National Germplasm Discussion Paper

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Contents

Executive Summary **1**

Project Objectives 1

Project Outline 1

Summary of Key Findings 1

Recommendations 2

1. Why do we need a National Grapevine Germplasm Collection? **3**

2. The concept of a National Grapevine Collection as a coordinated system of assets and resources **4**

3. The current state of play in Australia **6**

3.1 Current germplasm assets in Australia 6

3.1.1 Public Collections 6

3.1.2 Private Collections 9

3.2 Geographical proximity of the current germplasm collections 10

3.3 Organisational and intellectual assets and resources 11

3.3.1 DNA typing 12

3.3.2 Virus: surveillance testing and virus elimination 12

3.3.3 The propagation industry 12

3.4 National Coordination 12

4. The 'Strategic Framework' for a National Grapevine Collection **14**

5. Proposed Model for a National Grapevine Collection **16**

6. Asset and resource alignment for the functions and enabling activities of the National Vine Collection **18**

6.1 Function 1: Protect key cultivars in high security storage (Vine Integrity Collection). 18

6.2 Function 2: Protect and supply high health, true-to-type, commercially-relevant cultivars and rootstocks (via Nuclear Collections) 21

6.3 Function 3: Preservation of genetic diversity through the maintenance of Germplasm Collections 25

6.4 Function 4: The facilitation of vine enhancement projects (breeding, preservation, importation, variety and clone evaluation projects) 26

6.5 Function 5: Ensure the bio-secure and rapid importation of new cultivars from overseas breeding and selection programs (public and private imports). 26

6.6 Enabling Activity 1: Oversight and management by a central National Grapevine Collection coordinator and technical committee. 27

6.7 Enabling Activity 2: Oversight of a national certified standard for grapevine propagation. 28

6.8 Enabling Activity 3: The development of a searchable, publicly available national register of grapevine varieties and clones (that includes private imports) 30

6.9 Enabling Activity 4: Access to pathogen testing and virus elimination services 31

6.10 Enabling Activity 5: Access to DNA typing 31
6.11 Enabling Activity 6: Demonstration of best-practice management of viruses and grapevine trunk disease 32
7. Where to from here? 32
8. References 34
Appendix 1. List of Definitions and Acronyms 36
1.1 General Terms 36
1.2 Description of Collections 37
Appendix 2. The strengths and weaknesses of existing Germplasm Collections in Australia. 39
2.1 Collections and data assembly 39
2.2 Summary of public collections 40
2.3 Public Collection Strengths and Weaknesses 41
2.4 Collections Associated with Private Nurseries 46
Appendix 3. Wine Sector Consultation 47
3.1 Participants and representative organisations 47
3.2 Summary of comments from the consultation sessions 48
Appendix 4. Risk analysis of candidate sites (SAVIA and WAVIA) to determine suitability to protect grapevine genetic resources as Nuclear Collections. 52
4.1 Background 52
4.2 Method 52
4.3 Consultations: 53
4.3 Results 54
4.3.1 SAVIA Collection: Pest Risk Analysis 54
4.3.2 SAVIA Collection: Hazard Analysis 59
4.3.1 WAVIA Collection: Pest Risk Analysis 62
4.3.4 WAVIA Collection: Hazard Analysis 68
Appendix 5. Cost modelling: DNA and Virus testing for transition of the SAVIA and WAVIA collections to Nuclear Collections and estimation of ongoing vineyard management costs 72
5.1 Modelling method and assumptions for Virus and DNA testing 72
5.2 Modelling Results 73
5.3 Summary of total costs by collection 73
5.4 Estimated ongoing management costs 74
5.5 Summary of immediate and on-going funding requirements 75

Executive Summary

Project Objectives

1. To develop a model for a National Germplasm Collection.
2. Identify a Licensed Entity (LE) for the CSIRO collection.

Project Outline

The implementation of the project was structured around five deliverables, with wine sector consultation at all stages of the project:

1. Review existing reports funded by Wine Australia/GWRDC and others on germplasm collections.
2. Review the current germplasms; strengths/weaknesses.
3. Define why we need a National Germplasm Collection and what role it will play for wine sector stakeholders.
4. Construct a technical (biosecurity and risk), environmental (soil and climate) and practical (resources) framework to define what a suitable site/system might look like and where collections might be best located.
5. Identify and expand on the support mechanisms required for the implementation and management of a National Germplasm Collection (administrative, propagation, planting protocols, virus testing and removal, vineyard development, vineyard management and biosecurity protocols).

Summary of Key Findings

- The management of germplasm should be guided by the following principles (adapted from Calles *et al*., 2009; Reed *et al*., 2004):
    - Ensuring security
    - Ensuring availability
    - Maintaining genetic integrity and diversity
    - Providing information
    - Acquisition and introduction of new accessions
- Different crop-industries have different levels of complexity within their germplasm systems depending on the prescribed purpose of their system. The common theme between the industries is that they have alignment between their objectives, the assets/resources and the functions associated with that asset or resource.

- There are significant existing germplasm assets in Australia which comprise physical, organisational and intellectual assets. Many of the assets and resources were developed with industry funding. Centralised coordination of these assets and resources is vital to a national approach to germplasm management.
- Sector consultation identified that the role of the National Germplasm Collection is to protect grapevine genetics, facilitate the supply of healthy and true-to type planting material and support enabling activities that supplement the collection.

Recommendations

- Australia's 'National Grapevine Germplasm' should be referred to as the 'National Grapevine Collection' (NGC).
- The National Grapevine Collection should be considered as a system of coordinated assets and resources that are aligned to fulfil specific functions associated with the National Grapevine Collection objectives.
- Conduct discussions with collection stakeholders to address industry access to material and long-term security of the collections.
- The appointment of a National Grapevine Collection coordinator and technical committee whose primary role is to implement the strategic framework.
- The implementation of the grapevine certified standard for propagation material which will lay the groundwork for the conditions under which the collections in the National Grapevine Collection will be established and managed.
- The funding of essential research on the methodologies for virus surveillance of collections and source blocks identified by SAVIA in its report: *Protecting the high-health status of Australia's grapevine propagation assets: A business case for developing a science and standards-based management system'*,
- SAVIA has been identified as the organisation that is currently best suited to become the Licensed Entity for the CSIRO collection. It is recommended that discussions with SAVIA are initiated to identify the support mechanisms required (by SAVIA) to fulfil this important role.

1. Why do we need a National Grapevine Germplasm Collection?

The benefits to the Australian grapevine sector of investing in our grapevine foundation assets through the implementation of a National Grapevine Germplasm Collection, as stated in a previous study (Stanford *et al.*, 2014), are:

- *Timely and cost-effective supply of in-demand clones and varieties.*
- *Greater assurance of varietal and hence label integrity on Australian wine products.*
- *Access to a diverse range of varieties and clones to enable breeding and innovation.*
- *Quicker access to best available material in the event of a major replanting requirement.*
- *Preservation of heritage and unique varieties and clones for future generations.*
- *A higher overall standard of planting material used in Australian vineyards (including health status and performance characteristics).*
- *Maintenance of our international reputation for innovation and best practice in supply chain management.*

The current lack of a coordinated and maintained National Grapevine Germplasm Collection is a major risk to the sustainability of the Australian wine sector. If we continue to do nothing, then the immediate major threats include:

- Varietal misidentification and breaches of label integrity.
- The continued spread of grapevine virus, in particular GVLRaV-3.
- Loss of genetic diversity.
- Lack of contingency for incursions of significant pest threats such as *Xylella fastidiosa.*
- Fragmentation of Australia's grapevine germplasm assets.

This discussion paper argues the case that the 'National Grapevine Germplasm Collection' should be referred to as the 'National Grapevine Collection' (NVC) and that the National Grapevine Collection is a system of coordinated assets and resources that are aligned to fulfil specific functions associated with the National Grapevine Collection objectives.

While the National Grapevine Collection objectives and functions have been developed through consultation with the wine sector (outlined in section 4), they are guided by the general principles and guidelines of germplasm management (based on Calles et al., 2009; Reed et al., 2004) which are:

Ensuring security- conserve germplasm accessions in secure facilities that maintain accession health status and viability. Use duplicate collections and complementary ex-situ storage to manage risk.

Ensuring availability -maintain and distribute 'healthy' accessions in compliance with standards, agreements and regulations.

Maintaining genetic integrity and diversity- ensure that collections are adequately funded and actively managed and that accessions are re-generated in a timely manner.

Providing information- detailed information on accessions significantly increases the value of collection to the end-user.

Acquisition and introduction of new accessions/cultivars- to meet industry needs and to mitigate industry challenges.

2. The concept of a National Grapevine Collection as a coordinated system of assets and resources

As a part of deliverable 2, existing grapevine germplasm collections in other countries and perennial horticulture crop systems were reviewed. From this review it was clear that national germplasm collections are almost exclusively systems of interrelated assets and resources that are aligned to a common purpose, rather than a singular, physical asset. It must be noted that a system of aligned assets and resources is more capable of achieving the full suite of guiding germplasm principles whereas a singular asset may only achieve one or two.

The findings from the review are presented in Table 1, using the Australian almond and citrus industries along with the French grapevine industry as examples. The table summarises the objectives of each crop-industry and lists the assets/resources and associated functions that are deployed to meet the objectives.

Table 1. Matrix comparing the complexity of three perennial crop germplasm systems. The information relating to the Australian Almond and Citrus Industry is based on a review of these systems by McMichael (2013).

		Australian Almond Industry	**Australian Citrus Industry**	**French Vine and Wine Industry***
Asset/Resource	**Function(s)**	**Procure, secure, maintain and supply pathogen tested public scion clones**	**Protect and maintain the high health status of their foundation collection and supply public and private scion and rootstock seed.**	**To ensure the traceability, sanitary status and quality of each clone and to mitigate the issues related to wood, disease, virus and climate change.**
Nuclear Collection and multiplication rows for certified bud/scion-wood and rootstock.	To grow and supply certified propagation material.	Monash collection	AusCitrus (Dareton)	L'Espiguette and L'Vassal
Areas set aside in Nuclear Collections for maintenance of private imports	Fee for service for private imports.		AusCitrus (Dareton)	
On-site nursery facilities associated with collections or multiplication sites.	Rapid propagation for multiplication rows and source blocks.		Dareton and EMIA	L'Espiguette and L'Vassal?
On-site pathogen testing associated with collections or multiplication sites.	Virus testing and virus elimination services for high health attainment.		Dareton and EMIA	L'Espiguette
Insect-proof screen house.	To protect selected cultivars from biosecurity threats.		Duplicated across two sites Dareton** and EMIA (242 varieties).	L'Espiguette
Regional variety and clone evaluation trial sites.	To identify superior clones and varieties for specific conditions.			Significant and coordinated.
Germplasm conservation sites- (low health status or not regularly/recently tested)	Preservation and innovation-breeding, identification of clones and varieties for further evaluation.	Central Victoria	Arboreta at Dareton and DAFF-Bundaberg.	In most of the major regions covering the major varieties.
Privately owned collections of known health status.	Risk management.			Yes

**The French system delivers a broad range of functions including: germplasm maintenance, supply, heritage, biodiversity, high health and evaluation and is heavily subsidised by the French Government, with the Vassal collection entirely government-funded ($A625,000) and L'Espiguette receiving 60% of its funding from government sources (McMichael, 2013).*

***The recent installation of the 2400m² insect-proof screenhouse by Auscitrus to combat the threat of the citrus tristeza virus (spread by aphid vectors) cost $700,000 for the structure, with additional resources required for supporting facilities and on-going management (pers.comm, Tim Hermann, Auscitrus, Manager and Auscitrus Annual Report, 2019).*

The key finding from this review is that different crop-industries have varying levels of complexity within their germplasm systems, depending on the prescribed objectives of their systems. The common theme between the industries is that they have alignment between their objectives, the assets/resource and the functions associated with that asset or resource.

The following section will demonstrate that Australia has an abundance of germplasm-related assets and resources (physical as well as organisational and intellectual).

If we accept that the way forward is to consider that the National Grapevine Collection is a system of coordinated assets and resources, the key questions to consider are: what are the objectives and associated functions of the National Grapevine Collection; how do we align the existing assets and resources; and what does the final model look like and how is it coordinated and funded?

3. The current state of play in Australia

3.1 Current germplasm assets in Australia

3.1.1 Public Collections

The review of current public assets focused on the collections (Table 2) which in Stanford *et al.* (2014) were either deemed as 'an essential collection of germplasm material' (SARDI and CSIRO collections) or proposed as a 'strategic source of high-health material' (SAVIA, AVIA and WAVIA). The RVIC collection was also included in the review because of its genetic diversity and because it has supporting resources (propagation facilities and additional land for development).

Table 2. Germplasm collections identified as significant and reviewed as part of deliverable 2.

Collection	Owner	Location
AVIA collection	Australian Vine Improvement Association	Dareton, N.S.W.
SAVIA collection	South Australian Vine Improvement Association	Monash, S.A.
CSIRO collection of grapevine varieties & clones	Commonwealth Scientific and Industrial Research Organisation	Irymple, VIC.
WAVIA collection	Western Australia Vine Improvement Association	Manjimup, W.A.
SARDI collection	South Australian Research and Development Institute	Nuriootpa, S.A.
RVIC collection	Riverland Vine Improvement Committee	Monash, S.A.

The review found that ownership and management structures are diverse, with varying levels of maintenance (physical, pathogen and cultivar identity). There are varying levels of accessibility to propagation material within the collections and there is coordination between some of the collections. Table 3 provides a snapshot of the status of the collections with green indicating a strength, orange as neutral, and red a weakness.

Table 3. Strengths and weaknesses based on the collection attributes of the significant public germplasm collections in Australia.

Collection Attributes	Genetic Diversity/ Industry relevance	Industry Accessibility	Virus Status	Variety Identity- through DNA testing	Financial Stability	General Vine Health	Condition of Infrastructure
AVIA collection							
SAVIA collection							
CSIRO collection of grapevine varieties & clones							
WAVIA collection							
SARDI collection							
RVIC collection							

Based on the review it is possible to segregate the collections by their potential to fulfil different roles in a National Grapevine Collection, as follows. A more detailed review of the strengths and weaknesses of each collection can be found in Appendix 2.

Potential Nuclear Collections

A Nuclear Collection is defined in this paper as a formal field collection of selected cultivars in current or likely future commercial demand. This is the collection that is accessed to establish new source blocks for wider industry access. The proposed conditions for a Nuclear Collection are:

- Varietal identity verified via DNA testing against an international reference.
- Clone identity verified via traceability to an original verified source (or by molecular methods once the technology becomes commercially available- refer to section 3.3.1).
- Freedom from 'non-tolerated' pests and pathogens maintained through an agreed and audited program of regular testing and inspections.

A Nuclear Collection is maintained with strict protocols to minimise the risks of pest and pathogen incursion or impacts of hazards.

The WAVIA and SAVIA collections have the greatest potential to be developed as Nuclear Collections. The table highlights that SAVIA in particular requires limited funding to meet Nuclear Collection ideals, whereas the WAVIA collection requires funding for virus and DNA testing. The major benefit of the WAVIA collection is its relative isolation from local commercial horticulture activities (compared with other collections) and its macro-isolation from the majority of the Australian wine sector. Risk assessments and cost modelling for both collections were undertaken in this study (Appendices 4 and 5 respectively) and the results and the pathway for each collection to achieve Nuclear Collection status is presented in section 6.

