Appendix E
Technical Memos

Cardno

Technical Memorandum

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Date: July 24, 2020 and updated on February 4, 2021 to include reference to revised plans dated June 17, 2020

To: Steve Rodriguez, Contract Planner
County of Santa Barbara, Planning and Development Department

From: Rosemary Thompson, Ph.D., Senior Consultant, Biology Task Leader
Jennifer Scholl, Senior Consultant, Project Manager

RE: **Biological Resources Technical Memorandum, Peer Review of Potential Impacts to Sensitive Biological Resources, North Fork Ranch Frost Ponds Focused EIR (Case No. 16CUP-00000-00005)**

1 Introduction

1.1 Purpose of Memorandum

Under contract to the County of Santa Barbara Planning and Development Department (P&D), Cardno was selected, following a competitive process, to prepare the Focused Environmental Impact Report (EIR) for the North Fork Frost Ponds Project (Project). This memorandum is an appendix to the Focused EIR and presents the results of a peer review of the 2020 Biological Resource Assessment (BRA) completed by Kevin Merk Associates (KMA) for the Project. In addition, this memo incorporates information from resource agency comments on the Notice of Preparation (NOP), released in January 2020 for the Focused EIR, related to sensitive biological resources within the vicinity and at the Project site.

1.2 Project Description

The Project includes construction of three frost ponds (reservoirs) that would store water to be used for operation of a spray frost protection system at the North Fork Ranch Vineyards. The proposed reservoirs would serve approximately 840-acres of existing vineyards. Piping that would deliver water to the reservoirs from existing wells is already installed. Only minor pipe connections are proposed to connect the reservoirs to the vineyard's existing irrigation and frost protection systems. Reservoir No. 1 would be located on the eastern portion of the Project site, adjacent to Schoolhouse Canyon Road (a private road). Reservoir No. 2 would be located in the central portion of the Project site; and Reservoir No. 3 would be located on the western portion of the Project site approximately 0.75 miles east of Cottonwood Canyon Road. The existing vineyard is surrounded by six feet six-inch high hinge knot wire exclusionary deer fencing with two strands of barbed wire on top for total height of eight feet. Once constructed, the three reservoirs will each be fenced individually using material similar to the deer fencing.

The 6,565-acre project parcel is located in the Cuyama Valley, approximately nine miles west of the community of New Cuyama. The project parcel is located on the south side of State Highway 166 and the proposed reservoir sites are approximately 4,000 to 5,000 feet south of the Cuyama River. The proposed reservoir sites are currently vacant and adjacent to existing vineyards and were last disked in May 2016.

1.3 Board of Supervisors Findings to Address Biological Impacts

In 2016 Brodiaea, Inc. (Proponent) filed an application with P&D for a Minor Conditional Use Permit (Application #: 16CUP-00000-00005) for installation of three frost ponds in the North Fork Ranch vineyard. The County approved the application, processed the application, and circulated the draft Mitigated Negative Declaration (MND) for public comment. Comments were received and incorporated into the Final MND, which was adopted in 2018. The permit approval was appealed and subsequently heard before the Planning Commission and Board of Supervisors (Board). During the March 5, 2019 Board Hearing, the Board determined that the MND was inadequate and that a focused Environmental Impact Report (EIR) was required. At this hearing, the Board adopted findings directing P&D to prepare a Focused EIR to address potential biological impacts (amongst other issues) from the construction and operation of the frost protection system.

The Board findings noted that the Project may result in potential impacts on biological resources based on evidence that construction of the proposed reservoirs could adversely impact habitat suitable for special-status species. Biological resource surveys completed by KMA in 2015 were conducted during a period of extended drought, and evidence was presented, during Project hearings, that the drought may have adversely influenced the validity of rare plant surveys. In response to the Board of Supervisor’s findings, additional biological surveys were conducted by KMA in 2019. The 2019 BRA included mitigation measures for incorporation into the EIR.

Materials Reviewed

This memorandum presents a peer review of the KMA 2020 BRA, as well as consideration of NOP comments related to sensitive biological resources. Prior biological resources reports related to the project are included in the KMA 2020 BRA and were also peer reviewed and are listed below. NOP comment letters related to biological impacts were received from the United States Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW) that identified special-status species concerns and protection measures to be addressed and included in the EIR.

This technical evaluation was prepared by Rosemary Thompson, PhD, a Senior Consultant with over 45 years of experience in biological work in California. Her background includes relevant experience conducting biological resource surveys and developing feasible avoidance/minimization and mitigation measures for special-status species found in Santa Barbara County, including California red-legged frog (CRLF) and plant species that are potentially of concern for this Project.

The following documents were reviewed prior to preparation of this technical memorandum and Section 3.6 Biological Resources section of the Draft EIR:

1. NOP comment letter from USFWS, March 5, 2020;
2. NOP comment letter from CDFW, February 10, 2020;
3. KMA Memorandum, North Fork Ranch Frost Ponds Project, Supplemental Biological Resources Information, June 15, 2020;
4. KMA Biological Resource Assessment, North Fork Ranch Frost Ponds Project, February 24, 2016;
5. KMA Biological Resources Assessment, North Fork Ranch Frost Ponds Project, February 4, 2020;
6. Ray Shady.-mail to Brian Tetley, May 12, 2020, North Fork Ranch Frost P
7. North Fork Vineyards Frost Ponds Design Plans, prepared by Tom. A. Howell, June 13, 2017 and revised plans dated June 17, 2020; and
8. North Fork Ranch Frost Ponds Final Mitigated Negative Declaration (MND), August 1, 2018.

2 Peer Review of 2020 KMA Biological Resources Assessment

2.1 Current and Past Biological Resource Assessments

As listed above, two BRAs were completed by KMA for this Project. The first BRA was completed in 2016 and the second BRA was completed in 2020. The 2020 BRA includes the 2016 BRA, a peer review of that report by Dudek, and a revised KMA supplemental letter report dated June 2016 addressing comments from the Dudek peer review. The 2016 BRA provided figures to illustrate project details and habitats, summarized surveys conducted for blunt-nosed leopard lizard and other plant and wildlife species, and summarized regulatory agency consultation by the Applicant with state and federal agencies. The 2019 KMA survey results were supplemented with information in the KMA Memorandum dated June 15, 2020.

The 2020 BRA described the field surveys conducted at the project site in the spring of 2019. The BRA is comprised of sections covering basic survey methods, survey results, impact analysis, recommended mitigation, conclusions, and references. Attachments to this assessment include seven figures (site, vicinity, habitat maps for each of the three proposed reservoirs, soils map, and California Natural Diversity Data Base [CNDDB] results). The 2020 BRA includes the 2016 BRA, a list of plants and animals observed, a special-status biological resource summary, photo plate, San Joaquin kit fox (SJKF) avoidance measures, and site plans. All report sections and attachments were peer reviewed by Rosemary Thompson, Ph.D.

2.2 Scope of 2019 Surveys

The proposed Project includes construction of three, approximately five acres each, agricultural reservoirs to provide water to supply frost prevention protection for the North Fork Ranch vineyards. Due to heavy, above-average rainfall in the winter of 2019, supplemental biological resource surveys were conducted in the spring of 2019 to examine the 2019 existing conditions at the reservoir sites and evaluate the potential for special status species and habitats. Prior to conducting biological surveys in March and April of 2019, KMA biologists reviewed relevant information for the area and completed a CNDDB search covering April-December 2019. Floristic field surveys were conducted on 28 March and 26 April 2019 within the project footprint plus an approximate 100-foot buffer surrounding each reservoir by Kevin Merk and Melissa Mooney. Wildlife observations were also made during plant surveys and are listed below in Section 2.3.2. No protocol surveys were conducted for any of the listed species of plants or animals in 2019. However, San Joaquin wooly threads were viewed at a reference site to verify whether the species was identifiable at the time of the 2019 survey. None were observed in the reservoir footprints or buffer areas.

2.3 Results of 2019 Biological Surveys

The following sections summarize the 2020 BRA by vegetation, wildlife, and special-status species.

2.3.1 Vegetation

No native trees were found within the project footprint or within an approximate 100-foot buffer around each frost pond location.

Frost Pond No.1: Vegetation in March 2019 was dominated by non-native hare barley (*Hordeum murinum* ssp. *leporinum*) and native fiddleneck (*Amsinckia intermedia*) with patches of native miniature lupine (*Lupinus bicolor*), goldfields (*Lasthenia gracilis*), dove clover (*Trifolium albopurpureum*), tidy tips (*Layia platyglossa*), and purple owl's clover (*Castilleja exserta*). By April, the non-native red brome (*Bromus madritensis* ssp. rubens) was more dominant than the hare barley. Based on the plant species present, the plant community was determined to be *Amsinckia* (*intermedia, menziesii*) Herbaceous Association of the Fiddleneck-Phacelia Fields Alliance (Figure 1). This is not a sensitive natural community (G4, S4 rankings). According to Holland (1986), the plant community descriptions were Non-native grassland with patches of Wildflower Fields where native forbs occur. The roadway surrounding the reservoir was classified as Ruderal, while the buffer on the north side of the pond was composed of Agriculture (vineyards). An intermittent drainage crosses the northwest corner of the buffer with a California juniper (*Juniperus californicus*) at the edge of the buffer.

Frost Pond No. 2: This site was dominated by the native fiddleneck in 2019. Other native species present included common monolopia (*Monolopia lanceolata*), common phacelia (*Phacelia distans*), blue dicks (*Dichelostemma capitatum*), arroyo lupine (*Lupinus succulentus*), pinpoint clover (*Trifolium gracilentum*), two-seeded milkvetch (*Astragalus didymocarpus* var. *didymocarpus*), and miniature lupine. Abundant non-native species included red brome, hare barley, red-stemmed filaree (*Erodium cicutarium*), and wild oats (*Avena barbata*).The plant community descriptions are the same as for Frost Pond No. 1 with the surrounding roadway being classified as Ruderal and Agriculture on the north and west sides of the pond in the buffer (Figure 2).

Frost Pond No. 3: In the northern, flatter, portion of the site, the non-native red brome was dominant with other non-native grasses such as soft chess (*Bromus hordeaceus*) and hare barley. The native miniature lupine and non-native red-stemmed filaree were also present. This plant community description is classified as a Bromus rubens Semi-Natural Alliance. In the Holland classification, this is Non-native grassland, and it is not a sensitive community. The southwestern portion of the site, mostly outside the pond footprint, has Native bunchgrass grassland (with greater than 10 percent cover) present on a steeper slope. Dominant species were curly bluegrass (*Poa secunda*), common monolopia, and stinging lupine (*Lupinus hirsutissimus*). This community is of special concern in the County. The roadway on the north side of the pond site, within the buffer, is classified as Ruderal, and adjacent to the north is classified as Agriculture (Figure 3). The amount of native grassland within the pond boundary is 0.01 acre and within the buffer is 0.42 acre.

2.3.2 Wildlife

The vineyards where the frost ponds are proposed to be located are surrounded by a 6-foot high, plus an additional 2 feet of barbed wire, deer fence that limits wildlife use of the sites. The 2019 BRA surveys found little evidence of wildlife use in the frost pond areas. This is most likely because the deer fencing will prohibit passage of most medium sized animals such as coyote and deer that are present in the region. Only occasional Botta's pocket gopher (*Thomomys bottae*) and Heerman's kangaroo rat (*Dipodomys heermannii*) burrows were observed. Although, coyote (*Canis latrans*) sign (tracks and scat) were observed near Frost Pond No. 1. A large flock of American crows (*Corvus brachyrhynchos*) were present south of Frost Pond No. 1. Very few birds were seen as well, but red-tailed hawks (*Buteo jamaicensis*) and turkey vultures (*Cathartes aura*) were observed soaring high overhead.

2.3.3 Special-Status Species

Based on the CNDDB search and KMA expertise, 14 special-status plants and 16 special-status animals are known to be present in the general project area. Identified locations from CNDDB were visited during the 2019 surveys to verify if the species were present. Only San Joaquin wooly threads (*Monolopia congdonii*) and Blakely's spineflower (*Chorizanthe blakelyi*) were found on North Fork Ranch property, outside the frost pond sites (and buffers), during site surveys from 2015-2019. Animal species that are unlikely, but have a slight chance of being in the project area include San Joaquin Kit Fox (SJKF) (*Vulpes macrotis mutica*), California glossy snake (*Arizona elegans occidentalis*), American badger (*Taxidea taxus*), and giant kangaroo rat (*Dipodomys ingens*). In addition, specifically regarding observations of badgers, KMA determined that there were no recent observations near the Project site based upon CNDDB records and KMA biologists' onsite observations from 2015 – 2019. None of these species of plants or animals were found on the three frost pond sites, or buffers, and are not expected to be present in these locations due to existing and planned future habitat conditions. The KMA report provides discussion about why they are not expected to occur (KMA, 2020).

2.4 KMA BRA Peer Review Comments

Initial Cardno peer review concerns were related to understanding the extent of area surveyed in 2019, whether any wildlife was observed during these surveys, and confirmation of the last time that the reservoir sites had been disked. These concerns were address in the KMA Memorandum, North Fork Ranch Frost Ponds Project, Supplemental Biological Resources Information, June 15, 2020 and subsequent information provided by the Applicant on May 12, 2020.

3 Special-status Species Concerns Raised in NOP Comment Letters

As noted in Sections 1.1 and 1.4, this section addresses specific comments received on the NOP for the Focused EIR, related to sensitive biological resources within the vicinity and at the Project site. As a result of the concerns expressed in these letters, it was determined that addressing and acknowledging the appropriateness of mitigation measures to protect special-status species needed to be part of this peer review. A complete and detailed list of all comments and responses are included in DEIR Appendix C: Comment Letters and Responses.

USFWS Letter Comments and Responses:

USFWS Comment: USFWS recommend updated surveys for San Joaquin kit fox (SJKF).

Cardno Response: A qualified biologist surveyed the project area for a second time in 2019. No dens or sign (scat tracks, etc.) were observed within the Project footprint during field surveys. While the Project site is within the historic range of the species, it was determined that protocol SJKF surveys are not warranted given review of existing information, known occurrence records in the region, and site-specific observations. No recent observations of SJKF were identified on or adjacent to the proposed Project site. The last recorded occurrences of SJKF in the immediate area are from 1975, and ongoing agricultural operations in the greater Cuyama Valley and on the Project site and the existing exclusionary deer fencing surrounding the North Fork Ranch vineyards would likely have restricted movement opportunities for this species in the Project area. It is possible that a SJKF, if present in the area, could move through the proposed reservoir sites during foraging or migration activities, but the lack of a well-developed prey base and no suitable denning habitat within these sites indicate a very low potential for this species to occur. After construction, the reservoir sites will also be surrounded by exclusionary fencing similar to the vineyard perimeter deer fencing, which minimizes the potential for SJKF to enter the reservoir sites. The KMA BRA determined “potential” for SJKF to occur and included avoidance measures as an attachment to the report be implemented prior to and during construction. Implementation of the USFWS recommended avoidance measures will be sufficient to ensure the SJKF are not adversely affected by construction of the three reservoirs.

USFWS Comment: Federally threatened California red-legged frogs [CRLF (*Rana draytonii*)] have been documented less than seven miles west of the Project site. CRLF can move up to 1.7 miles in search of breeding opportunities during the rainy season. While dispersing, CRLFs may use waterways that would otherwise be unsuitable for breeding or non-breeding occupation and may make straight-line migrations across the landscape, without apparent regard to topographic features. According to CDFW, there is one ephemeral drainage within 100 feet of Reservoir No. 2 and two ephemeral drainages within 250 feet of Reservoir No. 3. Given the presence of these drainages within 1.7 miles of the project site, CRLF potentially use habitat within the project area. Please know that the Service stands by to assist applicants in understanding how to comply with the Act and provide recommendations to avoid take of listed species.

Cardno Response: CRLF individuals can move 1.7 miles during the rainy season as noted in the comment, but the distance to the pond sites is at least 7 miles away, from the closest recorded CRFL, over four times the expected dispersal distance of the species. Thus, potential for CRLF to use nearby ephemeral drainages or the frost ponds is very low due to the distance from locations where the species has been recorded in the region.

No CRLF were identified in the CNDDB five-mile search area. The KMA 2016 report noted ephemeral drainages on the site do not provide suitable habitat, and CRLF are not expected to occur onsite or be affected by the proposed reservoir project. Therefore, it is considered highly unlikely that CRLF are located on or near the reservoir sites. Thus, no protocol surveys are recommended for this species prior to construction of the frost ponds due to the lack of suitable habitat currently present at these locations and no recent records of this species within about 2 miles (expected travel distance) of the sites. The reservoirs when completed, could attract CRLF, but distance (7 miles) from known occupied habitat make this unlikely, even during wetter than normal periods.

USFWS Comment: Recommend EIR project description include all feasible alternatives (and no action).

Cardno Response: DEIR Chapter 6 includes a discussion of feasible alternatives including the No Project Alternative.

USFWS Comment: Recommend quantitative assessment of habitat impacts for each listed species.

Cardno Response: The KMA 2020 BRA provides the basis for onsite habitat that could support listed species. DEIR Section 3.6 includes a discussion of project impacts and calculations of impacts by habitat type.

USFWS Comment: Recommend minimizing use of pesticides, herbicides, or rodenticides prior to, during, and after site-disturbance and/or construction phase.

Cardno Response: A mitigation measure has been included in DEIR Section 3.6 prohibiting the use of pesticides, herbicides, and rodenticides for the area of the proposed frost ponds.

USFWS Comment: All sensitive (federal and state) species should be addressed in DEIR.

Cardno Response: This memorandum and DEIR Section 3.6 includes a discussion of special-status federal and state species.

CDFW Letter Comments and Responses:

CDFW Comment: Appropriately timed surveys for sensitive species of plants and animals and map locations of sensitive species are needed in the DEIR.

