Assessment Schedule – 2018

Agricultural and Horticultural Science: Analyse a New Zealand primary production environmental issue (91532)

Assessment Criteria

Achievement	Achievement with Merit	Achievement with Excellence
“Analyse” involves: • explaining the environmental issue arising from the primary production management practices • explaining potential courses of action to mitigate the negative impacts of the management practices • recommending sustainable production practices.	“Critically analyse” involves: • explaining, in detail, the environmental issue arising from primary production management practices • evaluating potential courses of action to mitigate the negative impacts of the production management practices • recommending sustainable production management practices that best address the issue.	“Comprehensively analyse” involves: • evaluating the environmental issue arising from primary production management practices • justifying potential courses of action to mitigate the negative impacts of the management practices • recommending and justifying sustainable production management practices that best address the issue and are economically viable.

N1	N2	A3	A4	M5	M6	E7	E8
Attempts to describe examples of the negative environmental and social impacts that the selected agricultural or horticultural production system may contribute to, but provides little information of relevance. *AND* Mentions possible courses of action, but with little relevant information.	Describes an example of the negative environmental and social impacts that the selected agricultural or horticultural production system may contribute to. *OR* Only ONE impact is explained. *AND* Describes a course of action that a producer could use to mitigate the negative impacts on freshwater quality by agricultural or horticultural production systems.	Explains in general terms (describes what the impact is and what causes it) the negative environmental and social impacts that the selected agricultural or horticultural production system may contribute to. TWO impacts are explained. Either the environmental or social explanation is weak. *AND* Provides a partial **explanation of possible courses of action** that could be implemented to mitigate the negative effects on freshwater quality by agricultural or horticultural production systems. *OR* **Explains** the conflicts and challenges between increasing productivity and in making all rivers swimmable in the future.	Explains in general terms (describes what the impact is and what causes it) the negative environmental and social impacts that the selected agricultural or horticultural production system may contribute to. TWO impacts are explained. *AND* **Provides explanations** of possible courses of action that could be implemented to mitigate the negative effects on freshwater quality by agricultural or horticultural production systems. *OR* **Explains** the conflicts and challenges between increasing productivity and in making all rivers swimmable in the future.	**Explains, in detail,** the negative environmental and social impacts that the selected agricultural or horticultural production system may contribute to. ONE explanation (environmental or social) only, in general terms. *AND* **Provides detailed explanations** of possible courses of action that could be implemented to mitigate the negative effects on freshwater quality by agricultural or horticultural production systems. *OR* **Explains in detail** the conflicts and challenges between increasing productivity and in making all rivers swimmable in the future.	**Explains, in detail,** the negative environmental and social impacts that the selected agricultural or horticultural production system may contribute to. *AND* **Provides detailed explanations** of possible courses of action that could be implemented to mitigate the negative effects on freshwater quality by agricultural or horticultural production systems. *OR* **Explains in detail** the conflicts and challenges between increasing productivity and in making all rivers swimmable in the future.	**Explains, in detail,** the negative environmental and social impacts that the selected agricultural or horticultural production system may contribute to. *AND* **Justifies** the recommended course of action that is considered the **most viable** towards the pledge to make all New Zealand rivers swimmable. *AND* **Discusses** the conflicts and challenges between increasing productivity and in making all rivers swimmable in the future.	**Explains, in detail,** the negative environmental and social impacts that the selected agricultural or horticultural production system may contribute to. *AND* **Comprehensively justifies** the recommended course of action with **detailed** consideration of what action they believe would be the **most viable** towards the pledge to make all New Zealand rivers swimmable. *AND* **Discusses** the conflicts and challenges between increasing productivity and in making all rivers swimmable in the future.
N0 = No response; no relevant evidence.							