Potential Germplasm Collections

A Germplasm Collection is defined in this paper as a formal field collection maintained to ensure for the preservation of high genetic diversity in the National Grapevine Collection. Each Germplasm Collection is maintained with a specific function. These functions may be as a back-up to Nuclear Collections, for innovation purposes (breeding, research and meeting new market trends) or for heritage/ preservation purposes. To fulfil its main purpose as a source of genetic diversity, a Germplasm Collection may have variable health status, which make proposed management conditions less restrictive than Nuclear Collections or a Vine Integrity Collection. Because of the potential variable health status, the conditions of movement of material out of a Germplasm Collection are restricted depending on the purpose of that material (e.g. virus compromised cultivars should not be supplied for use in commercial vineyards, but can be used for research purposes).

The AVIA collection was established with high ideals, is well isolated from commercial vineyards, is relatively inexpensive to maintain ($4200/ha/year) and has additional land available for expansion. An ideal scenario would be that the AVIA collection is maintained as Germplasm Collection with the specific function as a ‘back-up’ or ‘reserve’ to the Nuclear Collections. However, its current virus status is only partially known, with the last comprehensive testing carried out in 2010-2012. More recent sporadic testing has indicated presence of Grapevine Pinot Gris Virus (GPGV), Leaf-Roll 3 (GVLRaV3), Grapevine Virus A (GVA) and Fleck (GFkV). While the vines that tested positive for GVLRaV3 and GVA have been removed, the GPGV- and GFkV-positive vines are still in the collection. A commitment to the maintenance of the AVIA collection as a Germplasm Collection would need some initial investment in developing and implementing a virus surveillance program to understand the extent of the problem. A program to verify variety identity of the AVIA collection using the SNP library would add further value to the collection.

The CSIRO collection is the largest and most diverse in Australia and contains the majority of the unique selections in Australia. Its major weakness is its incomplete virus status and its current

inaccessibility to industry, but if these issues can be overcome it is ideally attributed to be maintained as Germplasm Collection with an innovation focus.

Much of the SARDI collection is over 30 years old, with the infrastructure and vines at the end of their economic life, and it is likely that many of the accessions carry virus. As with the CSIRO collection, the SARDI collection is also currently closed to industry. However, the collection has genetic, cultural and historical significance and it is probably best maintained as a Germplasm Collection under a 'preservation' remit, focusing on diversity and heritage accessions with the understanding that it is maintained with a potentially lower health status.

Access to the CSIRO and SARDI collections via a 'Licensed Entity'

The CSIRO and SARDI collections contain approximately 80% of the unique accessions in Australia (McMichael, 2013). CSIRO has stated that there is potential for future access by the wine sector to the collection, subject to arrangements that are acceptable to CSIRO. The current preferred arrangements for CSIRO is for the appointment of a 'Licensed Entity' (LE). The role of the Licensed Entity would be to manage movement of DNA-verified cultivars from the CSIRO collection, put those cultivars through virus elimination if required, propagate and establish the cultivars in the Nuclear Collection and then distribute propagation material to Vine Improvement Groups, nurseries and growers. It is considered logical that the same 'Licenced Entity' appointed for the CSIRO collection be also nominated for the SARDI collection, but this would be at the discretion of SARDI management. The current obvious collection best suited to be a potential 'Licensed Entity' is the SAVIA collection. It is recommended that discussions with SAVIA are initiated to identify the support mechanisms required (by SAVIA) to fulfil this important role.

3.1.2 Private Collections

In addition to the public collections there are well-maintained and significant private collections at Yalumba Nursery, Chalmers Nursery, ARM Nursery and Binjara Nursery (Table 4). More detailed information on each private collection can be found in Appendix 2.

Table 4. Locations of significant private collections

Collection	Location
Yalumba Nursery	Oxford Landing, S.A.
Chalmers Nursery	Merbein, VIC.
Binjara Nursery	Euston, N.S.W.
ARM Nursery	Busselton, W.A.

These are deemed significant collections because collectively they contain over 250 unique and sought-after varieties and clones that have been imported from renowned overseas programs. These varieties and clones are almost exclusively supplied under either non-propagation agreements or under PBR (Plant Breeder Rights) licensing arrangements. The nurseries are also significant in their market share across the wine grape and table grape sectors. The combination of having high market share and demand for these imported varieties and clones means that nursery collections account for a significant proportion of all planting material that is currently being supplied in Australia. As a result, it is critical that private collections are incorporated into the concept of the National Grapevine Collection. As a first step, the accessions in these private collections should be included in a publicly available national register. There may also be benefits for the owners of private collections (and the wine sector) to include key accessions from the private collections in the Nuclear Collections under specific licensing arrangements that restrict or control the supply of this propagation material.

3.2 Geographical proximity of the current germplasm collections

A major concern with the current state of play is that the majority of the public and private germplasm collections are located within a relatively small geographical area and associated with high intensity horticulture (Figure 1).

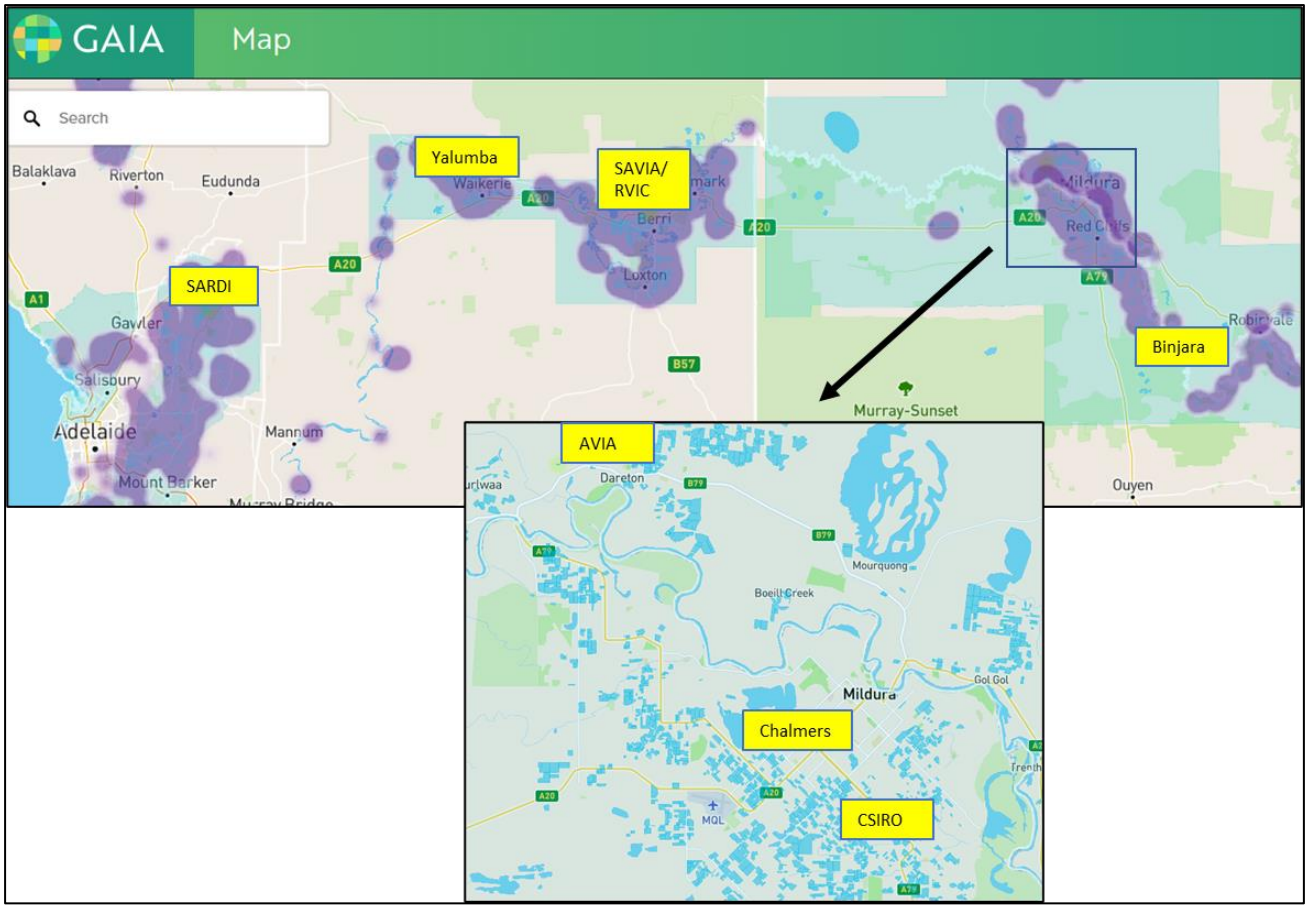


Figure 1. Locations of the significant private and public germplasm collections in S-E Australia.
Purple shading on the map indicates presence of vineyards.

Geographical proximity becomes significant in the event of a pest incursion in the vicinity of the collections. The exception to this is the location of the WAVIA and ARM Nursery collections in south-west Western Australia. As already discussed, the macro-isolation of the WAVIA collection is a major potential strength for the National Grapevine Collection.

The National Grapevine Collection strategy must ensure that this weakness is taken into consideration, particularly with the selection of Nuclear Collection sites and considerations for high security accession storage.

3.3 Organisational and intellectual assets and resources

There are significant existing organisational and intellectual assets that could be aligned to the objectives of the National Grapevine Collection. Many of these assets and resources have been developed with industry funding. The list below provides a brief snapshot of some the assets and resources that would be deployed in a National Grapevine Collection.

3.3.1 DNA typing

CSIRO is near completion of project CSP1501 'Grapevine Germplasm Variety Identification'. The major output of CSP1501 has been the development of a SNP marker library that could potentially be licensed to a commercial provider such as **AGRF** for the molecular typing of grapevine varieties. The development of a formal relationship between such a service and the National Grapevine Collection would have significant advantages.

The **AWRI** has established a robust methodology for Chardonnay clonal identification that harnesses the detailed information provided by whole-genome DNA sequencing (Roach *et al.*, 2018) and is currently developing a similar system for the identification of clones of Pinot noir. This approach may be applied to develop clonal identification in other varieties and a project has been developed by the AWRI for the commercialisation of a clonal typing service. Such a service would clearly become a vital tool in germplasm management.

3.3.2 Virus: surveillance testing and virus elimination

Both **AWRI and AgriBio** offer commercial services for virus testing and virus elimination and the University of Adelaide has been researching the application of remote sensing for the detection of virus. Access to the research and services that these organisations provide along with their intellectual resources is critical to the success of a National Grapevine Collection. These organisations and the funding of related research must be aligned with the objectives and functions of the National Grapevine Collection.

3.3.3 The propagation industry

VINA, SAVIA and to a lesser extent AVIA all own organisational and intellectual assets and resources that will be critical in the implementation of the National Grapevine Collection. Specifically:

VINA- The VINAS manual and VINA accreditation system for the production of propagation material is the current standard for industry. VINA also have a network of nursery members.

AVIA- the Intellectual Property for the National Vine Accreditation Scheme (NVAS)

SAVIA- undertaking a review of part 1 of the NVAS: Procedures Manual- Vine Improvement groups. SAVIA has networks with regional and state-based Vine Improvement groups.

3.4 National Coordination

As has been identified in Constable *et al.* (2004), McMichael (2013) and Stanford *et al.* (2014), national coordination of germplasm activities has been lacking in the Australian wine sector. Leadership and coordination of assets and resources are critical to the success of the proposed

National Grapevine Collection. In Stanford *et al.* (2014),the appointment of a 'collections coordinator' is recommended to undertake activities necessary to a national approach to germplasm management. This recommendation is supported by the author and will be discussed as part of the proposed model in Section 5.

The key finding from the review of the current state of play is that there are significant physical, organisational and intellectual germplasm assets and resources in Australia, many of which were developed with industry funding. Centralised coordination of these assets and resources is vital to a national approach to germplasm management.

4. The 'Strategic Framework' for a National Grapevine Collection

The grape and wine community were consulted to identify the challenges that the sector is faced with and the role of a National Grapevine Collection in the mitigation of these challenges. The consultation process was delivered across three sessions focused on different sectors of the grape and wine community: research and extension, propagation and vine improvement groups, and state and national bodies. In total 26 participants were involved, covering organisations in South Australia, Victoria, New South Wales, Western Australia, Queensland and Tasmania. The key objectives of the sessions were to:

1. Identify sector challenges that can be met through the implementation of a coordinated National Grapevine Collection (including regulatory, biosecurity, environmental, practical and quality challenges).
2. Identify functions associated with a National Grapevine Collection that can help to mitigate those challenges and how a coordinated approach to management of a collection can meet the needs of various stakeholder groups.

The sessions provided valuable insights and identified the challenges and associated functions and activities that are seen as the most important in a National Grapevine Collection. A full list of participants and comments from the sessions can be found in Appendix 3.

Based on the findings from the consultation sessions and taking into consideration the knowledge gained from the review of previous reports, a strategic framework has been developed (Table 5) which outlines the over-arching objectives of the National Grapevine Collection, the associated functions that are required to fulfil the objectives and the enabling activities required to support the functions. To ensure that the National Grapevine Collection is meeting the guiding germplasm principles, each relevant principle has also been listed for each function.

