House Agricultural Consultants

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Preliminary Report on Feasibility of Farming the Bottom of Heidrick Pond for Covell Village

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1 Introduction

This report has been prepared by House Agricultural Consultants for Covell Village Company as a preliminary investigation of the feasibility of farming the bottom of the Heidrick Pond, a flood-control project that Covell Village Company intends to build to satisfy drainage requirements of the larger Covell Village project. Due to time constraints and rainy weather, critical data necessary for conclusions to this study are not available at this time. When weather permits access to the site, House Agricultural Consultants will collect these data, then compile and analyze them to prepare of our final report and opinion.

> ☞ **Special note** The facts, observations, analyses, and conclusions presented in this report are interdependent and are valid only insofar as this report shall be used in its entirety.

2 Conceptual description of Heidrick Pond: our assumptions

As described by Martin Lewis of Cunningham Engineering, the proposed Heidrick Pond is a temporary storm-water retention basin adjacent to the north east portion of the Covell Village project, approximately 90 acres (36 hectares) in size. The intent of the Heidrick Pond is to capture upstream storm-water from the Covell Drain.

Our assumption is that during construction of the Heidrick Pond, the top 60 centimeters of soil will be stripped, stockpiled, and later replaced at the bottom of the pond after the pond has been excavated; thus final elevation of the pond will be 2.5 meters (8 feet) below the original surface elevation.

3 Suitability of the modified pond soil for agriculture

3.1 General background information

3.1.1 Soil-survey information

According to the *Yolo County Soil Survey*, published by the United States Department of Agriculture, Soil Conservation Service (June, 1972), the soil of the Heidrick Pond is composed of two distinct soil units. These are *Pescadero silty clay, saline-alkali* and *Rincon silty clay loam*. The former makes up approximately 57% of the area of the pond field, and the latter 43% of the pond-field area.

Pescadero silty clay, saline-alkali lies in basin formations having less than one percent slope. This soil suffers from high salinity that has resulted from poor drainage over geologic time. The sodium content of this soil is excessively high; the word alkali in its name refers to this. High sodium causes a loss of soil structure which limits water-holding capacity, leads to such problems as crusting, poor tilth, and decreased permeability, causing the soil to stay wet after irrigation or spring rains long after other soils without alkali have dried out. Crop plants vary in their sensitivity to sodium in soils. Although at high concentrations sodium is toxic to plants, generally it precludes a wide range of plants by its damaging effects on soil structure before actual metallic toxicity becomes significant. The native vegetation of this soil is adapted to highly sodic and alkaline conditions. All crops grown on this soil must be similarly tolerant of high sodium and high pH 8.0 to 8.9. Where improved drainage and applications of gypsum have reduced the effects of sodium, this soil has been used for sugar beets, barley, wheat, and rice. Crop yields, though, are typically far below county averages. Other uses for this soil are dry-land pasture and wildlife habitat.

Pescadero silty clay, saline-alkali is classified within capability unit IVw-6 of the USDA Soil Capability Classification System. Class IV soils have very severe limitations that reduce the choice of crop plants, require very careful management, or both. The chief limitation of this soil of this soil unit, as indicated in the suffix w-6, is its high sodium content. The Storie Index of this soil unit is 14. The Storie Index is an alternative soil rating rating system that expresses, on a scale of 1 to 100, the relative suitability of a soil in its native state for intensive agriculture. While a Storie Index rating of 100 is considered ideal, a Stoire Index rating of 14 is very low, indicating that *Pescadero silty clay, saline-alkali*, is unsuitable for most crops and will produce poor yields of even the most sodium-tolerant crops.

Rincon silty clay loam is a well drained soil found on alluvial fans; slopes are less than one percent. This soil is classified within capability unit IIs-3 of the USDA Soil Capability Classification System. Class II soils have moderate limitations that reduce the choice of crop plants or require moderate conservation practices. It is much more adaptable and productive in its native state than *Pescadero silty clay, saline-alkali*. The chief limitation of *Rincon silty clay loam* is its heavy clay subsoil, which causes slow permeability of rain or irrigation water. The Storie Index of this soil unit is 73, indicating it is suitable for most crops but has a few limitations (noted above) that narrows the choice of crops somewhat and has a few special management needs, especially care not to over-irrigate.

