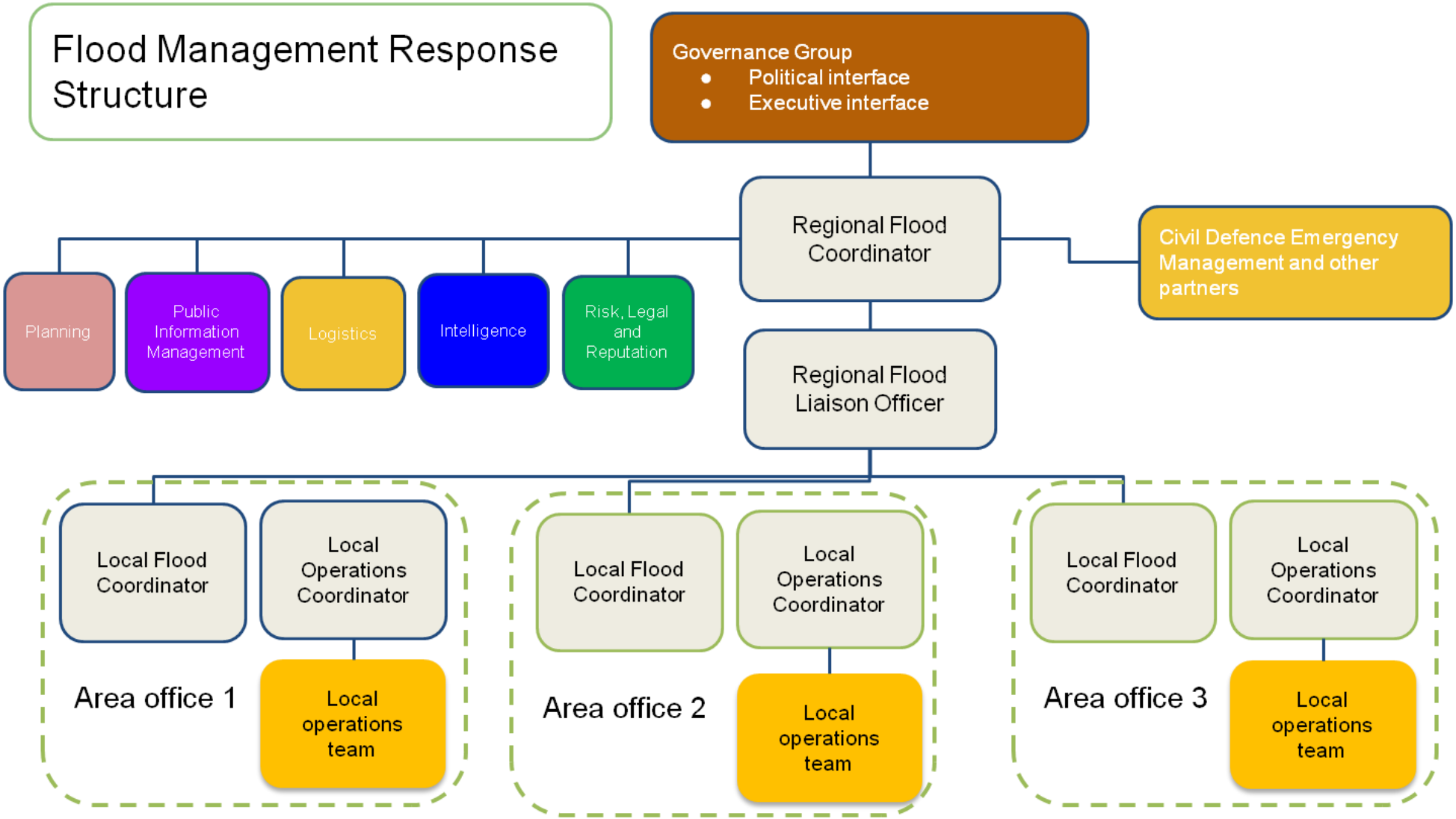



**Figure 9: Flood response management structure described in the RFRMP (WRC Technical Report 2016/01), using three affected area offices as an example.**

## 3.3 March 2017 response

A Regional Flood Response was undertaken from 8 March to 11 March. Between these times the Regional Hazards and Regional Flood Response duty team (WRC staff available and trained to fill the Regional Flood Coordinator and Regional Flood Liaison Officer roles) remained in monitoring mode in case of further escalation and to support the Zones as required. The Flood Room was activated at approximately 11:00 on Wednesday 8 March and deactivated at 17:30, it was then reinstated at 09:00 until approximately 17:30 on Thursday 9 March and Saturday 11 March in response to the band of severe weather that affected the region overnight on Friday.

The event clearly fulfilled the trigger points required to be classified as a Tier 2 response as described in the Regional Flood Response Management Plan (Doc # 4098288) due to:

- Two or more area offices being directly involved in response (Coromandel and Waihou/Piako);
- The regional team was activated in a support capacity, and
- Local resources were starting to get stretched, but could still be managed locally.

# 4 Operations Observations and Event Impacts

The following impact observations and operations actions were taken from situation reports released by WRC zone management and Thames Valley Emergency Operating Area (TVEOA) Civil Defence.

A summary of the relative level of impacts for mapped river catchments (extent of land where surface water will drain into river system) is shown in Figure 10. This includes area where there was roading and property damage, and land damage that will require significant remediation (high), areas where there was some disruption to roading and flood protection/drainage schemes required inspection (medium), and areas where river levels were higher than normal seasonal averages but levels were either contained by schemes or did not cause significant disruption (low).