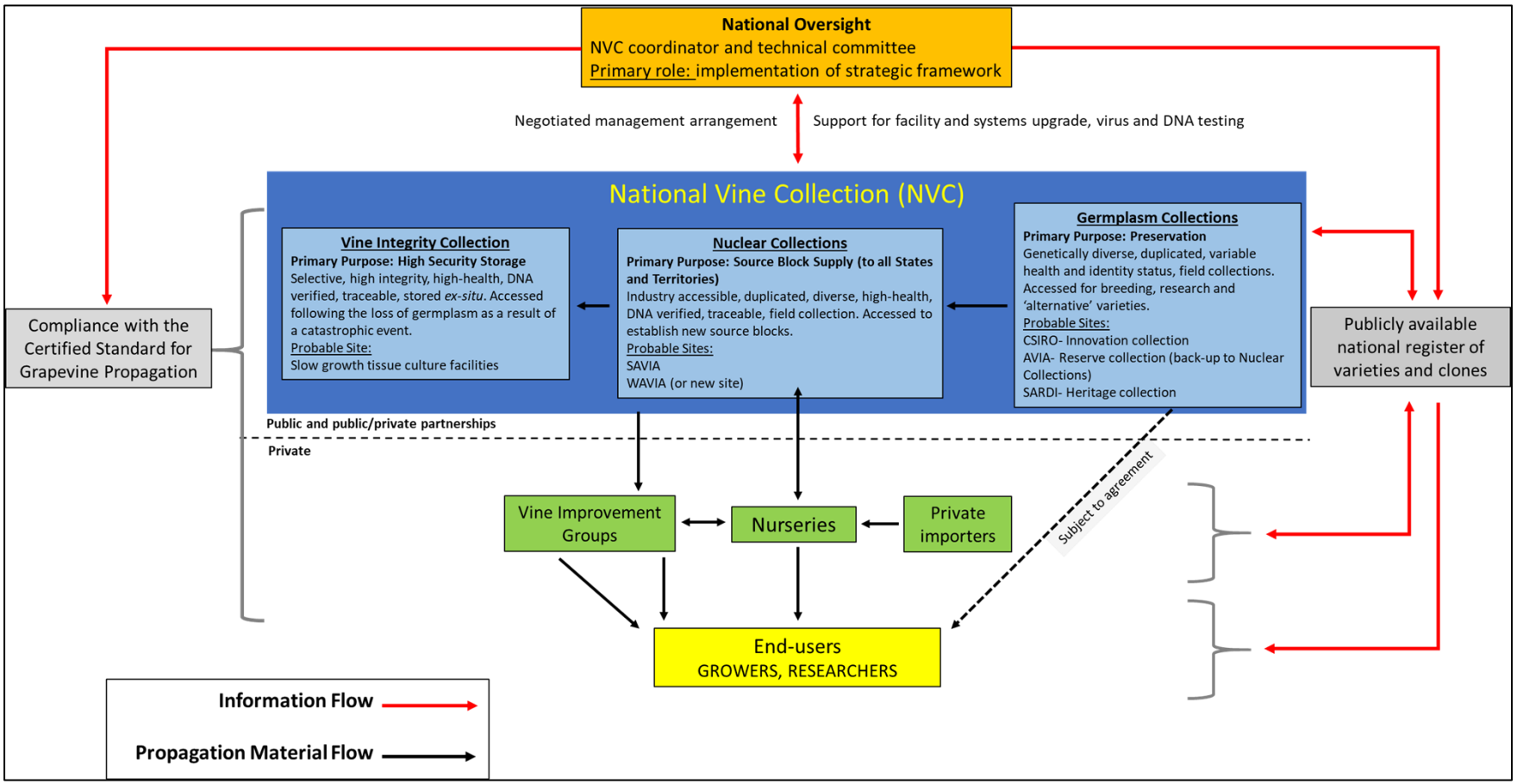
The following two sections will detail and describe a proposed model for the National Grapevine Collection and discuss and outline the selection/justification for the alignment of existing assets and resources to each function/enabling activity while also identifying gaps and further actions.

Table 5. The 'Strategic Framework' for a National Grapevine Collection.

Objectives:	**1. Protection of Australia's grapevine genetic resources.** **2. Facilitation of the supply of commercially relevant, healthy, true-to type planting material.** **3. Support of 'enabling activities' that supplement the National Grapevine Collection.**				
Functions:	**1. Protect key cultivars in high security storage- Vine Integrity Collection.**	**2. Protect and supply high-health, true to type, commercially relevant cultivars including rootstock - via Nuclear Collections.**	**3. Preserve genetic diversity through the maintenance of Germplasm Collections.**	**4. The facilitation of vine enhancement projects (breeding, preservation, variety and clone evaluation projects).**	**5. Ensure the biosecure and rapid importation of cultivars from overseas breeding and selection programs (public and private imports).**
Germplasm Principles:	**Ensuring security and genetic integrity.**	**Ensuring security and availability.**	**Maintaining genetic integrity and diversity.**	**Introduction of new cultivars, providing information, maintaining genetic diversity.**	**Introduction of new cultivars, ensuring security.**
Enabling Activities:	**Oversight and management by a central NVC coordinator.**				
	Maintenance of a certified standard for grapevine propagation.				
	A publicly available national register of grapevine varieties and clones (that includes private imports).				
	Access to pathogen testing and virus elimination services.				
	Access to DNA typing for variety and clone identification.				
	Development and demonstration of best-practice management of viruses and grapevine trunk disease.				
	Access to certified 'rapid' propagation facilities.				

5. Proposed Model for a National Grapevine Collection

To achieve the objectives and functions outlined in Table 5, it is proposed that the following model be adopted:



Key aspects of the model are:

a. **The model is an extension of the concept proposed by Stanford *et al.* (2014) and is based on the co-ordination of a National Grapevine Collection (NVC) which is a system of inter-related 'fit for purpose' grapevine collections, each with specific functions**:

   I. **Vine Integrity Collection**- High security, selective, high integrity, high-health, DNA verified, traceable, stored *ex-situ*. This is the collection that is accessed following the loss of grapevine germplasm as a result of catastrophic events.

   II. **Nuclear Collections-** Industry accessible, diverse, high-health, DNA verified, traceable, field collection. This is the collection that is accessed to establish new source blocks.

   III. **Germplasm Collections-** Primarily for innovation, preservation and access to less known 'alternative' varieties. Genetically diverse and variable health field collections. These are the collections that are accessed for breeding, research and previously untested 'alternative' varieties.

b. **The pillars of the National Grapevine Collection are a national certification standard for grapevine propagation material and a centrally maintained and publicly available national database of grapevine varieties and clones.**

c. **The National Grapevine Collection is managed by a central coordinator and a technical committee made up of representatives from vine improvement groups, nurseries, research and industry.**

Adoption of this model will:

- Underpin the supply chain and ensure the integrity and quality of future vine plantings.
- Ensure innovation and continuous improvement in the development of 'cultivars' best suited to our environments and markets.
- Provide security for the wine sector in the event of a catastrophic pest incursion or other event.

Further Actions

It is recognised that further work is required to define the mechanisms for the movement of material out of the CSIRO and SARDI collections and through the supply chain. Two specific issues were raised in the final consultation period:

I. The mechanism by which individual growers might wish to request genotypes from either the nuclear collection or the germplasm collections (via a LE) that are listed in the National public register will need to be developed.

II. The model shows direct movement of material from the Germplasm collection to the Nuclear Collection, however this would be subject to the virus status of that material. If the material does not meet the conditions of the Nuclear collection it would need to be put through virus elimination and then propagated by a nursery- both processes done under an agreement developed by the management of the Nuclear Collection. If the material does meet the conditions of the Nuclear Collection then it would then need to be propagated by a nursery under an agreement developed by the management of the Nuclear Collection.

It is anticipated that an output of the national certified standard will be to define the criteria for movement into and out of each collection type.

6. Asset and resource alignment for the functions and enabling activities of the National Grapevine Collection.

With reference to the Strategic Framework (Table 5) and the Proposed Model, as above, this section will detail and discuss the functions and enabling activities of the National Grapevine Collection, outline the selection/justification for the alignment of existing assets and resources to each function or enabling activity and identify gaps and further actions.

6.1 Function 1: Protect key cultivars in high security storage (Vine Integrity Collection).

High security storage of germplasm, either *ex-situ* or in insect-proof screenhouses, greatly reduces the risk of losing germplasm due to environmental hazards and pathogenic threats and provides an ideal complement to field-based collections (Offord and Meahger, 2009).

One of the major catastrophic threats to Australia's wine sector and its grapevine genetic resources is *Xylella fastidiosa*. While the development of duplicated collections will help minimise risks associated with this pest, it was identified in the hazard analysis of the SAVIA and WAVIA collections

(Appendix 4) that high security storage is a critical component of a National Grapevine Collection to minimise risk posed by highly mobile and destructive vector-based pathogens.

There are two options for high security storage: insect-proof screenhouses or *ex-situ* storage (slow-growth tissue culture or cryopreservation).

Insect-proof screenhouse

A recent example of the implementation of an insect-proof screenhouse is a project by Auscitrus Australia to combat the threat of the citrus tristeza virus (spread by aphid vectors). Auscitrus recently completed the construction of 2400m² insect proof screenhouse at a cost of $700,000. This investment delivered the structure alone and does not include the supporting facilities that were already on-site or ongoing maintenance (pers.comm. Tim Hermann, Auscitrus; Auscitrus Annual Report 2019). Apart from the high cost of establishment, a new insect-proof screenhouse facility for grapevines would require additional funding for site identification and feasibility studies as well as significant annual funding to maintain both the facilities and the accessions.

It is the view of the author that the high cost of implementation and maintenance renders this option for a Vine Integrity Collection is currently unviable and that funding is better invested in national coordination, upgrading field collections (SAVIA and possibly WAVIA as outlined in Function 2), and the alternative approach of *ex-situ* storage (as outlined below).

Ex-situ storage

There are two options generally considered for *ex-situ* grapevine germplasm preservation: slow-growth tissue culture storage and cryopreservation.

In the United States **cryopreservation** has been used by the USDA at the Agriculture Genetic Resources Preservation Research facility in Fort Collins, Colorado to conserve 'almost 1 million accessions' including *Vitis vinifera*.

A research project based out of the University of Adelaide successfully cryopreserved almonds for up to 2 years (Wirthensohn et al. 2006) however a commercial service was not developed. The Australian Plant Bank (part of the Australian Botanic Gardens at Mount Annan) is currently in the process of undertaking research into cryopreservation options to protect threatened native species in particular rainforest species, but is finding it challenging (pers. comm., A. Rollason). The University of Queensland has been funding research on cryopreservation of avocado shoot tips. The program is in its initial steps and has recently published a first report (O'Brien et al., 2020).

Apart from the apparent lack of commercial options in Australia, there are a range of challenges with cryopreservation. There are high costs associated with laboratory set-up, a high level of expertise required to develop and implement protocols and there are high labour costs of getting each accession into the preservation state with only 2-3 accessions successfully preserved per technician per week (Volk, 2019). There are also the challenges of working with liquid nitrogen and the requirement for handling facilities and appropriately trained staff. Each plant species and tissue type has very specific requirements for the way in which it is prepared, frozen and thawed. So significant amounts of research are required before cryopreservation can be successfully applied. (Meagher and Offord, 2019).

Based on this assessment it is considered that cryopreservation is not currently a viable option for grapevine accessions in Australia, however it should not be discounted as a future option if commercial services become available.

Slow-growth tissue culture storage is a technique that has been successfully applied to a range of crop-types and can provide up to two years of growth without additional maintenance (Ashmore, 1997). In Australia, the Strawberry industry currently holds approximately 80 varieties in slow-growth tissue culture at AgriBio in Victoria (Fiona Constable, pers. comm.) The service costs approximately $500 per cultivar for initiation and an additional $300 for annual maintenance. (These costs do not include the costs associated with pathogen testing of mother plants prior to collection of propagation material).

The benefit of tissue culture storage is that it is possible to store a large number of cultivars in a small space. Once plants are in culture they can be multiplied rapidly and relatively inexpensively in controlled environments away from threat of virus and other pests or pathogens. However, it must be noted that there is the potential for 'genetic drift' of genotypes while in tissue culture storage. There are multiple factors involved but the number of sub-cultures (which are performed to renew ex-plants) is the major contributing factor. In the strawberry industry the number of sub-cultures is limited to 10 to limit the potential for genetic drift (Boxus et al. 2000).

Slow-growth tissue culture is common practice, there is access to commercial services and therefore it provides the best current option for high-security storage of grapevine cultivars. Prior to the establishment of this collection the following actions should be completed.

Further Actions

- Conduct wine sector consultation to identify criteria for entry of cultivars into *ex-situ* storage.
- Discuss options for housing a high-security grapevine collection as slow-growth tissue culture with AgriBio and other organisations which have tissue culture facilities (Yalumba Nursery, AWRI and Agromillora and any other identified service providers).
- Investigate and develop protocols to limit the potential for genetic drift.

While *ex-situ* storage options and relevant protocols for a Vine Integrity Collection are being developed, negotiated and organised, cool storage of dormant buds of key cultivars is an option to provide short-term security. Note: Cool storage of dormant buds would need to be renewed annually to maintain bud viability and mothervines would need to be virus tested prior to bud collection to ensure freedom from non-tolerated virus.

6.2 Function 2: Protect and supply high health, true-to-type, commercially-relevant cultivars and rootstocks (via Nuclear Collections)

As has been identified in previous reviews and during the consultation process for this work, the maintenance and supply of healthy, true to type planting material from a foundation source (i.e. Nuclear Collection) is a critical requirement for the Australian wine industry as it will '*underpin the supply-chain and ensure the integrity and quality of future vine plantings'* (McMichael, 2013).

Under the model, Nuclear Collections are an elite collection of carefully selected cultivars in current or likely future commercial demand. Cultivars within the collection have known varietal identity (via DNA testing), highly probable clone identity (initially via traceability, in the future via DNA) and a freedom from non-tolerated pests which is maintained through an agreed and audited program of regular testing and inspections.

Every Australian State and Territory will have equitable access to cultivars in the Nuclear Collections.

Duplication of key cultivars is a guiding principle of germplasm management and was highlighted as a critical need during the consultation sessions. Accordingly, the model suggests maintenance of Nuclear Collections on two geographically separated, secure sites. The collections will not be carbon copies of each other, but identified key cultivars will be common to both

Asset/Resource Alignment

The SAVIA and WAVIA collections were identified in Deliverable 2 (Section 3.1.1) as having the greatest potential to be transitioned to Nuclear Collection status. This finding was based on the two

collections having (in relative terms compared to the other collections): industry relevance and diversity in cultivars, DNA verification or traceability records, a recent history of virus testing, sound vine health and infrastructure in good condition.

As a result of their identification as collections best suited to hosting Nuclear Collections, both the SAVIA and WAVIA collections and their associated sites were subject to an extensive risk assessment process which covers both pests and hazards (see Appendix 4). Measures to manage current risks were identified, together with additional control measures and funding requirements to map a pathway for the collections to meet Nuclear Collection status. The risk analysis process also provided the framework and support mechanisms required for the development of an independent 'green-field' Nuclear Collection site that can be used in the event that either site is unable to meet Nuclear Collection status.

Further to the risk assessment, cost-modelling has also been undertaken to determine what funding is required to:

a) Undertake the required DNA and virus testing to transition each collection to a Nuclear Collection.
b) Manage the collections and maintain their Nuclear Collection status (through triennial virus testing).

Recommendations for action:

SAVIA collection

Based on the review of the collection (appendix 2.), risk analysis (appendix 4) and cost modelling (appendix 5), the SAVIA collection is very well situated to be upgraded to a Nuclear Collection. Furthermore, the SAVIA collection is best situated to become the Licensed Entity (LE) for the CSIRO and SARDI collections due to its association with the propagation facilities and resources at RVIC. Additional control measures identified from the risk analysis to achieve this status are summarised in Table 5, together with estimated costing.

Table 5. Actions required to transition the SAVIA collection to a Nuclear Collection in the National Grapevine Collection

Activity	Estimated cost
Procedural upgrades: entry of people and equipment, vector monitoring and virus surveillance, virus management and pre-harvest testing	$10,000
Capital works:	
Erection of security fencing (approx. 600m at $65/m inc. transport, gates etc.)	$40,000
Washdown pad	$30,000
Parking area	$20,000
DNA typing and virus testing of the collection	$120,000
TOTAL	$220,000

WAVIA collection

The WAVIA collection (in a hazard and pest-risk sense) is well-positioned to be developed as a Nuclear Collection to complement the SAVIA collection. As with the SAVIA site, additional control measures are mostly associated with procedural upgrades and the requirement for greater site security.

The major gap in the WAVIA collection is that its current virus status is unknown beyond the viruses GVLRaV-1 and GVLRaV-3. A baseline understanding of the virus status of the collection is required prior to investment in other measures (such as DNA typing) to inform whether rogueing or other maintenance measures are required, or whether an alternative Nuclear Collection site needs to be sought.