Cardno Response: Surveys of reservoir footprint plus a 100-foot buffer found no special-status plants or animals, except a small amount of native grassland in the edge of Pond #3 and in the pond buffer. This plant community was mapped in the KMA 2020 report and is further discussed in DEIR Section 3.6. The frost pond sites and buffer were surveyed for special-status plants and animals in the spring of 2019 following an above normal rainfall winter. No special-status species or their sign were observed during those surveys. As noted above in the response to USFWS comments, given the distance of the proposed reservoir sites from the closest reported special-status species, confirmation of the lack of sign during surveys, the existing exclusionary deer fencing, and the disturbed nature of the site, it was determined that no protocol surveys were necessary.

CDFW Comment: Prohibit use of rodenticides that can cause secondary poisoning of wildlife.

Cardno Response: A mitigation measure has been included in DEIR Section 3.6 prohibiting the use of rodenticides.

CDFW Comment: Conduct a jurisdictional delineation of waters and riparian habitat along drainages.

Cardno Response: Frost pond construction and operation would not affect any streams or riparian habitat, so no delineation was conducted by KMA. Peer review of the KMA 2020 BRA confirmed that no delineation is required.

CDFW Comment: Include CDFW requirements in DEIR biological resources baseline and impact assessment sections.

Cardno Response: DEIR Section 3.6 includes a discussion of baseline biological resources and an impact assessment.

4 Discussion

The KMA BRAs provide information about existing biological conditions with the information from 2015-2016 KMA BRA having more detail. The botanical information from the 2019 KMA BRA survey is detailed and adequate for the EIR preparation. Wildlife information was confirmed in the KMA Memorandum dated June 15, 2020.

No new information about the CRLF was included in the 2019 BRA. However, review of aerial photographs, considering species habits and habitat requirements, as well as Cardno expertise with this species, the potential for this species to be in or attracted to the project frost ponds, even as a transient during wet conditions, is very unlikely due to distance from known locations where the species has been observed and habitats present between reported species locations and the Project site.

Section 3.6 of the EIR addresses impacts on native grasslands since native grasses were found and mapped in the 2019 surveys, and were not addressed in the 2018 MND. Information provided for this native grassland in the 2019 BRA is adequate to address this plant community in the EIR.

5 Conclusions and Recommendations

Existing information is adequate to prepare the biological resource sections of the EIR for vegetation and wildlife habitat and special-status plant and wildlife species. To address concerns raised during the Cardno peer review regarding wildlife surveys, KMA provided a clarifying letter confirming that the field biologists that performed the 2019 BRA surveys were provided with the necessary information to support an analysis of impacts and development of mitigation measures.

Measures to protect or compensate for impacts on native grasslands have been developed for the EIR that are effective in terms of protection, cost, and feasibility. These include avoiding the native grasslands located within the Pond #3 boundary and buffer to limit the amount of grassland that would be permanently lost and protect the area that could be affected within the buffer. As a result, the DEIR analysis identifies that potential impacts to native grasslands, with these protection measures, falls below the County’s threshold requiring further mitigation. The native grassland would be fenced to protect it during construction activities.

Impact assessment in the BRAs and MND will be used, as appropriate, for the EIR analysis with additional information/language from P&D CEQA guidance and Standard Conditions & Mitigation Measures.

6 References

County of Santa Barbara Planning and Development. Revised March 2018. Environmental Thresholds and Guidelines Manual.

County of Santa Barbara Planning and Development. August 1, 2018. Final Mitigated Negative Declaration 17NGD-00000-0004 North Fork Ranch Frost Ponds 16CUP-00000-00005.

Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service.

Holland, R.F. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. California Department of Fish and Wildlife, Sacramento.

Kevin Merk Associates (KMA), LLC. February 4, 2020. North Fork Ranch Frost Ponds Project Biological Resources Assessment. Prepared for Mesa Vineyard Management.

KMA Biological Resource Assessment, North Fork Ranch Frost Ponds Project, February 24, 2016.

KMA Memorandum, North Fork Ranch Frost Ponds Project, Supplemental Biological Resources Information, June 15, 2020.

Shady, R., North Fork Ranch Frost P-mail to Brian Tetley, May 12.

U.S. Fish and Wildlife Service. 2011. Standardized Recommendations for Protection of The Endangered San Joaquin Kit Fox Prior to or During Ground Disturbance. January.

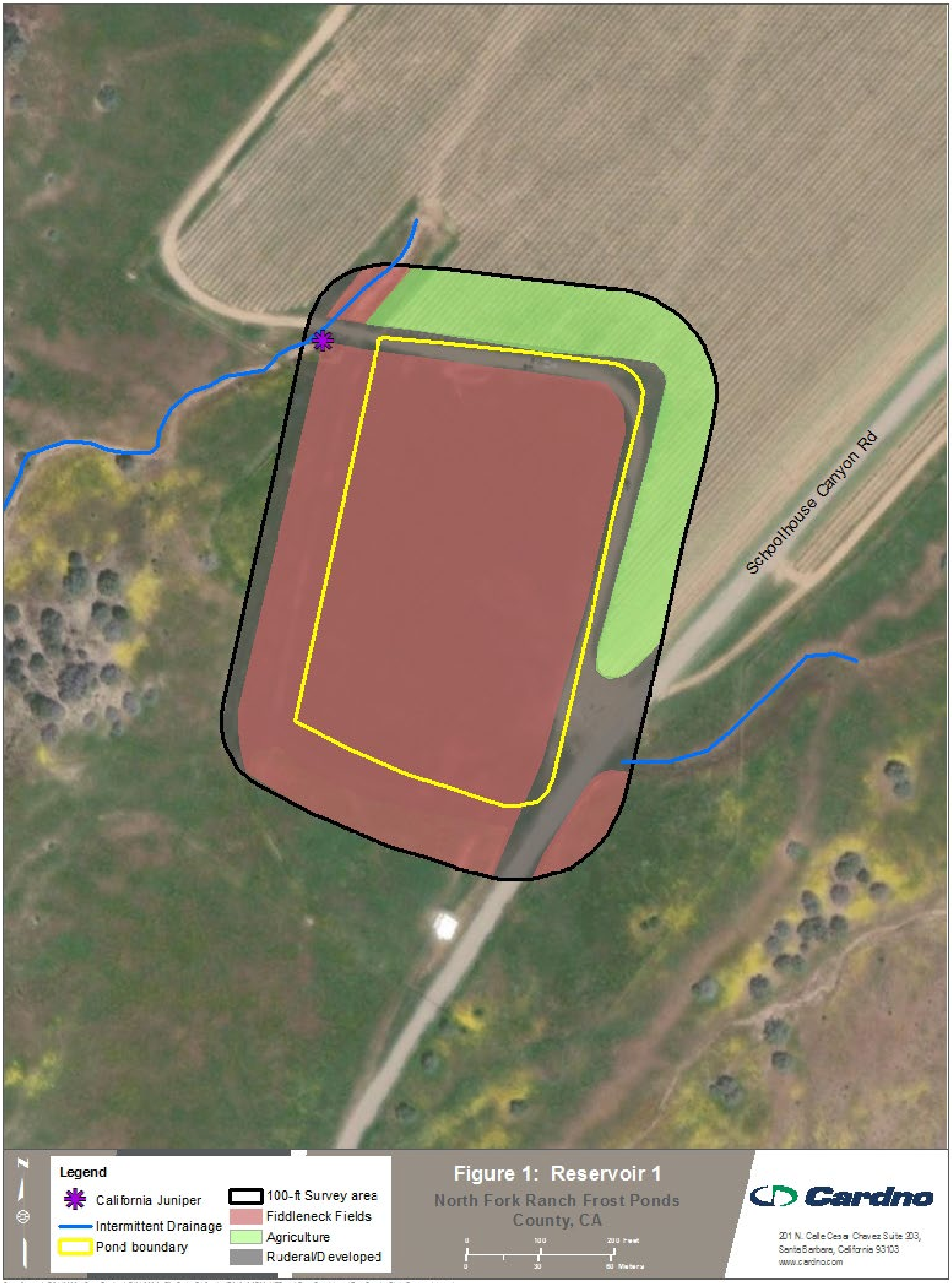

Figure 1 Vegetation at Frost Pond No. 1.

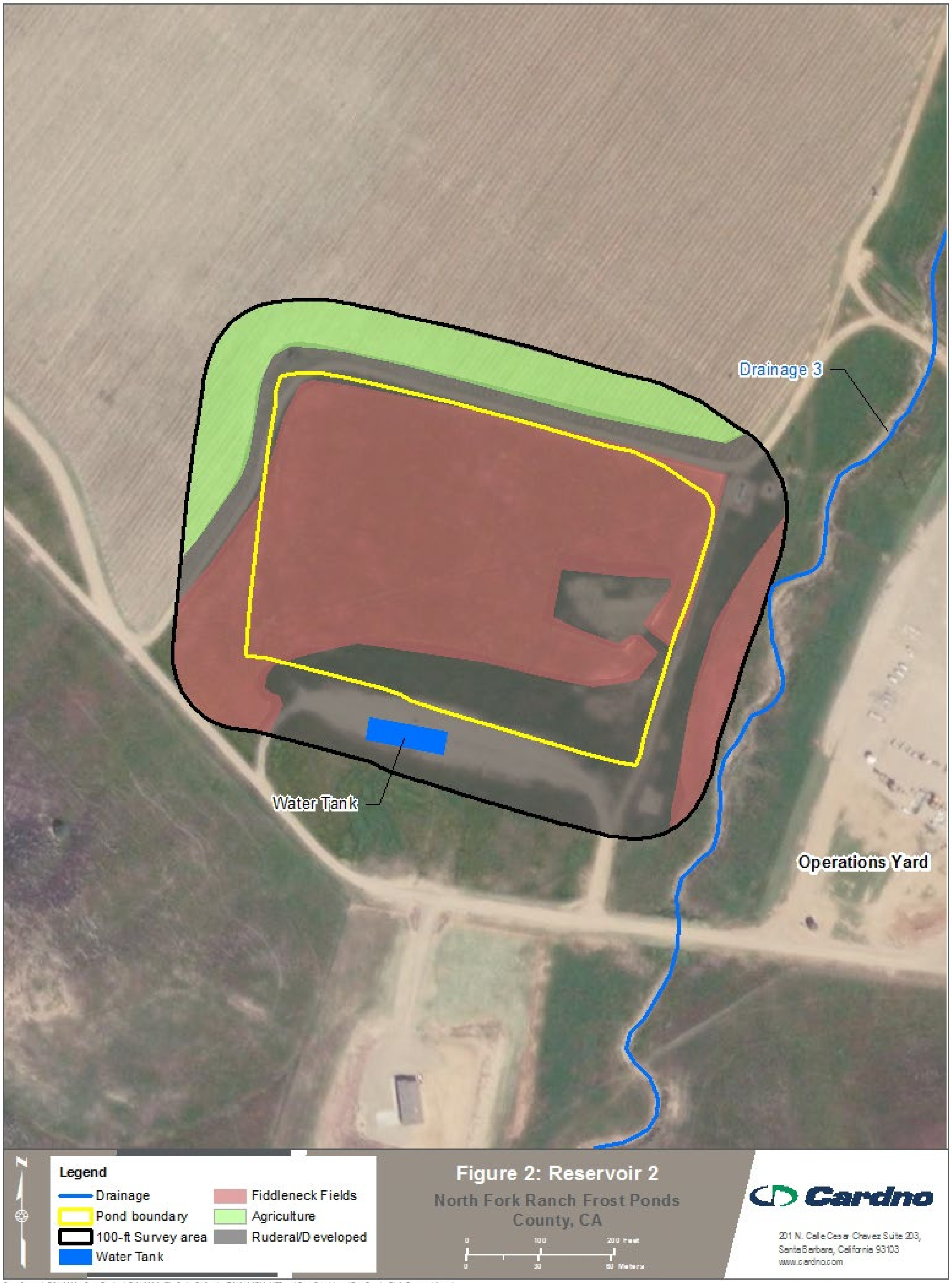

Figure 2 Vegetation at Frost Pond No. 2.

Figure 3 **Vegetation at Frost Pond No. 3.**

Technical Memorandum

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Date February 4, 2021

To: Steve Rodriguez, Contract Planner
County of Santa Barbara, Planning and Development Department

From: Mark Gookin, PC, CFM, QSD, QISP, Senior Consultant
Jennifer Scholl, Senior Consultant, Project Manager

RE: **North Fork Ranch Frost Pond Project – Review of Potential Flooding Impacts Associated with Frost Pond Failure**
North Fork Ranch Frost Ponds Focused EIR (Case No. 16CUP-00000-00005

1 Introduction

1.1 Purpose of Memorandum

Under contract to the County of Santa Barbara Planning and Development Department (County), Cardno was contract to prepare the Focused Environmental Impact Report (EIR) for the North Fork Frost Ponds Project (Project). This memorandum is an appendix to the Focused EIR and presents an independent analysis of potential frost pond flooding issues raised in the public hearing process. The memo also addresses the Notice of Preparation comment letters received from Caltrans and Department of Water Resources (DWR) Division of Safety of Dams (DOSD) that included comments related to the structural integrity of the proposed frost ponds. In addition, in response to concerns raised by DWR DOSD, Brodiaea, Inc. (Proponent) provided formal correspondence dated December 21, 2020 and a set of revised plans dated July 17, 2020 which were also reviewed prior to finalizing this memorandum.

1.2 Project Description

The Project includes construction of three frost ponds (reservoirs) that would store water to be used for the operation of a spray irrigation frost protection system at the North Fork Ranch Vineyards. The proposed reservoirs would serve approximately 840-acres of existing vineyards. Piping that would deliver water to the reservoirs from existing wells is already installed. Only minor pipe connections are proposed to connect the reservoirs to the vineyard's existing irrigation and frost protection systems. Reservoir No. 1 would be located on the eastern portion of the project site, adjacent to Schoolhouse Canyon Road (a private road). Reservoir No. 2 would be located in the central portion of the project site; and Reservoir No. 3 would be located on the western portion of the project site approximately 0.75 miles east of Cottonwood Canyon Road.

The 6,565-acre North Fork Ranch is located in the Cuyama Valley, approximately nine miles west of the community of New Cuyama. The project parcel is located on the south side of State Highway 166 and the proposed reservoir sites are approximately 4,000 to 5,000 feet south of the Cuyama River. The proposed reservoir sites are currently vacant and adjacent to existing vineyards.

1.3 Board of Supervisors Findings to Address Flooding Impacts

In 2016 the Applicant filed an application with the County for a Minor Conditional Use Permit (Application #: 16CUP-00000-00005) for installation of three frost ponds in the North Fork Ranch vineyard. The County approved the application, processed the application, and circulated the draft Mitigated Negative Declaration (MND) for public comment. Comments were received and incorporated to the Final MND, which was adopted in 2018. The permit approval was appealed and subsequently heard before the Planning Commission and Board of Supervisors (Board). During the March 5, 2019 Board Hearing, the Board determined that the MND was inadequate and that a focused Environmental Impact Report (EIR) was required. At this hearing, the Board adopted findings directing the County to prepare a Focused EIR to address potential flood impacts (amongst other issues) from the construction and operation of the frost protection system reservoirs and location in relation to State Route (SR) 166 and other downstream infrastructure. These findings were based on the size of the Project's storage ponds, and concerns with potential downstream flooding of roads expressed by Caltrans and others.

1.4 Hydrologic Setting

The Project proposes to construct three frost ponds – each with a capacity of 49 acre-feet. Flood issues relate to potential failure of the frost pond embankments due to seismic events, hydrostatic pressures of the impounded water, related wave action and potential overtopping, as well as impacts from nearby watercourses which could erode the external side of the embankments. The proposed frost ponds are located south of State Highway 166 and distinctly separate such that potential failure of one pond would not have an effect on another (refer to Figure 1). Generally, stormwater runoff approaches the three proposed frost pond areas as sheet flow or poorly defined watercourses originating from steep terrain to the southwest.

Cardno utilized mapping from the Federal Emergency Management Agency (FEMA) and publicly available topographic mapping of the project area to determine flow patterns in the event of a reservoir breach. FEMA provides Flood Hazard Boundary Mapping (FHBM) for the United States and mapping has been prepared in the project area (refer to Figure 2, below). The site is located generally south of a FEMA mapped Zone A floodplain. The Zone A designation indicates that FEMA has only studied the watercourse associated with this floodplain using approximate methodologies.

1.5 Materials Reviewed

Cardno reviewed background data related to pond design including:

> Topographic conditions in the area of the site;

> Available background information related to nearby flood flow magnitudes;

> Provisions of the County's Grading Ordinance that would be implemented to minimize the potential for flooding impacts;

> The project geotechnical report (GSI 2016) which documents the likelihood for seismic events and geologic hazards, such as liquefaction, to cause a breach of the berms as well as potential impacts from surface flows on the proposed pond berms;

> Project plans dated June 2017 and June 2020;

> Related guidance documents including DWR DOSD guidance related to facilities from which discharge may impact important infrastructure; and,

> DOSD correspondence dated 12/21/20

This technical evaluation was prepared by Mark Gookin, PE, CFM, QSD, QISP, Senior Consultant with over 30 years of experience conducting hydrology and water resources assessments for large-scale construction projects related to flood control, drainage, and resource protection throughout the southwest.

