

Assessment of Effects

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Project no: IA273100
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1 Introduction

The Arawhata Wetland project involves the construction of engineered treatment wetlands and restoration of natural wetlands in the Arawhata Stream catchment of Punahau/Lake Horowhenua ("the lake"), near Levin. Punahau) that has degraded over many years. The lake outflows to the sea via the Hokio Stream and has several tributaries, the majority being modified watercourses that flow through vegetable cropping land, dairy farms, other rural land uses as well as Levin township. Groundwater accounts for more than half the inflow into the lake.

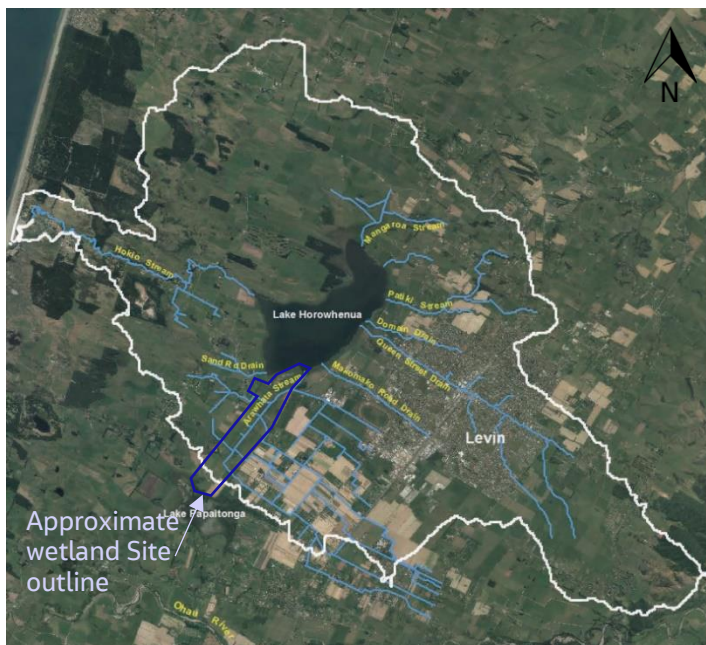


Figure 1: Lake Horowhenua, its' catchment, and the proposed wetland location

The Arawhata Stream (as well as contributing farm drains), which feeds Punahau, is high in nitrogen, phosphorus, and sediment. These contaminants have impacted the Arawhata Stream and the lake over many years including impacts on:

- Water quality
- Weed and algae growth

- Biodiversity of freshwater flora and fauna

Figure 1 also shows the location of the proposed wetland site ("the Site"). This is defined as the area within the property boundaries shown on the attached figures (Attachment 1 to 3) but excluding the area to the north-east of the existing sediment trap.

Horizons Regional Council (Horizons) engaged Jacobs New Zealand Limited (Jacobs) to undertake an options assessment, followed by development of a preferred concept to support the consent application process and ministerial application.

The objectives of the wetland project, as agreed by the governance group, are to:

- Contribute to the enhancement of the Mauri and water quality of Lake Horowhenua through reducing the impact of flows into the lake, in combination with other measures in the lake environs
- Reduce sediment and nitrogen loads into the lake
- Ensure that the wetland complex is culturally appropriate with Muaūpoko Mātauranga input
- Ensure the project is feasible and can be phased to align with funding available
- Enable the proposed wetland complex to provide for social amenity (kai, job creation etc.) and recreational opportunities and connectivity to other high amenity features in the local vicinity

This intervention opportunity has been made possible through the Horowhenua Freshwater Management Unit (FMU) Water Quality Interventions project contracted with the Ministry for the Environment (MfE).

2 Purpose

The purpose of this memo is to provide a brief overview of the project as well as an Assessment of Potential Environmental Effects. This memo focusses primarily on water quantity and quality related effects as well as some construction related effects. Our assessment of these effects is based on the Options Assessment (Jacobs, 2022a) and Concept Development work (Jacobs, 2022b) undertaken to date, which have been based on available data. Data collection (water quality, flows, soils etc) is still ongoing, and this will be used to undertake a full quantitative analysis of effects during the next stage of the project. For the purposes of this report, a qualitative description is therefore generally provided.