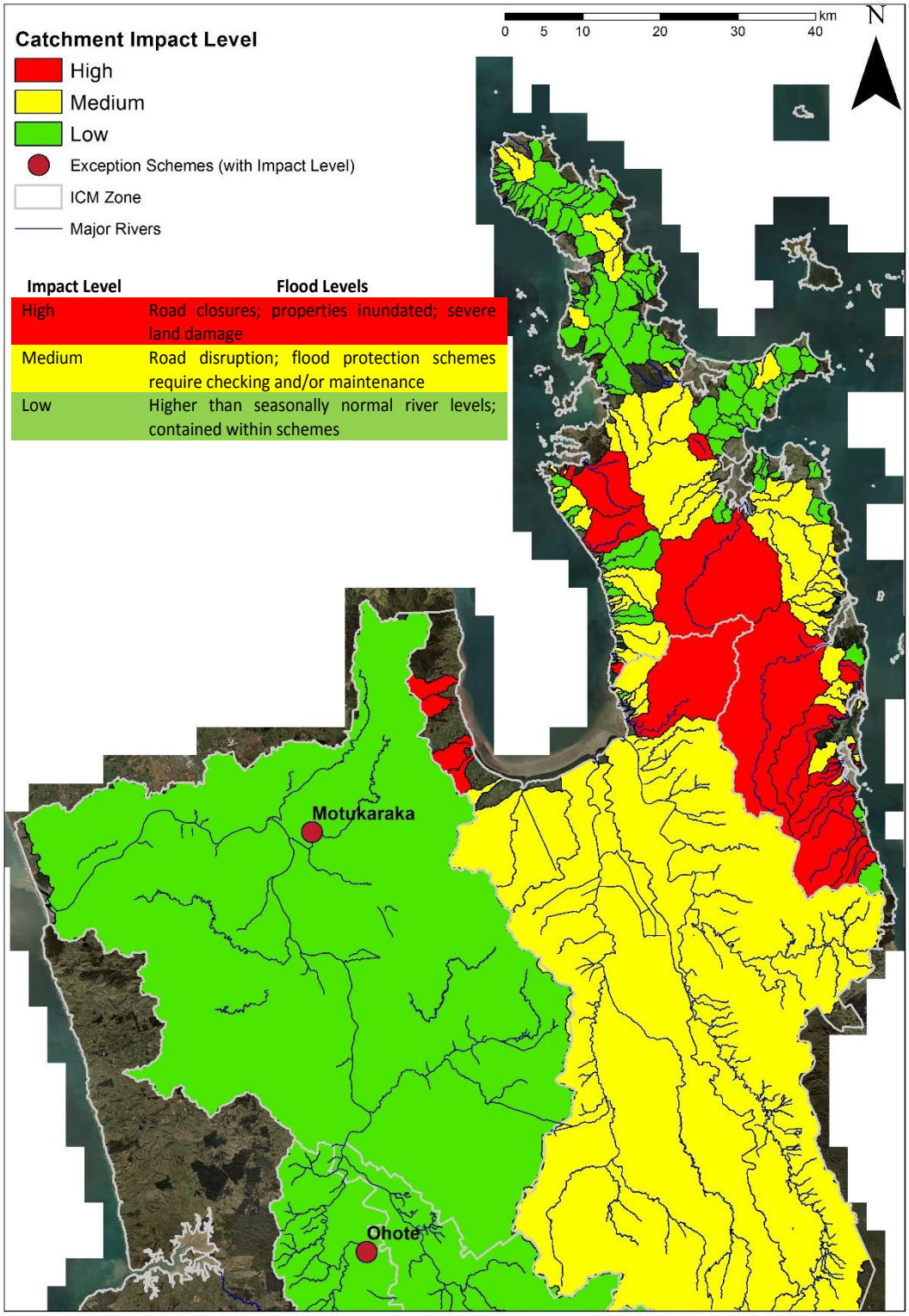



**Figure 10: Catchment impact levels.**

# 4.1 Coromandel

## 4.1.1 Lifelines

The heavy rainfall overnight on the 7-8 March 2017 forced numerous road closures in the Coromandel area, which included multiple locations along State Highway 25 including between Tairua and State Highway 25A, near Whitiroa, Opoutere, Manaia and south of Whangamata. Numerous other roads in the area reported issues with slips and flooding that caused significant delays (Table 4).

Road closures due to flooding and slips isolated multiple townships including: Whitiroa (from 8 to 10 March); Onemana (from 8 to 9 March); Opoutere (from 8 to 9 March); Pauanui (from 8 to 9 March); Whangamata (8 March); Whitianga (8 March); and Pauanui (from 10 to 11 March).

Flooding of regional roads in coastal areas was experienced at high tide, particularly on the 8 and 11 March (03:37, 15:57; and 00:15 respectively). Numerous major roads (not district or minor) also experienced closures and delays (Table 4).

**Table 4: Major road closures (red), delays (blue) and disruption in the Coromandel Zone (Supplied by NZTA).**

| Route | Location | Impact | Cause | Start time/date | Length |
|---|---|---|---|---|---|
| Whangamata To Opoutere | Whangamata | Road Closed | Flooding | 08-Mar 03:00 | 9 h 22 m |
| Tairua To Whangamata | Tairua | Caution | Flooding | 08-Mar 04:11 | 1 h 11 m |
| Tairua To Sh25a | Pukepoto | Delays | Flooding | 08-Mar 05:14 | 1 d 11 h 59 m |
| Whangamata To Waihi | Waihi | Caution | Flooding | 08-Mar 05:54 | 2 h 5 m |
| North Of Whakatete Bay | Whakatete Bay | Caution | Flooding | 08-Mar 06:57 | 4 h 20 m |
| Whiritoa Both Directions | Whiritoa | Road Closed | Slip | 08 Mar 07:21 | 1 d 13 h 2 m |
| Kereta To Te Kouma | Manaia | Road Closed | Flooding | 08-Mar 08:45 | 6 h 32 m |
| Whitianga - Wade Rd To 309 Rd | Whitianga | Road Closed | Flooding | 08-Mar 10:09 | 1 h 48 m |
| Whitianga - Wade Rd To 309 Rd | Kaimarama | Road Closed | Flooding | 08-Mar 11:27 | 4 h 55 m |
| Harry Watt Rd To Port Rd Both Directions | Whangamata | Road Closed | Slip | 08-Mar 17:13 | 3 d 1 h 25 m |
| At Sh25 | Duck Creek | Caution | Flooding | 10-Mar 20:25 | 1 h 3 m |
| And The 309 Rd (whitianga To Tairua) | Kaimarama | Caution | Flooding | 10-Mar 21:39 | 5 h 38 m |
| 309 Rd To Wade Rd Both Directions | Kaimarama | Road Closed | Flooding | 10-Mar 23:12 | 4 h 2 m |
| Tairua To Whangamata Both Directions | Duck Creek | Caution | Flooding | 11-Mar 00:44 | 16 h 19 m |
| Tairua To Whangamata Both Directions | Whangamata | Caution | Flooding | 11-Mar 00:44 | 16 h 19 m |
| Kopu to Hikuai Both Directions | Hikuai | Road Closed | Flooding and Slip | 11-Mar 01:10 | 7 h 37 m |

During the day on 8 March, a couple lost their car trying to negotiate floodwaters in the Kauaeranga Valley near the Department of Conservation (DOC) visitors centre. The road from the Visitors Centre inland remained closed until the weekend.

Communications within the Coromandel Zone suffered disruptions that made getting the full situational awareness to plan operations difficult in the initial 12 hours of the storms. These outages included both major telecommunications networks in Whangamata, Whitianga, Onemana, Whiritoa and numerous other smaller settlements. WRC personnel were unable to communicate with any people on the emergency flood contact list at Wharekawa throughout 8 and 9 March. This contact list is made up of people who want to be contacted in a flood event to be informed of any potential issues.

Waste water treatment services were shut down at Whangamata (due to infiltration) on the 8 March, and Whitianga residents were requested to conserve water on the 11 March. Potable water supplies at Tairua, Pauanui, and Onemana all had issues due to low pressure, poor water clarity, and power disruptions to pumps and treatment plants throughout the rainfall event.