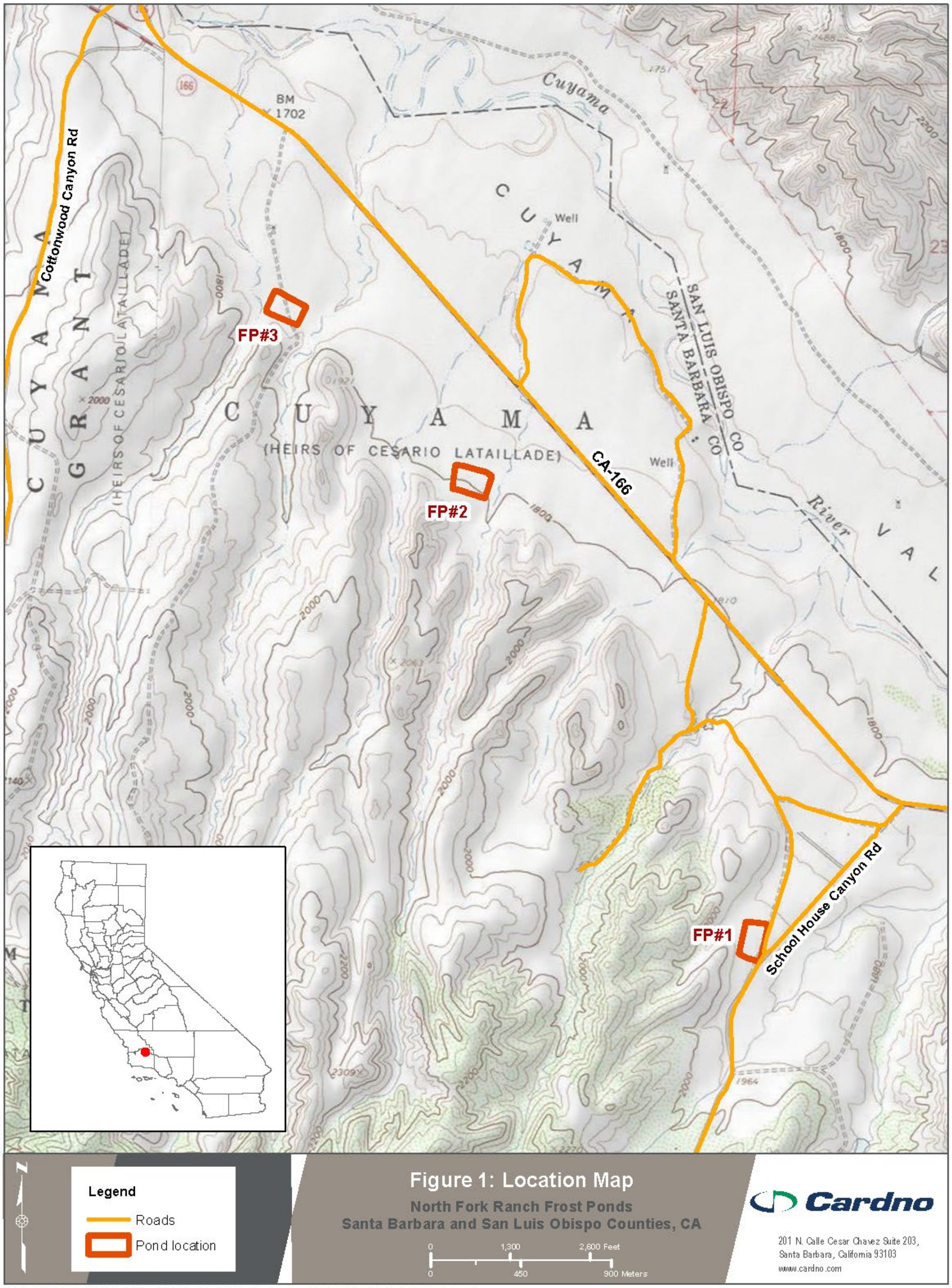

Figure 1: Location Map
North Fork Ranch Frost Ponds
Santa Barbara and San Luis Obispo Counties, CA

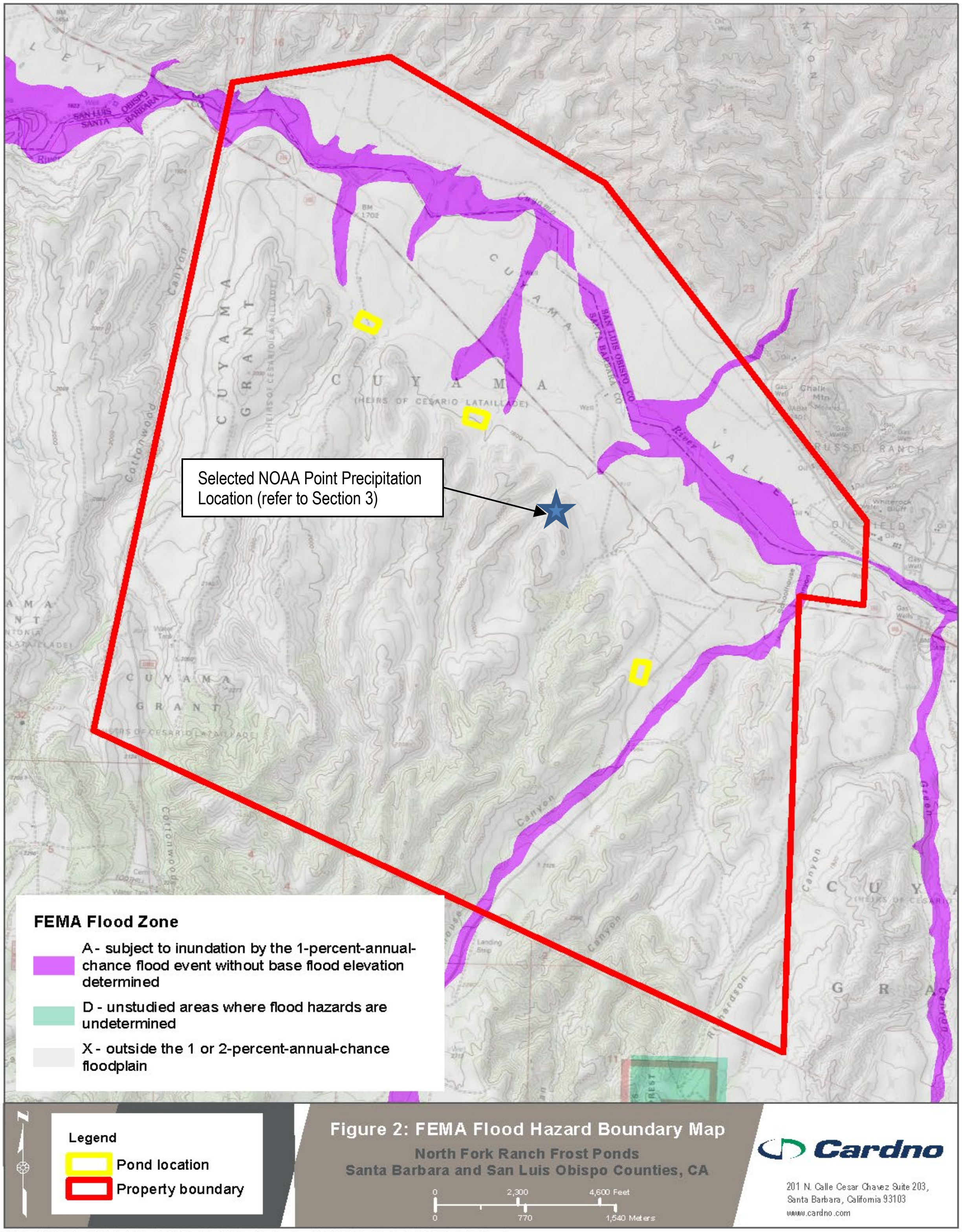

Figure 2: FEMA Flood Hazard Boundary Map

2 Cardno Review of Project-Related Materials

The sections below summarize Cardno's review and comments of the Proponents Geotechnical Report and Design Plans.

2.1 Summary of Applicant Geotechnical Report

The Proponent has included in support of their proposed frost pond design "Geotechnical Investigation North Fork Vineyards Highway 166 New Cuyama, California" (Geotechnical Report) prepared by GSI Soils Inc. (GSI), dated January 4, 2016. This geotechnical analysis includes several recommendations and considerations particularly relevant to the frost pond construction:

> "Concentrated surface water runoff within or immediately adjacent to the site should be conveyed in pipes or in lined channels to discharge to areas that are relatively level or that are adequately protected against erosion."

> "Erosion resistant matting such as Miramat, or other similar products, may be considered for lining drainage channels."

> "Based on our experience, over excavation of the upper 3 to 5 feet appears to have been effective in minimizing the potential for hydro-consolidation/collapse for typical rainfall amounts and irrigation practices. For collapse to occur a source of excess water would need to be present at the site. It will therefore be important to control water sources at the site…".

> "It is our understanding that the reservoirs will be constructed with inboard and outboard slope gradients of 2-1/2:1 (horizontal : vertical).

> "The inboard slopes and bottom of the pond will be covered with a HDPE type liner."

> "Due to the loose conditions of the near surface soils and the sloping terrain, keys and benches will be required to construct the reservoir slops and berms." Additional details regarding the recommend keys and benching are provided in GSI's Figure 3.

> "Field observation and testing during the grading operations should be provided by the Geotechnical Engineer" (and other related activities as described in the Geotechnical report.

2.2 Summary of Applicants Design Plans

The "North Fork Reservoirs/Frost Ponds #1-3" plans dated June 13, 2017 (and updated plans dated July 17, 2020) prepared by Tom A. Howell incorporate three strategies to protect the frost ponds from damage due to runoff approaching from the southwest:

> All three ponds have been located to avoid low-lying defined watercourse areas;

> Although the upslope side of the ponds is proposed to be in "cut" (excavation proposed to remove soil to the proposed bottom elevation), a berm is proposed to be "keyed into" the top of the embankment to ensure deflection of offsite flows from the south (consistent with the geotechnical recommendations).

> A surface drainage feature is proposed to intercept "sheet" flow and stormwater in small and poorly defined flow paths approaching from the southwest. The drainage feature appears to most consistently be referred to as a "drainage swale" on the plans but in one instance is referred to as a "brow ditch".

In addition to the features described above intended to protect the ponds from damage from flows that may approach from the southwest during storm events, the plans call for a 40 millimeter HDPE liner to prevent seepage and to protect the interior slope of the ponds from erosion.

2.3 Comments from CalTrans and DOSD

The Project proposes to construct three frost ponds – each with a capacity of less than 50 acre-feet. Fifty acre-feet represents the threshold whereby the analysis, design, and construction would fall under the review jurisdiction of the State of California, DWR DOSD. Based on information contained on the plans, the proposed frost ponds do not appear to meet criteria, which would meet the requirements of a jurisdictional sized dam as defined by the DWR, DSOD.

> *"As defined in Sections 6002 and 6003, Division 3, of the California Water Code, dams 25 feet or higher with a storage capacity of more than 15 acre-feet, and dams higher than 6 feet with a storage capacity of 50 acre-feet or more are subject to State jurisdiction. The dam height is the vertical distance measured from the maximum possible water storage level to the downstream toe of the barrier."*

The identified plans include a calculation of storage up to the top of the proposed dams which exceeds 50-acre feet. However, the maximum water storage level is determined by the spillway crest which, in this instance, is provided by overflow pipes. The intent of the plans appears to be to provide for an outlet invert elevation which is below the dam crest and which results in containment of a maximum storage volume of less than 50 acre-feet. DOSD's letter of December 21, 2020 indicates that impoundments as shown on the Proponent's July 17, 2020 plans do not fall within DOSD jurisdiction. In addition to DOSD's comments, Caltrans expressed concern in their July 7, 2017 letter with the "structural integrity and adequacy" of the project's berms to reduce potential impacts to less than significant with mitigation. However, Caltrans' July 7 letter also incorrectly identifies the project as including a "147-acre-foot reservoir" rather than the three smaller distinctly separate ponds proposed.

3 Cardno Hydrologic Analysis

The Proponent has not provided hydrologic or hydraulic analysis for the proposed frost ponds. Minor, offsite generated sheet-flow runoff from the southwest is anticipated to be intercepted by the proposed drainage swales. The collection of rainfall within the frost ponds is limited to rainfall which falls directly within the area of the containment berms. The issue of concern with respect to overtopping of the dams and related damage and failure is the adequacy of the proposed 15" diameter overflow pipes. Debris considerations, which are often important in evaluating adequacy of flood control facilities, such as detention basins, are not expected to be a concern for the Project as there is no sediment or debris source. The only water which gets into the basins is that which is pumped in for frost protection purposes and rainfall that falls directly into the reservoirs.

The National Oceanographic and Atmospheric Administration (NOAA) provides estimates of rainfall intensities for various recurrence intervals and durations as presented in the following Figure 3. The most critical period from a dam overtopping perspective would be should a powerful storm occur when the frost ponds are full up to the elevation of the invert of the overflow pipes. The surface area at the top of the containing berms is typically approximately 6% more than that of the surface area with the water surface at the invert of the pipe overflow. Therefore, estimates of the rise in water surface created by strong rainfall events needs to consider the slightly larger area at the top of the berms. Although intense, short duration storms, such as a 60 minute (1-hour) 500-year storm, would only result in a 1.6-inch rise in water surface (1.52 inches from Figure 3 times a factor of 1.06) even if no outflow occurred through the overflow pipe. Such a minor rise does not present a concern with respect to the integrity of the containment berms. Conversely, while a long duration storm such as a 3-day, 500-year storm event is estimated by NOAA to provide rainfall amounting to 10.8 inches, the overflow pipe system can readily keep up with flow rates delivered by such long-duration storms. For example, the described 3-day event average flow can be expressed as follows:

> 10.8 inches rainfall x 1 foot / 12 inches x 3.02 acres (Pond 1 area at top of berm) x 43,560 square feet/acre / (3 days x 24 hours/day x 3,600 seconds/hour) = average flow of 0.46 cubic feet per second (cfs)

With a flow of 0.46 cfs, the calculated depth at the entrance of the overflow pipe is 4 inches. Thus, the proposed 15-inch overflow pipes can readily keep up with flows from such a long duration storm. Using the same procedure, but for the more intense 500-year 24-hour storm, results in average flows of 0.91 cfs as presented below.

> 7.17 inches rainfall x 1 foot / 12 inches x 3.02 acres (Pond 1 area at top of berm) x 43,560 square feet/acre / (1 days x 24 hours/day x 3,600 seconds/hour) = average flow of 0.91 cfs

With a flow of 0.91 cfs, the calculated depth at the entrance of the overflow pipe is 6 inches. Thus, the proposed 15-inch overflow pipes can readily keep up with the peak flow from even with the more intense 24-hour storm. By inspection, the 6- and 12-hour storm events can also be readily handled by the proposed system in that the water surface at the overflow pipes would only rise a few inches even with no outflow (an unrealistically conservative assumption). The analysis presented is simplistic and conservative in that the storage and attenuation of the flow peak within the reservoirs is not considered. A more sophisticated analysis (using HEC-HMS for example) would be expected to result in a lower depth of flow at the overflow pipes. Based on these calculations, the ponds are not expected to fail and the recommended mitigation measures noted below are intended to ensure that project plans identify consistent construction for all three ponds.

In addition to consideration of potential overtopping due to storm events, wave action can present potential for overtopping damage to the pond embankments. Based on the 95 percentile wind speeds corrected to the longest fetch direction, wave heights are anticipated to be less than 0.12 feet. These limited wave heights would be expected to be readily contained within the HDPE-lined embankment freeboard.

The project Geotechnical Report indicates low potential for liquefaction in the project area. Further, the Geotechnical Report provides recommendations for embankment grading which appears to consider potential seismic events. However, the Geotechnical Report fails to directly state the anticipated response of the pond embankments to seismic events.