Note that the proposal will also result in a range of other potential effects not addressed in detail here. These will be addressed by other subject matter experts in other supporting documents. Effects are likely to include:

- **Cultural Effects:** Cultural Impact Assessments are being undertaken to inform the project by local iwi/hapu, specifically Muaūpoko and Raukawa. It is however anticipated that the cultural effects of the project will be primarily positive given the project objective is to improve the water quality of the lake and to restore this natural wetland. An accidental discovery protocol will be required during construction to minimise adverse effects should any artefacts be found.
- **Visual and Landscape Effects:** The proposal will restore a natural wetland of cultural significance and hence is expected positive. There will be temporary visual impacts during construction due to the presence of construction equipment, stockpiling of soil and earthworks.
- **Noise:** Construction equipment is likely to generate noise during the construction period.
- **Ecological Effects** during construction and operation.
- **Geotechnical Effects** related to lowering drain invert levels (on Horizons land and within the road reserve) to intercept groundwater for treatment in the wetlands, including:
 - **Drain Bank Stability** - For drains that are lowered, battering of the drain banks may be needed to maintain their stability. The need for this battering will be determined after soils investigations have been undertaken.
 - **Consolidation Settlement** - Lowering of the water table could potentially result in consolidation settlement depending on the soil type. It is not anticipated that this will result in adverse effects on grazing lands.

Note that section 1.6 discusses other effects related to the lowering of the drains.

3 Description of the Proposal

3.1 Overview

It is proposed that the wetlands be developed over three phases, with the key components of each phase described in the following sections. Each phase will introduce new components to build on those established in previous phases and further enhance the benefits of the wetland.

It should be noted that it is currently proposed to only consent Phases 1 and 2, hence the Assessment of Effects section only covers these two phases. Phase 3 is also described here as it will provide an opportunity to further enhance the benefits of the wetland development at a future date. This will need to be consented separately.

3.2 Phase 1

Phase 1 of the wetland includes the following elements as shown on Attachment 1:

- A sediment basin located where the southern farm drain (Kohitere Stream) enters the Site, this being the highest flow drain (Labelled (A) on Attachment 1).
- Existing farm drains (taking surface and groundwater) as well as new drains along the property boundary adjacent to Joblins drain, will have a perforated pipe placed in the invert, then will be backfilled with woodchips, bark, and soil. These will provide groundwater flow treatment (B).
- Existing farm drains entering the Site from the vegetable growing areas (Kohitere Stream and Joblins Drain) will discharge into new channels which will be constructed flatter than the ground slope, such that flows will discharge onto the ground surface further downslope. This way the flow can be directed overland and through a series of surface wetlands on the western side of the existing Arawhata Stream (C).
- Partial planting of the wetland areas (E). Much of the area will be undisturbed with minimal earthwork and will restore historic wetland hydrology through the removal or blockage of paddock drains and other features described in this list. These areas will be replanted with native vegetation to match historic conditions as closely as possible.
- Retention of the existing groundwater sump and pump (F) as well as the artesian stockwater well for discharge to the wetland for treatment of groundwater (G). A decision as to whether these pumps will be used will be made once further modelling has been undertaken
- Collection of groundwater along the boundary either side of Joblins Drain (H).
- Cleaning out and deepening of existing farm drains (within Horizons land and the road reserve) discharging into Arawhata Stream such that groundwater is intercepted. Some of this flow will discharge into the wetlands (where grade is available) and some will discharge into the Arawhata Stream (I).
- Extension of the stopbanks along the Arawhata Stream west side (J).
- The existing culvert alongside the existing sediment trap (north of Hokio Beach Road) will be fitted with a slide gate to redirect flows through the sediment trap, rather than along the main Arawhata Stream to the lake (K).
- The addition of riprap on the slope of the existing sediment trap outlet to control water levels and protect the embankment (L)
- Retention of the existing "sediment trap" north of Hokio Beach Road (M).

3.3 Phase 2

Phase 2 of the wetland includes the following elements as shown on Attachment 2:

- The existing Whelans drain will discharge into new channels which will be constructed flatter than the ground slope such that flows will discharge onto the ground surface further downslope. This way the water can then flow overland, and through a series of surface wetlands on the eastern side of the existing Arawhata Stream (Labelled (C) on Attachment 2).
- Further planting of both the Phase 1 and 2 areas (E).
- Installation of a small new pump to irrigate sediment pond water onto the Kohitere Stream alluvial fan where it cannot flow under gravity (O).
- A new stopbank/bund on the eastern side of Arawhata Stream to contain the Phase 2 wetland (J) and restore historic wetland hydrology that existed before the Arawhata Stream was modified.