Sample evidence

PART A

Horticulture and agriculture, and the impact on freshwater

- Freshwater is a valuable renewable resource that is used for irrigation in vineyards and market gardens, and on arable and horticultural crops. Water can be pumped or diverted (via ditches, drains, and pipes) from waterways. In some parts of the country, crops cannot be grown without irrigation; in others, irrigation is used to enhance crop yield (growth).
- Water take (abstraction) should be limited by minimum flow restrictions to protect mahinga kai cultivation habitats. However, changes to supply and demand may put pressure on existing resources if sustainable practices are not incorporated. Water quantity varies seasonally with, for example, variable amounts of ice melt from glaciers, rainfall, and groundwater recharge, while growers typically require a constant or increasing amount of irrigation water to maintain productivity.
- Pastoral land use contributes three principal pollutant types: the nutrients nitrogen (N) and phosphorus (P), sediment, and faecal microbes. Nutrient enrichment of waterways can lead to growth of unwanted plants (waterweeds and algae). Excess sediment may cause siltation, impair oxygen transfer processes, and degrade water clarity. Faecal matter and its associated pathogens present a risk to human and animal health through waterborne infectious diseases. The extent of this risk is assessed by measuring water concentrations of the benign indicator organism, *Escherichia coli* (*E. coli*).
- Freshwater is essential to New Zealand's economic, environmental, cultural, and social wellbeing. It gives our primary production and tourism sectors their competitive advantage in the global economy. Freshwater is highly valued for its recreational aspects, and it underpins important parts of New Zealand's biodiversity and natural heritage. It also has deep cultural meaning to all New Zealanders. Many of New Zealand's lakes, rivers, and wetlands are iconic and well-known globally for their natural beauty and intrinsic values. The Treaty of Waitangi (Te Tiriti o Waitangi) is the underlying foundation of the Crown – iwi / hapū relationship with regard to freshwater resources. Addressing tāngata whenua values and interests across all areas of wellbeing, and including the involvement of iwi and hapū in the overall management of freshwater, are key to meeting obligations under the treaty. All New Zealanders have a common interest in ensuring the country's freshwater lakes, rivers, aquifers, and wetlands are managed wisely.

Impacts of water take (abstraction) on water quality and mahinga kai

- Changes in flow – changing water levels, which cause flow variability, alter available mahinga kai habitat and impact on the invertebrates that feed on it.
- Reduction in habitat – a decrease in water levels reduces habitat for fish and can impact on feeding and spawning success.
- Reduction in specialist habitats – a decrease in water levels reduces flow to riparian wetlands, backwaters, and intermittent streams.
- Decreases in species abundance and diversity – aquatic species have developed life history strategies in direct response to natural flows; for example, diadromous fish species migrate up and down waterways at various times of the year and rely on preferred velocities and depths.
- Changes in sediment accumulation – flow reduction affects movement and deposition of sediments in streams and rivers.
- Changes in water quality parameters and physical characteristics – for example, turbidity and temperature levels can increase with reduced flows in rivers.
- Increases in algae accumulation – algae respond to changes in temperature and nutrients, which are likely to increase with reduction of flow, especially during summer months.

Applying water to land (irrigation) to improve production can result in:

- Changes to the type of crop that can be carried by the land, i.e. allows crops that need large quantities of water to be grown in arid areas, with potential effects on erosion or water quality.
- Increases in effluent discharge – some irrigation practices can produce significant surface water runoff and increase the contaminant loads that reach waterways.
- Increases in nutrients reaching waterways from higher fertiliser application rates.

PART B

Orchard management

Pesticide use

- Minimising the need for pesticides by applying them only when needed, at times when they are most likely to be effective, and in recommended concentrations.
- Using, wherever possible, new-generation chemicals that have a high degree of target specificity, have low persistence in the environment, and are less inclined to be leached to groundwater or carried in surface runoff.
- Applying chemicals in conditions and with equipment that prevent spray drift and coverage of non-target plants and waterways.
- Avoiding, whenever possible, applying chemicals immediately prior to rain.
- Investigating alternative methods to the use of herbicides for control of weeds and unwanted grass in the orchard.

Fertiliser use

- Applying only as much fertiliser as the crop can utilise.
- Using soil testing and foliage analysis to determine crop fertiliser needs.
- Applying fertiliser in split dressings to maximise plant utilisation and minimise losses to groundwater and streams.
- Avoiding applying fertiliser immediately prior to rain, on saturated soils, and during winter months when plants are not growing.

Water usage

- Avoiding excess water applications that could lead to surface runoff.
- Applying water at times and at rates equal to the needs of the particular crop.

Land and vegetation management

- Maintaining a sizeable buffer zone between the orchard edge and any stream, pond, lake, or wetland, and maintaining a thick cover of grasses or sedges in that zone to serve as a filter for water and sediment, and for fertiliser and pesticide runoff.
- Maintaining a healthy grass sward between tree rows and at the end of rows as a filter.
- Avoiding excessive soil compaction that could promote surface runoff.