Power outages were widespread particularly affecting Tairua, Opoutere and Tapu during the initial 24 hours of the storm.

Property damage was reported, especially on the east coast (Table 5).

**Table 5: Reported property damage within Coromandel Zone (from TVEOA situation reports).**

| Place | Number/Type | Cause | Timing |
|---|---|---|---|
| Whiritoa | Multiple including fire station | Flooding | AM 8 March |
| Whangamata | Multiple businesses and ~4 houses<br>6 houses | Flooding<br>Slip | AM 8 March<br>AM 8 March to AM 10 March |
| Onemana | 2 houses | Slip | AM 8 March |
| Hikuai/ Duck Creek | 6-10 houses and School | Flooding | AM 8 March |
| Opoutere | 3 mobile homes<br>3 houses | Flooding<br>Slip | AM 8 March<br>AM 11 March |
| Whitianga | 1 house | Flooding | AM 8 March |
| Manaia | School | Flooding | PM 8 March |
| Coroglen | 1 house | Flooding | AM 9 March |
| Whenuakite | School<br>School | Flooding<br>Flooding | PM/AM 8/9 March<br>AM 11 March |

Severe impacts from the storm were not observed in the northern part of the Coromandel Peninsula except for downed landlines in Port Charles.

### 4.1.2 Thames Coast

#### 4.1.2.1 Initial rainfall event (7-9 March)

Flood protection schemes at Te Puru, Waiomu and Tapu were visited by WRC staff on the 8 March. The schemes were observed to be performing well with flow contained within the banks and stream mouths open. Some erosion was observed at Pohue and Manaia, and a blockage, likely formed during the initial rainfall event, was removed from the Wairotoroto Stream on the morning 10 March (Figure 11).

**Figure 11: Debris blockage in Wairotoroto Stream.**

#### 4.1.2.2 Second main rainfall event (10 - 11 March)

Flood response staff were placed on high alert due to further heavy rainfall forecast for overnight Friday. Due to changes in stream conditions (debris, gravel, erosion, etc.) caused by the initial event and very little time to do any remedial works, affected areas were more vulnerable to subsequent flooding. A media release was prepared by WRC Communications advising the public of these risk factors.

The river broke its banks at Manaia flowing over the road but rapidly receded. No issues were reported at Te Puru, Waiomu, and Tapu, other than the WRC gauge board being washed away at Tapu.

The most significant damage was to the catchments south of Coromandel Town to Waikawau. In the Waikawau and Manaia rivers, there was significant stream bank erosion and landslips (Figure 12). This damage will make up the majority of the remediation work and recovery costs. The Thames Coast Schemes were relatively unaffected even though there was significant rainfall and flooding in many areas.

**Figure 12: Damage on the Waikawau River, and (right) temporary bund in place to prevent erosion of hillside at the same location**

## 4.1.3 East Coast

### 4.1.3.1 Initial rainfall event (7-9 March)

The Pitone Stream (Kuaotunu) needed to be unblocked by a contractor on the morning of 8 March, in order to prevent issues with high flow. Campers at a nearby campsite all left the site voluntarily.

The Waiwawa River burst its banks in the early hours of the morning of 8 March, which inundated the Coroglen Saleyards and the southern approach to the bridge over the river. Significant erosion occurred on the underside of the bridge on the true right bank side running from near the domain toilets to the stockyards. Significant sediment deposits occurred throughout the domain in Coroglen, including roading debris that were dislodged by flood waters. This was inspected by WRC operations staff and Beca Engineering on behalf of NZTA (Figure 13). Beca also spray painted the banks to track any further erosion.

**Figure 13: Photographs taken on Thursday 9 March showing erosion under the State Highway 25 Bridge over the Waiwawa River (left), with silt deposits showing the extent of inundation (right).**

Localised flooding occurred along the Whitianga waterfront at high tides on the 8 (03:37 and 15:57) and 9 March (04:39 and 16:59) and debris was observed in the harbour.

At Whiritoa, multiple properties flooded including the fire station, compromising its ability to receive communications. WRC operations staff were on standby to unblock Ramarama Stream, as is sometimes needed after a storm event, however the stream naturally unblocked itself.

Around midday on 9 March the Waiwawa flooded again. This caused one house in Coroglen to suffer further inundation. This was short-lived with the river receding again within a couple of hours. Silt deposits were observed that indicated that water levels in the Kapowai River had also exceeded its bank level.

The Tairua River burst its banks at multiple locations, most notably in the valley where Hikuai and Duck Creek are located. Significant flooding in the area affected houses and isolated the population causing road and school closures.

**Figure 14: Photographs taken on Thursday 9 March showing Grahams Creek Flood Protection Scheme functioning in high flows.**

The relatively recently operational Grahams Creek Flood Protection Scheme performed well throughout the event (Figure 14), with small scale ponding nearby the only issue reported in the vicinity.

Another issue that further complicated problems caused by high river flows was the transport of forestry 'slash' from upper catchments. This occurred on the lower reaches of the Te Weiti Stream where forestry debris blocked culverts that required operations staff to organise clearing through NZTA's Contractors (Figure 15). Broad Spectrum (NZTA contractor) were able to arrange traffic management and the contractor (EPL Construction) completed the works on 9 March.

On 10 March a contractor observed a large amount of forestry debris upstream in the Te Weiti floodplain, which was at risk of travelling further downstream and re-blocking the area around State Highway 25. Rayonier (forestry company) were contacted and advised that this could not be cleared until 13 March. The WRC Resource Use team were also advised of the issue.

**Figure 15: Photographs taken on 9 March showing floodwaters and debris at Te Weiti Stream.**

The Waikiekie Stream also had large amounts of forestry slash travel down the catchment, however when inspected by operations staff it was decided that no actions were required. Large amounts of forestry slash was also observed in the Tairua and Whitianga harbours but no actions were required to clear this. At Wharekawa a contractor observed an estimated 2,000 tonnes of forestry debris on a hill at 1014 Tairua Road (10/3/2017). This was not in the nearby stream but at risk of being washed down during further events. No further serious issues were reported.

The Wentworth River broke its banks causing the stranding of 20 campers at a DOC campground. This was reported to the Whitianga office and was passed on to Thames Valley Civil Defence personnel.

#### 4.1.3.2 Second main rainfall event (10 - 11 March)

Overall, the impacts of the second band of rainfall were less severe than the first. However, some isolated areas such as Whenuakite observed similar impacts on the 8 and 11 March, and some such as Ounuora River (Mill Creek) reported worse impacts for the second main rainfall band. This was likely due to the cumulative effect of the rainfall damaging rock groynes in the area.

The Northern Coromandel area also reported issues, with road flooding from the left channel observed overnight at Colville and the stream running out of channel at Waikawau. Strong winds also affected power and communications at Sandy Bay. These issues were short-lived and did not require WRC intervention.