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.086** (0.076-0.098)	**0.111** (0.098-0.127)	**0.148** (0.130-0.170)	**0.181** (0.157-0.210)	**0.230** (0.191-0.278)	**0.271** (0.220-0.338)	**0.317** (0.249-0.408)	**0.369** (0.279-0.492)	**0.447** (0.320-0.629)	**0.514** (0.353-0.757)
10-min	**0.123** (0.109-0.140)	**0.159** (0.141-0.182)	**0.212** (0.187-0.244)	**0.259** (0.228-0.301)	**0.329** (0.274-0.399)	**0.388** (0.315-0.484)	**0.454** (0.356-0.585)	**0.528** (0.400-0.705)	**0.640** (0.459-0.902)	**0.737** (0.506-1.09)
15-min	**0.148** (0.131-0.169)	**0.193** (0.170-0.221)	**0.257** (0.226-0.295)	**0.313** (0.273-0.363)	**0.398** (0.331-0.482)	**0.470** (0.381-0.586)	**0.549** (0.431-0.707)	**0.639** (0.484-0.853)	**0.774** (0.555-1.09)	**0.891** (0.612-1.31)
30-min	**0.211** (0.186-0.241)	**0.274** (0.242-0.313)	**0.365** (0.321-0.418)	**0.445** (0.387-0.516)	**0.565** (0.471-0.685)	**0.667** (0.541-0.832)	**0.780** (0.612-1.00)	**0.908** (0.687-1.21)	**1.10** (0.789-1.55)	**1.27** (0.869-1.86)
60-min	**0.292** (0.258-0.333)	**0.380** (0.335-0.434)	**0.505** (0.445-0.580)	**0.616** (0.537-0.715)	**0.783** (0.652-0.949)	**0.924** (0.749-1.15)	**1.08** (0.848-1.39)	**1.26** (0.951-1.68)	**1.52** (1.09-2.15)	**1.75** (1.20-2.58)
2-hr	**0.434** (0.384-0.495)	**0.557** (0.493-0.637)	**0.735** (0.647-0.844)	**0.894** (0.779-1.04)	**1.13** (0.944-1.37)	**1.34** (1.08-1.67)	**1.57** (1.23-2.01)	**1.82** (1.38-2.43)	**2.21** (1.59-3.11)	**2.55** (1.75-3.75)
3-hr	**0.550** (0.487-0.628)	**0.704** (0.622-0.805)	**0.927** (0.816-1.06)	**1.13** (0.981-1.31)	**1.43** (1.19-1.73)	**1.68** (1.37-2.10)	**1.97** (1.55-2.54)	**2.30** (1.74-3.07)	**2.79** (2.00-3.93)	**3.22** (2.21-4.74)
6-hr	**0.786** (0.696-0.897)	**1.01** (0.890-1.15)	**1.33** (1.17-1.52)	**1.61** (1.40-1.87)	**2.04** (1.70-2.48)	**2.41** (1.96-3.01)	**2.82** (2.22-3.64)	**3.29** (2.49-4.39)	**4.00** (2.87-5.63)	**4.62** (3.17-6.79)
12-hr	**1.02** (0.901-1.16)	**1.31** (1.16-1.50)	**1.73** (1.52-1.98)	**2.10** (1.83-2.44)	**2.66** (2.21-3.22)	**3.13** (2.54-3.91)	**3.66** (2.87-4.71)	**4.26** (3.22-5.68)	**5.16** (3.70-7.26)	**5.94** (4.08-8.74)
24-hr	**1.40** (1.25-1.59)	**1.81** (1.62-2.06)	**2.40** (2.14-2.74)	**2.93** (2.59-3.37)	**3.71** (3.19-4.40)	**4.37** (3.69-5.29)	**5.11** (4.21-6.32)	**5.93** (4.76-7.54)	**7.17** (5.54-9.47)	**8.23** (6.16-11.2)
2-day	**1.68** (1.51-1.91)	**2.20** (1.97-2.50)	**2.94** (2.63-3.36)	**3.61** (3.20-4.16)	**4.63** (3.98-5.49)	**5.49** (4.63-6.65)	**6.46** (5.32-7.99)	**7.55** (6.06-9.59)	**9.20** (7.11-12.1)	**10.6** (7.95-14.5)
3-day	**1.86** (1.67-2.12)	**2.45** (2.19-2.79)	**3.31** (2.95-3.78)	**4.08** (3.62-4.70)	**5.27** (4.53-6.26)	**6.29** (5.31-7.62)	**7.44** (6.14-9.22)	**8.76** (7.03-11.1)	**10.8** (8.31-14.2)	**12.5** (9.36-17.1)
4-day	**1.99** (1.78-2.27)	**2.63** (2.35-3.00)	**3.56** (3.18-4.07)	**4.41** (3.90-5.07)	**5.71** (4.91-6.78)	**6.84** (5.77-8.28)	**8.12** (6.69-10.1)	**9.58** (7.69-12.2)	**11.8** (9.13-15.6)	**13.8** (10.3-18.8)
7-day	**2.24** (2.01-2.55)	**2.97** (2.66-3.38)	**4.04** (3.60-4.61)	**5.01** (4.44-5.77)	**6.51** (5.59-7.72)	**7.81** (6.58-9.45)	**9.28** (7.65-11.5)	**11.0** (8.81-13.9)	**13.6** (10.5-17.9)	**15.8** (11.8-21.6)
10-day	**2.36** (2.11-2.69)	**3.13** (2.81-3.57)	**4.27** (3.81-4.88)	**5.31** (4.70-6.11)	**6.89** (5.92-8.18)	**8.27** (6.98-10.0)	**9.83** (8.11-12.2)	**11.6** (9.33-14.8)	**14.4** (11.1-19.0)	**16.8** (12.6-22.9)
20-day	**2.96** (2.66-3.38)	**3.94** (3.53-4.49)	**5.36** (4.79-6.13)	**6.64** (5.89-7.65)	**8.60** (7.39-10.2)	**10.3** (8.68-12.5)	**12.2** (10.1-15.1)	**14.4** (11.6-18.3)	**17.8** (13.7-23.5)	**20.7** (15.5-28.3)
30-day	**3.37** (3.02-3.83)	**4.50** (4.02-5.12)	**6.13** (5.47-7.00)	**7.60** (6.73-8.75)	**9.82** (8.44-11.7)	**11.7** (9.89-14.2)	**13.9** (11.4-17.2)	**16.3** (13.1-20.7)	**20.1** (15.5-26.5)	**23.3** (17.5-31.8)
45-day	**3.90** (3.49-4.44)	**5.20** (4.66-5.93)	**7.08** (6.32-8.09)	**8.76** (7.76-10.1)	**11.3** (9.69-13.4)	**13.4** (11.3-16.3)	**15.8** (13.0-19.6)	**18.5** (14.9-23.5)	**22.6** (17.5-29.9)	**26.2** (19.6-35.7)
60-day	**4.53** (4.06-5.15)	**6.00** (5.37-6.84)	**8.11** (7.24-9.27)	**9.97** (8.84-11.5)	**12.8** (11.0-15.1)	**15.1** (12.7-18.3)	**17.7** (14.6-21.9)	**20.6** (16.6-26.2)	**25.0** (19.3-33.0)	**28.8** (21.5-39.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Figure 3 NOAA Precipitation Frequency Estimates for the Frost Pond Sites

4 Conclusion

The frost ponds as configured on the project plans generally incorporate features which meet the standard of practice for protecting downstream properties and infrastructure. However, additional information and clarifications on the design plans will help to ensure continued proper functioning of the three frost ponds throughout their period of use as identified in the following mitigation measures. The EIR will include these measures in the standard County format to identify plans, requirements, timing, and reporting.

4.1 Mitigation Measures

> The Proponent shall provide a maintenance and operations plan, which includes requirements for regular inspection of the frost pond embankments, pond liner, overflow piping (including entrances, outlets, and outlet energy dissipation), and perimeter drainage ditches and criteria for implementing any corrective actions.

> There are multiple potential concerns associated with the pond designs, as a result, the following measures need to be taken:

  - In order to address seepage concerns, the Proponent shall incorporate filter diaphragms or other means in lieu of the seepage collars shown on the plans.
  - The frost protection pond outlet pipes do not allow for gravity drawdown of the ponds in the event of an emergency. Final design shall include an outlet pipe which allows for controlled manual lowering of impounded water by gravity to the level of the downslope toe of the lowest elevation embankment.
  - The Geotechnical Engineer does not directly state the adequacy of their recommended embankment configuration to withstand seismic events. The final design submittal shall include measures to provide protection during seismic events and be confirmed by the Geotechnical Engineer.

> There are multiple potential concerns regarding the proposed drainage swales shown on the revised plans dated July 17, 2020:

  - Drainage ditches proposed for the upstream and adjacent sides of the ponds are identified as both a drainage swale and “brow ditch” (sheet 4). No detail or other clarifying information is provided for the “brow ditch”. It appears that this is a minor drafting error and that the feature should have been identified as a drainage swale. If the design engineer intended that this feature is to be different than a drainage swale, additional details shall be provided.
  - The “Santa Barbara County Building & Safety Division Grading Notes #8” on sheet 1 of the plans, indicates that existing slopes that are to receive fill materials shall be keyed and benched per the Geotechnical Engineer’s recommendation. The Geotechnical Report, Figure 3, calls for the perimeter swales to be lined with concrete or shotcrete. Other portions of the Geotechnical Report also call for drainage channels to be lined (Sections 5.8.1, 5.8.2). However, the design plans indicate that perimeter drainage channels shall be unlined “earthen swales” (“Scope of Work” Sheet 1, Drainage Swale Detail Sheet 10). The drainage channels which are intended to intercept surface flows and avoid impacts to the proposed fill slopes shall be armored per the Geotechnical Report.
  - The proposed ponds have been located to avoid significant drainage flow paths. However, minor concentrations of storm flows may approach the ponds from the southwest. The detail provided on sheet 10 of the plans indicates that the minimum depth of drainage swale is 6 inches. Plan sheets 4-7 appear to depict a much greater depth for the perimeter swales. The design engineer shall clearly indicate the slope angle for these much deeper swales and any proposed armoring measures.

5 References

California Department of Transportation (CALTRANS). Letter dated February 10, 2020. NOP Comments for the North Fork Ranch Frost Ponds Project at 7400 Hwy 166 Near New Cuyama.

California Department of Water Resources (DWR). Letter dated January 17, 2020. Notice of Preparation for the North Fork Ranch Frost Ponds Draft Environmental Impact Report SCH2017061009.

County of Santa Barbara, Board of Supervisors Agenda Letter, March 5, 2019, Adopt Findings Requiring Preparation of a Focused EIR for the North Fork Ranch Frost Ponds Minor Conditional Use Permit, Fifth Supervisorial District. County of Santa Barbara Planning and Development. Revised March 2018. Environmental Thresholds and Guidelines Manual.

County of Santa Barbara Planning and Development. August 1, 2018. Final Mitigated Negative Declaration 17NGD-00000-0004 North Fork Ranch Frost Ponds 16CUP-00000-00005.

GSI Soils Inc., Geotechnical Investigation, January 4, 2016, North Fork Vineyards, Highway 166, New Cuyama, Prepared for Kevin Merrill, Mesa Vineyard Management.

National Oceanographic and Atmospheric Administration, Point Precipitation Frequency Estimates, April 17, 2020, https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_printpage.html?lat=35.0103&lon=-119.8487&data=depth&units=english&series=pds

Tom A. Howell, North Fork Reservoirs/Frost Ponds #1-3" Plans, June 12, 2017 and as revised per plan set dated June 17, 2020, prepared by Tom A. Howell.

Technical Memorandum

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Date May 17, 2021

To: Steve Rodriguez, Contract Planner
County of Santa Barbara, Planning and Development Department
Holly Owen, Supervising Planner, Planning and Development Department

From: Michael Clough, P.E., T2 Utility Engineers, Senior Project Manager
Jennifer Scholl, Senior Consultant, Project Manager, Cardno
Tamara Klug, Principal-in-Charge and Southern California Business Unit Leader

RE: **North Fork Ranch Frost Pond Project – Water Budget Technical Memorandum**
North Fork Ranch Frost Ponds Focused EIR (Case No. 16CUP-00000-00005)

In recognition of the technical contents of this memorandum, the following table of contents has been provided for reference.

1 Introduction

1.1 Purpose of Memorandum

Under contract to the County of Santa Barbara Planning and Development Department (P&D), Cardno was selected, following a competitive process, to prepare the Focused Environmental Impact Report (EIR) for the North Fork Frost Ponds Project (Project). This memorandum is an appendix to the Focused EIR and presents a review of the applicant's analysis, and an independent technical analysis of water use associated with the operation of the proposed frost ponds and frost protection system.

This technical evaluation was prepared by Mike Clough, PE, a Senior Project Manager/ Agricultural Engineer with T2 Utility Engineers, with nearly 40 years of experience in agricultural irrigation, drainage, farm development, frost protection, and water use permitting in California and elsewhere. His background includes relevant experience quantifying water use and evaporative losses from agricultural systems of the type proposed for this Project. Application of calculations for evaporative losses are industry standard, as noted in Section 3.1.8 and the Section 6 References, and Mr. Clough has specifically used this approach for similar crop frost protection systems in Texas and Florida.

1.2 Project Description

The Project includes construction of three frost ponds (reservoirs) that would store water to be used for the operation of a spray irrigation frost protection system at the North Fork Ranch Vineyard. The proposed reservoirs would serve the existing vineyards. Piping that would deliver water to the reservoirs from existing wells is already installed. Only minor piping is proposed to connect the reservoirs to the vineyard's existing frost protection systems. Reservoir No. 1 would be located on the eastern portion of the project site, adjacent to Schoolhouse Canyon Road (a private road). Reservoir No. 2 would be located in the central portion of the project site; and Reservoir No. 3 would be located on the western portion of the project site approximately 0.75 miles east of Cottonwood Canyon Road.

The 6,565-acre project parcel is located in the Cuyama Valley, approximately nine miles west of the community of New Cuyama. The project parcel is located on the south side of State Highway 166 and the proposed reservoir sites are approximately 4,000 to 5,000 feet south of the Cuyama River. The proposed reservoir sites are currently vacant and adjacent to existing vineyards. Refer to Figure 1 for the aerial overview of the Project location.

The vineyard operation is 1000-acres and includes access roads, proposed reservoir sites, O&M facilities and storage yards, with 828-acres of planted grape vines. Frost protection is not necessary for the entire 828-acres of planted vines, only the areas with early- or mid-budding varietals, making up 765.41-acres of the total vine area, with the remaining 63-acres of planted vines being late season-budding varietals, not requiring frost protection. Therefore the three proposed reservoirs located within the North Fork Ranch Vineyard, would provide frost protection for 765.41-acres of existing vineyards (actual acreages planted), as well as contributing seasonally to the existing drip irrigation for the entire 828-acre vineyard between the end of the frost protection season and the time period when the reservoirs have reached a three-foot maintenance elevation (described in greater detail, below). The reservoirs would supply the frost protection system that operates by sending a sustained-spray stream directly to the grape vines when frost has the potential to cause damage. The overhead sprinkler system would spray the emerging grape vine buds, resulting in freezing the water upon contact with the vine and then melt once the sun rises and temperature increases. Based on comments from the Applicant frost protection would generally be required during the months of March and April.

The initial inputs for Cardno's analysis regarding the amount of planted vines were derived from materials supporting project plans dated June 13, 2017, as referenced in Section 6 below. The inputs do not reflect the current acreages as noted in the revised plan set dated, February 1, 2021, however, the differences are relatively minor and after careful review, do not change Cardno's final conclusions and recommendations.

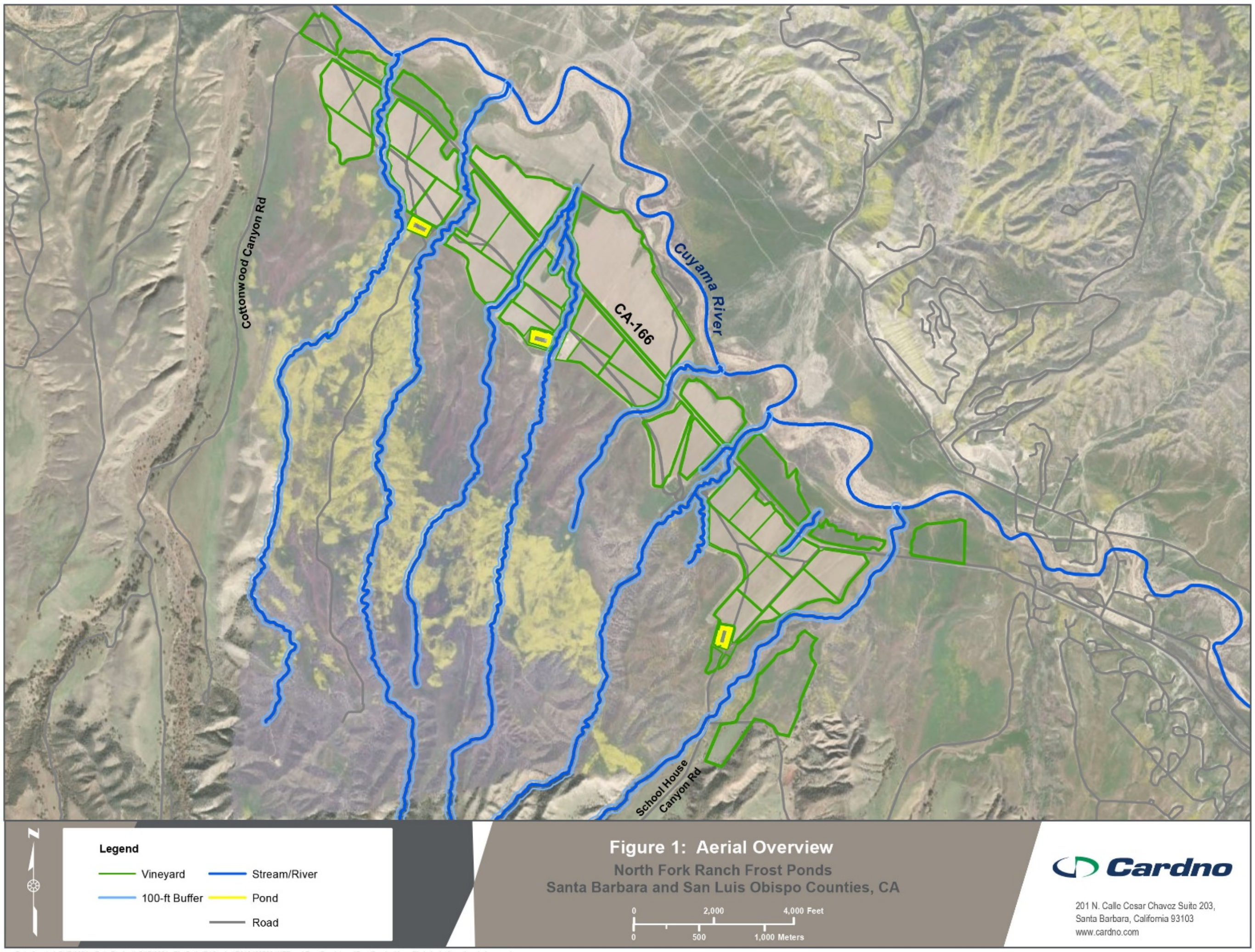

Figure 1: Aerial Overview
North Fork Ranch Frost Ponds
Santa Barbara and San Luis Obispo Counties, CA

1.3 Board of Supervisors Findings to Address Water Use Impacts

In 2016, the Applicant filed an application with P&D for a Minor Conditional Use Permit (Application #:16CUP-00000-00005) for installation of three frost ponds in the North Fork Ranch Vineyard. P&D approved the application, processed the application, and circulated the draft Mitigated Negative Declaration (MND) for public comment. Comments were received and incorporated into the Final MND, which was adopted in 2018. The permit approval was appealed and subsequently heard before the Planning Commission and Board of Supervisors (Board). During the March 5, 2019 Board Hearing, the Board determined that the MND was inadequate and that a focused Environmental Impact Report (EIR) was required. At this hearing, the Board adopted findings directing P&D to prepare a Focused EIR to address to address water use impacts (amongst other issues) from the operation of the frost protection system (reservoirs and frost protection sprinkler system).