It is therefore recommended that approximately $43,000 (based on cost modelling) be invested into undertaking a complete virus screen of the WAVIA collection. If virus results indicate that the collection requires minimal maintenance to remove non-tolerated virus, then further funding for DNA typing and site and procedural upgrades should be made available to transition the collection to sit alongside the SAVIA collection as a Nuclear Collection.

If virus testing results clearly show that that the collection cannot be remediated of virus then a new site for a Nuclear Collection outside W.A. must be identified (a new site in Western Australia would not be considered due to the inhibitory cost of importing grapevine material into the state). The WAVIA collection would then be maintained as Germplasm Collection.

The road-map in Figure 2 summarises the pathway for the WAVIA collection to transition to Nuclear Collection status and the point at which a decision is made on the identification of an alternative Nuclear Collection site.

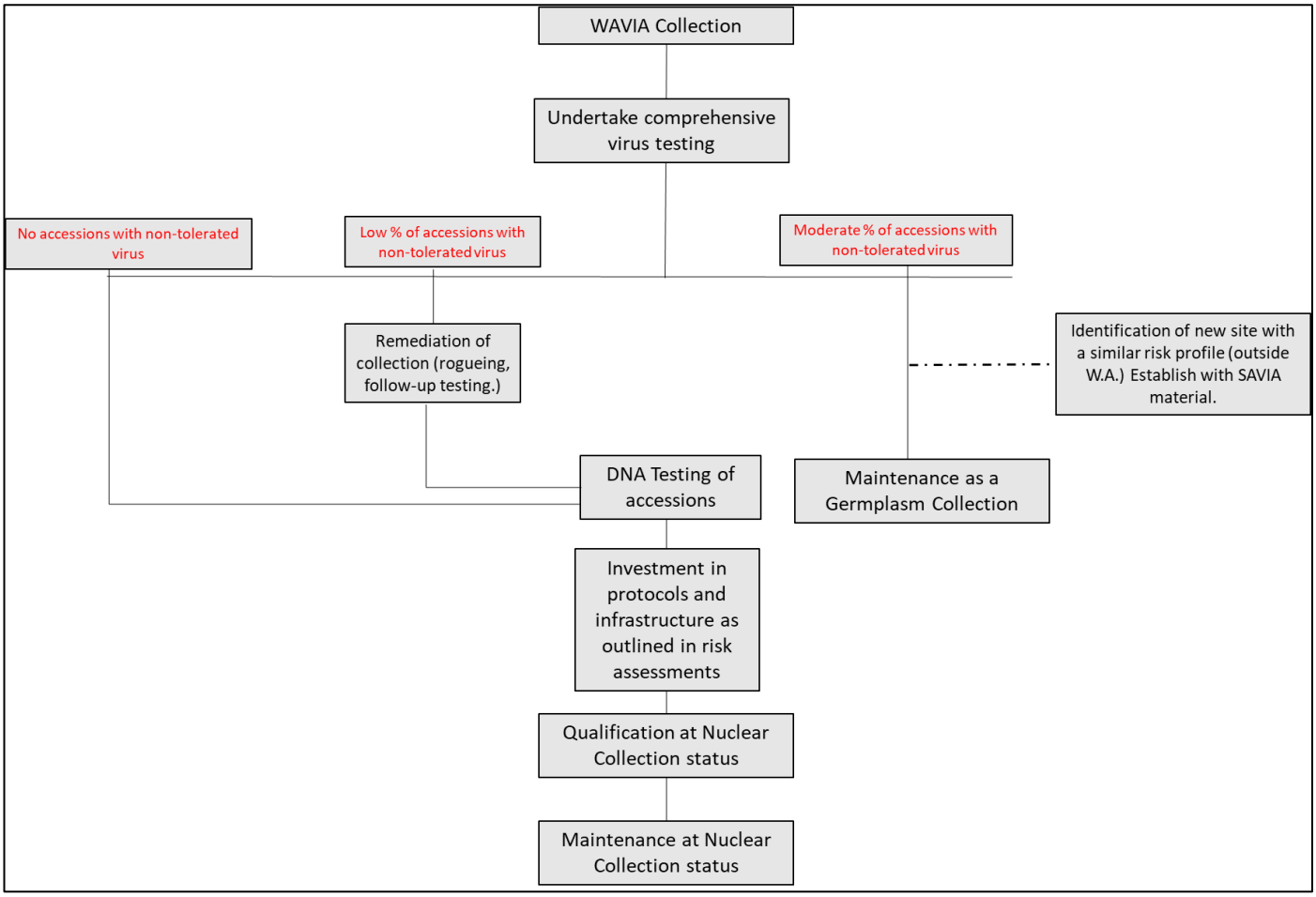


Figure 2. Road-map for the transition of the WAVIA collection to Nuclear Collection status

Full details on the risk assessments results and methodology can be found in Appendix 4. Full details on the cost modelling results and methodology can be found in Appendix 5.

Alternative options for Nuclear Collections sites

In the event that either of the nominated collections are unable to successfully transition to Nuclear Collection status then there will be a need to identify suitable alternative sites. As the majority of the public and private germplasm collections are located within a relatively small geographical area in the Riverland and Sunraysia (Figure 1),it is recommended that areas outside these regions be targeted.

Joint discussions with NSW DPI and the NSW Wine Industry Association have indicated that they would collectively be interested in exploring the opportunity to develop a Nuclear Collection at either the NSW DPI site in Orange or the NSW DPI site in Trangie (near Dubbo). Both sites are

relatively isolated from commercial vineyards in NSW (particularly Trangie) and provide an excellent starting point should an alternative site be necessary.

6.3 Function 3: Preservation of genetic diversity through the maintenance of Germplasm Collections

Under the model proposed here, not all cultivars are maintained in the Nuclear Collections. To ensure that diversity is preserved, additional in-field collections would be maintained as Germplasm Collections, each with defined functions aligned with specific industry requirements. The phytosanitary standards and degree of DNA verification for each collection would be different based on the role of that collection. For example, it would be a requirement that a 'reserve' collection would have higher phytosanitary status and degree of DNA verification compared with the 'preservation' collection.

Asset/Resource Alignment

- The CSIRO collection would be primarily maintained to provide accessions for innovation purposes. It is the collection that would be accessed when material is required for breeding or selection or for trialing of emerging or alternative cultivars.
- The SARDI collection would be primarily maintained as a 'preservation' collection, with its primary purpose in maintaining heritage germplasm for future generations.
- The AVIA collection would ideally be primarily maintained as 'reserve' collection to the Nuclear Collections, subject to the results of virus surveillance.
- Vine Improvement groups and regional associations would facilitate identification of significant local heritage selections that require preservation, to be added to Germplasm Collections (subject to the conditions of the collection; virus status and DNA verification).

Further Actions

- Develop further detail around the specific role(s) of each Germplasm Collection.
- Negotiate MOU (or similar) with each collection stakeholder.
- Negotiate and implement Licensed Entity arrangements for access to the CSIRO and SARDI collections.
- Develop and implement an appropriate virus surveillance program and variety verification for the AVIA collection to determine its suitability to be maintained as a reserve collection to Nuclear Collections.
- Development management plans and an associated budget for each collection.
  Undertake a review of infrastructure to identify and plan for any potential capital expenditure.

6.4 Function 4: The facilitation of vine enhancement projects (breeding, preservation, importation, variety and clone evaluation projects)

Identified in the consultation process was a range of activities related to breeding, preservation and variety and clone evaluation that is currently being undertaken by public and private organisations. These activities would benefit from strategic facilitation *via* the National Grapevine Collection coordinator and technical committee.

Furthermore, the implementation of a National Grapevine Collection and appointment of a National Grapevine Collection coordinator provides a clear pathway for renewed, strategic investment in the importation of industry critical cultivars and rootstocks. A salient example of this are the five Pierce's Disease resistant varieties developed at UC Davis (Raiz *et al*., 2009).

Asset/Resource Alignment

The National Grapevine Collection coordinator would work closely with research organisations, private importers, Vine Improvement groups and regional organisations.

Further Actions

A review of previous and current projects related to vine enhancement should be undertaken. This review would have a number of objectives including developing extension strategies for existing information and identification of knowledge gaps and future research priorities.

6.5 Function 5: Ensure the bio-secure and rapid importation of new cultivars from overseas breeding and selection programs (public and private imports).

The Australian wine sector is reliant on the importation of grapevine genetics from overseas programs to increase the diversity of the national germplasm. The quarantine process and related protection from exotic pests is critical in maintaining one of the Australian wine grape sector's key competitive advantages. However, there are considerable restrictions in the importation process, including time, cost and scope of access. Barriers to importing *via* legal channels may encourage illegal importation and subsequent increased biosecurity risks. There would be major benefits to the wine grape sector having centralised oversight of the importation and quarantine process, which would ideally include information on the cultivar identity of material being imported and PEQ exotic pest interception data.

Asset/Resource Alignment

Wine sector communication with Post Entry Quarantine (PEQ) is via the 'wine-grapes representative' on the PEQ advisory committee. Representatives on the PEQ advisory committee are provided with updates on new testing techniques and are expected to provide feedback on the reviews of import conditions and also in the review of 'approved sources' for imported material. Currently the Department of Agriculture Water and Environment (DAWE) appoints members of the committee on two-year terms based on applications from interested individuals rather than as representatives of strategic, relevant industry organisations. It is recommended that the National Grapevine Collection coordinator or a member of the National Grapevine Collection technical committee be appointed to the position in the future to ensure that the strategic needs of the wine sector are being properly communicated.

Further Actions

Develop a communication channel with the Department of Agriculture Water and Environment (DAWE) to ensure that the next appointed representative is either the National Grapevine Collection coordinator or a member of the NVC technical committee.

6.6 Enabling Activity 1: Oversight and management by a central National Grapevine Collection coordinator and technical committee.

A National Grapevine Collection coordinator is required to carry out the activities necessary to implement the model. This position will be guided by a technical committee made up of (but not limited to) representatives from each collection (Vine Integrity Collection, Nuclear Collections and Germplasm Collections), each stakeholder group (Vine Improvement groups, VINA, research and the wine grape sector) and relevant experts (possibly from outside the wine industry).

The National Grapevine Collection coordinator and technical committee is responsible for:

1. Interaction with collection owners to facilitate coordination of the collections.
2. Oversight of a certification system for the propagation of grapevine planting material.
3. The development of a searchable, publicly available national register of grapevine varieties and clones (that includes private imports).
4. Interaction with technical specialists to identify and facilitate uptake of new technologies related to germplasm preservation and management.
5. Ensuring that the industry has the capacity to rapidly multiply planting material.
6. Developing priorities for variety/clone evaluation and for breeding and selection.

7. Communication with AQIS/PEQ and international breeding and selection programs.
8. Regular reviews to ensure that collections remain fit-for-purpose, fulfil their functions and meet sector requirements for in-demand cultivars.

6.7 Enabling Activity 2: Oversight of a national certified standard for grapevine propagation.

The development of a certified standard for grapevine propagation material will ensure the integrity and health status of planting material throughout the propagation supply chain and into vineyards and will specifically address the following:

- Grapevine viruses
- Grapevine trunk diseases
- Guidelines on evidence traceability
- Trueness to type (i.e. Identity verification)
- Physical specifications of cuttings, rootlings and potted vines
- Secure rapid propagation for source block establishment

To enable the development of a national certified standard that will be valued by industry and the propagation sector, a set of principles should be established to ensure that the framework of the standard will be customer-focused, transparent and built on HACCP principles. The new national certified standard must also be aspirational, inclusive and allow for continuous improvement.

Asset/Resource Alignment

SAVIA- is undertaking a review of part 1 of the '*National Vine Accreditation Scheme (NVAS): Procedures Manual- Vine Improvement groups'*. They have also recently completed a paper '*Protecting the high-health status of Australia's grapevine propagation assets: A business case for developing a science and standards-based management system'*. This paper focusses on the current gaps in knowledge in the science to support the standards. The business case is based on a risk analysis that identifies 52 major risks to Vine improvement activities and these risks have been prioritised into 15 research projects.

SAVIA has networks with regional and state-based Vine Improvement groups.

VINA- The VINAS manual and VINA accreditation system for the production of propagation material is the current standard for industry. VINA also have a network of nursery members.

AVIA- owns the intellectual property for the National Vine Accreditation Scheme (NVAS).

Vinehealth Australia (VHA)- One of the statutory functions of Vinehealth Australia is in ensuring that there is the production of propagation material that is free of specified pests. As this is a primary function, contributions collected under section 23 of the Phylloxera Act can be used to support in the development, implementation and ongoing management of the standards as a part of VHA role in protecting South Australian vineyards from disease.

AWRI- would play an important communication role in disseminating the purpose and benefits of the certified standard to the grape and wine sector. Also, there is the ability to further promote the use of material produced under the certified standard through their role in Sustainable Winegrowing Australia.

Wine Australia has committed to funding a project to 'review the Grapevine Propagation and Supply Standards and Develop a draft of a new National Standard' and it is recommended that Wine Australia support structural reform (as outlined in the proposed model) that will deliver, support and administer the standard.

Further Actions

The successful implementation of a national certified standard for grapevine propagation requires the delivery of two strategic objectives defined by their regulatory and technical and outputs:

Regulatory- develop a business model for the certified standards which outlines the structure for the ownership, administration and management of the standards, the collection of levies and funding (sponsorship and corporate partners) and the distribution of those levies for management, research, training and promotion of the benefits of using certified planting material. The outputs of the regulatory objective are to provide a financially sustainable structure and to address the barriers to adoption by nurseries and growers.

Technical- develop the standard (definitions and pathways to produce each certification level), review, update and integrate parts 1 and 2 of the NVAS/SAVIA/VINAS manuals based on the standards and the development and inclusion of standards for rapid/green propagation (for source block establishment). The SAVIA business case identified the need for more complete information on source block virus status, the development of updated virus sampling methods and consistency in

virus testing methodologies as the major gaps in current knowledge that needs addressing as part of the development of part 1 of the standards.

The output of the technical objective is to provide a blue-print for the professional management of source areas and nurseries to ensure that the propagation outcomes have been produced under industry-recognised/science based best practices, resulting in the supply of vines that are healthy and true-to-type.

6.8 Enabling Activity 3: The development of a searchable, publicly available national register of grapevine varieties and clones (that includes private imports)

Asset/Resource Alignment

An up-to-date, searchable, publicly available national register of grapevine varieties and clones is required to support the functions of a National Grapevine Collection. It does not currently exist. Generation of such a register will build on two previous Wine Australia-funded projects which attempted to survey the material held within Australian grapevine collections: S*ummary of a review of grapevine germplasm collections in Australia (GWR1112)* and *Australian Germplasm Register Project (WA1902).* Furthermore, the soon to be completed *Grapevine Germplasm Variety Identification Project* (CSP1501) will provide updated information on the varietal identity of the CSIRO and SARDI collections.