One area of particular concern was again the Coroglen Bridge, where severe erosion had already occurred. Further erosion took place. Operations confirmed that full-time monitoring together with periodic inspections were put in place by Broad Spectrum and Beca.

At Onemana, a farmer reported the loss of 60 head of stock overnight on the 10/11 March.

The Wentworth River went over its banks, with the golf course inundated on the morning of 11 March.

Slips along State Highway 25 south of Whangamata were re-inspected and engineers confirmed that minimal further movement had occurred. Hikuaia Settlement Road briefly closed in the early hours of the 11 March but was confirmed to be open by operations staff at 0955. Further minor slips were also observed near Kuaotunu.

# 4.2 Waihou/Piako

Waihou/Piako flood protection scheme components discussed in the following sections are identified in Figure 5.

## 4.2.1 Lifelines

### 4.2.1.1 Thames-Kauaeranga State Highway 25 Spillway

The Thames-Kauaeranga spillway operated twice during the period of the weather system, closing State Highway 25 (Table 6; Figure 16).

**Table 6: Kauaeranga Spillway operation and road closures with rainfall.**

| Date | Time RL recorder >10.5m* | Time when RL recorder returned <10.5m | Time of road closure (NZTA) | Time of road reopening (NZTA) | Time of most recent high tide | 6 hour rainfall before road closure (Pinnacles) | 12 hour rainfall before road closure (Pinnacles) |
|---|---|---|---|---|---|---|---|
| 8/3/2017 | 8-Mar 03:30 | 8-Mar 07:50 | 11-Mar 05:30^ | 11-Mar 10:34 | 8-Mar 04:04 | 247.0 mm | 328.5 mm |
| 10/3/2017 | 10-Mar 21:45 | 10-Mar 22:55 | 10-Mar 23:25 | 11-Mar 08:40 | 10-Mar 18:32 | 99.0 mm | 134.0 mm |

*10.5 m at the Kauaeranga at Smiths telemetry site signals that use of the spillway is imminent.
^Road not officially closed by NZTA or Broad Spectrum, rather WRC operations staff when spillway was seen to be operational.

**Figure 16: Photographs taken on 8 March (approx. 0645 and 1000 hours) showing the Kauaeranga State Highway 25 Spillway operating.**

Landowners were advised of impending spillway operation at approximately 04:00 on 8 March and some stock were moved. Illegal campers were evacuated by WRC staff from Rhodes Park in the early hours of the morning of 8 March as it became clear that spillway operation was inevitable.

### 4.2.1.2 Other issues

In addition to the Thames-Kauaeranga State Highway 25 Spillway, multiple other major roads were closed, had delays or required caution (Table 7). This table does not include the multiple district and minor roads that were also affected.

**Table 7: Additional road closures (red), delays (blue) and disruption in the Waihou/Piako Zone (Supplied by NZTA).**

| Route | Location | Impact | Cause | Start time/date | Length |
|---|---|---|---|---|---|
| Between Monument Rd And Dimmock Rd | Maramarua | Caution | Flooding | 08-Mar 06:07 | 1 h 52 m |
| Near Bush St | Karangahake | Caution | Flooding | 08-Mar 06:21 | 1 h 37 m |
| Pokeno To Paeroa | Maramarua | Caution | Flooding | 08-Mar 06:46 | 2 m |
| Karangahake Gorge | Waikino | Road Closed | Flooding | 08-Mar 07:34 | 23 m |
| Kopu To Thames | Kopu | Delays | Flooding | 08-Mar 07:39 | 11 h 6 m |
| Sh2 Junction To Matamata | Waharoa | Caution | Flooding | 08-Mar 08:26 | 31 m |
| Pokeno To Paeroa | Maramarua | Caution | Flooding | 08-Mar 11:06 | 16 m |
| Paeroa To Waihi | Karangahake | Caution | Flooding | 10-Mar 22:51 | 3 h 50 m |
| Paeroa To Thames | Hikutaia | Caution | Flooding | 10-Mar 23:11 | 9 h 24 m |
| Paeroa To Thames | Komata | Caution | Flooding | 10-Mar 23:13 | 9 h 26 m |
| Paeroa To Thames | Puriri | Caution | Flooding | 10-Mar 23:20 | 9 h 14 m |
| Karangahake Gorge | Karangahake | Caution | Flooding | 10-Mar 23:28 | 3 h 15 m |
| Near Puriri Valley Rd | Puriri | Caution | Flooding | 10-Mar 23:33 | 9 h 6 m |
| Pokeno To Paeroa | Maramarua | Caution | Flooding | 10-Mar 23:56 | 1 h 57 m |
| Karangahake Gorge Both Directions | Paeroa | Caution | Flooding | 11-Mar 00:31 | 2 h 12 m |
| Pokeno To Thames | Thames | Caution | Flooding | 11-Mar 02:31 | 1 m |
| Matamata To Tirau | Matamata | Caution | Flooding | 12-Mar 13:42 | 2 h 1 m |
| Outside 5176 Sh26, Te Aroha | Te Aroha | Caution | Flooding | 12-Mar 15:26 | 48 m |
| Tauranga To Te Poi | Lower Kaimai | Caution | Flooding | 12-Mar 17:39 | 1 h 29 m |

The settlement of Kaiaua was isolated due to flooding on roads from the early hours of the morning until just before midday on 8 March.

Clinics and surgery at Thames Hospital were closed on 8 March. Power outages affected Ngatea (8 March) and Kerepehi (8 March). Multiple properties reported damaged by flooding and wind (Table 8).

**Table 8: Reported property damage within Waihou/Piako Zone (from TVEOA situation reports).**

| Place | Number/Type | Cause | Timing |
|---|---|---|---|
| Kaiaua | 8 houses | Flooding | AM 8 March |
| Matatoki | School | Flooding | AM 8 March |
| | | | AM 8 March |
| Te Aroha | 1 house and 1 clubroom<br>1 basement area | Wind damage<br>Flooding | AM 11 March |
| Matamata | 1 house | Flooding | AM 11 March |

The ford on Neavesville Road, Puriri (near property number 500) was washed out by flooding containing forestry slash on 11 March. This left residents isolated at the end of the road until contractors cleared it.

### 4.2.2 Initial rainfall event (7-9 March)

The Waihou, Piako, and Turua Rivers had elevated water levels and flow but remained within scheme design parameters. The initial alarm (14.0 m) was triggered for the Ohinemuri River at Karangahake (peaked at RL 14.7 m at 10:50 8 March). Paeroa and Te Aroha WRC operations staff were placed on standby in case stoplogs were needed. Stoplogs did not end up being deployed during the event.

The Barrys Road Bridge in Waihi was flooded for a short time early on the 8 March. This receded without intervention.