2 Cardno Review of Applicant Materials

Information analyzed prior to the preparation of the Focused EIR regarding estimated net evaporative losses from the reservoirs was provided by the Applicant as part of application submittal materials. Evaporation from the reservoirs was estimated by a report titled North Fork Vineyards Frost Protection Reservoirs No.1, No. 2 and No. 3 – Analysis of Reservoir Evaporative Losses (Monsoon Consultants, August 10, 2017). The Applicant's estimate was based on a variety of factors: 1) the months of the year that the reservoirs would be maintained in a full condition; 2) the months of the year that the reservoirs would contain a maximum of three feet of water; 3) annual precipitation; and 4) reference evaporative losses. The Applicant's estimate concluded that the combined average annual net evaporative losses from all three proposed reservoirs would be approximately 26.28-acre feet per year (AFY) of water. Therefore, the Applicant concluded that net evaporative losses from the reservoirs would not exceed the County's Environmental Thresholds Manual, ground water use threshold of 31 AFY, and subsequently result in a less than significant water use impact.

The Applicant also identified that the amount of water used for vineyard frost protection can vary substantially each year depending on the number, duration, and severity of frost events. The Applicant has indicated that during a frost event, water would be sprayed on the vines at a rate of 45-gallons per minute per acre; typically, the vines would be sprayed for a duration of two to three hours; and not all frost events would require that the entire vineyard be sprayed. The Applicant noted that the frost protected area of vineyard was a total of 765 acres, with a unit rate of 0.108 inches / square foot / hour of frost protection application and approximately 6.87 acre-feet / hour of water would be used during frost protection.

The Applicant further stated that all water used for frost protection would be available for uptake by the vines, resulting in no water lost during the frost protection events. Therefore, net evaporative losses from the reservoirs and frost protection would not exceed the water use threshold of 31 AFY and the project would result in a less than significant water use impact.

2.1 Analysis of Reservoir Evaporative Loss

An *Analysis of Reservoir Evaporative Losses* was prepared by Monsoon Consultants for the North Fork Ranch Frost Protection reservoirs on behalf of the Applicant in August 2017. This previous assessment was reviewed as part of this updated analysis, noting the following comments:

> The assumed frost protection period in this previous assessment was from February 1 to April 31, which means frost protection was assumed to occur 1 month prior to the March 1 start for early season vines adopted in this analysis. The notes that the Applicant provided regarding frost protection periods are based on several years of operation of the vineyard since this previous analysis, and are deemed more appropriate than the frost period of this previous analysis (Grapevine Capital Partners, 2020a).

> The analysis assumes the reservoirs empty instantaneously on May 1 in this previous analysis where our analysis suggests this emptying to non-frost season levels occurs typically over a 2-3 week period and is completed in mid-May.

> The average Lake Factor (used to calculate evaporative loss for water bodies) adopted within this previous analysis compared to the average annual evapotranspiration (ETo) is 1.25, which is higher than the Lake Factor adopted in this analysis of 1.05. The average annual ETo of 61.6 inches / year is similar to the average annual ETo from Cuyama Gauge of 61.554 inches / year

> The gross evapotranspiration (ET) losses from the reservoirs in the previous analysis adopted annual Lake Factor ET depths of 76.6 inches, where this analysis has significantly lower annual Lake Factor ET values for the selected years between 65.3 – 66.6 inches, resulting from the different Lake Factors described above.

> The rainfall inputs to the reservoirs in the previous analysis adopted annual rainfalls of 7.84 inches where this analysis has significantly lower annual rainfalls for the selected years of between 3.57 – 6.84 inches (California Department of Water Resources, 2020).

> The results of the previous analysis showed a net evaporative loss (ET less rainfall) for the three reservoirs combined of 26.28 acre-feet. This is slightly higher than the net evaporative losses for the reservoirs calculated in this analysis (refer to **Table 7**, below) of 21.5 - 24.2 acre-feet. However, it is concluded that the results of the evaporative loss from the reservoirs and the previous analysis and this analysis are generally in agreement.

3 Cardno Independent Hydrologic Analysis

Cardno's scope of work was to review the Applicant's analysis and independently estimate the evaporative losses from the three proposed frost pond reservoirs as well as water loss from the frost protection sprinkler system. To determine water losses Cardno calculated the water budget supported by the following information: 1) information presented during the Project's application processing; 2) information collected from public sources; 3) meteorological and system operational parameters provided by the Applicant; and 4) extensive experience with the application of models used to predict water use and evaporative losses.

The following sections present the Available Data, then Water Budget Methodology, and finally the Water Budget Results.

Frost Protection Water Losses

The Cardno analysis focused on the water losses from the frost pond system based upon the following considerations. Water used to support agricultural operations conducted on properties with agricultural zoning is considered an allowed use and no land use entitlements are required for such uses (LUDC Section 35.21.030). The existing vineyards that the proposed water storage reservoirs would support, are located on property with agricultural zoning (AG-II-100). Therefore, the vineyard operations and irrigation water used by the vineyards do not require any land use entitlements from the County, and water impounded in the proposed reservoirs that would be used to support (i.e., provide frost protection) to the existing vineyards would not be subject to the water use threshold established for the Cuyama Valley Groundwater Basin. However, the proposed water storage reservoirs are a conditionally permitted use in the AG-II-100 zone and require the approval of a discretionary Minor Conditional Use Permit. Therefore, water impounded in the reservoirs, not directly or indirectly used to irrigate the existing vineyards, is subject to the water use thresholds of the County's Environmental Thresholds Manual. Also, any evaporative water losses from the frost protection system that do not irrigate the vineyards or recharge the aquifer would count towards the water use threshold of 31 acre-feet per year (AFY). Water impounded in the reservoirs that would not be directly or indirectly used in support of the vineyards would be the water that evaporates. If the amount of water that evaporates from the proposed frost protection system throughout the year plus the amount of water that evaporates from operation of the proposed reservoirs exceeds the threshold of 31 AFY, the project would result in a significant water use impact.

Water Loss Analysis

The detailed analysis of the vineyard water use was accomplished by looking at two scenarios; (1) the current scenario operating without reservoirs and not using water for frost protection, and (2) constructing reservoirs and using them for water supply for irrigation and frost protection for the vineyard.

Both scenarios analyzed 3 years of operation. Meteorological data was downloaded from the California Irrigation Management Information System (CIMIS) Cuyama weather station from the period of record 2000-2018. Cardno reviewed the record and chose 3 years to represent light frost protection requirement (2015), average frost protection requirement (2017) and heavy frost protection requirement (2009).

In the scenarios, the year was divided into daily increments and a water balance on the vineyard was prepared for every day of the year. For each day, the following water quantities were determined:

- Crop water needs
- Effective rainfall (rainfall contributing to crop water requirements)
- Water contained in the soil profile
- Water draining from the soil profile (deep percolation)
- Irrigation quantities
- Groundwater pumping

For the “With Reservoir” scenario, the following additional quantities were determined;

> Water level in the reservoir
> Water used for frost protection
> Evaporation from the reservoirs
> Evaporation from the soil surface after frost protection events

3.1 Available Data

3.1.1 Precipitation Gauge Data

Gauge data for this analysis was sourced from the CIMIS weather station ID 88 at Cuyama in Central Coast, California. The gauge is located near New Cuyama Airport (34.942525 degree N and 119.6738 degree W), approximately 10-miles southeast of the subject property. The data from this gauge used in this analysis was recorded daily from January 1, 2000 to December 31, 2018, a period of record of 19 years.

The following data from this gauge was adopted in this analysis:

> Daily precipitation depths in inches were the basis of the rainfall inputs
> Daily reference evapotranspiration (ET) depths in inches were used as the basis for ET inputs
> Hourly temperatures in degrees F were used in the analysis of frost days. Hourly records were used for March 1 – April 30 for the years 2009, 2017, and 2015 – 2019.

Across this 19-year period from 2000-2018 the average annual rainfall was 4.016 in / year and the average annual ET was 61.554 in / year.

3.1.2 Recorded Recent Frost Data and Gauge Recorded Temperatures

Based upon data provided by the Applicant, the frost season is as follows for the existing vines based on 2-3 years of observations (use of on-site meteorological stations and temperature gauges used to confirm frost events by the designated ranch supervisor):

> 600.07 acres of vines are early-season budding, meaning they are at risk of frost from early in the season, assumed to be from March 1 – April 30 in this analysis (beginning of filling of the reservoirs prior to frost season assumed to occur February 15, refer to **Section 2.2**).
> 165.24-acres of vines are mid-season budding, meaning they are at risk from March 15 – April 30 in this analysis.
> An additional 74.11-acres of vines are late-season budding, however they bud outside of currently recorded frost events.

The Applicant supplied an hourly summary of actual frost periods based on their on-site weather records from 2016 onwards. They identified that frost hours per year would have been 20 hours for 2016, 2 hours for 2017, 12.5 hours for 2018, and 0 hours for 2019, with an average over the 4-year period of 8.63 hours / year (Grapevine Capital Partners, 2020b).

In lieu of more extensive actual frost records, the best indicator of likely frost events is air temperature, the assumption being when below a temperature threshold, frost is likely to occur.

In order to establish the frost temperature threshold that best replicates these actual frost records from 2016-2019, three temperature thresholds were analyzed; 34 degrees (commonly adopted as the frost threshold temperature), 33 degrees and 32 degrees.

The hourly gauge data for Cuyama was compared to that of the Applicant's weather gauge for March 1 – April 30 for four years of record 2016 – 2019. The data for this gauge is presented in 15-minute intervals. The annual average hours of temperatures for the three intervals are compared in **Table 1.**

Table 1 – Comparison of Hours / Year of Temperatures Below 32, 33, or 34 degrees F for Cuyama Gauge and Applicant Gauge for 2016 - 2019

March 1 - April 30 in 2016 - 2019	**Cuyama**			**Applicant Weather Station**		
Frost Temp Interval Threshold (degrees F)	**34**	**33**	**32**	**34**	**33**	**32**
Number of Frost Days (4 years)	21	15	**10**	35	26	**20**
Frost Days / Year	5.25	3.75	**2.50**	8.75	6.50	**5.00**
Average Hours / Frost Day	0.95	0.92	**0.84**	0.62	0.61	**0.52**
Total Frost Hours / Year	**20.00**	**13.80**	**8.40**	**21.75**	**15.90**	**10.30**

The results in **Table 1** show that the two gauges compare as follows (ordered Applicant vs. Cuyama):

> There are more frost days in the Applicant data set for 34 degrees (35 vs 21), 33 degrees (26 vs 15), and 32 degrees (20 vs 10)

> There are more frost hours / frost days for the Cuyama data set for 34 degrees (0.62 vs 0.95), 33 degrees (0.61 vs 0.92) and 32 degrees (0.52 vs 0.84)

> When multiplied together to get the total frost hours per year (Frost Days/Year x Average Hours/Frost Day) these two things balance each other out with comparable hourly total / year results for 34 degrees (21.75 vs 20.0), 33 degrees (15.9 vs 13.8) and 32 degrees (10.3 vs 8.4), respectively.

The difference in gauge recording interval is likely the cause for differences with respect to frost days / year and frost hours / frost day. Recording every 15 minutes, the Applicant's gauge is likely to pick up more frost days because it takes 4 times more daily recordings than the Cuyama gauges hourly recordings. However, for the same reason, it is likely that the frost times / day are shorter because each reading represents 15 minutes vs 1 hour for the Cuyama gauge. The calculation of frost hours / year is a longer-term analysis and lessens the impacts of the different recording intervals of the two gauges.

The results in **Table 1** show that the gauges have good agreement with the average frost hours per year based on numerous temperature thresholds producing similar results between the two gauges. The similarity of results to the on-site gauge validates the use of the Cuyama gauge as a fair representation of the site's weather being located 10 miles southeast of the project site.

The results in **Table 1** show that over the same four years of record (2016-2019), the 32 degree F threshold (8.4 hours / year) is the closest to the actual frost records provided by the Applicant (8.63 hours / year). Therefore, the 32 degree F threshold has been adopted to determine frost times in this analysis.

3.1.3 Long Term Average Frost Days

The Applicant recorded frost hours, discussed in **Section 1.2**, that show strong variability in frost hours / year with between zero (0) – 20 hours / year of frost events. With such a high variability and small sample size (4 years), it is not possible to determine what a normal year of frost events is based on using this data set alone. Therefore, an analysis of CIMIS Cuyama weather station ID 88 gauge daily minimum temperatures from 2000 – 2018 (19 years) was used, coupled with the 32 degree threshold for March 1 – April 30 to estimate the long-term average of frost days / year.

The estimated number of frost days per year for 2000 – 2018 are shown in **Figure 1**. Across this 19-year period, the average number of frost days is 10.74 days / year (median of 10 days / year). Comparatively the average frost days for the recent period 2016-2018 of recorded frosts (see **Section 1.2**) is 4.0 days. This suggests that the recent period with average recorded frost of 8.4 hours has relatively fewer frost events than the long-term average for the area, a trend observed in **Figure 1**.

As discussed further in **Section 2.1**, three years were selected for the analysis; a 'light' frost year, a 'normal' frost year, and a 'heavy' frost year. These years were selected based on the number of frost days compared to the long-term average of 10.74 days / year. These years are (shown circled in **Figure 1**):

> Light frost year – 2015 with an estimated 3 frost days/year (28% of long term average)

> Normal frost year – 2017 with an estimated 9 frost days/year (84% of long term average)

> Heavy frost years – 2009 with an estimated 27 frost days/year (251% of long term average)

The stated method of selection for analysis years used the temperature threshold to estimate the number of frost days based on daily minimum temperature records. As discussed in **Section 2.1,** in the actual analysis, a more detailed analysis of number of frost hours was adopted using hourly temperature recordings.

3.1.4 Soils Data

Local soil information has been sourced from the Natural Resources Conservation Service (NRCS) Custom Soil Resource Reports for the area (extracted January 9, 2020). The subject property was divided into three custom maps East, North and South Ranch, which were combined into a single analysis. The soil types and areas for only vineyard (crops), excluding non-vineyard areas of the subject property, are shown in **Table 2**. A soil storage for these four soil types in inches / foot was sourced from the NRCS Web Soil Survey. The soil storage of each was weighted by percentage of crop area and the composite soil storage across all crop areas was calculated to be 1.6 inches / foot as shown in **Table 2**. This soil storage is expressed as 100% of water holding capacity, beyond which water will drain from the soil.

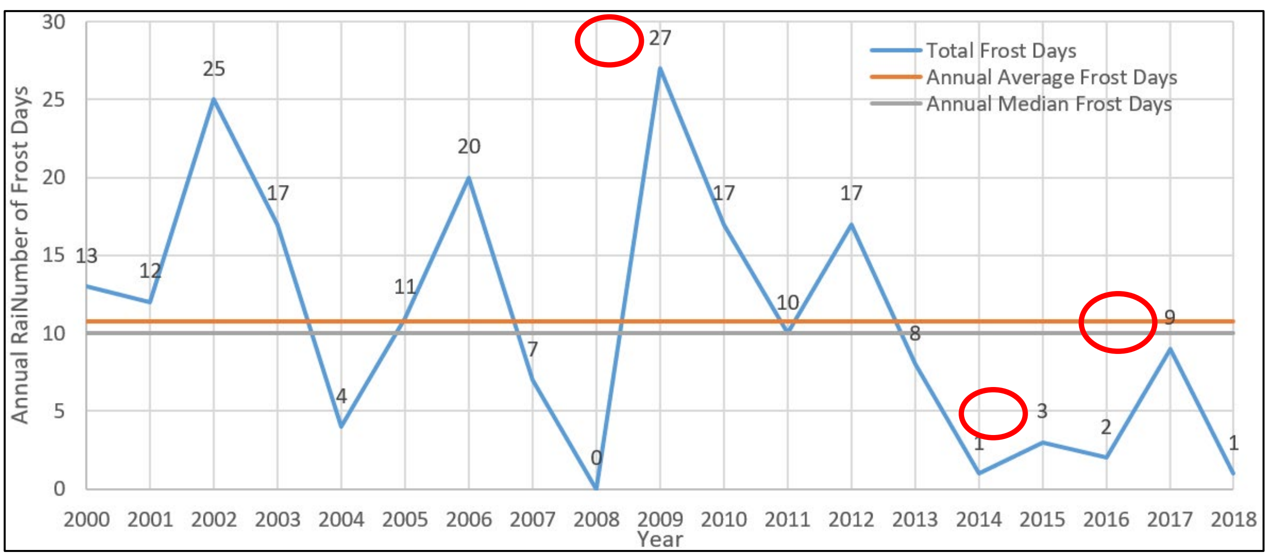

Figure 1 – Annual Number of Frost Days from 2000 – 2018

Table 2 – Soil Types and Areas of Crop Areas Only

Map Unit Symbol	Map Unit Name	Acres	Percent of Area	Soil Storage (in / feet)	Weighted Soil Storage (in / feet)
PcA	Panoche sandy loam, 0 to 2 % slopes	91.5	9.2%	1.72	0.157
PcC	Panoche sandy loam, 2 to 9 % slopes	137.4	13.7%	1.72	0.236
PeC	Panoche loam, 2 to 9 % slopes	372.8	37.3%	1.8	0.671
PnC	Pleasanton sandy loam, 2 to 9 % slopes	397.7	39.8%	1.34	0.533
Total		**999.4**			**1.60**

The planted acres of vines is within the area of these map units. For our analysis, a relatively conservative root zone depth for the vineyard was estimated to be 3 feet, for a total water storage capacity of 4.8 inches of water.

3.1.5 Irrigation Details and Reservoir Design

Details of the existing operation were compiled from information provided by the Applicant including crop area and existing well capacity as shown in **Table 3** below. The maximum capacities provided in Table 3 have been used in the water budget analysis to determine the refill rate of the proposed reservoirs.

The total irrigated area, which includes several grape varietals, has been stated by the Applicant to be 827.65-acres (531.83-acres south vineyards and 295.82-acres north vineyards) which is based on the reservoir design plans provided by the Applicant (Howell, T., 2017). The sprinkler design plans (AG Ideas LLC, 2017) note a slightly higher proposed irrigated area of 837.4-acres (547.3-acres south and 290.1-acres north), but since these were dated 6 months prior, the areas from the later set of design plans by Howell, T have been adopted.