Further Actions

Initiate a project that builds on the database developed in WA1902 and addresses the gaps and data limitations identified in GWR112 including: naming guidelines, consistent reporting of imposed treatments (i.e heat-therapy for virus elimination), agreement on accepted synonyms and the removal of duplication of varietal and clonal names. It is anticipated that the project would be undertaken by a consultant under the direction of the NVC coordinator and technical committee and should address the following:

- That the database is available on-line, can be updated as necessary and can also be value-added with additional layers in the future. Input on the structure should be sought from a database developer in the initial stages of the project.
- That currently the information related to private collections (assembled in WA1902) is not publicly available and is bound by confidentiality agreements.
- That accepted methodology for clone identity verification and agreed guidelines on evidence traceability is lacking. It is recommended that national guidelines on naming, health testing

and clone identity verification be included as part of the development of the certified standard for grapevine propagation, to provide consistency across all collections.

- Investigate the options for integration with source block registers and GIS.

6.9 Enabling Activity 4: Access to pathogen testing and virus elimination services

Complementary management strategies for virus, which include but are not limited to diagnostics and vector management, are required to ensure that high-health material retains its integrity throughout the propagation supply chain and into vineyards.

Asset/Resource Alignment

Both the AWRI and AgriBio offer commercial services for virus testing and virus elimination. Continued provision of, and access to, the services that these organisations provide, along with their intellectual resources, is critical to the success of a National Grapevine Collection.

Further actions

The development of consistent sampling and testing protocols.

These organisations and the funding of related research must be aligned with the objectives and functions of the National Grapevine Collection.

6.10 Enabling Activity 5: Access to DNA typing

The supply of propagation material that is not true-to-type has reputational and financial consequences throughout the whole of the supply chain.

Asset/resource alignment

CSIRO is near completion of CSP1501 'Grapevine Germplasm Variety Identification'. This has developed a SNP marker library that could potentially be licensed to AGRF for provision of a commercial variety testing service. Alignment between such a service and the National Grapevine Collection would have significant advantages.

The AWRI has established a robust methodology for Chardonnay clonal identification that harnesses the detailed information provided by whole-genome DNA sequencing (Roach *et al*., 2018) and is currently developing a similar system for the identification of clones of Pinot noir. This approach may be applied to other varieties and a project has been developed by the AWRI for the

commercialisation of a clonal typing service. Such a service would clearly become a vital tool in germplasm management.

Further Actions

Access to commercial services for both variety and clone identification will be integrated into the national certified standard for grapevine propagation.

6.11 Enabling Activity 6: Development and demonstration of best-practice management of viruses and grapevine trunk disease

Critical to the supply of 'healthy' planting material is the development and maintenance of best-practice virus and trunk disease management guidelines specific to the propagation supply chain. These practices will be integrated into the national certification standard for grapevine propagation.

Asset/resource alignment

Previous Wine Australia-funded research in virus and grapevine trunk disease has resulted in current management practices used by the sector and will be deployed along with outputs from ongoing projects to ensure that best management practice is achieved.

7. Where to from here?

This discussion paper recommends significant structural reform of the grapevine propagation sector and identifies a number of action items to progress to a National Grapevine Collection. Three initial actions are recommended.

Initiate discussions with the organisations associated with each of the collections included in the National Grapevine Collection (CSIRO, SAVIA, WAVIA, AVIA and SARDI) with a view to negotiating management arrangements and identifying support requirements.

The implementation of the grapevine certified standard for propagation material is an immediate priority, as it will lay the groundwork for the conditions under which the collections in the National Grapevine Collection will be established and managed. Underpinning the certified standard is the essential research identified in SAVIA's business case (see section 6.7) on the methodologies for virus surveillance of collections and source blocks.

The appointment of the National Grapevine Collection coordinator and technical committee should be undertaken as the final immediate priority to provide the leadership to drive the process and implement the strategic framework.

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Appendix 1. List of Definitions and Acronyms

The language of the grapevine propagation sector can be difficult to navigate. The aim of this section is to provide the basis for a common language for use in the discussion paper. The definitions are based on past reviews and reports and from consultation with the steering committee and during the consultation sessions.

1.1 General Terms

Clone- A derivative line, generally genetically indistinct from an originating cultivar using currently available DNA typing methods, with distinct performance characteristics relative to the originating cultivar".

Cultivar- a distinct genetic identity whose origin or selection is primarily due to the intentional actions of human-kind. In this paper it is proposed that a cultivar is a variety/clone combination for example Merlot/D3V14.

Accession- refers to an individual that has been given a designated identity (number or combination of numbers and letters) that allows for its traceability to a source or process. There can be multiple accessions of the same cultivar.

Example of the distinction between the terms accession and cultivar using Merlot clone D3V14:

Variety	**Clone**	**Cultivar**	**Accession No.**
Merlot	D3V14	Merlot/D3V14	I.C.65.8013
Merlot	D3V14	Merlot/D3V14	I.V.64.2093

The important distinction between the terms accession and cultivar is that the accessions designated identity (number or combination of numbers and letters) should never change, whereas a cultivars identity may change depending on the results of DNA testing or via a change to a valid varietal synonym. There are situations where the terms may correctly be used interchangeably.

Germplasm- a term used to describe the total genetics of a crop-type.

Source Blocks- A group of vines that is used to supply vine material for propagation.

Vine Improvement- the process of:

• identification and procuring of superior clones and varieties.

• cultivar disease testing, evaluation and elimination.

• evaluation of cultivars.

• establishment and maintenance of collections.

Vine Improvement Groups (VIG's) are regional or state-based organisations that establish and manage source blocks and may also undertake vine improvement activities as described above.

'High-health' status- should be used to describe the status of a collection that is free of non-tolerated pathogens. (i.e. a collection may or may not have a high-health status).

1.2 Description of Collections

The National Grapevine Collection (NVC)

The inter-related system encompassing the Vine Integrity Collection, Nuclear Collections and Germplasm Collections. Vines in the NVC could take numerous forms i.e. field grown, potted or tissue culture or cryopreservation.

Vine Integrity Collection

A high security, selective, high integrity collection that addresses biosecurity, traceability and maintenance of vine health. Accessions are preserved in a location or condition to protect them from pests and hazards. Conditions of entry:

- Varietal identity verified via DNA testing against an international reference.
- Clone identity verified via traceability to an original verified source (or by molecular methods once the technology becomes commercially available).
- Freedom from non-tolerated pests and pathogens maintained through an agreed and audited program of regular testing and inspections.

The location or growing conditions may be in an insect-proof screenhouse, in tissue culture, cryopreservation or cool storage.

Nuclear Collection

A Nuclear Collection is defined in this paper as a field collection of selected cultivars in current or likely future commercial demand. This is the collection that is accessed to establish new source blocks for wider industry access. The proposed conditions for a Nuclear Collection are:

- Varietal identity verified via DNA testing against an international reference.
- Clone identity verified via traceability to an original verified source (or by molecular methods once the technology becomes commercially available).

- Freedom from non-tolerated pests and pathogens maintained through an agreed and audited program of regular testing and inspections.

A Nuclear Collection is maintained with strict protocols to minimise the risks of pest and pathogen incursion or impacts of hazards.

Germplasm Collections

A Germplasm Collection is defined in this paper as a formal field collection maintained to ensure for the preservation of high genetic diversity in the National Grapevine Collection. Each Germplasm Collection is maintained with a specific function. These functions may be as a back-up to Nuclear Collections, for innovation purposes (breeding, research and meeting new market trends) or for heritage/ preservation purposes. To maintain the genetic diversity a Germplasm Collection may have variable health and so proposed conditions are less restrictive than Nuclear Collections or a Vine Integrity Collection. Because of the variable health and identity status the conditions of movement of material out of a Germplasm Collection are restricted depending on the purpose of that material (i.e. virus compromised cultivars should not be supplied for use in commercial vineyards, but can be used for research purposes).

Collection Assets

General term used to describe the collections and associated procedures and protocols that make-up the NVC i.e (Variety Integrity Collection, Nuclear Collections, Germplasm Collections)

Collection Resources

The associated resources that underpin the National Grapevine Collection including propagation facilities, testing facilities, shadehouse/glasshouse storage.

Appendix 2. The strengths and weaknesses of existing Germplasm Collections in Australia.

2.1 Collections and data assembly

Data was collected from the six significant collections of publicly held germplasm in Australia (Section 3.1.1). The following information was assembled either from the reports reviewed in deliverable 1 or through direct contact with key individuals associated with the collections:

Purpose, Governance, Policies and Structure

- Current role and function
- Auditing
- Management structure
- Policies around distribution
- Alignment within the industry
- Committee activity.

Virus and health

- Collection philosophy with respect to virus management
- Entry and rejection criteria
- Testing regime
- Current status
- Degree of isolation
- Grapevine trunk disease status
- Comments on general health.

Genetic Improvement Activities

- Variety, clone rootstock development/trials
- Prospecting of potential mother vines
- Virus elimination of existing clones/varieties
- Importation activities.

Genetic Resources

- Collection focus and relevance to industry
- DNA testing
- Ampelography
- Provenance records.

Capability, Capacity and Resources

- Access to labour
- Access to hot-water treatment
- Access to propagation facilities
- Available land
- Access to water
- Current funding
- Condition of infrastructure (trellis, irrigation, sheds).

2.2 Summary of public collections

Collection Name	Number of Accessions (from WGG1902)	Collection focus and relevance to industry
AVIA collection	216	216 total entries, with a focus on 'major' wine grape varieties (88 out of the 166 wine grape entries), with only 6 multi-purpose and 4 tablegrape varieties. 131 selections from overseas programmes (87 from FPS). No new clones imported from overseas or introduced from recent local clone selection programs since establishment.
SAVIA collection	466	Highly diverse collection with a strong focus on winegrape varieties (only 5 multi-purpose/tablegrape varieties). 301 entries imported from overseas programs. Wide range of origins of material including from Vitis Rauscedo, Plansell and Provedo. High proportion of non- major varieties are of interest i.e. considered as 'emerging' and have commercial potential. High diversity also in rootstock collection (35 varieties, 65 clones).
RVIC collection	374	Majority of the collection either extension rows or source blocks (only 34 entries with <6 vines). Strong focus on emerging varieties. High degree of overlap with SAVIA collection (because of the need for large source areas for commercial cutting supply).
CSIRO collection of grapevine varieties & clones	Based on the information in the 2012 Germplasm register there are 989 entries, numbers need to be updated based on findings from CSP1501.	The CSIRO is the largest collection in Australia and contains the majority of the unique selections in Australia. Based on the 2012 germplasm register there are 989 different accessions; 62% (618) winegrape accessions and 104 rootstock accessions, which makes it the largest and most diverse collection of rootstock in the country. Approximately 60% of the collection was sourced from more than 40 different overseas collections. The collection has been primarily used for R&D and breeding purposes and is considered to have high research value.
WAVIA Collection	192	High proportion of table grapes compared with other collections. Focus on virus freedom (leafroll 1 and 3). Good diversity of rootstock varieties represented. Represents good diversity of 'older' imported varieties with the majority of these from Foundation Plant Services/UC Davis collections. Limited number of unique varieties/clones.
SARDI collection	Based on the information in the 2012 Germplasm register there are 270 entries, but these numbers need to be updated based on findings from CSP1501.	Highly valuable as it houses earliest generation selections for high significance Australian selected clones of Shiraz, Cabernet Sauvignon, Grenache, Riesling and Semillon.

2.3 Collection Strengths and Weaknesses

2.3.1 AVIA Collection

Summary

The collection is located in Dareton, NSW on the DPI Agriculture and Advisory station. Established as a Nuclear Collection in 2003, the collection is currently in 'maintenance' mode providing a small volume of cuttings to industry via distribution from VAMVVIA. The collection contains 216 accessions with a focus on winegrape varieties. The mix of varieties and clones 'is a product of its time of establishment' and it has a high proportion of less relevant varieties (based on current market demand).

Strengths

Isolation- the closest vineyard is more than 500m away.

Available land- the block is approximately 1.2 Ha and is only approximately 50% planted leaving space for the potential addition of approximately 100 (4-vine plot) accessions.

Traceability/Provenance- while the collection has not had variety identity verified through DNA testing when it was set-up as a Nuclear Collection it was sourced from 'the cleanest available material' from CSIRO and SARDI. 90% of the collection has had ampelographic inspection by George Kerridge.

Cost of management- current total cost of vineyard management per year (exclusive of virus and DNA testing) is $2400 ($4000 per hectare).

Weaknesses

Current virus status- current status is partially known with the last comprehensive testing from 2010-2012. More recent testing has indicated presence of GPGV (in 4 rootstock accessions), GVLRaV3, GVA and GFkV. Vines that tested positive for GVLRaV3 and GVA have been removed.

Variety identity- no accessions have been sampled for DNA testing and so identity is reliant on ampelography, however as accessions were sourced from the CSIRO and SARDI collections which have been verified some assumptions on identity could be made.

Governance- the collection has only limited oversight via VAMVVIA and SAVIA.

Cultivar mix- less relevant to current industry requirements. For example, the collection contains 11 Semillon accessions, 15 Riesling accessions, along with 4 accessions of Colombard and 3 Muscat Gordo accessions. These 4 varieties account for 18% of the scion collection.

2.3.2 South Australian Vine Improvement Association (SAVIA) Collection

Summary

The collection at Monash was set-up to replace the AGFPS collection at Kapunda. The collection has a high-health status and also has been partially DNA verified and so with some further investment in DNA profiling would qualify as a Nuclear Collection. The cultivars in the collection have been selected for their current and future relevance to the wine industry. It has a program of vine improvement activities including virus elimination and importation of unique varieties from other collections (AVIA and MIAVIS). The collection serves as the access point for the establishment of new source blocks in South Australia.

Strengths

Collection diversity and relevance- A highly diverse collection with a strong focus on winegrape varieties (only 5 multi-purpose/tablegrape varieties). 301 accessions imported from overseas programs. Wide range of origins of material including from Vitis Rauscedo, Plansell and Provedo. High proportion of non- major varieties are of interest i.e. considered as 'emerging' and have commercial potential. High diversity also in rootstock collection.

Virus status- All cultivars must be free of GVLRaV1, GVLRaV2, GVLRaV3, GVA, GVB, GFkV and GPGV upon entry. 100% of the collection has been tested since 2016. The current strategy is to sample and test 25% of the collection annually using pooled three vine samples. The collection is well isolated from high-risk commercial vineyards.

Variety identity- Close to 50% of accessions have had their identity verified with DNA testing using the IFV database and the collection had ampelographic inspection by Laurent Audeguin in 2019.

Governance and financial stability- The SAVIA committee is very active and engaged and has invested heavily in the establishment and maintenance of this collection. The collection is supported by a cutting levy that is collected by the SAVIA regions however it must be noted that income is related to demand for planting material which can fluctuate significantly.

Weaknesses

Reliance on external parties- not a major weakness but SAVIA does not own the land upon which it has its collection but instead leases from RVIC. The land that SAVIA leases from RVIC is near fully planted. Propagation must also be undertaken through a third-party.

2.3.3 CSIRO Collection of Grapevine Varieties and Clones

Summary

The CSIRO collection located at the Irymple Farm is currently closed to third parties and since its closure has been a resource for CSIRO research and development activities. There is potential for future re-opening, subject to arrangements that are acceptable to CSIRO. The Wine Australia DNA profiling project was conducted with the aim to verify variety integrity.