- A lower section of riprap lined stopbank will be constructed at the downstream end of the Phase 2 wetland to discharge treated wetland flow into the Arawhata Stream (N).
- New groundwater collection drains along Hokio Beach Road and the wetland Site boundary (H).

3.4 Phase 3

Phase 3 of the wetland includes the following elements as shown on Attachment 3:

- Construction of wetlands and planting of plants on the western side of the Phase 1 wetlands in an area referred to as Paenoa Swamp (R). Much of this area will be undisturbed with minimal earthwork, and will restore the historic wetland hydrology through the removal or blockage of paddock drains and other features described in this list. These areas will be replanted with native vegetation to match historic conditions.
- An additional outlet from the existing sediment trap north of Hokio Beach road to create a more dispersed discharge to Lake Horowhenua (S).
- Cleaning out and deepening of existing farm drains on neighbour's land discharging into Arawhata Stream such that more groundwater is intercepted. Some of this flow will discharge into the Paenoa Swamp and Phase 1 wetlands (where grade is available) and some will discharge into the Arawhata Stream (U).
- Further planting of the Phase 1 and 2 wetlands (E)
- Planting of the upper area at the south end of the Site with forest (Q).
- Construction of a walking trail between Lake Horowhenua and Lake Papaitonga (to the south of the Site) (T).

4 Potential Effects

4.1 Overview

The construction of the Arawhata Wetlands is proposed to improve water quality in Lake Horowhenua. As such, the proposal is expected to have a range of significant benefits as well as some adverse effects which can be effectively managed via the design of the wetland system and implementation of a construction management plan including erosion and sediment control measures.

This qualitative assessment is based on the conceptual design and assessment undertaken to date by our multi-disciplinary design team and our previous experience with wetland projects both in New Zealand and around the world. A more detailed analysis of the actual and potential effects will be completed for the purposes of the consent application once concept design, further data collection and assessment is completed.

This section focusses on the effects of Phases 1 and 2 as these are what is proposed to be consented.

4.2 Potential Positive Effects/Benefits

By nature of the project, a range of benefits to the lake should be realised as a result of each of the project stages, described below. Note that the water quality benefits (% removals) have been modelled (as described in more detail in Jacobs (2022b)).

Phase 1 (Sediment Basin + diversion of flows to wetland area + planting + wood chip trenches)

- Reduction in sediment inputs to the Arawhata Stream and downstream system resulting from treatment in the sediment basin (sedimentation) and diversion of flows into wetlands for treatment (sedimentation).
- Improvements to water quality due to treatment of surface water in the wetland areas and groundwater in wood-chip trenches. Woodchips, and bark will provide a carbon source for the conversion of nutrients in groundwater to other chemical forms. Overall expected levels of nutrient removal are 69% reduction of nitrates and 26% reduction in phosphorus after Phase 1 is complete. A 94% removal of sediment is expected from the proposed Phase 1 wetland. More detailed information on expected removals is provided in Attachment 4.
- Removal of dairy cows from the Site, hence reduction in effluent sourced nutrients and sediment discharges due to movement of cows around the Site.

Note that the existing Sediment Trap will continue to provide additional treatment. This will be enhanced by additional planting and the modification of the existing outlet culvert such that flows pass through the trap normally, rather than passing through the outlet culvert directly to the lake.

Phase 2 (Additional planting, wetland area expansion)

- Phase 2 will result in additional improvements to water quality due to additional wetland areas being developed as well as increased planting. Our preliminary modelling shows that after Phases 1 and 2 are constructed there will be a 70%, 93% and 27% reduction in nitrates, sediment and phosphorus respectively. More detailed information is provided in Attachment 4.

4.3 Effects on Surface Water Quality

4.3.1 Sediment

During the period in which earthworks will be conducted to construct the wetlands, it is possible that discharges of sediment could occur, especially during periods of rainfall. Such discharges of sediment may result in sedimentation of the bed and banks of the Arawhata Stream and other farm drains within the Site, in turn potentially smothering vegetation within the drain, reducing light transmission to plants, as well as higher than normal/current sediment discharges to Lake Horowhenua. The risk of these effects is likely to be temporary and will be minimised through erosion and sediment control measures. The risk of sedimentation effects will also reduce after the Site is stabilised and planted post construction.