A number of drainage pumps in the Piako catchment were not operating due to excess weed and routine maintenance, which is common for the time of year. March is traditionally a month when this work is done as it is late enough in the tropical cyclone season that the risk of these

northerly systems is low, but rain patterns associated with the winter months have not yet started. Unfortunately, 2017 did not follow this pattern and maintenance was underway for multiple pumpstations when the March event occurred.

Issues were recorded at Heale Street pumpstation (Waihou Scheme) where storm water systems had blockages. These issues were resolved within the first 24 hours of the event by Hauraki District Council and WRC operations staff.

Stocks pumpstation (Waihou Scheme) was undergoing an upgrade at the time, meaning that it was not operating and a coffer dam was in place. The coffer dam was overtopped by the increased flows (Figure 17), and the site was handed over from the contractor back to WRC to manage. This resulted in the inundation of WRC-owned land immediately proximal to the pumpstation. A pump was set up with probes to maintain the water level.

**Figure 17: Stocks Floodgate on 8 March showing coffer dam overtopping.**

At the North Road pumpstation (Waihou Scheme), one of the two pumps was out for routine service but was replaced as soon as possible, minimising the impact of its absence.

At Mill Road pumpstation (Waihou Scheme), pumpstation 1 was out of commission during the event due to starter failure and pumpstation 2 had issues with power fluctuations, however this was able to be reset manually by operations staff. These issues were exacerbated by weed blockages. By the 10 March, pumpstation 1 had its electrical issues temporarily resolved.

A digger was moved to Scott's, Marshalls and Campbell floodgates (Piako Scheme) to desilt outlets and allow gates to function fully at low tide (completed 9 March for Scotts and Marshalls; 10 March for Campbell). The silt trap at Coxs floodgate (Piako Scheme) was blown out into the river and needed stabilisation work (10 March).

Due to routine maintenance the Ngarua Central pumpstation (Piako Scheme) was not functioning, however mobile pumps were used and the pump was replaced on 11 March. Therefore the effects on the system and surrounding area were minimal.

WRC staff were sent to investigate the situation in Kaiaua (Figure 18), where several houses were inundated and farmland damaged. Hauraki District Council assisted residents with sandbagging to protect properties from flood water. Some of the flooding originated from the Hauarahi Stream where the channel capacity was reduced because of mangrove growth. WRC does not currently have any channel clearance agreements in place here.

**Figure 18: Floodwaters and farmland damage; and mangroves encroaching Hauarahi Stream (right) on 8 March (when WRC staff visited) at Kaiaua (left).**

High velocity wind was recorded at Te Aroha on the 8-9 March (gusts of up to 98km/hour recorded at Paeroa, but thought to be significantly higher in Te Aroha). This caused a roof to partially lift, serious damage to the golf clubrooms, numerous trees, signs, and fences blown down, and multiple fire callouts.

### 4.2.3 Second main rainfall event (10 -11 March)

A WRC media release regarding changes to river conditions (debris, gravel, erosion, etc.) leaving affected areas are more vulnerable to subsequent flooding was issued before the second rainfall event began (the same warning as given for the Coromandel Zone). Although predicted rainfall totals and impacts were expected to be lower in the Waihou/Piako area.

One of the main impacts from this rainfall event was the need to evacuate 1,000 concertgoers from Dickies Flat overnight on 10/11 March. This was coordinated by the Thames Valley Emergency Operating Centre and the NZ Defence Force. WRC was not required to assist.

The Kauaeranga River spillway operated again in the early hours of the morning on 11 March.

The Mill Road pumpstations (Waihou Scheme) experienced further problems with weed blockages causing electrical disruptions to pumpstation 1, and pumpstation 2 remained on manual mode.

North Road and Steiner's pumpstations (Waihou Scheme) both had one pump out for maintenance, which were urgently replaced.

Utilities companies were alerted that pole fuse issues were occurring at Rowes East pumpstation (Waihou Scheme).

The pump that was located behind the coffer dam at Stocks pumpstation (Waihou Scheme) was severely compromised by weed on the inlet screen, forcing Hauraki District Council-owned drains to full capacity. This was rectified by WRC operations staff.

Landowners were concerned about water level at Alexander's Pumping station and the pump was observed to be stalling at Paeroa Main Drain pumpstation (Waihou Scheme). Hauraki District Council attended both sites and cleaned weed screens and confirmed pumps were running at full capacity.

In Thames, the Karaka Stream was identified as needing the debris trap and sediment pond to be re-cleaned after the second event.

WRC operations staff also attended affected areas in Puriri. Pasture and numerous private fences were damaged by large amounts of forestry and flood debris (Figure 19). WRC staff assessed and were able to respond to questions from the public.


**Figure 19: Flood debris at Upper Puriri River on 11 March.**

# 4.3 Lower Waikato

Lower Waikato flood protection/drainage scheme locations discussed in the following sections are identified in Figure 7.

## 4.3.1 Initial rainfall event (7-9 March)

No operational response outside of "business as usual" was required in this zone after the initial event. The Lower Waikato Zone never officially activated throughout the event.

The main issue that occurred in the zone was in the Motukaraka drainage scheme. There were reports of water ponding and crops under water. Pump power failure issues occurred intermittently overnight on 8/9 March and again on the morning of 9 March. Rainfall at the top of the Motukaraka catchment is best represented by the Mangatangi rainfall site. This recorded a <1% AEP frequency event (over a 24 hour period), which is significantly greater than the 10% AEP event that the scheme was designed to drain within 72 hours. Whilst land was underwater for less than the 72 hours specified in the scheme's level of service, ponded water caused some damage to horticultural crops in the area.

## 4.3.2 Second main rainfall event (10-11 March)

The screw pump and 2 Harland pumps at Motukaraka were inspected by operations staff and found to be fully operational on 11 March.

Additional pumps were delivered to the Tuakau Scheme on 11 March to enable fields with crops to be drained quicker.

Engineers were sent to investigate the Archimedes screw at Mangatawhiri Compartment 3 as it was running slowly. A mobile pump was deployed to assist whilst this was rectified.

# 4.4 Waipa

Reports were received on 11 March that the stopbanks of the Ohote Scheme were at capacity with instances of minor overtopping in some places. Operations Staff went to inspect the scheme, particularly the Laxon Road floodgate near where issues were reported. The scheme is of a lower standard design than others in the region (the specific design standard is not fully quantified) but still did not suffer any major damage.

The Lower Waikato, Waipa, and Central Zones did not have the same widespread lifeline disruption or property damage that was seen in the Coromandel and Waihou/Piako areas. However, disruption to road networks caused by flooding was reported (Table 9).