Strengths

Genetic diversity- The collection is the largest and most diverse in Australia and contains most of the unique selections in Australia. The results from the recent project CSP1501 will eventually be able to provide exact numbers on the collection; based on the 2012 germplasm register there are 989 different accessions; 62% (618) are winegrape accessions and there are 104 rootstock accessions, which makes it the largest and most genetically diverse collection of rootstock varieties in the country.

Variety identity- A significant percentage of accessions in the collection will have had their identity DNA verified by March 2021 through the Wine Australia funded project CSP1501.

Vine health and infrastructure- As the collection was re-established in 2011 the vine health and infrastructure are in good condition.

Financial stability- The collection is managed by CSIRO and the CSIRO is committed to maintaining this resource. It is currently 50% funded through the bilateral funding agreement with Wine Australia.

Weaknesses

Virus status- Virus indexing and testing occurred over many years up to closure of the original site of the collection at Merbein in 2009 and records exist. However, since closure and relocation of the collection to Irymple Farm, virus testing has been mainly focused on CSIRO bred varieties and clones. The collection should only be considered to have a partly known virus status.

Access- The CSIRO collection located at the Irymple Farm is currently closed to third parties.

2.3.4 WAVIA Collection

Summary

The collection is located in Manjimup on Department of Primary Industries and Regional Development (DPIRD) land. It was established to provide the Western Australia grapegrowing industry with 'a source of class A propagation material of wine, table, multipurpose, drying and rootstock material'.

Strengths

Financial stability- costs borne from management of the Germplasm Collection is covered exclusively by DPIRD. Orders and distribution is managed by WAVIA.

Genetic improvement activities- DPIRD are highly active in variety and clone evaluation supported by the Wine Australia Regional Program. Demonstrating emerging varieties and assessing clones.

Virus status- 100% of the collection has been tested in the last 5 years (using ELISA) and found free of GVLRaV1 and GVLRaV3. The collection has a low risk of infection due to its isolation from commercial vineyards.

Weaknesses

Limitation of virus testing- virus testing has focused only on GVLRaV1 and GVLRaV3 and so while this testing has been extensive, outside these two virus, status of other virus types is unknown.

Access to new accessions (from outside Western Australia)- the grapevine import regulations for Western Australia require a period of quarantine for entries which is time consuming (10-12 months) and expensive and so is prohibitive to the expansion of the collection.

2.3.5 SARDI Collection

Summary

The collection has genetic, cultural and historical significance but due to lack of maintenance the infrastructure and vine health has declined. It contains the highest hierarchical representations of highly significant accessions and the site was integral in the early development of Australia's clone selection program.

Strengths

Variety identity- All accessions in the collection will have had their identity DNA verified by March 2021 through the Wine Australia funded project CSP1501.

Weaknesses

Virus status- There is no regular phytosanitary testing completed on this collection and it is likely that many of the accessions carry virus. The station is located amongst other vineyards and there is no attempt made to isolate the collection or individual accessions.

Infrastructure and vine health- Much of the Germplasm Collection is over 30 years old and the infrastructure and vines are at the end of their economic life.

2.3.6 RVIC Collection

Summary

The focus of the RVIC collection is to provide commercial quantities of cuttings from high-health status source blocks to nurseries and growers. The collection has a strong focus on emerging varieties and RVIC recognise that they have a role to preserve lower demand cultivars for occasional supply.

Strengths

Financial stability- RVIC is a major supplier of cuttings to industry and so has a relatively consistent income with a commercial nursery supporting that income.

Access to resources-The RVIC collection has associated hot-water treatment and propagation facilities (although unable to produce potted vines). There is also additional land available for planting and development and they have good access to labor.

Variety identity- only 285 varieties have had their identity confirmed with DNA testing (through IFV). Ampelographic inspection is conducted by an RVIC staff member who has completed the AVIA Source Area Inspectors Course and hence is certified to inspect source vineyards for homogenous integrity.

Weaknesses

Collection type/number of vines per cultivar- the size of the cultivar source blocks means that only a small % of vines are sampled and virus tested (in-line with current source block testing protocols) as opposed to a Nuclear or Germplasm Collection (with 3-4 vine plots) where it is possible to test all vines on a short rotation (every 3-4 years), and so a distinction needs to be made i.e it should be considered a high health status source block.

2.4 Collections Associated with Private Nurseries

2.4.1 Yalumba Nursery

The current collection (situated at Oxford Landing in the Riverland) contains over 75 unique selections of quality clones from the ENTAV-INRA collection (France), ITACYL (Spain) and proprietary tablegrape varieties imported through the International Fruit Genetics (IFG) program. Yalumba Nursery has developed clonal selections of Shiraz, Grenache and Semillon and these selections are also held in the collection. The majority of unique selections are supplied under non-propagation agreement (ENTAV-IRA) or PBR licensing arrangements (IFG). Yalumba Nursery is currently investing in a new high-health status source block vineyard.

2.4.2 Chalmers Nursery

The Chalmers collection (situated in Merbein, Victoria) contains over 85 unique selections mostly imported from VCR and Matura in Italy. The nursery is currently investing in expansions of both scion and rootstock source blocks and are continuing with their import program with another 7 cultivars currently in quarantine.

2.4.3 ARM Nursery

ARM is a significant grapevine nursery in Western Australia focusing primarily on winegrape cultivars. The collection contains over 40 cultivars which while they are not unique to Australia they are unique to Western Australia which is significant considering the barriers to importation of grapevine planting material into Western Australia. ARM currently have a number of new cultivars in quarantine supplied by Mercier in France that upon release will be unique cultivars.

2.4.5 Binjara Nursery

A highly significant supplier of tablegrape planting material based out of Euston, NSW. The nursery has a license (and associated source blocks) for the propagation and distribution of PBR varieties from 6 leading international tablegrape breeding programs: International Fruit Genetics (IFG), Sunworld, Sheehan Genetics, ARRA (Grapa), Ralli and ITUM.

Appendix 3. Wine Sector Consultation

3.1 Participants and representative organisations

Session 1: Research and Extension-11am Thursday November 26th 2020

Organisation	**Participant**
SARDI	Paul Petrie
CSU	Jason Smith
AWRI	Mardi Longbottom and Con Simos
DPIRD WA	Richard Fennessy
CSIRO	Rob Walker
NSW DPI	Bruno Holzapfel
Agriculture Victoria	Fiona Constable

Session 2: Propagation and VIG's-1pm Thursday November 26th 2020

Organisation	**Participant**
VINA	Andy Gordon
VAMVVIA	Garry Thomas
AVIA	Hilary Davis
WAVIA	Jim Campbell-Clause
SAVIA	Prue Henschke
ARM	Steve Partridge
MIAVIS	Jeremy Cass

Session 3: State and National Bodies-11am Thursday December 3rd 2020

Organisation	**Participant**
Wine Australia	Sharon Harvey, Alex Sas
AGW	Anna Hooper
Wine Victoria	Damien Sheehan
Vinehealth Australia	Inca Lee
Dried Fruits Australia	Jenny Treeby
Winegrape council of South Australia	Lisa Bennier
NSW Wine industry association	Liz Riley
AWRI	Mark Krstic

Queensland wine industry association	Mike Hayes
Wine Tasmania	Paul Smart

Adam Hall (Yalumba Nursery) and Cassandra Collins (Adelaide University) were both contacted and consulted on December 7th as they were unable to attend their respective sessions.

Engagement is a critical factor to success in any change project and particularly because of the historical issues in the propagation and vine improvement sector and so theses consultation sessions should be regarded as successful in terms of 'getting everyone in the tent' and expressing views openly and honestly. As a result of the open and honest discussion the consultation sessions provided highly valuable insights and identified the challenges and associated functions that are seen as the most important in a National Grapevine Collection as well as suggested actions and priorities to enhance a system in the short, medium, and longer-term

3.2 Summary of comments from the consultation sessions

The session from which the comments were collected can be identified by following the key. In some instances, comments have been further grouped into sub-headings.

State, National and Regulatory Organisations- (SNR)
Research and Extension- (R&E)
VIG's and the Propagation Sector- (VIG+PS)

3.2.1 The protection of Australia's grapevine genetic resource

Vine Integrity Collection (via insect proof shadehouse)

Need to understand how effective they have been in preventing infections (SNR),

An insect proof shadehouse would have a limited role in the supply end of the supply chain (VIG+PS),

Closed systems are not full-proof and are expensive to maintain due to the high-level associated protocols. (VIG+PS)

How to fund an insect proof system as it's establishment and maintainence would be very expensive? (VIG+PS)

There are significant practical considerations associated with an insect proof system. (VIG+PS)

Risk Mitigation in Collections

A very strong risk profiling exercise needs to be undertaken on any site and the implementation of best management practices once established. (SNR)

Need to consider if these collections get caught up in a pest outbreak (e.g. fruitfly) and how this will impact access. (SNR)

Location is critical- as it can help to mitigate risks. (SNR)

Remoteness can help manage a lot issues- need to balance with other requirements, access to labor, general resources. (SNR)

Need to take into consideration the state borders. (SNR)

Collection Replication- do we have everything we need at this point in the right places? (R&E)

Maintenance in TC should be investigated as a back-up. (R&E)

3.2.2 The maintenance of industry accessible Nuclear Collections (verified true to type and pathogen tested) of key varieties and rootstocks

Having a guaranteed source and restricted numbers within that source is critical as this is the preferred starting point for any multiplication through the supply chain. (VIG+PS)

The role of the national collection is to allow industry access to known (true to type) high health status material. (SNR)

Need to ensure that there is a Nuclear Collection and guaranteed funding to maintain and that the funding is ongoing regardless of demand. (VIG+PS)

For research you rely on access to a collection with high levels of assurance related to pathogen and identity. (R&E)

Oversight of a certification system for the propagation of grapevine planting material

Implementation of a certification scheme based on true-ness to type and pathogen testing. (R&E)

Oversight of a certification system. (SNR)

The lack of a certification system is a weakness in our industry. (R&E)

Any standard should be set-up as a national standard. (VIG+PS)

The development of an industry accessible national register of grapevine varieties and clones that includes private imports.

An updated register with locations of material would be an incredibly valuable resource. (VIG+PS)

Understanding what we have in the country i.e the need to conduct a stocktake of what is in the country. (SNR)

Knowing what's coming in and what is already here via national database would be very useful for future planning. *(R&E)*

3.2.3 Support of enabling activities that supplement the NVC.

National co-ordination

Lack of national co-ordination is a challenge that needs to be overcome. (VIG+PS)

Ensuring that the industry has the capacity to rapidly multiply material (from Nuclear Collections).

Rapid access to planting material following loss of vineyards as a result of a significant pest incursion is of utmost importance. (SNR)

There is a need for rapid propagation techniques and related protocols to remove risk. (VIG+PS)

Ideally the industry needs rapid multiplication capacity that can produce volumes to avoid the need for multiplication rows because multiplication rows need to be in isolated areas to avoid virus vectors and this a logistical challenge. (VIG+PS)

VIG's in regions need to be responsive and plant source blocks, but to do this they need market information and rapid access to planting material. (VIG+PS)

Age of source block is a risk as older source blocks have higher risks of virus infection. Access to planting material for a source block establishment is a barrier. (VIG+PS)

Multiplication from a base collection needs strict protocols with respect to virus vectors (risk in glasshouse) and therefore the need for oversight within the rapid multiplication nursery systems. (VIG+PS)

Preservation

Preservation of heritage material and then using genomic techniques understand how this material might be used in the future. (SNR)

The genetic pool reducing through removal of old vineyards (sometimes due to vineyard ownership changing hands) how do we preserve these genetics? (SNR)

Variety Evaluation

There needs to be Facilitation of information on performance of varieties that have been identified as having attributes (wine, viti) that are suited to changing climatic conditions. (SNR)

There needs to be information made available to industry so that better decisions can be made on varieties for climate change, (SNR)

Communication through the supply chain

Need VIG's in regions to be responsive and plant source blocks, but to do this they need market information (and rapid access to planting material). (VIG+PS)

Facilitate communication through the supply chain. (SNR)

Facilitate the establishment of source blocks derived from Nuclear Collections. (SNR)

Communication with quarantine and importation partners

Direct line of communication with AQIS to ensure needs of industry being met. (VIG+PS)

Investigate modern techniques to facilitate the rapid transfer of material through quarantine- still ensuring trueness to type. Could this be done with better relationships and alignment with high assurance overseas collections? (SNR)

Facilitate the accreditation of overseas collections to lead to more rapid and efficient access (R&E) + to improve health status of material on release. (VIG+PS)

Facilitate the importation of disease resistant varieties (climate change mitigation, biosecurity). (SNR)

The need to understand AQIS testing techniques (high throughout) and for testing of Nuclear Collections with these new AQIS techniques. (VIG+PS)

Appendix 4. Risk analysis of candidate sites (SAVIA and WAVIA) to determine suitability to protect grapevine genetic resources as Nuclear Collections.

4.1 Background

Two existing germplasm collections have been identified as having potential to be maintained as grapevine Nuclear Collections: the SAVIA site at Monash S.A. and the WAVIA site at Manjimup W.A. To understand the suitability of each site to fulfil the key function of a Nuclear Collection i.e. the protection of Australia's grapevine genetic resources there is a need to implement a systematic analysis that assesses the physical and biological risks in the every-day environment to which the collections are exposed. Furthermore, the ongoing management of risk at each site involves responsible adherence to best practice and the provision of appropriate growing conditions and so it is an essential component of this project to identify the gaps (additional control measures and contingencies) in current risk management strategy and policy.

4.2 Method

4.2.1 Pest Risk Analysis

1. Identify the critical control points and related pest risks in the management of the collection based on the pathways of entry for key pests, surveillance and monitoring of key pests and the distribution of cuttings.
2. In consultation with site stakeholders document the current control measures for each key pest at each site.
3. Identify the gaps in the control measures and make recommendations on any additional control measures that are required to:
   i) Reduce the risk of pest incursion into the collection to an acceptable level and
   ii) Reduce the risk of distribution of a key pest into the supply-chain from a collection to an acceptable level.

4.2.2 Hazard (non-pest) Risk Analysis

1. Identify non-pest hazards associated with each collection using administrative, environmental, access to resources and local land use as the basis for identification.

2. In consultation with site stakeholders document the current contingencies for each non-pest hazard.
3. In consultation with site stakeholders document the additional contingencies for each non-pest hazard to reduce hazard impact to an acceptable level for a Nuclear Collection.

4.3 Consultations:

The risk analyses were conducted with input from key pest and biosecurity experts and in consultation with key personnel from each collection.