It is proposed that the discharge of sediment will be minimised and actively managed by the contractor employing a range of erosion and sediment control measures appropriate for the Site soils (including for example, use of silt fences and sediment ponds) and the works being undertaken during favourable weather conditions. The construction methodology and erosion and sediment control measures will comply with good practice standards. All works will be undertaken in accordance with approved Construction Management and Erosion and Sediment Control Management Plans.

4.3.2 Nutrients

The overall purpose of the proposal is to reduce nutrient concentrations in the Arawhata Stream and the lake however, to achieve this overall benefit, some localised increases in nutrient concentrations are possible, as noted below.

Much of the vegetation currently growing in the Arawhata Stream and farm drains are a result of the high nutrient load in the waterways and groundwater, sourced from nitrogen and phosphorus generating activities in the area. Changes to surface water quality (reductions in nutrients), as a result of the wetland, are likely to reduce the abundance of such vegetation and this should therefore be seen as a positive effect, in combination with reestablishment of more beneficial waterway plant species over time. It is, however, likely that such effects will occur over the longer term as wetland plant species as well as micro flora and fauna establish over time within the wetland, post construction.

The existing stream channel will be preserved and will capture groundwater and water treated in groundwater collection pipes laid in organic media backfill (woodchips). The stream flow will be clearer and lower in nutrients than it has been historically. The surface water that enters the Site will receive wetland treatment, prior to discharge to the Arawhata Stream channel at the Hokio Beach road culvert. All water that leaves the Site will also flow through the existing sediment trap before entering the lake, which will provide further nutrient removal.

Where the existing farm drains (on Horizons land and within the road) are to be cleaned and deepened, it is anticipated that groundwater will be intercepted and discharged to surface water. This groundwater can be higher in nutrients than the surface water therefore has the potential to reduce surface water quality. Where there is sufficient grade, it is proposed that this channel flow is discharged into the proposed wetlands for treatment. However, this will not be possible in the northern part of the Site where there is insufficient grade. Localised (in the sections of channel not flowing to the wetlands) increases in nutrients may therefore be possible, however by the time the combined flow enters the lake, the overall effect will be a significant reduction in nutrients discharging to the lake (refer also to Section 1.3.2 for overall removal rates).

4.4 Contaminated Materials/Soils

Discharges from contaminated materials/soils during earthworks are less likely but may consist of contaminated material exposed during construction, and potentially discharges of oils, greases and petrol/diesel from vehicles or earth moving equipment.

Discharges from potentially contaminated materials/soils will be managed by undertaking (currently underway) a search of the Horizons HAIL (contaminated site) register and consequently any required desktop and in field investigations. Any contaminated areas that are identified will be managed based on the contaminants present, to mitigate any impacts. In addition, accidental discovery protocols are also expected to be included in consent conditions. Discharges of any oils/greases/petrol/diesel will also be managed by way of best practice construction methodologies and consent conditions which, as a minimum, will exclude maintenance and refuelling of vehicles and equipment within a set-back distance of waterways/lakes.

Overall, the surface water quality entering the lake will be improved by the wetland proposal, although there may be the potential for some temporary adverse effects during the construction period. These effects will be managed through, as far as practicable, avoidance and minimisation of run-off and discharges during construction.

4.5 Effects on Surface Water Quantity and Flows

The proposed wetlands will potentially have effects on surface water volumes, flows, velocities and water levels. These effects are expected to be slightly different during the different flow conditions i.e. low flows versus storm flows, and summer versus winter.

It should also be noted that at this Site, surface water and shallow groundwater are interconnected in the top 1-2m of soil, with water moving between the two depending on rainfall and the operation of the wetlands (new channels bringing water to the surface plus irrigation from the sediment basin).

It is anticipated that flow velocities through the Site (during both low flows and storm flows) will be slower due to the flow passing through wetlands. Due to the grade of the Site and storage of flows within the wetlands (on the surface and in the soil beneath), it is expected there will be a reduction in peak flows overall. The flow rate in Arawhata Stream in the upper reaches will be reduced given most drain water that enters the Site will be diverted into wetlands rather than flowing directly into the stream channel. Flood levels are expected to be the same if not slightly lower within the Site and surrounding farmland (see below for further discussion).