3.1.2 Our knowledge of same soil units on nearby farms

Although we have as yet been unable to examine and sample the soils of the Heidrick Pond, we are familiar with the soil units described above from our experience on other nearby farms. We have observed and analyzed these same soil units many times over the past 25 years. Our experience leads us to conclude that the *Rincon silty clay loam* is adaptable to many different crops and will produce economic yields. The *Pescadero silty clay, saline-alkali*, however, is problematic, and under today's economic climate for agriculture, we generally do not recommend farming this soil unless it happens to be a small part of an already established field, situated in such a way that it cannot easily be removed from production (an example of how it might be removed easily is if it were situated in one corner of a field that could not be farmed while allowing the majority of the field to remain in production). In cases where it cannot be avoided, this soil can be improved some practices that improve permeability, including amendment with gypsum, deep ripping, and installation of drain ditches where appropriate.

One key problem of *Pescadero silty clay, saline-alkali*, as noted, is its high sodium content, which makes it difficult to till and also directly stunts crop growth. The effects of high sodium, especially in the amounts often found in this soil unit, are difficult to mitigate. Another chemical problem associated with this soil unit in this area of Yolo County is boron. Boron is a relatively rare element worldwide but is found in abundance in many areas of Yolo County, especially those areas that formed from alluvium originating from overflows of Cache Creek. Boron is also present in high amounts in well water in many parts of the county, including Davis and Woodland. The use of such water for irrigation adds to the already high amount present in the soil. Most plants are highly sensitive to boron, and thus the anticipated presence of this element in the soil of the Heidrick Pond is a strong restriction on possible crops—limiting the choice of crops to those that posess some tolerance to boron. This conjecture is subject to field verification.

3.1.3 Current use, crops, & water source

According to tenant William Maddocks, the Heidrick Pond property is currently divided into two fields that drain to the center of the parcel. The fields are planted to a perennial grass hay, which produced approximately 6.5 tons per acre of hay last year. The hay was cut approximately six times last year and was sold to a dairy farmer in Petaluma for an average price of $90 per ton. The grass hay crop was irrigated 8 times last year during the growing season. Water for irrigation has been obtained from two sources, principally from Willow Slough, and secondarily from the Covell Drain when it has drain water. Water is lifted from Willow Slough using an electric lift pump and then diverted via ditches (and pipeline under Road 29) approximately one and one half miles south to the Heidrick Pond area. Portable pumps are used to draw water out of the Covell Drain. There are no water wells on the Heidrick Pond fields.

3.1.4 Groundwater elevation data

Groundwater elevation data has been collected from sites proximate to the Heidrick Pond for many years (see references). However, these data are not from site within the actual area of the Pond, and so are subject to interpretation and verification through field observation that will be conducted later this month by House Agricultural Consultants.

Examination of the reports from 1989 through 2003 for the data collection sites near the Heidrick Pond indicate water table levels will be at approximately 0 to 25 feet below ground surface after the Pond is constructed. The most recent figures available indicate a trend of rising water table, with values at the low end of the range stated (i.e., averaging within 5 to 7 feet of the surface) that also fluctuates seasonally (higher water table in winter and spring, lower in summer and fall).

If these data are verified by the planned field observation, such water table levels will eliminate from cropping consideration all deep-rooted perennial crops that are sensitive to saturated soil conditions: tree crops common to the area, and probably alfalfa hay.

This high water table does not necessarily pose a problem for a variety of other crops grown in the area, notably field maize, safflower, grass hay crops, and certain perennial pasture grasses; many crops in the Sacramento River Delta area routinely grow well with the static water table at 5 to 7 feet below ground surface. Problems are possible, however.

A problem can arise for the crops if the water table rises above 5 feet below ground surface. This could happen in high rainfall years. The problem is acute when the water table rise occurs suddenly during the growing season. During such periods planted crops could suffer economic damage from the saturated soil conditions. However, it is more likely that in high rainfall years the Pond will be planted after the threat of the rain-caused high water table is passed, or the Pond will not be planted at all.

In summary, the water table data available at present indicates a limitation in both cropping choices as well as a limitation in the dependability of planting the field every year. Nevertheless, some common area crop choices for the Pond field remain with these limitations.

3.2 Limitations compared to typical surface farming

3.2.1 Anticipated effect on soil quality

During the creation of the pond it is assumed that the top 24 inches of soil will be stripped, stockpiled, and later replaced at the bottom of the pond after it has been excavated. The subsoil, that is, the soil profile below the 24 inches of restored top soil, however, will be different than its native state, to wit, six feet of the soil profile will have been removed. What is left at this newly created depth of 24 inches and below, is not described in the Yolo County Soil Survey, which ends its soil descriptions at 72 inches. However, from previous observation, this deeper soil is anticipated to be, in the case of the *Rincon silty clay loam*, similar to the lower portion of the removed subsoil. This subsoil (soil horizon B3: depth 56 to 72 inches below soil surface) is described in the *Yolo County Soil Survey* as a "light yellowish-brown and brown silty clay loam" that is less dense and compacted than the B1 and B2 soil horizons above it. This deeper subsoil may be slightly more calcareous than the B horizons above it. In the case of *Pescadero silty clay, saline-alkali*, the deeper, newly exposed subsoil is anticipated to be similar in texture but higher in sodium and boron than the removed soil.