Pest Experts:

Expert and Organisation
Suzanne Mcloughlin (Vine Health Australia)
Fiona Constable (Agribio)
Mark Sosnowski (SARDI)
Craig Elliot (Wine Australia)

Site Stakeholders:

Collection	**Key Personnel**
AVIA	Garry Thomas and Hilary Davis
SAVIA	Prue Henschke and Peter Arnold
WAVIA	Richard Fennesey

4.3 Results

4.3.1 SAVIA Collection: Pest Risk Analysis

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection
Acquisition of new grapevine accessions from local sources.	Grapevine planting material is infected with GVLRaV-3, GPGV, phylloxera, *Xylella fastidiosa,* virus vectors or other non-tolerated pests or pathogen including grapevine trunk disease pathogens (Botrysphaeria sp., cylindrocarpon sp.and phaeacromonium sp.)	Vines are only sourced from accredited nurseries and vine improvement groups. 100% of the cuttings prior to propagation are tested at the point of origin for GVLRaV-3, GVLRaV-1, GVA, GVB, the GVLRaV-4 complex, GVFLK and GPGV using PCR at a NATA accredited laboratory. Movement of grapevine planting material follows the National Phylloxera Management Protocol i.e. cuttings and vines are sourced from PEZ's. Cuttings are hot-water treated for 30 minutes at 50˚C prior to propagation. Vines for planting in the collection are propagated in an accredited nursery and grown in soil-less media (i.e. supplied as a potted vine). 100% of the vines to be planted in the collection are virus tested for GVLRaV-3, GVLRaV-1, GVA, GVB, the GVLRaV-4 complex, GVFK and GPGV using PCR at a NATA accredited laboratory prior to planting.	No detections of non-tolerated pests or pathogens.	Auditing of virus testing records. Inclusion of testing of exotics pests in pre-establishment testing.

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection
Acquisition of new grapevine accessions from overseas collections (via AQIS).	Introduction of exotic and or endemic non-tolerated pests including phylloxera, GVLRaV-3, GPGV and *Xylella fastidiosa*.	Adherence to import conditions imposed by AQIS which includes a requirement for a phytosanitary certificate from the country of origin and the following treatments: • Immersion in a broad spectrum miticide/Insecticidal dip containing 100ppm Imidacloprid and 1% Eco-Oil® for 30 seconds. • Immersion in a sodium hypochlorite (NaOCl) solution of 1% available chlorine for 5 minutes. • Hot water treatment at 50°C for 30 minutes prior to growth in the closed quarantine facility. Plants must also be grown for a minimum of 16 months (12 months closed quarantine followed by 4 months open quarantine in a screenhouse) for visual screening and pathogen testing for all quarantinable pathogens.	No detections.	Testing for endemic virus at point of origin. Testing for endemic virus prior to release from quarantine.
Entry of authorised people (inc. staff and visitors) into the collection.	The introduction of virus vectors (viruliferous and non-), phylloxera and nematodes into the collection on clothing, shoes or equipment.	Entry into the collection is generally limited to key staff (except the use of labour hire staff during fruit removal activities). Entry into the collection is on the basis that personnel: • Are wearing clean clothing (i.e. clothes have not been worn into a vineyard or have been cleaned following entry into a vineyard). • Foot-wear has been disinfested in a chlorine bath or supply of alternative footwear • Equipment has been appropriately sanitized.	To be determined.	Development of auditable protocols based on Vine Health Australia's 'Farm-Gate Hygiene' Fact-sheet. i.e. use of signs, visitor register and risk assessment, disinfestation station etc https://vinehealth.com.au/wp-content/uploads/2018/10/VHA-Farm-gate-hygiene-activities-fact-sheet.pdf
Entry of unauthorised people into the collection.	The accidental introduction of virus vectors (viruliferous and non-), phylloxera and nematodes into the collection on clothing, shoes or equipment. The deliberate introduction of pests (i.e. agricultural terrorism).	All visitors must report to the office prior to entry into the collection. Entrance gates are locked after-hours.	No entry of unauthorised persons.	Restrict access through the construction of security fencing (with lockable gates) around the collection.

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection
Vehicle entry into the collection (including down vine rows or closely adjacent vines).	Vectors (viruliferous and non-), may be introduced into the collection on soil, plant residue or the physical transmission from the vehicle surface.	Vehicles do not enter the collection and must park on the closest headland. Vehicle entry into the area adjacent the collection is limited to key personnel.	No entry of vehicles into the collection.	Develop a specific parking area for vehicles away from the collection. Implement multi-language signage to instruct personnel on where to park and the protocols for entry into the collection.
Entry into the collection of shared vineyard equipment from the RVIC source blocks.	Introduction of vectors (viruliferous and non-) from the RVIC source block either directly from physical transmission from the vineyard equipment or on grapevine shoots or leaves that may have been dislodged and inadvertently moved into the collection.	RVIC source blocks are regularly virus tested and monitored to ensure that virus loads and vector levels are maintained at very low-negligible levels.	Appropriate disinfestation and inspection of equipment following established protocols.	Development of protocols to limit risk of transmission of viruliferous vectors i.e. disinfestation of equipment prior to entry (and that also take into consideration the virus retention rates in vectors). Implementation of a wash-down facility at the entrance to the collection (and heat-shed?)
Entry of external/contractor farm/vineyard equipment and machinery.	Introduction of vectors (viruliferous and non-), phylloxera or nematodes from the equipment either directly from physical transmission from the equipment or on grapevine shoots or leaves that may have been dislodged and inadvertently moved into the collection.	No external machinery is used in the collection except for the very occasional use of specialized equipment (i.e. back-hoe, soil moving equipment). Any external machinery used in the collection must be clean of soil and plant residue before entry. Inspection of machinery undertaken by vineyard supervisor (have a procedure, but no audit record).	Appropriate disinfestation and inspection of equipment following established protocols.	Audit record required for proof of origin of equipment and disinfestation and inspection of machinery and equipment.
Wind dispersal of vectors.	Introduction of virus vectors (viruliferous and non-), and vectors of exotic diseases (*Xylella fastidiosa*) from adjacent (infected) vineyards or host crops.	The collection is established at a site that takes prevailing winds into consideration. There is a distance of 300m to the nearest vineyard which is a RVIC source block that due to virus testing protocols has a relatively low risk (compared with commercial vineyards).	No detections.	Consider the use of traps to determine the extent and associated risks of entry via wind dispersal.

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection.
Monitoring and control of vectors populations.	Development of vector populations in the collection may allow for the transmission of non-tolerated virus from undetected infected vines. Vectors include: mealybug, scale, bud and blister mite.	Implementation of cultural practices to limit vector populations (including fruit removal and targeted insecticide sprays) coupled with sporadic visual inspections for vectors.	No detections.	Develop protocols for the regular monitoring of vectors by trained personnel. Development of thresholds for spray programs. Auditing of monitoring and spray records.
Surveillance of non-tolerated virus.	Virus can remain asymptomatic in some varieties and if these vines remain undetected they can they lead to spread of virus through the collection or the distribution of virus infected cuttings.	Virus surveillance is based on testing every vine in the collection on a 3-4 year cycle using PCR at a NATA accredited laboratory, testing includes GVLRaV1, GVLRaV-3, GVA, GVB, the GVLRaV-4 complex, GVFK and GPGV. Annual visual inspections are also conducted to identify vines with symptoms with follow-up testing conducted on suspicious vines.	No detections.	Development of surveillance protocols based on current best practice.
Management of the detection of non-tolerated pests in the collection.	If detection is not appropriately managed, then it can lead to further transmission of the pest throughout the collection or the distribution of infected cuttings.	Current cultural practices include inspecting vines for known pest and diseases and their vectors. Any suspicious identifications are reported to the Supervisor and Management. Further inspection to confirm incidences are performed and action plans are then developed to manage the risks.	No follow-up detections.	The development of protocols for the management of virus infected vines based on current best practice. The development of contingency plans for the detection of phylloxera or *Xylella fastidiosa*
Distribution of cuttings from the collection.	If virus is not detected in vines prior to the collection of cuttings then it can lead to the distribution of infected cuttings into the supply chain.	Prior to collection of cuttings, ensure virus records are consulted to confirm clear virus result within last 3 years.	Nil supply of infected cuttings.	Development of protocols for pre-harvest testing of vines.
Introduction of exotic pests ie. *Xyllela* or phylloxera into the region	If exotic pests or phylloxera are introduced into the region it will significantly impact the ability of the collection to function.	Reliant on State and National systems to ensure that phylloxera and exotics are not allowed to enter the region. Vehicle and personnel entering site are clean prior to entry, free of soil and plant tissue. On site equipment is regularly cleaned, and where appropriate, cleaned prior to entry into Collection.	Maintenance of exotic and phylloxera pest-free status.	Partial duplication of the collection in geographically separate region. Establishment of key accessions in high security storage.

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection.
Pruning of vines in the collection	Pruning creates wounds that can lead to the introduction of Eutypa lata and Botryspaheria sp. both pests which can lead to vine decline.	Pruning is undertaken later in the season when conditions are drier and less conducive to these pests. Vines are pruned with sanitized equipment. Vines are sprayed with Tebeconazole following pruning (generally within three weeks).	Appropriate disinfestation and inspection of equipment following established protocols.	Monitoring for symptoms.

4.3.2 SAVIA Collection: Hazard Analysis

Germplasm Conservation Principle	Identified hazard	Current contingencies to minimise the impact of the hazard	Additional contingency measure(s) to reduce the hazard impact to an acceptable level for a Nuclear Collection
Ensuring Availability	Damage to vines in the collection due to extreme environmental events. Hail events have damaged vines in the collection.	2 damaging hailstorms in over 20 years at site. No current contingencies.	Collection management has investigated the cost of establishing hail nets. Current estimate is $54,000 per Ha.
Ensuring Availability	Damage to vines from grass fire or exposure to radiant heat from fire in adjacent native vegetation.	Grass fire risk limited due to headlands and bare tracks around collection. Only one small pocket of native vegetation is within close proximity to the collection.	Overhead sprinklers could be installed in the collection.
Ensuring Availability	Long-term drought or heat-waves impacting vine growth and development of viable cuttings for distribution.	Irrigation water from the Murray River is supplied to RVIC through CIT infrastructure. Murray River irrigation entitlement restrictions being imposed is a risk- but additional water can be purchased.	None required.
Ensuring Availability	Off-target spray drift from neighbouring properties in particular phenoxy herbicides (2,4-D)	Nearest cropping farmer is 1.5km to North and they are aware of risks of spray drift to collection.	None required.
Ensuring Security	Trespassing into the collection and deliberate damage to the vines in the collection (agricultural terrorism)	The collection is located within a larger property which is protected by fences and lockable gates which are secured after hours.	The collection could be protected with fences and lockable gates within the RVIC property.

Germplasm Conservation Principle	Identified hazard	Current contingencies to minimise the impact of the hazard	Additional contingency measure(s) to reduce the hazard impact to an acceptable level for a Nuclear Collection.
Ensuring Security	That the collection is managed in such a way that vines become unviable and are allowed to decline and die before regeneration can take place.	The collection is managed using current best practice.	Management practices should be regularly reviewed and updated by an external panel of experts. Each accession needs to be monitored and contingencies developed to ensure that accessions are re-generated prior to the onset of vine decline.
Ensuring Security	That the collection is not adequately funded leading to loss of control of genetic and pest integrity.	SAVIA is funded by regional Vine Improvement levies imposed on cutting sales.	There must be a commitment from industry to supply funding for the maintenance of the collection.
Ensuring Security and Availability	The SAVIA collection was established on land leased from RVIC. If this arrangement ceases to exist or if the land is sold, then the security of the collection and the ability to supply cuttings could be jeopardised.	Agreements are in place for the lease (it is not a separate 'section' defined by Government surveyed cadastral boundaries – and therefore cannot be selectively sold).	Negotiation of agreements that ensure the long-term security of the collection.
Maintaining genetic integrity	That accessions are not true-to-type	DNA testing is currently being undertaken on accessions within the collection and is approximately 45 % complete. L. Audeguin (IFV) conducted a physical ampelography inspection Oct 2019 and confirmed most cultivars appeared true to type. Those appearing inconsistent were followed up with DNA test. Record keeping provides traceability ensuring that accessions match clone identity.	New additions to the collection should be DNA verified at the point of origin.

Germplasm Conservation Principle	Identified hazard	Current contingencies to minimise the impact of the hazard	Additional contingency measure(s) to reduce the hazard impact to an acceptable level for a Nuclear Collection.
Providing Information	Inadequate information on accessions will decrease the value of that accession and ultimately the collection to the end-user and the broader industry.	Information is available on request.	Development and maintenance of a publicly accessible database containing information on the origin, history, treatments, description (white, red, table-grape, rootstock), availability, registration status, virus testing history.
Providing information	Information stored electronically on the collection including the accession database, field maps, auditable records (including virus testing) is lost/deleted.	Much of the electronic information has been shared with various SAVIA representatives and is also stored on the RVIC Server, which has 3 separate backup devices - rotated each day. The most recent of these backup devices are taken home each evening by an RVIC staff member.	Cloud storage of SAVIA Germplasm electronic data could be investigated and adopted.

4.3.1 WAVIA Collection: Pest Risk Analysis

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection.
Acquisition of new grapevine accessions from local (W.A) sources.	Grapevine planting material infected with GVLRaV-3, GPGV, phylloxera, *Xylella fastidiosa,* virus vectors or other non-tolerated pests or pathogen including grapevine trunk disease pathogens (Botrysphaeria sp., cylindrocarpon sp.and phaeacromonium sp)	As acquisitions have been sporadic no formal protocols have been developed outlining control measures. In general, the following control measure have been followed: Cuttings are propagated at an onsite greenhouse and prior to introduction to the collection vines are tested for GVLRaV-1 and GVLRaV-3, plus a visual inspection for pest and/or disease symptoms.	No detections of non-tolerated pests or pathogens.	Develop formal protocols for the control of key pests and other non-tolerated pests on grapevine planting material. Cuttings are hot-water treated for 30 minutes at 50˚C prior to propagation. Vines for planting in the collection are propagated in an accredited nursery and grown in soil-less media (i.e. supplied as a potted vine). 100% of the cuttings prior to propagation are tested at the point of origin for GVLRaV-3, GVLRaV-1, GVA, GVB, the GVLRaV-4 complex, GVFLK and GPGV using PCR at a NATA accredited laboratory. Auditing of virus testing records. Inclusion of testing for exotic pests in pre-establishment testing.

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection
Acquisition of new grapevine accessions from interstate.	Grapevine planting material infected with GVLRaV-3, GPGV, phylloxera, *Xylella fastidiosa,* virus vectors or other non-tolerated pests or pathogen including grapevine trunk disease pathogens (Botrysphaeria sp., cylindrocarpon sp.and phaeacromonium sp.)	Source vines are tested at the point of origin for GVLRaV-3, GVLRaV-1, GVA, GVB, the GVLRaV-4 complex, GVFK and GPGV using PCR at a NATA accredited laboratory. Importation of grapevine cuttings from interstate is subject to IRC69, related conditions of entry are the following: • Fumigated with methyl bromide. • Dipped in a 1% solution of sodium hypochlorite for 10 minutes. • Grown in closed quarantine at a post entry quarantine facility for a minimum of 1 year. • Vines must be free of Fan-leaf virus, Downy Mildew and Phomopsis upon release.	No detections of non-tolerated pests or pathogens.	After release from quarantine all vines must be tested for GVLRaV-3, GVLRaV-1, GVA, GVB, the GVLRaV-4 complex, GVFLK and GPGV using PCR at a NATA accredited laboratory.
Acquisition of new grapevine accessions from overseas collections (via AQIS).	Introduction of exotic and or endemic non-tolerated pests including phylloxera, GVLRaV-3, GPGV and *Xylella fastidiosa*.	Adherence to import conditions imposed by AQIS which includes: a requirement for a phytosanitary certificate from the country of origin and the following treatments: • Immersion in a broad spectrum miticide/Insecticidal dip containing 100ppm Imidacloprid and 1% Eco-Oil® for 30 seconds. • Immersion in a sodium hypochlorite (NaOCl) solution of 1% available chlorine for 5 minutes. • Hot water treatment at 50°C for 30 minutes prior to growth in the closed quarantine facility. Plants must also be grown for a minimum of 16 months (12 months closed quarantine followed by 4 months open quarantine in a screenhouse) for visual screening and pathogen testing for all quarantinable pathogens.	No detections.	Testing for endemic virus at point of origin. Testing for endemic virus prior to release from quarantine.