The total vineyard area of 827.65-acres is 62.34-acres larger than the frost protected crop area information originally provided by the Applicant in **Section 1.2**. It has been confirmed by the Applicant that that this additional 74.11-acres are vineyards that do not require frost protection, but require irrigation.

Table 3 – Groundwater Well Capacity for North Fork Ranch

Well	Capacity	
	Gallons / minute (gpm)	Million gallons / day (mgd)
CHG14	140	0.202
CHG13	75	0.108
CHG7	300	0.432
CHG6	90	0.130
CHG12	0	0.000
CHG5	320	0.461
CHG15	400	0.576
CHG1	350	0.504
CHG4	550	0.792
CHG3	350	0.504
CHG2	160	0.230
TOTAL	**2,735**	**3.938**

Note: 1 million gallons / day is equal to 694.4 gallons / minute (1,000,000 / 60 x 24)

The following details of the proposed operation have been compiled from design plans of the three proposed reservoirs (Howell, T., 2017), as provided by the Applicant:

> Stage storage relationships for Reservoirs No. 1, No. 2, and No. 3 have been combined into a total stage storage relationship:
  - The base surface area of the combined three reservoirs is 3.285-acres (143,095 square feet)
  - The max storage depth is assumed to be equivalent to the overflow pipe invert of the reservoirs which averaged across the 3 reservoirs is a height above base of 25.5 feet
  - This maximum depth corresponds to a combined surface area of 8.6-acres (374,572 square feet) with a combined volume of 147 acre-feet (49 acre-feet / reservoir).

> Frost protection system water demands were calculated based on irrigation design plans provided by the Applicant (AG Ideas LLC, 2017). The 2.15 gpm nozzle capacity stated in the design plans covers a 1,920 square foot area with 18,991 nozzles in total. These design details yield the following details adopted in the analysis:
  - An application soil depth of 0.108 inches / hour
  - Frost protection pumpage is 2.45 million gallons per hour (7.5 ac feet/hour).

3.1.6 Crop Coefficient for ET

Monthly crop coefficients for evapotranspiration were sourced from the Irrigation Training and Research Center (ITRC) *Irrigation Crop and Soil Evapotranspiration* (ITRC, 2003). This resource is based on thousands of annual simulations of evapotranspiration and is commonly used to estimate ET for irrigation scheduling and system design for different regions of California.

The reference was from the ETc (crop and soil ET) Table for Irrigation Scheduling and Design for Zone 6 and a Drip/Micro Irrigation Typical Year (1997). The vineyard is located in Zone 10, but this zone assumes normal surface irrigation, where the nearby Zone 6 assumes drip irrigation, as is used in the North Fork Ranch Vineyard, therefore Zone 6 was adopted as a more accurate representation of vineyard irrigation conditions. Table 4 provides ET for a reference grass (which is the ETo (ET reported by the CIMIS Cuyama weather station) as well as a range of other crop types including grape vines with 40% canopy cover. It is assumed that a canopy cover of 40% represents mature vines (currently not all vines are mature) thus, this analysis considers the future fully established scenario where all vines will be mature. Dividing the two ET values for the crop by the reference ET yields the adopted crop coefficient as shown in **Table 4** below.

Table 4 – Monthly Crop Coefficient for Grape Vines based on Reference Monthly ET values

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ETo - Grass Reference	1.45	2.6	3.98	5.54	6.89	6.49	6.11	6.01	5.13	3.75	1.79	1.73
ETo - Grape Vines with 40% canopy	1.61	0.73	0.56	1.73	2.9	2.65	2.36	1.99	1.64	0.15	1.09	1.34
Kc - Grape Vines with 40% canopy	**1.11**	**0.28**	**0.14**	**0.31**	**0.42**	**0.41**	**0.39**	**0.33**	**0.32**	**0.04**	**0.61**	**0.77**

3.1.7 Effective Rainfall %

Effective rainfall percentage was based on monthly average values shown in **Table 5**. The source of these monthly values is the NRCS Engineering Handbook – Irrigation Guide (1997). The effective rainfall % was calculated from a table that relates monthly rainfall to monthly crop irrigation requirements and is meant to estimate rainfall available to the crop after evaporation, runoff, and deep percolation.

Table 5 – Applied Monthly Effective Rainfall Percentages for North Fork Ranch

Month	Effective Rainfall (%)
January	69%
February	59%
March	30%
April	31%
May	36%
June	35%
July	35%
August	34%
September	31%
October	30%
November	31%
December	64%

3.1.8 Evaporative Losses from Sprinkler Frost Protection

This analysis assumes two primary forms of evaporative loss from a similar sprinkler surface irrigation systems such as proposed in the frost protection system for North Fork Ranch:

> Evaporation from mist water at the time of frost protection

> Evaporation from excess ground surface moisture after frost protection.

Various resources were reviewed regarding the first form of evaporation from mist water listed above, including:

> Thompson, A. et al (1993a) A Sprinkler Water Droplet Evaporation and Plant Canopy Model: I Model Development, American Society of Agricultural Engineers, Vol. 36(3):735-741 - May-June 1993

> Thompson, A. et al (1993b) A Sprinkler Water Droplet Evaporation and Plant Canopy Model: II Model Application, American Society of Agricultural Engineers, Vol. 36(3):743-750 - May-June 1993

> Thompson, A. et al (1997) Testing of a Water Loss Distribution Model for Moving Sprinkler Systems, Biological Systems Engineering: Papers and Publications. Paper 32

For the second form of evaporation, ground surface evaporation from excess moisture, guidance within the Food and Agriculture Organization of the United Nations (FAO) Irrigation and Drainage Paper No. 56 - *Crop Evapotranspiration (guidelines for computing crop water requirements)* (Allen, R. et al, 1998) was used.

It was concluded, based on the review of these papers that identify industry standards, that the evaporation loss from mist water at the time of frost protection is negligible in volume. This is because this form of evaporation can only occur during the time of frost protection, early morning close-to or at-freezing temperatures, when evaporation is least likely to occur. In addition, this time of day has high relative humidity. Conversely, based on the projected volumes of frost protection water, significant water is expected to be applied to soils around the vines that will remain within the soil surface layer after frost protection, until this water is used by the vines, evaporates, or percolates beneath the vine root zone. This results in significantly higher evaporation loss from the ground surfaces than the mist water at the time of frost protection.

Therefore, for the purposes of this analysis the effects of frost protection mist evaporation have been assumed to be negligible, while ground surface evaporation of frost protection water has been accounted for as follows:

> Water that was applied during frost protection remains in surface soil layer and available for evaporation for up to 2 days; and

> Soil surface evaporation is assumed to be the difference between reference ET and crop ET, unless by the second day after frost protection, the applied excess water is fully evaporated from the soil surface.

3.2 Water Budget Methodology

This water budget analysis assesses the impacts of the proposed surface reservoirs by comparing a 'without reservoir' (or pre-project) scenario, and a 'with reservoir' (or post-project) scenario. The analysis covers individual years using a water balance calculated each day. For each daily time step, the quantities of water pumped by the wells, used by the crop, added by rainfall, deep percolated, and held in storage in the soil are calculated. For the "with reservoir" analysis, the frost protection pumping, reservoir levels, reservoir evaporation and soil evaporation was also calculated daily.

The methodology for this analysis was guided by the *Irrigation Scheduling Water Balance Method* (Snyder, Richard L., 2014).

3.2.1 Years of Analysis

The impacts of the frost pond reservoirs are mostly influenced by the frost hours in a year; therefore, the approach to the analysis was to select three years from the record; a 'light' frost year, a 'normal' frost year, and a 'heavy' frost year. The selection of suitable years for each was based on number of estimated frost days and the long-term average of frost days discussed in **Section 1.3**. However, the analysis and the number of frost hours listed below are based on hourly temperature recordings. Also considered were annual rainfall volumes and annual ET. Based on the gauge data, the following years of recorded data were selected:

> Light frost year – 2015

- Annual hours of frost (less than 32 degrees F (March 1 – April 30) is 2 hours.
- Annual rainfall was 3.94 inches, 98% of the average annual rainfall (4.016 inches)
- Annual ET was 63.13 inches, 103% of average annual ET (61.554 inches)

> Normal frost year – 2017

- Annual hours of frost (less than 32 degrees F (March 1 – April 30) is 32 hours.
- Annual rainfall was 6.84 inches, 170% of the average annual rainfall
- Annual ET was 63.46 inches, 103% of the average annual ET

> Heavy frost year – 2009

- Annual hours of frost (less than 32 degrees F (March 1 – April 30) is 101 hours.
- Annual rainfall was 3.57 inches, 89% of the average annual rainfall
- Annual ET was 62.2 inches, 101% of the average annual ET

3.2.2 Assumptions

The following general assumptions have been made in the analysis in support of the water balance. All of the following assumptions have been applied to both the 'with' and 'without' reservoir scenarios:

> The vineyard rooting depth for the subject property has been estimated to be 3 feet. This estimate is used in determining the water holding capacity of the soil with 100% water holding capacity assumed to be 4.8 inches (3 feet deep soil x 1.6 inches of water/ foot) as discussed in **Section 1.4**). If daily soil water depths exceed 100% then the excess volume is lost to deep percolation.

> Irrigation efficiency of 85% has been assumed – common for a drip irrigation system. This means that 85% of water is used for irrigation with the remaining 15% accounted for in uniformity, evaporation, and other water losses.

> Vineyard operations have been established for irrigation to only occur when the previous day soil storage is less than 75% water holding capacity. This irrigation target soil storage aims to ensure sufficient irrigation is provided while soils do not oversaturate to minimize deep percolation losses of irrigation waters.

> The irrigated area is estimated to be 827.65-acres as discussed in Section 1.5. The early season frost protection acreage is 600.07 and the late season frost protection acreage is 165.24, as discussed in Section **1.2**.

> Irrigation demand is based on the daily Crop ET values, using the ETo value from the CIMIS Cuyama weather station, multiplied by the crop coefficient shown in **Section 1.6**.

The following assumptions have been made with regards to the design and operation of the reservoirs in the post-project scenario:

> As noted in **Section 1.2**, frost hours have been assumed to be those where the minimum air temperature is at or below 32 degrees F.

> The designated period of frost protection is March 1 to April 30, with late season being March 15 – April 30. Outside of this period, if temperatures drop below 32 degrees frost protection will not be administered because the vine growth is expected to be outside of the “budding” (pre- or post-budding) phase and can sustain under these conditions.

> The designated period of reservoir filling for frost protection season is February 15 to April 30, allowing an additional two weeks prior to frost protection for reservoirs to fill from 3 feet deep to 25.5 feet deep. The target reservoir levels during this filling period are 25.5 feet deep on average for all reservoirs representing a combined reservoir volume of 147 ac-feet (49 ac-feet per reservoir).

> Outside of the designated filling period, the target reservoir levels are 3 feet deep for all reservoirs representing a combined reservoir volume of 10.62 ac-ft. This will minimize evaporation from the reservoir surface water is used as the water source for non-frost protection irrigation demands.

> During normal operation, the groundwater wells will pump into the reservoirs (**Table 3**) to maintain constant water levels, however during the filling period prior to frost protection the wells will pump every day until the reservoirs are full, and during emptying period after frost protection, the wells will not pump until the reservoirs drain down to normal level.

> A Lake Coefficient of 1.05 (refer to **Section 1.8**) has been applied to recorded daily ET values, using the daily combined surface area of the reservoirs to calculate evaporation volume.

> All water demand for irrigation and frost protection is sourced from the three reservoirs. The reservoirs are supplied by existing groundwater wells and from local rainfall / runoff into the reservoirs with no direct irrigation from the groundwater wells.

> During frost protection, the water that falls on the soil will be subject to evaporation for a period of 48 hours after the frost protection with the amount of soil evaporation from this frost protection being the difference of reference ET less crop ET. Refer to **Section 1.9** for explanation.

3.2.3 Soil Storage Calculations

Daily soil storage calculations are as follows (in inches [in]):

> Daily soil storage (in) = previous day storage (in) + gross irrigation provided (in/day) + effective rainfall (in/day) + frost protection (in/day) – crop ET (in/day) – frost protection soil ET (in/day).

Where:

- Gross irrigation provided (in/day): If frost protection that day, then irrigation = 0, if reservoir volume too low, then irrigation = 0, if previous day soil storage greater than target then irrigation = 0, otherwise, irrigation volume is daily crop ET / irrigation efficiency %, which is 85%.
- Effective rainfall (in/day): Daily recorded rainfall x monthly effectiveness percentages (**Table 5**).
- Frost protection (in/day): If within designated protection period, with frost temperatures, and reservoir has sufficient capacity on previous day then frost protection occurs equal to hourly frost protection of 0.108 in/hour multiplied by the number of frost hours in a given day.
- Crop ET (in/day): Equal to daily-recorded ET x monthly crop coefficient (Kc) (**Table 4**).
- Frost protection soil ET (in/day): If frost protection occurs, the surface evaporation of the soil is the reference ET less the crop ET for the day of the frost protection and the day after the frost protection, unless the full frost protection volume is evaporated across the 2 days.

If the daily total soil storage exceeds 100% of soil capacity (4.8 inches) then the excess depth is considered deep percolation which is subtracted from the soil water balance, and that quantity cannot be used for irrigation.

3.2.4 Demand Volumes and Reservoir Volume Calculations

For the ‘without reservoir’, or pre-project scenario, the water demand of the groundwater wells is the gross irrigation converted from in/day to acre-feet by multiplying by the irrigated area.

For the ‘with reservoir’, or post-project scenario, the reservoir filling occurs over a 2 week period beginning February 15 and then emptying beginning April 30, with the time needed to empty varying depending on the irrigation demand in the various years. Outside of this period the reservoir is maintained at or close to the target depth of 3 feet.

The calculation of reservoir water balance is as follows (all in millions of gallons/day [mgd] unless otherwise stated):

> Reservoir volume (mg) = previous day volume (mg) + inflow from wells + surface runoff - previous day reservoir evaporation - frost protection – irrigation

Where:

- Surface runoff (mgd): Daily recorded rainfall x total combined reservoir surface area (9.06 acres, assumes no wider drainage areas flow to reservoirs).
- Previous day reservoir evaporation: Previous day calculated water surface area x daily-recorded ET x Lake Factor (1.05). *Note: needed to be based on previous day water surface area as an approximation to avoid circular references in equations.*
- Frost protection: If no frost protection was provided on a day then zero (0), if early season frost, then equal to 0.108 inches/day x frost hours x 600.07 acres of early season vines. If late season frost, then equal to 0.108 inches/day x frost hours x 765.31 acres of late season vines.
- Irrigation volume: Equivalent to the gross irrigation volume in the soil storage water balance converted to mgd by multiplying by irrigated area (827.65-acres) and converting to gallons.

> Inflow from wells (mgd): Daily inflow to reservoirs is equal to the volume outflows (previous reservoir evaporation + frost protection + irrigation volume). This balances reservoir daily inflows and outflows and ensures the reservoir remains at the target depth. Exception is if reservoir outflows exceed maximum daily well capacity of 3.938 mgd then proceeding days filling will continue until target reservoir depth is met. Target reservoir depth varies based on two different times of year:

  - When outside of the designated filling period (May 1 – January 14) – Target is 3 feet depth (10.62 acre-feet)
  - Within designated filling period (January 15 – April 30) – Target is 25.5 foot depth (147 acre-feet)

For the 'with reservoir', or post-project scenario, the water demand of the groundwater wells is the inflow from wells in the above calculation.

3.3 Water Budget Results

3.3.1 'Without Reservoir' Scenario

The 'without reservoir' scenario soil storage inputs (effective rainfall, and gross irrigation) and output (crop ET) for the light (2015) frost year, normal (2017) frost year, and heavy (2009) frost year are shown in **Figure 2, Figure 3**, and **Figure 4,** respectively. The water balance results are shown in **Table 6**.

As can be seen in **Figure 2**, there were no major rainfall events within the year 2015, so soil water storage % does not exceed 80% which results in no deep percolation. The limited major rainfall events in 2016 (it has the lowest total annual rainfall at 1.7 inches) results in irrigation demand remaining consistent throughout the year with the highest gross irrigation demand (21.78 inches). Conversely as shown in **Figure 3** there were large rainfall events in January – April 2017 which causes peaks in soil storage throughout this period, with one peak exceeding 100% soil storage, resulting in 0.5 inches of deep percolation loss. This period of high rainfall results in negligible irrigation volume needed throughout this period and the lowest gross irrigation demand for this year at 20.05 inches. For the year 2009, as seen in **Figure 4,** there are rain events in January – February resulting in reduced irrigation demand from February to March. However, as these rainfall events are not as significant as those in 2017 (total rainfall depth for 2009 is 1.79 inches as compared to 4.04 inches in 2017), the soil storage does not exceed 90% in 2009 and there is no deep percolation.