It is proposed that farm drains on Horizons' land and in the road reserve will be cleaned out and the inverts lowered (to 1-2 m below ground surface) such that shallow groundwater and water that seeps out of the wetlands is intercepted and drained. The perimeter of the Site near Hokio Beach Road and along part of the eastern boundary of the Site will have a new shallow groundwater collection drain installed. A portion of the eastern boundary will have perforated subsurface pipes installed to collect groundwater and convey it to surface water wetlands for treatment. Initially, after the creation of new drains and deepening of others (and also into the longer term) we anticipate there will be higher surface water flows as a result of intercepting more groundwater (See also section 4.9). This may be noticeable during low flow conditions however this will not likely be noticeable during storm flows. In summertime, there may be a reduction in peak flows and flood levels due to lower groundwater levels providing additional storage capacity in soils prior to runoff occurring. Overall, the impact of intercepting groundwater, will likely be an increase in low flows but no increase in peak flows (or a small reduction in summer).

Overall, the volume of water (groundwater and surface water) entering the lake will be essentially unchanged. The storage provided by the wetlands will buffer peak flows during storms, but the total volume of the storm will still be discharged, albeit over a longer period.

4.6 Effects on Ecology

Earthworks and any resulting discharges of sediment and other contaminants may have potential effects on instream/lake ecology (fish and invertebrates). Additional sediment could potentially smother fish and invertebrates, clogging fish gills, reducing light transmission as well as build-up of more toxic contaminants in the flesh of fish. It is proposed that industry standard construction management practices including erosion

and sediment control will be implemented such that these effects will be mitigated and minimised. It should also be noted that construction activities and hence the effects will be temporary in nature.

The proposal will also reduce the extent of existing fluvial (stream/drain) habitats by converting these into a fen/wetland system.

It is expected that a more detailed habitat/ecological assessment (including confirmation of species present) will need to be undertaken by an ecologist to confirm such impacts, however with appropriately sized, installed and monitored erosion and sediment control measures during construction, we anticipate that these effects will be minimised.

4.7 Effects on Air Quality

It is possible that earthworks will result in discharges of dust during construction as a result of wind at times when soils are exposed or when soils are being moved around the Site. Discharges of dust beyond the Site boundary could potentially impact neighbours. It is anticipated that dust management will be included in the Site Erosion and Sediment Control Plan/Environmental Management Plan and that measures will be proposed and implemented to minimise such discharges including dust suppression (water sprayed onto exposed soils) when wind and hence dust may be an issue.

4.8 Effects on Groundwater Quantity and Quality

4.8.1 Effects on Deep Groundwater

Groundwater moves under the Site of the Arawhata Wetlands in a profile that has been described by the previous landowner as a deep aquifer that provides drinking water and water for domestic and milking shed uses, and a shallow aquifer that is perched just below the ground surface most of the year. The deep aquifer may be confined and under some artesian pressure given the existing artesian livestock water bore (labelled G on Phase 1 plan in Attachment 1) on-site flows out of the well casing above the ground surface when it is not being pumped. The pump cycles off and on many times per day and within minutes of cycling off, the well casing fills with groundwater and flows out the top. This is an indication that the deeper groundwater may be protected from any contamination or deep percolation of surface water or the perched shallow groundwater. The well outflow without pumping is approximately 1 L/s. The outflow from the well is at an elevation that will always be above the water level in the wetlands so no surface water will enter the well. It is anticipated that this borehole well will be left undisturbed with the artesian flow being discharged by artesian head into the Phase 1 wetlands that surround the well. This decision will however be made once further modelling (water quality as well as hydrological/hydrogeological) has been undertaken at the next stage of the project.

It is also anticipated that the groundwater sump and pump (labelled F on the Phase 1 plan – Attachment 1) will discharge groundwater into the wetlands for treatment and for irrigation, however this will also be decided once further modelling has been undertaken.

There are additional wells on the Site including one near the dairy shed for sanitary and washdown use, one on the highest portion of the property at the end farthest from Lake Horowhenua, for domestic use at the house and a higher flow irrigation well also exists near the southern end of the property. These other existing wells are planned to be preserved but not used.

The overall effect on deep groundwater will be a reduced use with no change to the groundwater quality.

4.8.2 Effects on Shallow Groundwater

The shallow groundwater is currently intercepted in drains and in the deep channel of Arawhata Stream. Several springs and seeps are also visible along the toe of the slope on the south end of the wetlands. The restored wetlands will continue to collect shallow groundwater and will convey it to the surface for treatment in wetlands. The total volume of shallow groundwater under the Site is not defined but is estimated to be large. The percentage of groundwater that is intercepted by the wetlands will be small and will consist of only water within 2 m of the ground surface.

