MEMORANDUM

To: Ms. Abigail Fateman, Executive Director, East Contra Costa County Habitat Conservancy

From: Mark Woyshner, Gustavo Porras, Emma Goodwin, and David Shaw, PG

Date: February 5, 2020

cc.: Eve Pier Kieli and Mark Lindley, Environmental Science Associates

Subject: Results of Soil Trenching Investigation at North Parcel of Knightsen Wetland and Flood Protection Project

Introduction

Balance Hydrologics (Balance) developed conceptual grading approaches to restore upland dune and inter-dune wetland habitat on the north parcel of the East Contra Costa County Habitat Conservancy's Knightsen Wetland Restoration and Flood Protection Project (Project), located immediately north of Delta Road in Knightsen, California (Shaw and Woyshner, 2019). The conceptual grading plan (**Figure 1**) advances one of two alternatives put forth by ESA-PWA (ESA, 2019; Olsen and others, 2013) for restoration of dune and interdune seasonal wetland habitat, and is also largely based on detailed field geomorphic and soils investigations by Balance (reported in Woyshner and others, 2019). Based on team and community comments on the preliminary grading concepts, Balance conducted additional field work to characterize soils at trenches dug with a backhoe at the six locations (**Figure 1**) under consideration for restoration of interdune seasonal wetland and/or alkali marsh habitat. This memo summarizes and interprets the results of this soil trenching investigation with the objective to provide design assistance for the northern parcel.

Characteristics of the North Parcel

Review of aerial photos dating back to December 1938 shows dune fields across much of the north parcel (**Figure 2**). Sand dune fields were common along coastal California during the Pleistocene and related to glaciation in the Sierra Nevada. Pleistocene eolian sand deposits of granitic rock origin are commonly 20 to 40 feet thick in the Antioch, Oakley, and Bradford Island area, with the youngest sand dunes likely swept from glacial-age floodplains of the San Joaquin and Sacramento Rivers (Atwater, 1982). On site, mapped dune deposits are shown in **Figure 3** along with the associated Piper Fine Sandy Loam soil series (Welch and others, 1977). Concurrent deposition of silts and clays within the dune fields (during the Holocene and upper

Pleistocene) are mapped as alluvium of Marsh Creek and vicinity. This depositional environment is recorded as interbedded sand and clay in lithologic logs of water well completion reports on file with the State of California Department of Water Resources (DWR) and in shallow piezometers installed during initial hydrologic investigations (Woyshner and others, 2019) (**Figure 4**). Marcuse clay soils and Sacramento clay soils have formed in the alluvium at the historical landward margin of tidal wetlands. These soils are generally moderately saline and sodic and likely supported a mosaic of tidal wetland and alkali marsh habitats.

With the relative rise in sea-level since the last global glacial maxima, advancing tidewater into the Central Valley during the Holocene created extensive wetlands and tule marshes that covered most of the Delta and much of the sand dunes (before agricultural reclamation). Peat and mud accumulation in tidal wetlands over the past 7,000 years overlie the alluvium and eolian sand in a vertical sequence of deposits recording a landward spread of the tidal environment (Atwater, 1982). The landward margin of tidal wetland prior to reclamation for agriculture (circa 1850), which is delineated in **Figure 3** at the southwest corner of the north parcel (Atwater, 1982), was used as a basis to differentiate the historical extent of tidal wetland habitat and its boundary with alkali marsh habitat (Stanford, 2011). Across much of the north parcel, two apparent 'island' dunes that were apparently surrounded by tidal wetland habitat. Sacramento clay alkali soil formed at the margin of the delta deposits historically supported tidal freshwater emergent wetland habitats. Formed in nearly-level mixed alluvial deposits, this soil series is adjacent to the organic soils (peat and muck soils) on the Sacramento-San Joaquin Delta east of the site.

The December 1938 aerial photo (**Figure 2**) shows a former irrigation or drainage ditch extending from Rock Slough to the north parcel, with ditches branching into low-lying areas. The aerial photo also shows a prominent east-west drainage ditch and berm about 200 feet north of Delta Road cutting across the west portion of the parcel. These features remain present in the currently landscape to some degree. Present-day topographic relief within the parcel is on the order of 7 feet (between elevations 2 and 9 feet, NAVD88) and the west portion of the dune complex, in general, has less prominent ridge features than found in the center of parcel. It is not clear to what degree the dunes have been leveled, but the limited relief and less-defined dune features of the west portion of the dune complex, along with the presence of several ditches and berms, suggest that significant disturbance to these dunes and interdune wetlands has taken place.

The largest low-lying interdune area is found in the eastern portion of the parcel, which separates the prominent dune ridge in the center of the parcel from a smaller dune feature on the east boundary of the parcel and off site to the north. The existing utility easement through this interdune area limits restoration opportunities in the east portion of the parcel. Six smaller low-

lying interdune areas – labeled A through F in **Figure 1** – are the focus of the wetland restoration concepts.

Description of Trenching Method

We characterized soils at six trench sites labeled A through F **(Figures 1 through 3)** with an objective to address the following main questions:

- To what extent has sand been graded over these areas during former disturbance or leveling of the dune field?
- Are there soils at depth suitable for restoration of seasonal alkali marsh habitat?
- Is there sand available that would be a suitable source to rebuild dune topography?
- To what depth is groundwater found during the dry season and is there evidence of groundwater being perched above fine-grained soils?
- To what depths does groundwater rise during the wet season?