Table 6 – Water Balance Results – 'Without Reservoir' Scenario

Frost Year	Light	Normal	Heavy
Soil Balance – Inflows and Outflows	**2015**	**2017**	**2009**
Effective Rainfall (inches / year)	1.70	4.04	1.79
Crop ET (inches / year)	23.46	23.55	23.38
Gross Irrigation (inches / year)	21.78	20.05	21.60
Deep Percolation (inches / year)	0.00	0.50	0.00
Soil Storage Capacity %			
Avg Soil Storage %	74.7%	78.6%	75.8%
Max Soil Storage %	78.2%	100.0%	89.7%
Min Soil Storage %	72.5%	72.4%	72.4%
Annual Volumes			
Groundwater Well –Water Demand (ac-ft/yr)	1,502.0	1,383.0	1,490.1
Deep Percolation Volume (ac-ft/yr)	0.0	34.7	0.0

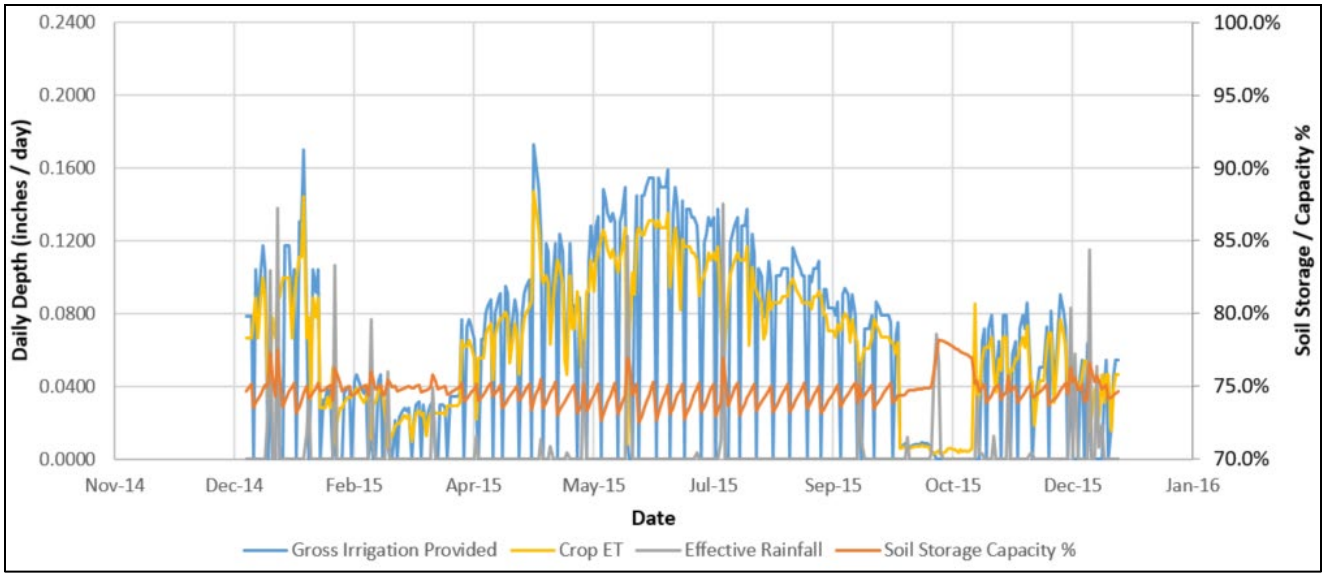

Figure 2 – 2015 Light Frost Year - Without Res Soil Storage Inputs and Outputs and Soil Capacity

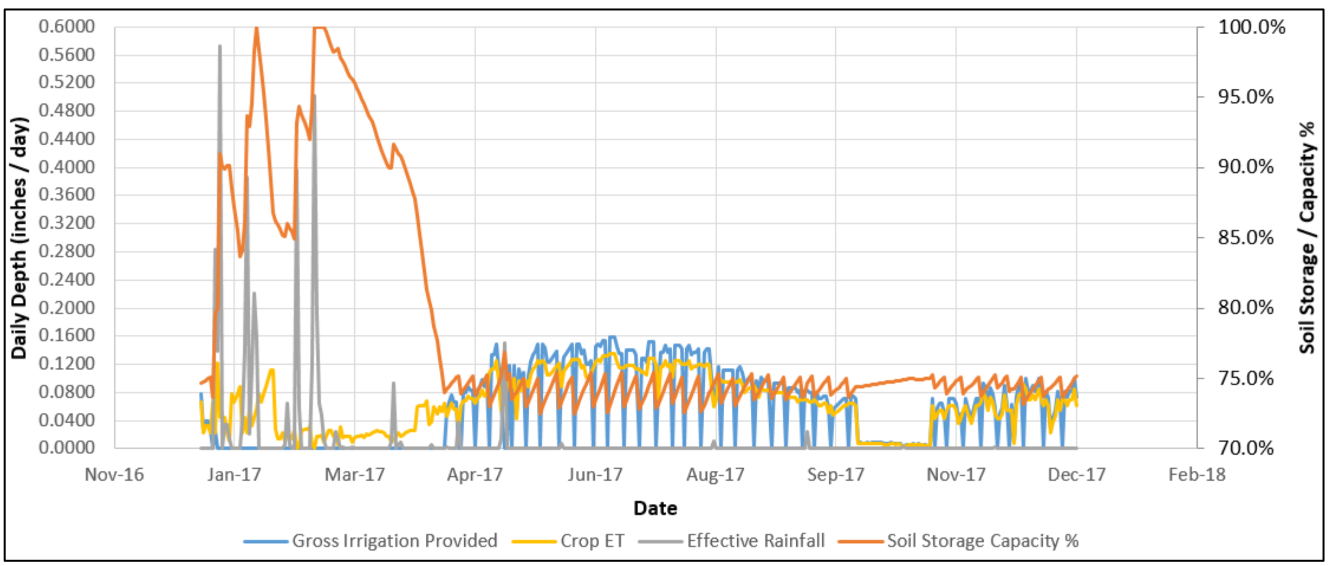

Figure 3 – 2017 Normal Frost Year - Without Res Soil Storage Inputs and Output and Soil Capacity

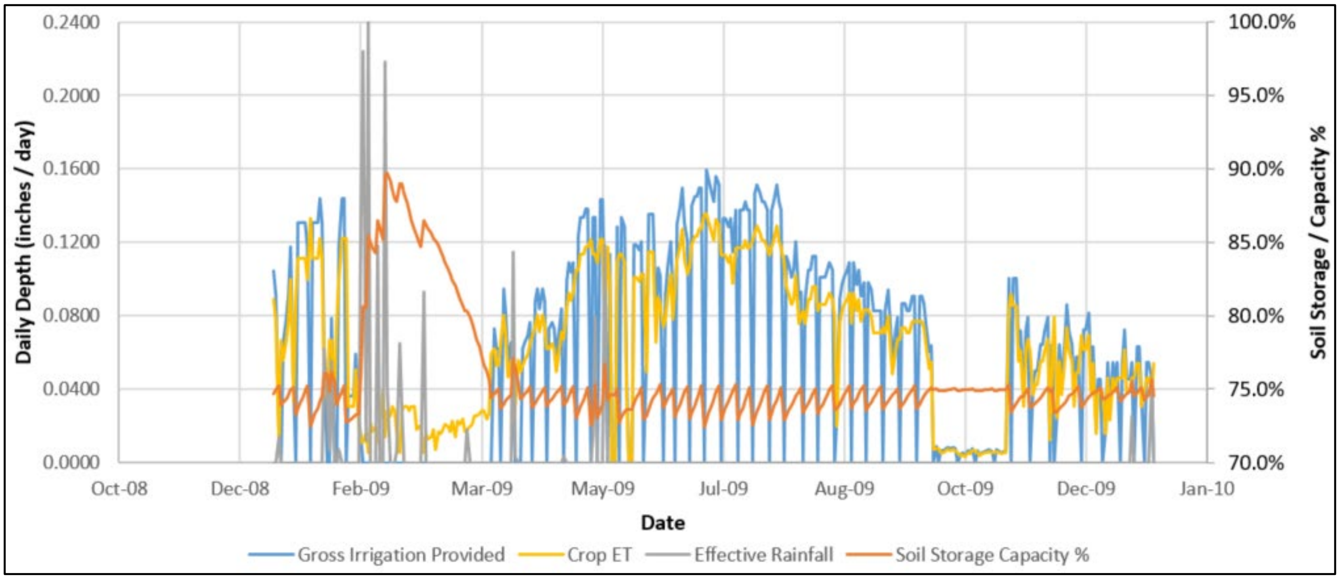

Figure 4 – 2009 Heavy Frost Year - Without Res Soil Storage Inputs and Outputs and Soil Capacity

3.3.2 'With Reservoir' Scenario

The 'with reservoir' scenario soil storage inputs (effective rainfall, gross irrigation, and frost protection) and output (crop ET) for the light (2015) frost year, normal (2017) frost year, and a heavy (2009) frost year are shown in **Figure 5, Figure 6**, and **Figure 7,** respectively. The water balance results – both soil and reservoir - are shown in **Table 7**.

As can be seen in **Figure 5** for the year 2015, the only frost protection event, a 2 hour event in early March does not cause a peak in soil storage, as a result of the short frost protection event, the entire volume is evaporated over 48 hours and none enters the soil storage. Because only this frost event has negligible impacts, the soil storage and volume time series generally reflect that of the 'without reservoir' scenario, shown in **Figure 2**.

For the year 2017, the frost protection events occur from March 1-7 as shown in **Figure 6**. These frost protection events are for longer periods than that of 2015, so not all of the volume is evaporated from the soil surface over the 48 hours following the event. Thus, significant volumes enter the soil storage causing additional peaks in storage above 100%, resulting in additional deep percolation of some of that water.

As shown in **Figure 7,** the frost protection events for the year 2009 occur throughout March and April with long durations and therefore large volumes of water causing significant peaks in soil storage that did not occur in the 'without reservoir' scenario.

Table 7 – Water Balance Results – 'With Reservoir' Scenario

	Light	Normal	Heavy
Soil Balance – Inflows and Outflows	**2015**	**2017**	**2009**
Effective Rainfall (inches / year)	1.70	4.04	1.79
Crop ET (inches / year)	23.46	23.55	23.38
Gross Irrigation & Frost Protection (inches / year)	21.94	20.05	29.89
Deep Percolation (inches / year)	0.00	0.50	4.23
Soil Storage / Capacity %			
Avg Soil Storage %	74.5%	78.9%	78.9%
Max Soil Storage %	78.2%	100.0%	100.0%
Min Soil Storage %	70.1%	72.4%	71.3%
Annual Volumes			
Groundwater Well –Water Demand (ac-feet / year)	1,533.7	1,570.3	1,968.7
Deep Percolation Volume (ac-feet / year)	0.0	166.1	233.0
Reservoir Evaporation Less Rainfall (ac-feet / year)	24.2	21.5	23.1
Frost Protection Soil Evaporation Loss (ac-feet / year)	10.8	39.6	249.5
Total Water Losses from evaporation (ac-feet / year)	**35.0**	**61.0**	**272.6**

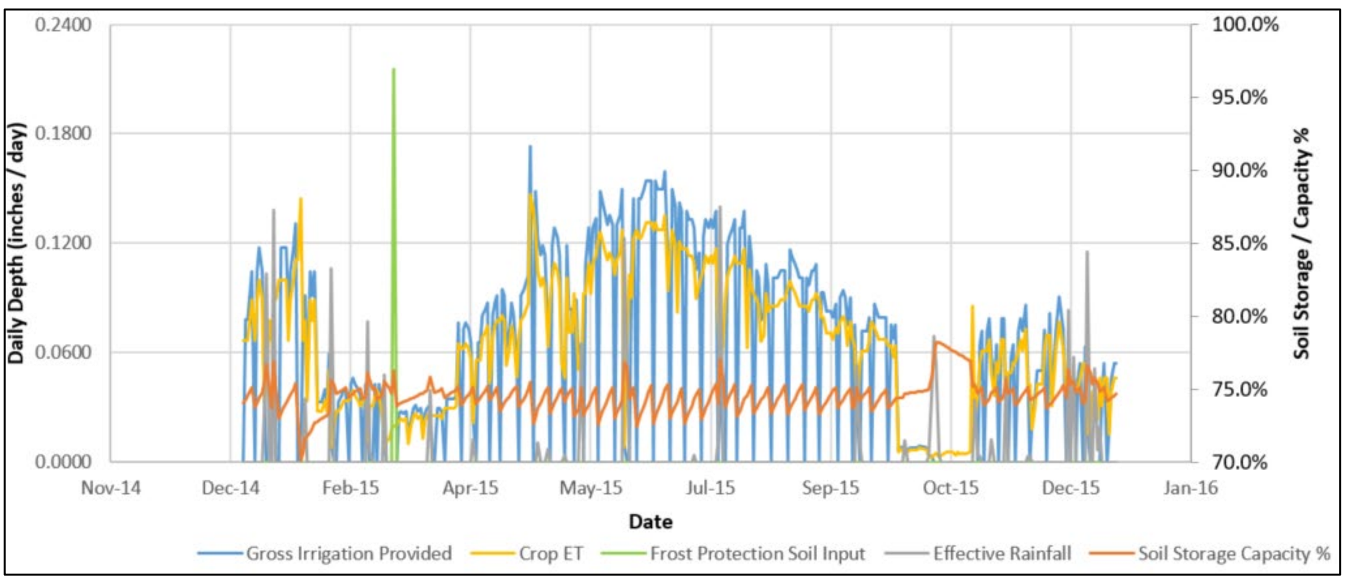

Figure 5 – 2015 Light Frost Year - With Res Soil Storage Inputs and Outputs and Soil Capacity %

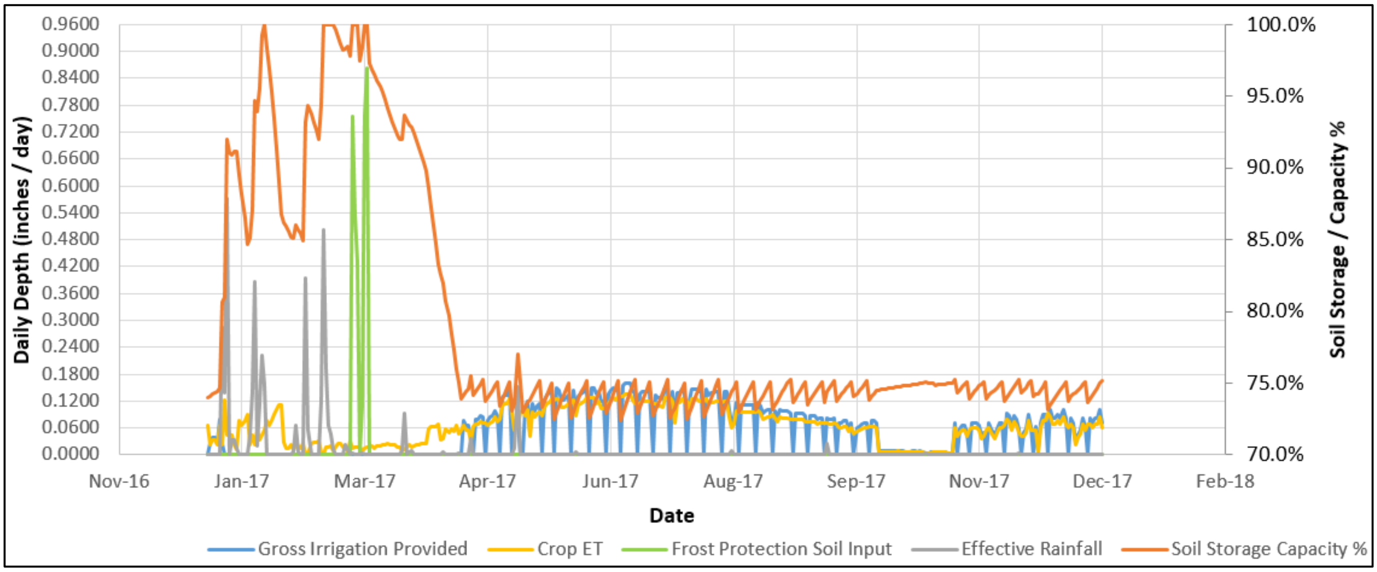

Figure 6 – 2017 Normal Frost Year - With Res Soil Storage Inputs and Outputs and Soil Capacity %

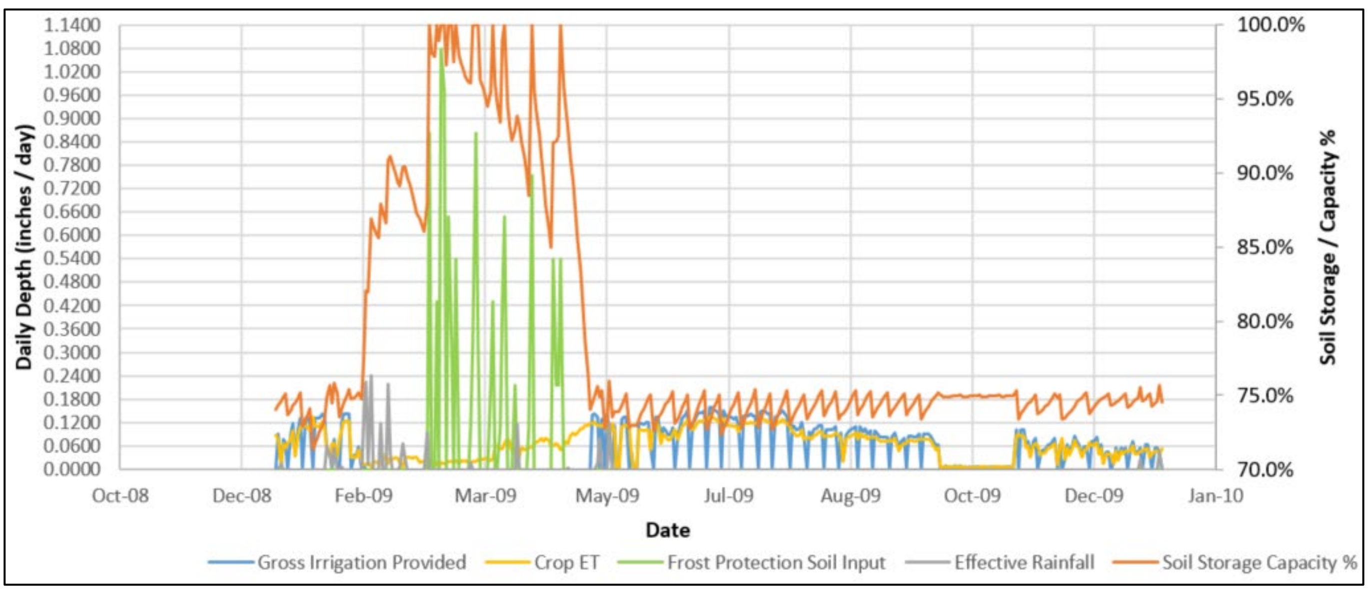

Figure 7 – 2009 Heavy Frost Year - With Res Soil Storage Inputs and Outputs and Soil Capacity %

The reservoir depths for the light (2015) frost year, normal (2017) frost year, and heavy (2009) frost year are shown in Figure 8, Figure 9, and Figure 10, respectively.