Simple steps to minimise the effects of chemical contamination on water quality and mahinga kai

- Use low-toxicity herbicides adjacent to waterways.
- Minimise the need for pesticides by applying them only when needed, at times when they are most likely to be effective, and in recommended concentrations.
- Use, wherever possible, new-generation chemicals that have a high degree of target specificity, have low persistence in the environment, and are less inclined to be leached to groundwater or carried in surface runoff.
- Apply chemicals in conditions and with equipment that prevent spray drift and coverage of non-target plants and waterways.
- Avoid applying chemicals immediately prior to rain.
- Investigate alternative methods to the use of herbicides for the control of weeds and unwanted grass.
- Reduce the level of contaminants entering waterways by planting riparian margins and maintaining and incorporating vegetated swales and constructed wetlands.
- Contain wastewaters carrying chemical preservatives as part of wood treatment within a closed loop application system.

- Prevent leaching of contaminated waters into the soil and groundwater.
- Line and waterproof storage areas and treatment areas (including agrichemicals, timber processing yards, and meat and dairy processing facilities).
- Recycle chemicals where possible.

Arable land and livestock management

Farm training and nutrient management

- Embed environmental management into farm practices by training and incentivising staff.
- Ensure staff responsible for effluent management are adequately trained.

Nutrient management

- Calibrate fertiliser spreaders to deliver the correct rate for the site. This lessens the risk of fertiliser landing in waterways or being over / under-applied. Self-operated spreaders require regular calibration. Fertiliser contractors should be Spreadmark certified.
- Plant maize or other deep-rooted crops to utilise or ‘mop up’ nutrients from high-fertility soils, e.g. effluent or whey blocks. Useful for effluent blocks, winter grazing areas, and land out of long-term pasture, providing fertiliser inputs are reduced. Effective for reducing runoff and soil loss, and improving soil quality and infiltration. Soils that have been grazed over the winter may be compacted or pugged, requiring more cultivation or resulting in rough paddocks. Requires modified planter machinery to deliver good seed placement for even plant establishment. Additional expenditure might be required for insect pest control. Trials conducted by the Foundation for Arable Research (FAR) show a benefit of $200 / ha to direct drilling if crop establishment costs and yields are similar.
- Test the nutrient content of manure, slurry, compost, or effluent before application. This will ensure that nutrients are not over-supplied, and may mean that the crop can be grown without additional fertiliser, but soil nutrient status must be determined before planting. Application must follow industry good practice to minimise runoff and should be undertaken at optimal growing times for the crop. It can be difficult to accurately calculate the application rate and optimal timing.

Riparian management

- Improve farm infrastructure to keep stock out of waterways – reticulate stock water; improve stock crossings; plant shade trees away from water.
- Riparian planting – effectiveness improves with a grass margin to help filter runoff, especially on steeper slopes. Effectiveness of planting depends on species. Ongoing weed and pest management is an added cost, but reduces with time. Can improve bank stability, and provide habitat for wildlife and instream shade for fish and insects.
- Fence swampy areas.
- Controlled summer grazing of swampy areas can be useful for keeping weeds down. Keeping stock out of swampy areas and wetlands will reduce stock losses and mustering time. If they are areas with high stock traffic and high water flows, excluding stock will be highly effective in reducing phosphorus losses to waterways.
- Install culverts or bridges – cost will depend on whether culvert or bridge is required. Bridges require resource consent. Improved crossings reduce stock and vehicle travel time.
- These improvements all add capital value to the farm, and provide animal health and welfare benefits alongside water quality benefits. Important to locate new troughs away from areas of high water flow and high stock traffic, e.g. gateways.

Irrigation

- Keeps soil water status above the trigger point for crop yield loss.
- High initial cost for system and ongoing cost for operation. Provides the opportunity for precise management of crop nutrients by reducing the risk of yield loss caused by water stress. Requires regular measurement of soil moisture throughout the life of the crop.
- Irrigation must be scheduled to match water supply with crop demand. Important to maintain at least 85% irrigation efficiency to minimise wastage of water and runoff

risk.