In both soil units, the newly created soil profile of this mix of mechanically redeposited topsoil and raw subsoil will require care and special management to become agriculturally useful. It is important to avoid packing the topsoil during redeposition or scraping and slickening the surface of the exposed subsoil. Although not immediately, in time a fertile soilstructure can be restored by means of cover cropping or the incorporation of imported compost or organic matter. Over time plant roots will bind the soil together, restoring the structure.

In terms of overall soil quality, we anticipate that the approximately 43% of the pond field (39 acres) that is mapped as *Rincon silty clay loam* can be restored to a productive state not dissimilar from its current condition, assuming that the *Rincon silty clay loam* topsoil is replaced on the same 39 acres from which it was removed. It is possible, however, that 57% of the pond field (51 acres), composed of *Pescadero silty clay loam, saline-alkali*, may be less productive than it currently is, due to higher concentrations of the detrimental elements boron and sodium. This remains subject to field and laboratory verification. This potential problem could be mitigated, and the 51 acres improved, if high-quality topsoil made available from the excavation of the habitat ponds immediately south of the Heidrick Pond were used as the replacement topsoil over the area of the Pescadero subsoil. The majority of the soil composing the habitat ponds consists of class-I and class-II soils, superior to the class-IV *Pescadero silty clay, saline-alkali*.

3.2.2 Assumptions of frequency & duration of Heidrick Pond flooding

According to recent studies described by Martin Lewis of Cunningham Engineering, the Heidrick Pond is likely to flood at least every other year for five to ten days duration during the rainy season, November through March.

Hydrological and hydraulic modeling of the proposed drainage facilities was done by Mead & Hunt for the CV Master Drainage Plan (MDP). The HEC-1 program was used to compute runoff, using available statistical rainfall data for the two-year, ten-year, and 100-year ten-day storms. The HEC-RAS program was used for the hydraulic analysis, and concluded that the pond receives water from Covell Drain in at least the two-year or greater storm. Since a one-year event was not analyzed, we cannot readily infer whether the pond is likely to receive water annually from Covell Drain.

3.2.3 Seasonal usage & cropping limitations due to flooding

The assumed frequency and duration of the Heidrick Pond flooding reduces the time period that crops can be in the ground. From our experience and knowledge of local history, we have assumed that the flood season for the Heidrick Pond is November through March. In this model crops can thus be safely planted in May, and must be harvested by October 31.

This forshortened growing season precludes farming permanent crops, which are sensitive to saturated soil conditions. Key limitations of saturated soil conditions are the exclusion of oxygen necessary to plant roots, concurrent with establishment of conditions favorable to the growth of plant-disease organisms causing root rots and other infections. There are no tree crops grown locally that we can recommended for this situation.

Also precluded are annual field and vegetable crops that would grow in the field during the possible months of flooding. These include winter-planted wheat and barley. It is possible to grow barley after the threat of flooding has passed, but it could not be planted in the autumn or winter as is the typically practice in this area. Also precluded is alfalfa hay, which is planted once every three to five years; alfalfa is typically overwintered in this area, and, being sensitive to saturated soil conditions, it would suffer economic loss due to root rot caused by flooding.

3.2.4 Limitations & detriments to production practices due to flooding

The limitations on planting and growing season are discussed in 3.2.3 "Seasonal usage & cropping limitations due to flooding" (page 7). Other practical limitations to farming caused by the flooding include the probability that seed bed tillage will be performed after the flood waters recede. Due to the shorter than typical growing season noted in section 3.2.3, there is less time in the autumn to prepare seed beds as is commonly done in this area, and a higher risk of failure (possible causes are soil deposition or re-settling of soil loosened by tillage) than typical due to the flooding if the bed preparation is undertaken in the autumn. It is likely, then, that tillage will occur in the late spring or early summer, further reducing the growing season for annual crops. Weed-seed deposition is also common during floods, not only increasing the weed seed bank but also potentially introducing new weed species. Fertilizers applied prior to a flood can be lost or made unavailable to target crops through leaching or volatization. Nothing can be left in the field over winter, for fear of water damage (in the case of large equipment) or floating away or blocking the drain in the case of smaller equipment such as weir boards, canvases, irrigation pipe, etc.

The sunken elevation of the Heidrick Pond will reduce winds. This could bring both benefits and detriments. The chief benefit would be sheltering during high winds. The chief detriment is that the susceptibility of certain crops to fungal diseases would increase during humid periods with low wind velocities. Air movement in the sunken field will low in this case, creating a stagnant-air microclimate conducive to some plant diseases.