The shallow groundwater under the Site that has been monitored contains as much, if not more, nitrogen as the surface drain water. It is therefore possible that any interconnection with shallow groundwater as a result of the proposal will maintain or improve its' quality.

It is anticipated that the wetlands will discharge treated surface water through the base, back into the shallow aquifer (as it is not proposed to line the wetland) and will maintain a high water-table similar to the existing condition but with reduced nutrient levels due to the treatment provided.

4.9 Other potential effects

In addition to the effects noted above, the following effects may also occur as a result of the lowering of drains (Phase 1 and 3) to intercept groundwater for treatment in the wetlands:

- **Health and Safety issues** arising from deeper invert levels- the drains will be deeper than existing (approx. 0.5-1.5m deep currently) therefore safe egress (should someone need to enter or if they fall into the drain) will need to be considered when designing these modifications (e.g. slightly battering the side slopes). Battering of the drain side slopes/banks will slightly reduce the paddock size.
- **Increased duration of drains being wetted** – These drains are anticipated to be wet for most, if not all, of the year, due to these collecting and conveying groundwater (potentially they dry out in the peak of summer for a brief period). Initially (post construction) it is anticipated that the deepened drains will have higher and more sustained flows as the surrounding area drains (could be months to a year depending on the soil types). In the long term, once the system has re-equilibrated and depleted the water in storage, there will be a sustained increase in flows and wetted duration due to the additional interception of throughflow. If the drain inverts are below seasonally low groundwater levels, then year-round wetting and flow can be expected. This would need to be quantified through modelling supported by field investigations. There are however no anticipated adverse effects of these drains being wetted for longer given they are present for drainage purposes.
- **Potential impacts on the use of the surrounding land for grazing** - By deepening the drains (on Horizons land and in the road reserve), this will potentially draw down the groundwater level. Given the low lying and generally wet nature of the pastures, reducing the groundwater level is anticipated to improve the ability of the surrounding land (areas of land owned by other parties) to be used for grazing as it will be drier due to lower groundwater levels.

5 Conclusion

The Arawhata wetland system has been proposed in order to achieve a range of positive outcomes for the Project. Based on work to date, it is anticipated that the proposed wetlands will yield significant positive effects for the lake as the project progresses.

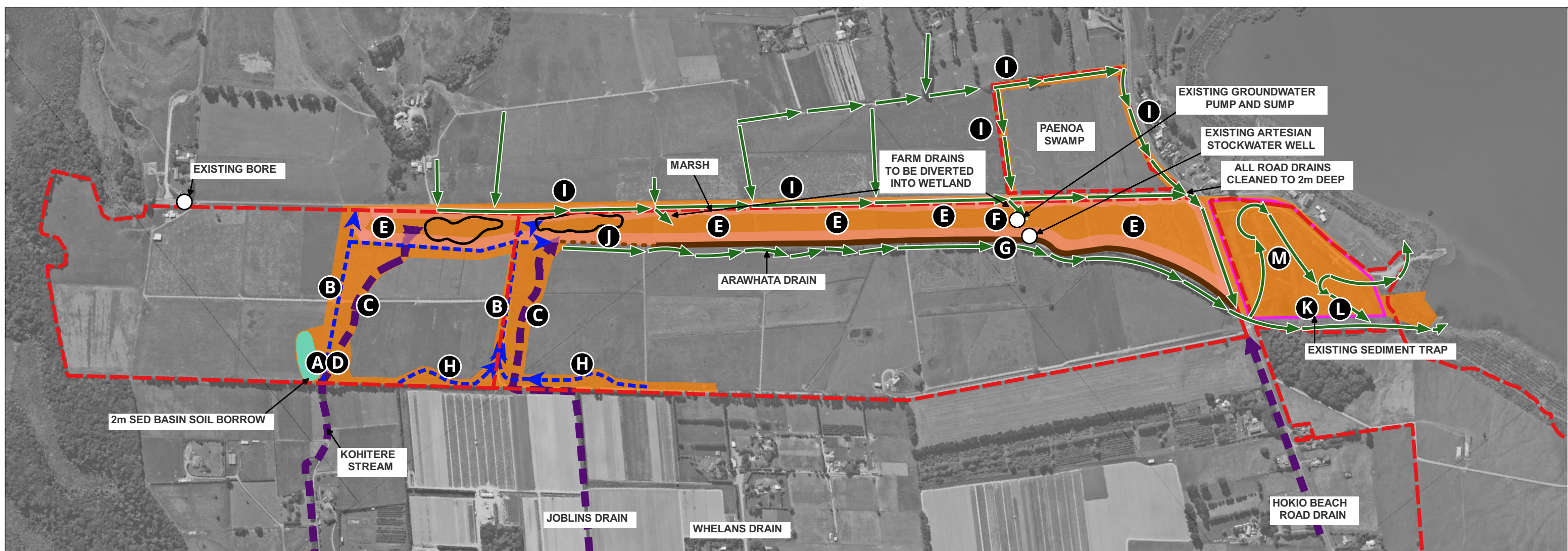
Some potential adverse effects, primarily during construction have been noted, but these are expected to be limited to the construction period. These construction effects can be managed as they occur through industry best practice construction management (erosion and sediment control) alongside consent conditions such that the impact is no more than minor.