**Table 9: Road disruption in the Lower Waikato and Central Waikato Zones (Supplied by NZTA).**

| Route | Location | Impact | Cause | Start time/date | Length | Zone |
|---|---|---|---|---|---|---|
| Pokeno To Paeroa | Mangatawhiri | Caution | Flooding | 08-Mar 04:24 | 4 h, 59 m | Lower Waikato |
| Lorne Street and Normandy Avenue | Melville | Caution | Flooding | 11-Mar 02:20 | 2 h, 1 m | Central |
| Near Fisher Rd | Huntly | Caution | Flooding | 11-Mar 03:00 | 1 h, 17 m | Lower Waikato |
| Hamilton To Raglan | Temple View | Caution | Flooding | 11-Mar 10:47 | 7 m | Central |
| Waikato Expressway | Horsham Downs | Caution | Flooding | 12-Mar 13:50 | 2 h, 23 m | Central |
| Huntly To Meremere | Huntly | Caution | Flooding | 12-Mar 13:55 | 3 m | Lower Waikato |
| Near To The Intersection Of Avon Rd, Mangatawhiri | Mangatawhiri | Caution | Flooding | 12-Mar 13:57 | 1 h, 5 m | Lower Waikato |
| Pokeno To Paeroa | Mangatawhiri | Caution | Flooding | 12-Mar 14:07 | 55 m | Lower Waikato |

All other zones within the region did not report any issues related to the weather system.

# 5 Debriefings and lessons

Debrief meetings were held at a zone and regional level within WRC. These debriefs focussed on identifying areas where improvements to flood management and response processes could be made. Issues and subsequent recommendations were collected and prioritised according to need and available resources.

# 6 Event summary

The rainfall event from 7 to 12 March was caused by a low pressure system that travelled across the Tasman picking up moisture before making landfall over South Auckland, Hauraki, Coromandel Peninsula and Western Bay of Plenty. The system stalled over the upper North Island for almost a week due to high pressure systems preventing it moving off.

The event comprised of a series of heavy rainfall bands with the two most significant rainfalls occurring overnight on 7/8 March and 10/11 March. The northerly, sub-tropical nature of the weather system and the stalling pattern made it very difficult to forecast exact timeframes and rainfall accumulation totals.

The size of the event varied across the affected Zones with the largest recurrence intervals recorded at Mangatangi (greater than a 1 in 100 year ARI event) and Pinnacles (50 to 60 year ARI event) (Table 10). The persistence of the rainfall throughout the week played a significant role in worsening impacts, with short gaps not allowing for full clean-up or any significant channel work.

**Table 10: Maximum magnitude river and rainfall levels during March 2017 within each Zone.**

| Zone | | Lower Waikato | Waihou/ Piako | Coromandel | Central | Waipa | West Coast | Taupo/ Upper Waikato |
|---|---|---|---|---|---|---|---|---|
| River Flow | Max. AEP | 20-10 | 10-5 | <2 | None greater than annual | None greater than annual | None greater than annual | None greater than annual |
| | Place | Mangata-whiri | Kauaeranga | Waiwawa | | | | |
| | Flow cumecs | 119.1 | 910.8 | 1075 | | | | |
| Rain-fall | Max. AEP | <1 | 5-3.3 | 2-1.7 | 10-5 | 50-20 | None greater than annual | None greater than annual |
| | Time pd | 6, 12, 24 hr | 48 hr | 6 hr | 24 hr | 24 hr | | |
| | Place | Mangatangi | Maunga-kawa | Pinnacles | Ruakura | Puniu | | |
| | Rain (mm) | 207 (24 hr) | 123.0 | 262.5 | 82.0 | 83.5 | | |

The event caused a significant amount of disruption to infrastructure such as roads, power networks and water supplies. A number of communities were isolated during the week, particularly on 8 and 11 March after significant overnight rainfall.

# 7 References

Basheer G 2002. Waihou Valley Scheme asset management plan: draft: volume 1. Hamilton, Waikato Regional (Environment Waikato) (Doc#: 815971).

Grant D 2014. Grahams Creek – Tairua: Hydraulic modelling of flood alleviation proposal. Waikato Regional Council Internal Series 2014/27. Hamilton, Waikato Regional Council.

Morris B, Beaufill J, Spooner R, O'Donnell E, Wood M, Langdon G, Peploe B A 2012. Coromandel zone management plan. Waikato Regional Council Policy Series 2011/16. Hamilton, Waikato Regional Council.

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Peploe BA, Mullholland M, Russell G, Martin A, Ferguson A 2011. Waihou Piako zone management plan. Waikato Regional Council Policy Series 2011/05. Hamilton, Waikato Regional Council.

# Appendix 1: MetService warnings/watches and WRC regional hazard advisories

**Table 11: MetService warnings (red), watches (yellow), cancellations (green) and WRC regional hazards advisories.**

| Date | Time | Watch/Warning/ Cancellation | Forecast | Area | Regional Hazard Advisory or Update |
|---|---|---|---|---|---|
| **Tuesday 7 March** | 0932 | Watch | Heavy rain Tuesday afternoon to Wednesday morning due to low moving across Tasman | Waitomo, Taupo | |
| | 0933 | Warning | 80-150 mm of rain in 18 hours from 6pm Tuesday to 12pm Wednesday (CP); 80-120 mm of rain in 12 hours from 6pm Tuesday to 6am Wednesday (W) | Coromandel Peninsula, Waikato | Regional Hazard Advisory sent 12:18 informing of forecast and potential for significant but difficult to forecast northerly system (Doc # 10075454) |
| | 1022 | Thunderstorm watch | Severe thunderstorms and downpours (25-40 mm/hr) from 10am Tuesday to 8am Wednesday | Coromandel Peninsula, Waikato | |
| | 1449 | Thunderstorm Watch | Severe thunderstorms and downpours (25-40 mm/hr) from 3pm Tuesday to 8am Wednesday | Coromandel Peninsula, Waikato | |
| | 2026 | Watch | Heavy rain from tonight until Wednesday morning | Waitomo, Taupo | |
| | 2027 | Warning | 80-130 mm of rain in 18 hours from 8pm Tuesday to 2pm Wednesday (CP); 70-110 mm in 10 hours from 8pm Tuesday to 6am Wednesday (W) | Coromandel Peninsula, Waikato | |
| | 2155 | Thunderstorm Watch | Severe thunderstorms and downpours from 10pm Tuesday to 8am Wednesday | Coromandel Peninsula, Waikato | |
| **Wednesday 8 March** | 0626 | Thunderstorm Watch | Severe thunderstorms and downpours (25-40 mm/hr) from 6am to 9.30am Wednesday | Coromandel Peninsula, Waikato | |
| | 0751 | Warning | 60-90 mm of rain in 7 hours from 7am to 2pm Wednesday (CP); 70-110 mm in 10 hours from 8pm Tuesday to 6am Wednesday (W) | Coromandel Peninsula, Waikato | |
| | 0814 | Thunderstorm Watch | Severe thunderstorms and downpours (25 to 40 mm/hr) from 8am to 12pm Wednesday | Coromandel Peninsula, Waikato | |
| | 0827 | Thunderstorm Watch | Severe thunderstorms and downpours (25 to 40 mm/hr) from 8am to 12pm Wednesday | Coromandel Peninsula, Waikato | |
| | 1001 | Warning | 50-80 mm in 5 hours from 9am to 2pm Wednesday and 150-180 mm in 36 hours from 12pm Thursday to 12am Friday | Coromandel Peninsula | |
| | 1001 | Cancellation (Warning) | | Waikato | |
| | 1015 | Cancellation (Thunderstorm Watch) | | Coromandel Peninsula, Waikato | |