- Measure and record soil moisture and rainfall to develop a soil water budget. There is value in collecting and using farm data to inform management decisions.
- Use the soil water budget and crop information to schedule irrigation. Water scheduling increases water efficiency. Benefits will depend on current practice, soil type, irrigation efficiency, and farm system. Seek professional advice on soil moisture monitoring and irrigation scheduling.
- Maintain irrigation equipment. Check pump performance and ensure pipes are not leaking and nozzles are not blocked. Poorly performing systems waste energy and water.

Cultivation and crops

- Reduce soil cultivation by adopting strip tillage or direct drilling, and minimising the number of passes over the paddock. Effective for reducing runoff and soil loss, and improving soil quality and infiltration. Soils that have been grazed over the winter may be compacted or pugged, requiring more cultivation or resulting in rough paddocks. Requires modified planter machinery to deliver good seed placement for even plant establishment. Additional expenditure might be required for insect pest control. FAR trials show a benefit of $200 / ha to direct drilling if crop establishment costs and yields are similar.
- Actively manage grazing of winter forage crop areas to reduce risk of nitrogen leaching, runoff, soil loss, and compaction. Graze from top to bottom of paddock contour. Avoid leaving stock on during wet periods, for long periods, or concentrated on small sections of the crop.
- Use low-nitrogen crops. Fodder beet and fodder radish have low nitrogen content and lower nitrogen urinary deposition. The benefit depends on how you use the crop in your farming system.

Emerging technologies and precision agriculture

- Consider deeper-rooted species in pasture composition. Mixed swards (e.g. chicory, lucerne) recover more soil nitrogen between January and May than does barley or pasture.
- Use of gibberellic acid to boost pasture growth. Only provides water quality benefit if used as a nitrogen substitute to reduce overall nitrogen inputs. Plant hormones should be used with care.
- Use placement tools, (e.g. GPS guidance, crop sensing) where possible. Delivers more precise nutrient inputs for expected crop yield. Likely to become more widely used as tractors are upgraded over time.

Managing critical source areas – hot spots (high sediment, phosphorus or faecal loads coming from small areas of high runoff)

- Reduce runoff from tracks and races (using cut-offs and shaping). Cost and effectiveness depends on contour of farm (higher risk of soil loss on steeper land, but will also require more work). Requires regular maintenance, but can reduce lameness, water damage, and long-term maintenance costs.
- Replace summer and winter sacrifice paddocks with sealed loafing pads. This allows pasture to recover more quickly after prolonged wet or dry periods. Collected effluent will be stored in an effluent pond for late spring application. Requires effluent capture and storage for land application.
- Move water troughs and gateways away from water flow paths. These areas of concentrated stock use have high nutrient loads and reduced vegetative cover, so are higher-risk for runoff. Cost and effectiveness depends on contour of farm (higher risk of soil loss on steeper land, but greater benefit).
- Fence and plant out unproductive steeper slopes. Planted steeper slopes will slow water movement from this area and reduce the potential for erosion. They will also reduce weed control costs and fertiliser expenditure.
- Use of off-pasture facility (e.g. shelters or loafing pads) suitable for removing stock from pasture during prolonged wet or dry periods (using bought-in feed). Requires feeding and effluent capture facilities with adequate storage and land application area. Also requires a revised nutrient budget to take into account the value of supplementary feed. Requires a different set of management skills from pasture-based farming systems. Benefits depend on soil type and climate.

Effluent management

- Increase storage volume and use deferred irrigation. Can be high-cost, as most existing pond systems are not able to be used for storage. There can be challenges with mechanical desludging. Lowers risk of effluent runoff during wet and / or busy periods.