6 References

Jacobs (2022a), *Arawhata Wetlands: Wetlands Options Assessment Report*, Jacobs New Zealand Ltd, June 30th 2022.

Jacobs (2022b), *Concept Development Report*, Jacobs New Zealand Ltd, 6th October 2022.

Attachment 1: Phase 1 Wetland



Legend

- Land Boundary
 - Deeper cut wetland areas
 - Existing Stopbank
 - Proposed Stopbank
 - Component Label - Phase 1
 - Existing/new channel farm drains
 - Subsurface perforated drain pipe laid in invert of existing/new drains then drain backfilled with wood chips, bark and hay
 - Channel taking flow from drains in vegetable growing area to feed into wetland
 - Approximate edge of wetland wetted area
 - Sediment Basin
- Construction Phases**
- Phase 1



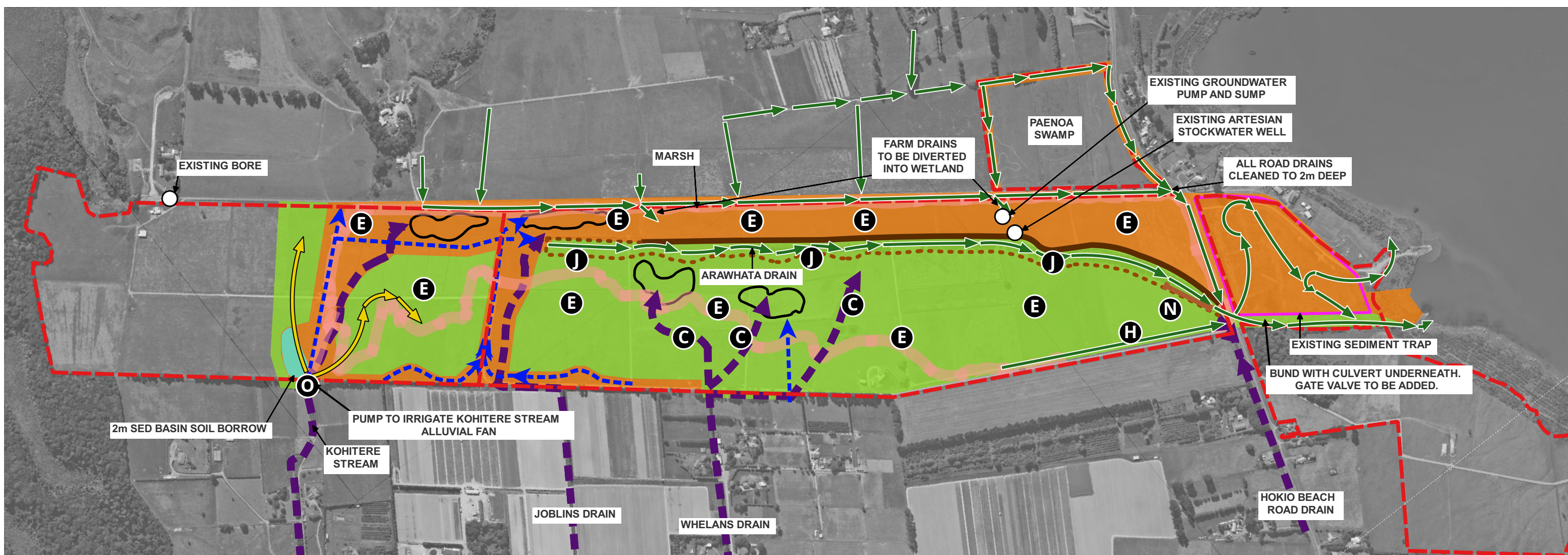
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Phase 1 Components