| | | | | | |
|---|---|---|---|---|---|
| | 1020 | Thunderstorm Watch | Severe thunderstorms and downpours from 10am Wednesday to 12pm Wednesday | Coromandel Peninsula, Waikato | |
| | 1041 | Watch | Bursts of heavy rain through until Friday | Waikato, Taupo | Regional Hazards Advisory sent 13:09 informing of continued heavy rain and high tide warning and times (Doc # 10080535) |
| | 1056 | Warning | 50-80 mm in 5 hours from 9am to 2pm Wednesday and 150-180 mm in 36 hours from 12pm Thursday to 12am Friday | Coromandel Peninsula | |
| | 1117 | Thunderstorm Watch | Severe thunderstorms and downpours from 11am to 2pm Wednesday | Coromandel Peninsula, Waikato | |
| | 1313 | Cancellation (Thunderstorm Watch) | | Coromandel Peninsula, Waikato | |
| | 1502 | Watches | Easterly gales Thursday morning | Coromandel Peninsula, Waikato | Regional Hazards Advisory sent 17:03 informing of further rain over the next 24 hours, but significantly less than last night (Doc # 10084270) |
| | 1643 | Warning | 30-40 mm of rain in 19 hours from 5pm Wednesday to 12pm Thursday. 150-180 mm of rain in 36 hours from 12pm Thursday to Friday night | Coromandel Peninsula | |
| | 1643 | Cancellation (Warning) | | Waikato | |
| | 2059 | Warning | 120-140mm in 27 hours from 9pm Wednesday to 12am Thursday | Coromandel Peninsula | |
| | 2101 | Watch | Easterly gales overnight and into Thursday morning | Coromandel Peninsula, Waikato | |
| **Thursday 9 March** | 0935 | Warning | 120-140 mm of rain in 21 hours from 12pm Friday to 9am Saturday | Coromandel Peninsula | Regional Hazards Advisory sent 11:12 informing of further rain predicted for Friday night and issues that the already saturated catchments may cause (Doc # 10087601) |
| | 1020 | Watch | Easterly gales | Coromandel Peninsula, Waikato | |
| | 2006 | Warning | 100-140 mm in 21 hours from 1pm Friday to 10am Saturday | Coromandel Peninsula | Regional Hazards Update sent at 16:21 confirming that after speaking with MetService the weather outlook is the same as detailed in the earlier advisory (Doc # 10089995) |
| **Friday 10 March** | 0857 | Warning | 100-140 mm of rain in 21 hours from 1pm Friday to 10am Saturday | Coromandel Peninsula | Regional Hazards Advisory sent at 09:38 informing of predictions for overnight and high tide times (Doc # 10091503) |
| | 0925 | Watch | Heavy rain from Friday night to Saturday morning | Waikato, Waitomo | |
| | 2054 | Watch | Heavy rain overnight Friday and into Saturday | Waikato, Waitomo, Taupo | Regional Hazards Update containing satellite pictures of the weather system that show its progression, also notifying that the flood room is standing down overnight but normal duty arrangements continue (Doc # 10095471) |
| | 2054 | Warning | 60-90 mm in 13 hours from 9pm Friday to 10am Saturday | Coromandel Peninsula | |

| | | | | | |
|---|---|---|---|---|---|
| **Saturday 11 March** | 0908 | Thunderstorm Watch | Severe thunderstorms and downpours (25 to 40 mm/hr) from 9am to 10pm Saturday | Coromandel Peninsula, Waitomo | RFC* summary sent at 07:27 provided summary of overnight events and current river conditions (Doc # 10157365) |
| | 0909 | Warning | 30-60 mm of rain from 9am to 12pm Saturday | Coromandel Peninsula, Waikato, Waitomo, Taupo | |
| | 0959 | Watch | Rain with heavy falls and possible thunderstorms until midday Saturday (W, W, T); Severe north to northeast winds (CP) | Waikato, Waitomo, Taupo Coromandel Peninsula | |
| | 1404 | Thunderstorm Watch | Severe thunderstorms and downpours (25 to 40 mm/hr) from 2pm to 10pm Saturday | Waitomo, Taupo, Coromandel Peninsula, Waikato | Flood Room Update sent at 16:55 after confirming forecast with MetService and informing that further heavy rain does not coincide with high tide times (Doc # 10087604) |
| | 1841 | Cancellation (Thunderstorm Watch) | | Waitomo, Taupo, Coromandel Peninsula, Waikato | RFC Update sent at 19:04 including river levels and notifying that flood room standing down overnight with normal duty arrangements in place (Doc # 10097752) |
| | 2113 | Cancellation (Warning) | | Coromandel Peninsula | |
| | 2139 | Watch | Heavy rain during Sunday (W, T); North to northeast gales Sunday morning (CP) | Waitomo, Taupo Coromandel Peninsula | |
| **Sunday 12 March** | 0939 | Watch | Heavy rain morning and afternoon (W, T); East to northeast gales (CP) | Waitomo, Taupo Coromandel Peninsula | RFC Update sent at 11:02 with current forecast and river levels (Doc # 10096352) |
| | 0939 | Cancellation (Warning) | | Coromandel Peninsula | |
| | 1457 | Watch | Heavy rain during Sunday, with west to southwest gales from CP | Waikato, Waitomo, Taupo, Coromandel Peninsula | |

*Note that outside of business hours advisories and summaries will come from the Regional Flood Coordinator in conjunction with flood room personnel (if activated).

# Appendix 2: Rainfall and river flow frequency calculation methodology

## Rainfall frequency methodology

The initial Rainfall return periods for the March event were estimated using a combination of WISKI[2] to extract intensity data and manual comparison with NIWAs HIRDS V3 programme. WISKI was used to extract the intensity data for durations of 10 minutes through to 72 hours which was then converted to rainfall in mm.

The outputs from HIRDS (https://hirds.niwa.co.nz/) were downloaded and compared with the rainfall totals for each duration to estimate return period.

The WISKI window in storm analysis used to extract the rainfall data for March is shown in Figure 15.