- Low-rate effluent irrigation. Requires some solid separation. Allows more “safe” irrigation days per year and lowers overall effluent storage need. Allows application to steeper land, but can be challenging to keep application rates consistent. Cost depends on system choice.
- Minimise effluent volumes at source (by reducing washwater volumes and rainwater in the system). Reduces pumping cost and need for storage. Improves water efficiency on the farm.
- Monitor soil moisture deficit for effluent irrigation, and use information to improve timing of effluent applications. This ensures that shed and feed pad effluent is applied without direct discharge to water or draining to groundwater. May mean increasing effluent storage capacity during wet periods. Use pond calculator to estimate pond storage required.
- Move to land application system from two-pond discharge to a water system. This is very effective for reducing nutrients to waterways, but increases farm labour requirements. Can be a more cost-effective alternative to upgrading old pond systems and allows for reuse of nutrients in the farm system, potentially reducing fertiliser requirements over time. Maximum nutrient gains can be achieved by using a whole farm nutrient budget. Less feasible on steep slopes or areas with poor soils.
- Optimise the volume of feed pad cleaning water. Recycle green water for feed pad cleaning.
- Optimise the volume of shed, yard, and cleaning water. Maximises storage capacity available, and allows effluent to be applied to land in optimum conditions. Flood wash with water from the effluent pond (refer to conditions of use from your milk processor).
- Prior to spreading, locate sand trap heaps on sealed pads and away from watercourses and drains. Ensure drainage is back to the pond, so contaminated rainwater can be captured and contained.

Conflicts and challenges – Peter Gluckman

- The very rapid intensification in recent years creates enormous challenges. On one hand, it is at the core of our economy, but on the other, it has led to rapid changes in land use, particularly through dairy expansion, with concomitant major and adverse impacts on the quality of our freshwater estate. Agriculture and horticulture are also creating supply-side issues in some catchments – that is, there are places and times where there simply is not enough water to meet everyone’s needs.
- There are many measures of water quality, reflecting its physical, chemical, and biological characteristics. However, no single measure is sufficient to understand the state of freshwater, and the analysis is further complicated by gaps and inconsistency in the monitoring regimes. This is reflected in the current confusion over the proposed new water standards.
- While the public understandably might hope for rapid restoration of water quality across all rivers and lakes in New Zealand, this is unrealistic and scientifically impossible. In some cases, we are dealing with contamination that occurred decades ago, and the legacy effects may take a similar time to flush from the system. Moreover, there are no silver bullets in water restoration – multiple actions are needed, requiring partnerships between central and local authorities, iwi, citizens, and businesses, including farmers.
- There are clearly very complicated trade-offs between public expectations, economic drivers and recreational considerations in protecting our freshwater. This will require sustained commitment by governments, industry, local authorities, and community groups, and an ongoing commitment to monitoring and research across multiple modalities.
- Restoration activities are being undertaken in many catchments all over the country, including riparian planting, fencing waterways, developing and operating within-farm environment plans involving calculating nutrient budgets, and other approaches. But in some cases it may take over 50 years to achieve the desired outcomes, because of the residence time of existing high nutrient levels in the water (groundwater around Lake Rotorua being but one example). We are often dealing with legacy effects and cumulative effects, exacerbated by new urban or agricultural developments. Even where restoration has occurred, this is generally not to the original state, nor can it generally be, given that humans and terrestrial mammals are only recent arrivals in Aotearoa. As New Zealanders, we want a vibrant economy, a quality environment, and preserved natural heritage – and there are no simple solutions.
- The drivers of change are complex and inter-related, and the impacts are cumulative over many decades. Human involvement through changed land use, the development and then recent intensification of pastoral agriculture and progressive urbanisation and industrialisation have all played their role. The state of our

freshwater is a consequence of this social and economic history. Preventing further degradation, protecting and enhancing water quality and ecosystem health, and addressing the likely impact of climate change are priorities for New Zealanders. The required management responses are complex, time-dependent, sometimes uncertain, and will be costly.

The impact of climate change

- Further pressure on our freshwater systems can be expected to arise as a result of climate change. The most likely scenarios arising from climate change will impact significantly on both where and when rain falls, and thus on river flows and the regional availability of freshwater. There are likely to be increased flows on the west coast of the South Island and in rivers draining the eastern flank of the Southern Alps, and decreased flows in rivers on the east coasts of both islands, and in Waikato and Northland.
- Other expected impacts on New Zealand’s freshwater include:
  - greater variability over time in river flows, with increased frequency of extreme floods and prolonged droughts. The degree of this variation will be different across the country, due to New Zealand’s complex geography
  - intensified stratification in deep lakes, and possibly intensified wind-driven mixing in shallow lakes
  - changes in the distributions of native species, valued introduced species, and invasive pests, and in the timing and severity of phytoplankton blooms. Warmer habitats are likely to favour the colonisation and spread of invasive species
  - increased need for water storage in eastern areas to meet irrigation demands that increase due to projected warming and drying.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 2	3 – 4	5 – 6	7 – 8