- Sediment Basin construction at Kohitere Stream/site boundary (A – see plan for location)
- Installation of perforated pipe in existing Kohitere and Joblins Drain channels (within the site boundary) and drains as well as new drains along the property boundary either side of Joblins Drain, backfilled with woodchips/bark/hay for groundwater treatment (Blue dashed arrows). (B)
- Construction of new channels at flatter grade than ground slope such that water can be discharged onto surface of wetlands from Kohitere stream and Joblins Drain. (purple arrows) (C)
- Surface water overflow from sediment trap directed into new channels (purple) under gravity. (D)
- Partial planting through wetland areas. (E)
- Retention of existing groundwater pump + southern well for irrigation (F)(G)
- Plants for phase 1 need to be purchased.
- Collection of groundwater along the boundary either side of Joblins Drain (H)
- Cleaning out/deepening farm drains and roadside drains such that groundwater is intercepted. Invert to still be sloped and discharged to either Arawhata Stream or the Phase 1 wetlands. (I)
- Extension of stopbanks along Arawhata Stream west side. (J)
- Construction of sliding weir gate on culvert in Arawhata Stream alongside the existing sediment trap. This will normally be shut to direct flows through the sediment trap. (K)
- Add rip rap on slope of the existing sediment trap outlet to control water level and protect embankment. (L)
- Sediment trap to be retained as is (M)

Attachment 2: Phase 2 Wetland



Legend

- Land Boundary
- Deeper cut wetland areas
- Existing Stopbank
- Proposed Stopbank
- Lower Section of Stopbank
- X Component Label - Phase 2
- Surface irrigation perforated pipe to irrigation Kohitere stream alluvial fan
- Existing/new channel farm drains
- > Subsurface perforated drain pipe laid in invert of existing/new drains then drain backfilled with wood chips, bark and hay
- Channel taking flow from drains in vegetable growing area to feed into wetland
- Approximate edge of wetland wetted area
- Sediment Basin

Construction Phases

- Phase 1
- Phase 2

Phase 2 Components

- Construction of new channels at flatter grade than ground slope such that water can be discharged onto surface of wetlands from Whelans Drains. (C)
- More planting in Phase 1 and Phase 2 areas (E)
- New bund on east side of existing Arawhata Stream to contain Phase 2 wetland. (J)
- A lower section of bund/stopbank will be built at the downstream end alongside Hokia Beach Road to discharge treated wetland flow into the main Arawhata drain. (N)
- New groundwater collection drains along Hokia Beach road and wetland site boundary. (H)
- Installation of small new pump to irrigate sediment pond water into Kohitere Stream alluvial fan in areas where it cannot flow under gravity. (O)

Attachment 3: Phase 3 Wetland

Attachment 4: Water Quality Improvement Modelling Results

Phase	Description	% of Phase flow	Avg Inflow m ³ /day	Avg Outflow m ³ /day	Inflow Concentration		Outlet concentration			Average % Concentration Reduction			Overall % reduction			
One					NO2-3N mg/L	TSS mg/L	TP mg/L	NO2-3N mg/L	TSS mg/L	TP mg/L	NO2-3N (%)	TSS (%)	TP (%)	NO2-3N (%)	TSS (%)	TP (%)
	Soil Infiltration	20%	2310	1195	8.70	126.81	0.70	0.7	0.00	0.4	92%	100%	50%			
	Surface flow wetlands with soil infiltration outflow	100%	10434	9537	8.30	111.71	0.67	4.8	26.34	0.61	42%	76%	19%			
	Sediment Trap Outlet	100%	9537	8398	4.80	26.00	0.61	2.7	8.00	0.52	45%	70%	14%	69%	94%	26%
Two	Soils infiltration	20%	139	0	2.90	296.10	0.60	1	0.00	0.4	66%	100%	40%			
	Surface flow wetlands with soil infiltration outflow	100%	555	148	3.80	296.10	0.90	0.3	33.37	0.28	93%	89%	68%	90%	89%	53%
One and two combined		100% of both phases	9685	8546	4.30	26.14	0.84	2.8	8.07	0.74	35%	69%	12%	70%	93%	27%