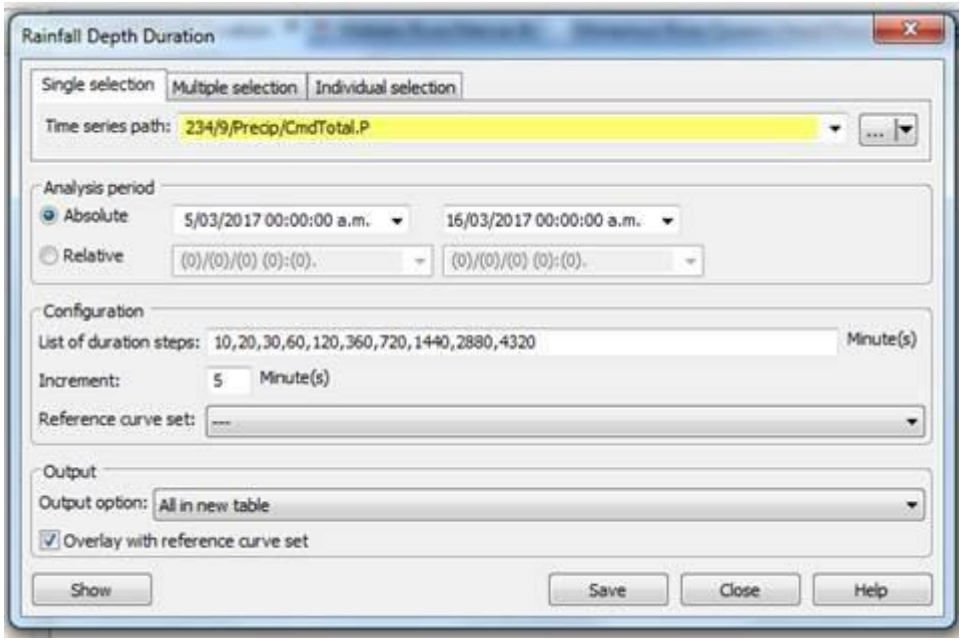



**Figure 20: Storm Analysis window in WISKI.**

## Instantaneous River Flow frequency methodology

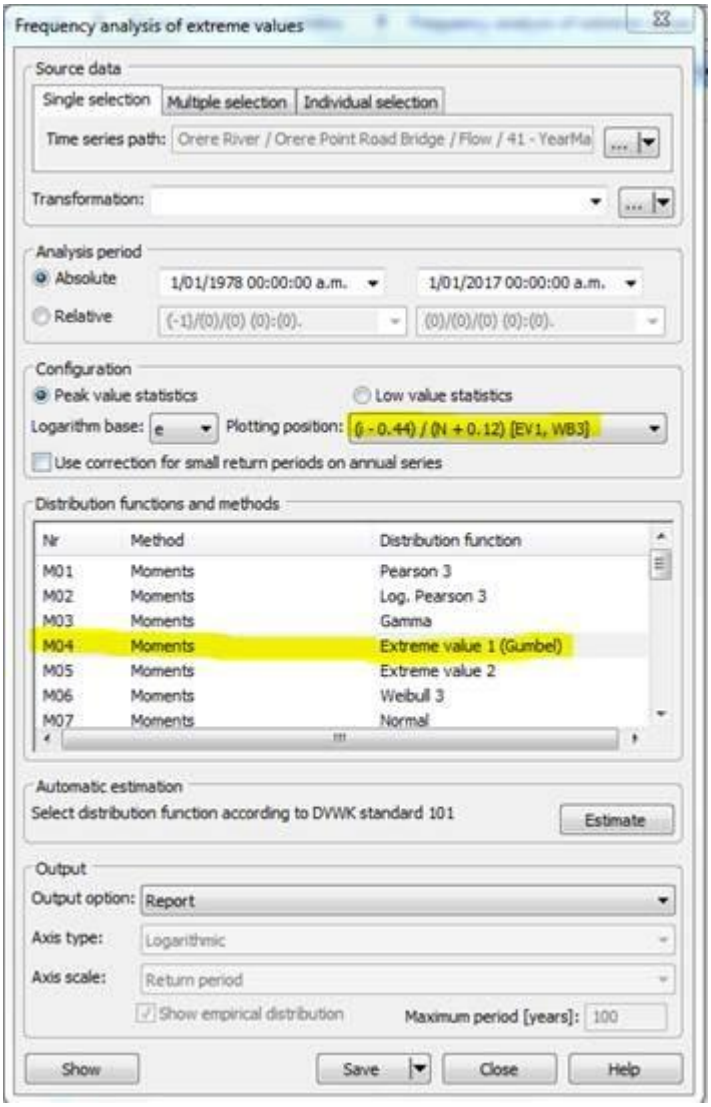
The return periods for instantaneous flood flow analysis were generated using the internal frequency analysis tool in WISKI.

The Gringorton plotting position and EV1 (Gumbel) distribution were used, which is consistent with what has been used in WRC analysis prior to using WISKI analysis.

Return periods beyond maximum extrapolation range are not reported (eg minimum 16 years for 50 year Return Period, 31 years for 100 year). Figure 16 shows the frequency analysis window and sample output from WISKI.

[2] WISKI is environmental data management software used by WRC for managing, analysing and reporting surface water, ground water, water quality, air quality, ecological and meteorological data.

A)




B)

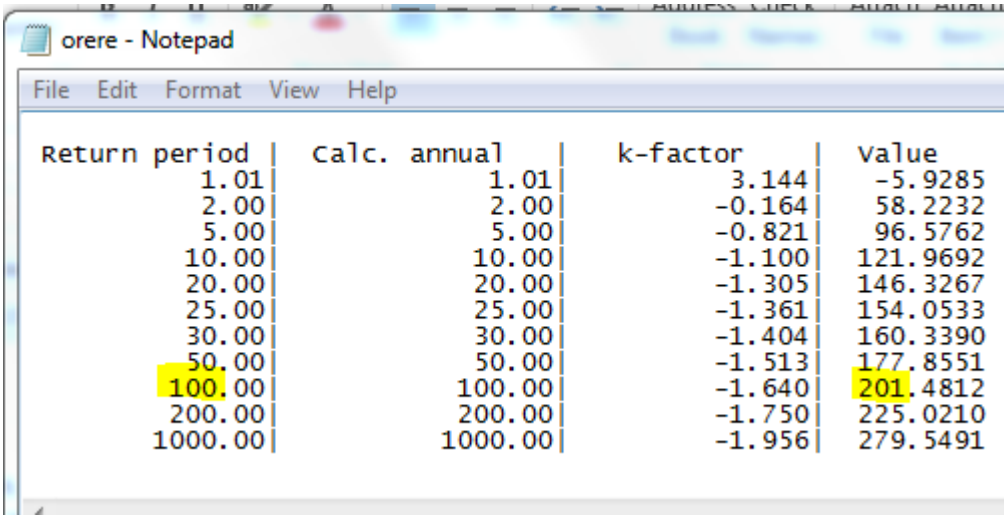



**Figure 21: Example of A) frequency analysis window and B) output.**