3.3 Suitable crops & pasturing uses

A number of annual field and vegetable crops planted after the flood season are possible choices given the demands imposed by the time of year, length of growing season, soil physical and chemical properties, and availability of water. Late-spring and summer planted crops (planted after May 1) such as safflower, field corn and milo are possible field crops. Rice is suited to the soil quality but an unlikely choice because of the quantity of water that would be needed for its culture. Among vegetable crops, the vine seeds (cucumbers, squashes, and melons) would be suitable on the better-soil areas.

Certain permanent pasture grasses and legumes that tolerate flooding are also possibilities. The grass hay that is currently grown on the property is a variant of this use, being cut for hay rather than grazed. Grass hay would remain a good crop choice for the Heidrick Pond. For pasture, grass and legume species are planted together once and maintained for many years. This crop choice allows use of the pond field for grazing, haying, production of grass seed, or a mix of these used.

4 Design considerations

4.1 Recommended slope for pond bottom

We assume that crops grown in the Heidrick Pond will be surface irrigated by such methods as furrow or basin-impoundment. This will require a graded slope that gently falls to one edge of the field where excess water can be quickly and efficiently drained away. For the crops likely to be grown, a slope of 0.3 feet to 0.4 feet per 100 feet will provide a timely, uniform application of water with benefits of water conservation, effective and adequate leaching of salts, and good crop performance. The only crop this slope would not be suitable for is rice, which requires less slope. However, rice is an unlikely crop for this situation as described above.

4.2 Management of irrigation water, storm water, & tail-water drainage

A secure source of irrigation water will be required. As the field will be eight feet below surrounding land elevation, the delivery point for the irrigation water must be planned to arrive at the high end of the field relative to its graded slope. A drop pipe structure could be implemented to lower the water from a ditch or pipeline into the field, adding the benefit of additional head pressure. The irrigation water will flow down the gradient to the low end of the field, where it will empty into Covell Drain if the elevation is suitable. If the Covell Drain is higher than the low end of the Pond field, the tail water will drain into a sump which should be designed to hold 4 to 5 acre-feet of water. A lift pump will be required to put the water into the drain, or the tail water could be reused if it were pumped through a buried pipe back up to the head of the field.

Regarding flood water from storms, the proposed point of diversion from Covell Drain will be just east of F Street, according to Martin Lewis of Cunningham Engineering. The pond will operate as an 'offline' pond. That is, for low discharges in Covell Drain, no storm water will be diverted to the pond. When the water level in Covell Drain reaches a certain threshold (i.e. a proposed side weir at elevation 33.4 feet above mean sea level), it will begin to spill into the pond. The pond will receive and store storm water until the water level in the Covell Drain has receded below the water level in the pond, then the pond will drain back into the channel. It is proposed that the pond drain by gravity if possible. As such, the target elevation for the bottom of the pond will be around 30–31 feet.

4.3 Management of groundwater, if applicable

If ground water is found near the ultimate surface of the Pond bottom, it may be necessary to improve drainage through the use of deep border ditches, or buried drain pipe. This will be further explored after field observation with the backhoe.

4.4 Field design considerations for access

The Heidrick Pond field should be designed to permit access to large farm machinery and truck and trailer. At a minimum, the road must be fifteen feet wide in the straight reaches. At turning and entry points this should be doubled. A graded earthen ramp will be sufficient to permit access from the surround ground elevation into the low area of the Pond.

4.5 Practices to minimize agricultural-chemical runoff

Concerns about agricultural-chemical runoff are focused on the possibility of agricultural chemicals applied to the Heidrick Pond that later might be picked up by the flood water, then entering into the Covell Drain as the flood water recedes and drains out of the Pond. There are several practical methods to minimize or eliminate this possibility. The three suggestions below, are listed in order of their likelihood of best achieving the goal of no agricultural-chemical runoff.

Firstly, the Heidrick Pond could be converted to organic farming; in this method of farming no chemicals of concern would be applied.

Secondly, the lease could specify that no agricultural chemicals of concern could be applied to the Heidrick Pond from October 1 through April 30 each year. A list of agricultural chemicals of concern is available from the Central Valley Region State Water Resources Control Board, which has recently implemented a program for monitoring the presence of these chemicals from agricultural water discharges.

Thirdly, the Heidrick Pond could be used exclusively for grazing. This would greatly decrease the likelihood of chemical runoff, since few if any chemicals are applied to pastures. There would remain a possibility that nitrates from animal manure enter into the Covell Drain, but this could be mitigated by proper use of filter strips (planted buffers) in the path of the drain water.