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection
Entry of authorised people (inc. staff and visitors) into the collection.	The introduction of virus vectors (viruliferous and non-), phylloxera and nematodes into the collection on clothing, shoes or equipment.	Entry into the collection is generally limited to key staff. Entry into the collection is on the basis that personnel: • Are wearing clean clothing (i.e. clothes have not been worn into a vineyard or have been cleaned following entry into a vineyard), • Foot-wear has been disinfested in a chlorine bath or supply of alternative footwear • Equipment has been appropriately sanitized.	To be determined.	Development of auditable protocols based on Vine Health Australia's 'Farm-Gate Hygiene' Fact-sheet. i.e. use of signs, visitor register and risk assessment, disinfestation station etc https://vinehealth.com.au/wp-content/uploads/2018/10/VHA-Farm-gate-hygiene-activities-fact-sheet.pdf
Entry of unauthorised people into the collection.	The accidental introduction of virus vectors (viruliferous and non-), phylloxera and nematodes into the collection on clothing, shoes or equipment. The deliberate introduction of pests (i.e. agricultural terrorism).	All visitors must report to the office for sign-in prior to entry into the collection. External boundary fence around the property. The collection site is isolated and away from the main road and the entrance gates are locked after-hours.	No entry of unauthorised persons.	Restrict access through the construction of security fencing (with lockable gates) around the collection.
Vehicle entry into the collection (including down vine rows or closely adjacent vines).	Vectors (viruliferous and non-), may be introduced into the collection on soil, plant residue or the physical transmission from the vehicle surface.	Vehicles do not enter the collection and must park on the closest headland. Vehicle entry into the area adjacent the collection is limited to key personnel.	No entry of vehicles into the collection	Develop a specific parking area for vehicles away from the collection Implement (multi-language) signage to instruct personnel on where to park and the protocols for entry into the collection.

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection
Entry into the collection of shared vineyard equipment from the trial blocks on the site (alternative variety and chardonnay pathology block).	Introduction of vectors (viruliferous and non-) from the other vineyard blocks either directly from physical transmission from the vineyard equipment or on grapevine shoots or leaves that may have been dislodged and inadvertently moved into the collection.	The adjacent alternative variety trial block was tested for GVLRaV-1 and GVLRaV-3 in 2020.	Appropriate disinfestation and inspection of equipment following established protocols.	Development of protocols to limit risk of transmission of viruliferous vectors i.e. disinfestation of equipment prior to entry (and that also take into consideration the virus retention rates in vectors). Construction of a wash-down facility at the entrance to the collection (and heat-shed?)
Entry of external/contractor farm/vineyard equipment and machinery (vector spread).	Introduction of vectors (viruliferous and non-), phylloxera or nematodes from the equipment either directly from physical transmission from the equipment or on grapevine shoots or leaves that may have been dislodged and inadvertently moved into the collection.	No external machinery is used in the collection except for the very occasional use of specialized equipment (i.e. back-hoe, soil moving equipment). Any external machinery used in the collection must be clean of soil and plant residue before entry (wash-down pads on site).	Appropriate disinfestation and inspection of equipment following established protocols.	Audit record required for proof of origin of equipment and disinfestation and inspection of machinery and equipment.
Wind dispersal of vectors.	Introduction of virus vectors (viruliferous and non-), and vectors of exotic diseases (*Xylella fastidiosa*) from adjacent (infected) vineyards or host crops.	Collection is highly isolated from any commercial vineyards, citrus or olive orchard.	No detections.	The adjacent alternative variety trial should be monitored for vectors and virus symptoms and treated as required.

Critical control point	Pest Risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection
Monitoring and control of vectors populations.	Development of vector populations in the collection may allow for the transmission of non-tolerated virus from undetected infected vines. Vectors include: mealybug, scale, bud and blister mite.	Lack of funding and resource has limited monitoring.	No detections.	Implementation of cultural practices to limit vector populations (including fruit removal and targeted insecticide sprays) Develop protocols for the regular monitoring of vectors by trained personnel. Development of thresholds for spray programs. Auditing of monitoring and spray records.
Surveillance of non-tolerated virus : GVLRaV1, GVLRaV-3, GVA, GVB, the GVLRaV-4 complex, GVFLK and GPGV.	Virus can remain asymptomatic in some varieties and if these vines remain undetected, they can lead to spread of virus through the collection or the distribution of virus infected cuttings.	All vines have been tested for GVLRaV-1 and GVLRaV-3 in the last three years using PCR at the DPIRD Diagnostic Laboratory Services (not NATA Accredited).	No detections.	Annual visual inspections should be conducted to identify vines with symptoms. Testing should be expanded to include GVA, GVB, the GVLRaV-4 complex, GVFK and GPGV. Consider using a NATA accredited laboratory to verify testing.
Management of the detection of non-tolerated pests in the collection.	If detection is not appropriately managed, then it can lead to further transmission of the pest throughout the collection or the distribution of infected cuttings.	Visual inspection made at times of vineyard tasks i.e. pruning, spraying.	No follow-up detections.	The development of protocols for the management of virus infected vines based on current best practice. The development of contingency plans for the detection of phylloxera or *Xylella fastidiosa*
Distribution of cuttings from the collection.	If virus is not detected in vines prior to the collection of cuttings then it can lead to the distribution of infected cuttings into the supply chain.		No supply of infected cuttings.	Development of protocols for pre-harvest testing of vines.

Critical control point	Pest risk	Current control measure(s)	Critical limit	Additional control measure(s) to reduce risk to an acceptable level for a Nuclear Collection
Introduction of exotic pests ie. Xyllela or phylloxera into the region	If exotic pests or phylloxera are introduced into the region it will significantly impact the ability of the collection to function.	Reliant on State and National systems to ensure that phylloxera and exotics are not allowed to enter the region.		Partial duplication of the collection in geographically separate region. Establishment of key accessions in high security storage.
Pruning of vines in the collection	Pruning creates wounds that can lead to the introduction of Eutypa lata and Botryspaheria both pests which can lead to vine decline.	Eutypa has not been detected in Western Australia. There are no specific protocols around pruning.	Appropriate disinfestation and inspection of equipment following established protocols.	Monitoring for symptoms Establishment on protocols based on best management practices.

4.3.4 WAVIA Collection: Hazard Analysis

Germplasm Conservation Principle	Identified hazard	Current contingencies to minimise the impact of the hazard	Additional contingency measure(s) to reduce the hazard impact to an acceptable level for a Nuclear Collection
Ensuring Availability	Damage to vines in the collection due to extreme environmental events.	No current contingency. Local climate conditions are relatively stable with frost and hail incidents considered to be very rare.	None required.
Ensuring Availability	Damage to vines from fire or exposure to radiant heat from fire in the adjacent forest area.	Firefighting equipment onsite.	Partial duplication of nuclear collection at geographically separated site. High-security storage of key accessions.
Ensuring Availability	Long-term drought or heat-waves impacting vine growth and development of viable cuttings for distribution.	Average annual rainfall is 900mm and it is considered a cool- moderate climate. Irrigation is not a limiting factor.	None required.
Ensuring Availability	Off-target spray drift from neighbouring properties, in particular phenoxy herbicides (2,4-D)	In W.A., spraying of any volatile ester of phenoxy acid is totally banned within five kilometres of a commercially sensitive crop (including vineyards) [i]	None required.
Ensuring Security	Trespassing onto the property and deliberate damage to the vines in the collection (agricultural terrorism)	Collection is currently maintained with relatively low levels of security.	The collection should be protected with fences and lockable gates.

Germplasm Conservation Principle	Identified hazard	Current contingencies to minimise the impact of the hazard	Additional contingency measure(s) to reduce the hazard impact to an acceptable level for a Nuclear Collection
Ensuring Security	That the collection is managed in such a way that vines become unviable and are allowed to decline and die before regeneration can take place.	The collection has oversight by an active and engaged vine improvement group, but the collection has minimal formal protocols around best-practice management and there is no staff onsite with viticulture expertise.	Management practices should be developed and regularly reviewed and updated by an external panel of experts. The collection requires a system of regular monitoring by someone who has experience with grapevines. Each accession needs to be monitored and contingencies developed to ensure that accessions are re-generated prior to the onset of vine decline.
Ensuring Security	That the collection is not adequately funded leading to loss of control of genetic and pest integrity.	The WAVIA collection vineyard is resourced to the discretion of DPIRD.	There must be a commitment from industry to supply funding for the maintenance of the collection.
Ensuring Security and Availability	The WAVIA collection was established on land owned by DPIRD. If this facility ceases to be funded, then the security of the collection and the ability to supply cuttings would be jeopardised.	No formal agreements between WAVIA and DPIRD in place.	Negotiation of agreements that ensure the long-term security of the collection.
Maintaining genetic integrity	That accessions are not true-to-type.	New material entering the collection has been either verified by DNA testing from another collection or undergoes a detailed trace back.	The entire collection should be DNA verified.

Germplasm Conservation Principle	Identified hazard	Current contingencies to minimise the impact of the hazard	Additional contingency measure(s) to reduce the hazard impact to an acceptable level for a Nuclear Collection
Providing Information	The lack of adequate information on accessions will decrease the value of that accession (and ultimately the collection) to the end-user (and the broader industry).	Information is available on request.	Development and maintenance of a publicly accessible database containing information on the origin, history, treatments, description (white, red, table-grape, rootstock), availability, registration status and virus testing history.
Providing information	Information stored electronically on the collection including the accession database, field maps, auditable records (including virus testing) is lost/deleted.	Information held on DPIRD servers, have back-up protocols in place.	None required.

Appendix 5. Cost modelling: DNA and Virus testing for transition of the SAVIA and WAVIA collections to Nuclear Collections and estimation of ongoing vineyard management costs.

5.1 Modelling method and assumptions for Virus and DNA testing

The basic requirements for a collection to achieve Nuclear collection status are that:

- All accessions within the collection must be DNA verified.

  All accessions must have a known viral status.

The cost modelling works on the following assumptions:

- The DNA testing service is information provided by Ian Dry (CSIRO) based on recent testing using SNP typing.
- The costs for virus testing are based on AWRI commercial services 'complete' virus screen which covers 12 virus (please note that this does not suggest that AWRI would be the only service used for virus testing):
  - Grapevine leafroll-associated viruses (detecting six virus types: 1, 2, 3, 4/4, 4/6 and 4/9)
  - Grapevine rupestris stem pitting-associated virus (RSPaV)
  - Grapevine virus A (GVA) and Grapevine virus B (GVB)
  - Grapevine fleck virus
  - Grapevine red blotch virus
  - Grapevine Pinot Gris virus
- Virus testing does not include:
  - Grapevine Fanleaf Virus (GFLV)
  - Arabis Mosaic Virus (ArMV)
  - Rupestris Stem Pitting Associated Virus 2 (RSPaV-2)
  - Grapevine Virus D (GVD)*
  - Grapevine Fleck Virus B (GFkV-B)

  (Contact details for this service are available at the end of this appendix).

- The modelling does not include costs associated with providing evidence or the auditing of traceability to verify clone identity.
- The modelling does not include costs associated with re-sampling, rogueing (removal of infected vines) and the associated administration of these activities.

- The modelling in this section does not include ongoing maintenance costs of the collection related to vineyard management, labour and regular virus surveillance. These costs are outlined in section 5.4

5.2 Modelling Results

Virus testing

Based on the information supplied by SAVIA the cost of virus testing is made-up of the following activities and associated costs per sample:

Activity	**Associated cost/accession**
Sample collection	$38.50
Analysis	$134
Administration	$48.50
Total	**$221**

DNA testing

Based on the information supplied by CSIRO on cost of analysis and SAVIA for cost of sampling the cost of DNA testing is made-up of the following activities and associated costs per sample:

Activity	**Associated cost/accession**
Sample collection	$38.50
Analysis	$50
Administration costs	$48.50
Total	**$137**

5.3 Summary of total costs by collection

Collection	**SAVIA collection**	**WAVIA collection**
Total number of accessions in each collection	466	196
Number accessions requiring virus testing	396*	196
Number accessions requiring DNA testing	247**	196
Virus testing	$221	$221

DNA testing	$137	$137
Total virus costs	$87,516	$43,316
Total DNA costs	$33,399	$26,852
Total cost	**$120,915**	**$69,898**

*Virus testing was completed for 70 accessions in 2020.

** 219 accessions have been DNA verified by SAVIA.

5.4 Estimated ongoing management costs

For the purpose of this exercise the ongoing vineyard management costs includes the following:

- Virus Surveillance (via testing every three years and annual inspections)
- Vineyard Management (pruning, canopy management, fruit removal, disease prevention)
- Water
- Land leasing costs

Two data sources are available from which to base this analysis; the first was supplied by SAVIA based on the activities at Monash and the second is from AVIA (via VAMVVIA) based on the activities at Dareton.

Total collection management costs	SAVIA collection (Monash)	AVIA collection (Dareton)
Tractor work (fungicide/herbicide spraying)	$2,640	$1,000
Foliage Wires	$385	$0
Fruit Removal	$7,007	$0
Pruning	$1,039.50	$250
Consumables	$1,400	$0
Water	$8,052	$1,250
Land Lease	$1,279	$0
Total cost	**$21,803**	**$2,500**
Number of accessions	466	216
Approximate area	1.8 Ha	0.6 Ha
Cost per accession	**$52**	**$12**
Cost per Hectare	$12,112.50	$4,166.67

As can be seen in the table the cost per accession is significantly different and reflects the different levels of maintenance.

Dareton is being managed in a very low maintenance mode with the SAVIA collection having much higher levels of maintenance. A good example of this is that fruit removal undertaken on the SAVIA collection (to reduce the risk of mealybug vectors), this single activity accounts for 30% of the cost per accession in the SAVIA collection.

Given that the Monash site is currently in a higher maintenance mode it better reflects the maintenance costs associated with managing a Nuclear Collection.

Coupled with the data generated from 5.3 (cost of virus testing per accession) it is possible to calculate ongoing maintenance costs of each collection based on the 'high' maintenance levels of the SAVIA collection and a virus surveillance program that tests each accession every three years.

	SAVIA collection, Monash	**WAVIA collection, Manjimup**
Annual virus testing cost per accession*	$74	$74
Annual vineyard management cost per accession	$52	$52
Total per accession	$126	$126
Number of accessions	466	196
Total annual funding requirements for each collection	$58,744	$24,708

* $221 per accession amortised over three years.

5.5 Summary of immediate and on-going funding requirements

- Based on the model assumptions, the cost for DNA and virus testing per accession is $358.
- To undertake virus testing and DNA testing to potentially get each collection up to the cost would be between (in round figures):
    - SAVIA collection- $120,000
    - WAVIA collection- $70,000