The only frost protection event to occur in 2015 is a 2 hour event, the volume needed for this event is lower than the pumping input capacity to the reservoirs, so reservoir levels do not drop as a result of this event as shown in Figure 8. The irrigation volume does not exceed pump inflows either so the reservoir levels are maintained at target levels throughout the frost protection until draining occurs at the end of the season.

Conversely the frost protection volumes for the years 2017 and 2009 are far greater (4 – 10 hour events some days) meaning that they significantly empty the reservoirs which then need refilling in the subsequent days as can be seen in Figure 9 and Figure 10, respectively. Even during the heavy frost year of 2009, the reservoir appears to provide sufficient storage for frost events. The minimum depth during frost season occurs in 2017 when the reservoir depth drops to 8.5 feet on March 7 after back-to-back 7 hour and 8 hour frost days. These results suggest the reservoir provides sufficient storage volume and pump refilling capacity to provide for frost protection.

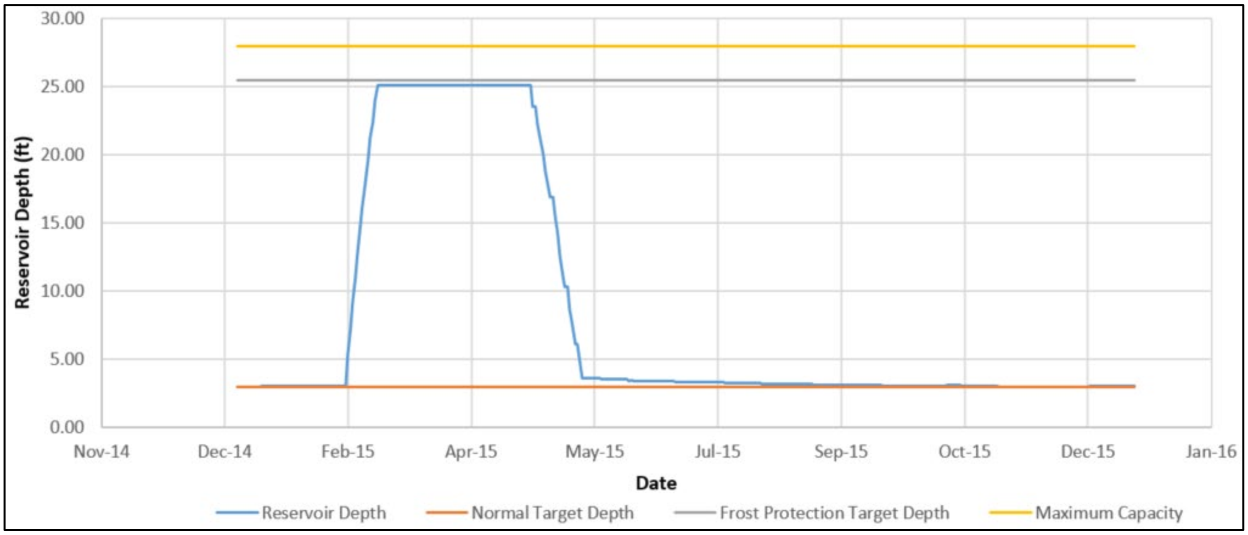

Figure 8 – 2015 Light Frost Year – Reservoir Depths in feet

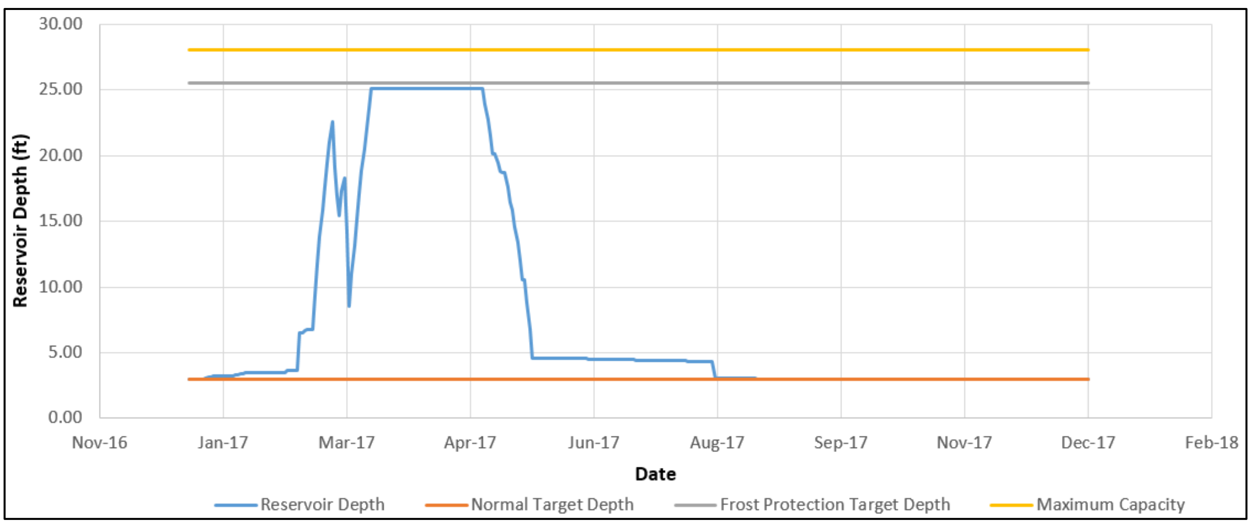

Figure 9 – 2017 Normal Frost Year – Reservoir Depths in feet

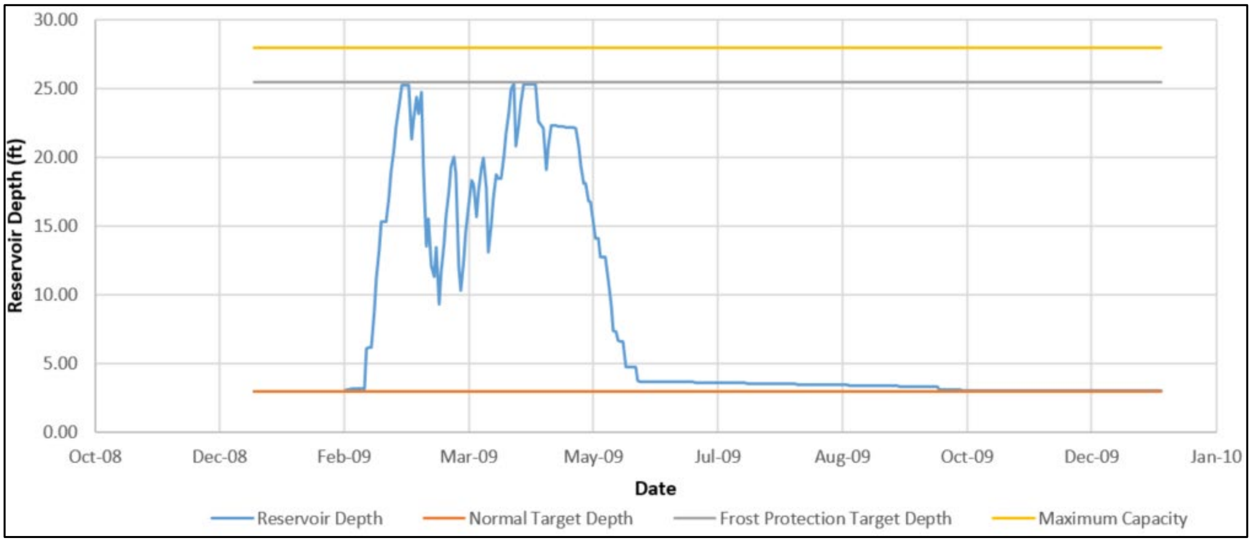

Figure 10 – 2009 Heavy Frost Year – Reservoir Depths in feet

4 Conclusion

Water used to support agricultural operations conducted on properties with agricultural zoning in Santa Barbara County is considered an allowed use. Therefore, the vineyard operations and water used by the vineyards do not require any land use entitlements from the County, and water impounded in the proposed reservoirs that would be used to support the existing vineyards is not subject to the ground water use threshold of 31 acre-feet per year (AFY) established for the Cuyama Valley Groundwater Basin in the County's Environmental Thresholds Manual.

However, the proposed water storage reservoirs are a conditionally permitted use in the AG-II-100 zone and require the approval of a discretionary Minor Conditional Use Permit. Therefore, water impounded in the reservoirs, not directly or indirectly used to irrigate the existing vineyards, is subject to the ground water use thresholds of 31 acre-feet per year (AFY). Any water losses from the frost protection system that do not irrigate the vineyards or recharge the aquifer would count towards the water use threshold. Therefore, evaporation from the frost ponds, or evaporation from the water used during a frost event would count towards the threshold.

The Applicant's estimate concluded that the combined average annual net evaporative losses from all three proposed reservoirs would be approximately 26.28-acre feet per year (AFY) of water. The applicant further stated that ***all*** water used for frost protection would be available for uptake by the vines, resulting in no water lost during the frost protection events. Therefore, net evaporative losses from the reservoirs and frost protection would not exceed the water use threshold of 31 AFY and the project would result in a less than significant water use impact.

Cardno conducted an independent analysis to determine water use from the Project and found water from the frost protection system will either go to (1) deep percolation, (2) runoff, (3) crop water use or (4) evaporation. Deep percolation was quantified, but is not considered a water loss in this study, since this water recharges the aquifer. In the Cardno analysis, runoff was estimated to be negligible due to the sprinkler rates, soil types and terrain. Frost protection system groundwater used to satisfy crop requirements does not count toward the threshold. Groundwater lost to evaporation from sprinklers during frost protection events was determined to be negligible due to the fact the sprinkler operation occurs near freezing temperatures and during high relative humidity and therefore not counted toward the threshold. However, evaporation losses from the three reservoirs over the course of the year, and evaporation from soil surface after frost protection events, was quantified and counted towards the threshold.

The Cardno analysis varies from the Applicant's analysis in that the Applicant calculated the evaporative losses from the reservoirs and not the evaporative losses from the soil. The Applicant stated no water is lost during the frost protection events because all water used for frost protection would be available for uptake by the vines. Cardno's analysis included evaporation from the reservoirs and evaporation from the soil after a frost event and determined that some water used for frost protection would evaporate from the soil and therefore not be considered irrigation water.

The estimated net evaporative loss (evaporation less rainfall) for the three reservoirs combined was calculated to be 24.2 ac-ft/yr 2015 – light), 21.5 ac-ft/yr (2017 – normal), and 23.1 ac-ft/yr (2009 - heavy). These results were similar to the net evaporative loss calculated by the Applicant's consultant of 26.28 acre-feet (Monsoon Consulting, 2007).

For evaporation from the soil surface after frost protection, the water from frost protection events can evaporate for several days after the frost protection event, if it is not uptaken by the vines. The amount of evaporation of water from the soil was calculated to be the difference between the reference ET and the crop ET, and was estimated for up to 2 days after the frost protection events. The estimated soil evaporation from frost protection system was calculated to be 10.8 ac-ft/yr (2015 – light), 39.6 ac-ft/yr (2017 – normal), and 249.5 ac-ft/yr (2009 – heavy). These losses are obviously dependent on the amount of frost protection required in a given year.

Combining the two types of water losses resulting from the reservoir evaporation and frost protection soil evaporation, the total losses were calculated to be 35.0 ac-ft/yr (2015 – light), 61.0 ac-ft/yr (2017 – normal), and 272.6 ac-ft/yr (2009 – heavy) for 2015 (2 hours frost), 2017 (32 hours frost), and 2009 (101 hours frost), respectively, as presented in **Table 8.**

Table 8 – Water Balance Results – Water Losses for 'With Reservoir' Scenario

Water Loss Types for 'With Reservoir' Scenario	Light	Normal	Heavy
	2015	**2017**	**2009**
Reservoir Evaporation Less Rainfall (ac-feet / year)	24.2	21.5	23.1
Frost Protection Soil Evaporation Loss (ac-feet / year)	10.8	39.6	249.5
Water Losses from using Reservoirs (ac-feet / year)	**35.0**	**61.0**	**272.6**

Cardno's independent technical analysis of water use associated with the operation of the proposed frost pond reservoirs and frost protection system found the average annual net evaporative losses for all three proposed reservoirs and soil evaporation to be approximately 61.45 AFY. In a light frost year, the total groundwater losses were calculated to be 35 AFY, a normal frost year was calculated at 61 AFY, and a heavy frost year was calculated at 272 AFY. Using these calculations the net evaporative losses from the reservoirs and frost protection groundwater use exceeds the threshold of 31 AFY and the project would result in a significant groundwater use impact.

5 Recommendations

Cardno has provided a range of available options that can be applied to reach the water use threshold of 31 AFY. Of these options there are two recommended alterations that are seen as the most feasible way to meet this threshold:

1. Installation and use of reservoir covers to reduce evaporative loss from each of the proposed reservoirs; and,
2. A limitation on the amount of groundwater used for frost protection.

These proposed alterations are discussed in the following sub-sections.

5.1.1 Reservoir Covers

Based on the three selected years of analysis, the evaporative losses for the reservoirs was calculated to be 24.2 ac-ft/yr 2015 – light), 21.5 ac-ft/yr (2017 – normal), and 23.1 ac-ft/yr (2009 - heavy). Essentially all of this evaporative loss from the reservoir waterbodies can be removed by providing protective covers on the surface of the waterbodies to protect against evaporation.

5.1.2 Frost Protection Groundwater Use Limit

As part of the analysis of the three selected years, Cardno conducted a review of the correlation between frost protection water use and frost protection evaporative losses. The objective of this analysis is to estimate the amount of frost protection use that can be applied to reach the water use threshold of 31 AFY.

The graph shown in **Figure 11** provides the best-fit linear interpolation of frost protection evaporative losses compared to frost protection use volumes. This graph shows a strong correlation between frost protection water use and resulting evaporative losses, as evidenced by an r-squared value of greater than 0.98. Statistical science uses an r-squared value to confirm the correlation of individual data points with a value of 1, being a perfect correlation.

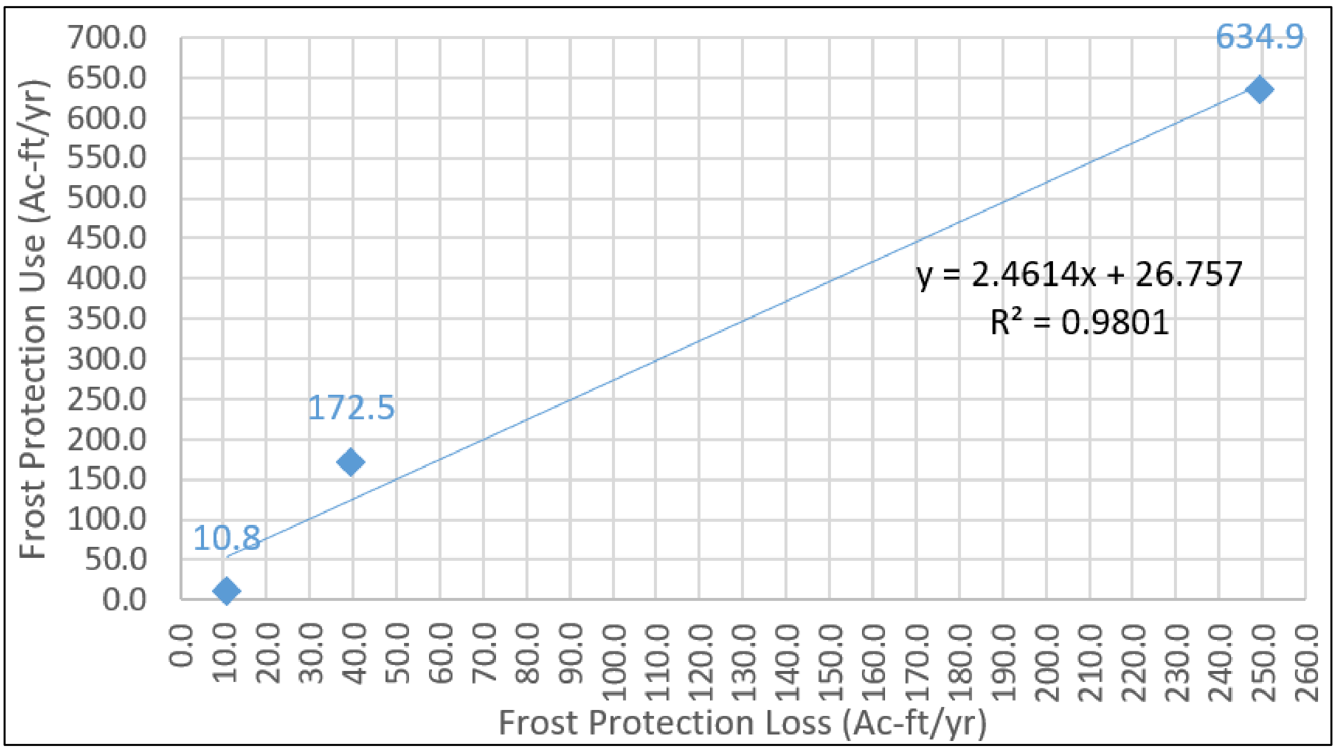

Figure 11 – Relationship Between Evaporative Losses

Using this analysis and the straight line equation shown in **Figure 11**, as modeled in this report, the Applicant can apply up to 103.1 AFY (2.4614 x 31 + 26.757) of frost protection in a year before reaching the 31 AFY water loss threshold. This frost protection use threshold is based on the assumption that the Applicant covers all three reservoirs, thus, eliminating evaporation from the reservoirs.

Cardno's recommendation is that a combination of reservoir covers to eliminate evaporation and a limit of 103.1 AFY of frost protection system water use will provide sufficient provisions for the project to comply with the water use threshold of 31 AFY.

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