The soil trenching was performed on September 9, 2020. One day prior to the soil trenching activities, on September 8, Nomad biologist Talaya Rachels flagged on-site areas of botanical significance to avoid. The trenches were dug using a rubber-tired backhoe operated by Dan Galvan. The trenches ranged in total depth from 6.5 feet to 9 feet and were approximately 15 feet long and 2 feet wide. As the trench was being dug, Balance's geological engineer Gustavo Porras characterized soils and collected bulk soil samples with the assistance of Balance hydrologist Emma Goodwin. Soil characterizations are summarized in **Table 1**. ESA archaeologist and cultural resource monitor Doug Alexander checked the holes for items of archaeological significance during the dig.

The specific conductance and temperature (SCT) of the groundwater seeping into the trench was measured with a YSI field meter.[1] At trench sites C, and D, a 2-inch diameter Schedule 40 PVC monitoring well casing with 0.02-inch slotted screen was installed to a depth of 5 feet with a 1-foot solid casing stickup. A similar monitoring well was installed at trench site B, but to a total

[1] Specific conductance (SC) measures the ability of the water to conduct electricity and is a widely used index for salinity or total dissolved solids (TDS). Rainwater water has very low SC and as water passes over and through the ground, salts are dissolved, increasing the specific conductance. Higher specific conductance indicates longer residence times in the ground or transmittal through salt-bearing soils or geologic formations. Normalized to 25°C, the SC of distilled water ranges 0.5 to 3 uS/cm (or µmhos/cm), while Sierra snowmelt is around 25 uS/cm and seawater is about 50,000 uS/cm. The drinking water maximum contaminant level (MCL) is 1,600 uS/cm. We measured SC in No Name slough ranging from 500 to 1,800 uS/cm@25°C.

depth 8.4 feet with the lowest 5 feet consisting of slotted screened casing and the upper 3.4 feet solid (blank) pipe. At the time of installation at site B, groundwater was seeping into the bottom of the trench. Well depths, depth to groundwater (if present), and measurements of specific conductance and temperature of the groundwater encountered in the trenches are summarized in **Table 2.** Each trench was backfilled immediately with the excavated spoils upon collecting soil samples. Photos of each trench are shown in **Figure 5**.

Results and Implications for Restoration Design

As one might expect, soils vary considerably across the north parcel, given the complex depositional history of the Delta during the late Quaternary and the location of the site relative to the landward margin of tidal wetlands onto the east portion of the parcel and basin floor alluvial deposits on the west portion of the parcel, interfingering with sand dune fields across the property. There are, however, general trends that can be recognized at some of the trench sites:

- Clayey soils generally overlie sandy soils at depths from 2 to 5 feet. The clayey soils appear suitable for wetland restoration and may likely have the ability to perch water.

- Surface and near surface sand up to 2 feet thick was found over clay and clay loam at trench sites D, E, and F, likely graded onto these areas from historical dune leveling activities. These sand deposits may be a source for rebuilding dune topography and exposing buried wetland soils or exposing soils generally suitable for restoring wetland habitat.

- While other trench sites showed accumulations of carbonate nodules and filaments (some quite abundant), Trench C uniquely had an intact cemented hardpan, potentially perching groundwater locally in the area north of that site. This area may be best left as is. Trench C also has mostly rounded, well-sorted sand at depth (below the cemented hardpan), potentially with higher permeability than at other trench sites which had sandy loam soil at depth.

- Groundwater seeped into the trenches at a depth of 7 to 8 feet and moist soil and mottles were found above the groundwater table up to a depth of about 2 feet.[2] In addition to mottles, soils were also commonly olive brown, greenish gray, or glayed, suggesting reduced or poorly aerated soils with a relatively high water-holding capacity and potentially a widely fluctuating seasonal water table that dries down during summer/fall months.

[2] At a total depth of 7 feet, Trench E was dry with moist soil, and at Trench F soils were wet at 6.5 ft but not enough to sample and measure specific conductance.

- Trench F, unlike any other sites, had wet, sticky, mucky soil at depth, which may be a suitable material and seedbank source for wetland habitat restoration.

- The specific conductance (SC) of the groundwater measured at the north parcel varied considerably. Groundwater from the cattle well at the southwest corner of the parcel (approximately 60-ft deep said Dan Galvan) measured 5,600 uS/cm@25°C. Groundwater seeping into Trench A (approximately 500 ft north from the well) was in a similar range at the cattle well, at 3,445 uS/cm@25°C. Groundwater in the center of the parcel (at trench sites B, C, and D) measured 12,000 to 30,600 uS/cm@25°C, reflecting favorable conditions for restoration and establishment of alkali wetland habitat. Monitoring well 17-8 at the east portion of the parcel previously ranged from 4,700 to 11,800 uS/cm@25°C (Woyshner and others, 2019).

General Limitations

This memo was prepared in general accordance with the accepted standard of practice in soils, geologic, and groundwater sciences existing in Northern California for projects of similar scale at the time the investigations were performed. No other warranties, expressed or implied, are made. The application of soil and geomorphic history to inferring future landscape and wetland design has a long and respected record in the earth sciences. As with all history or archival analysis, the better the record is known and understood, the more relevant and predictive the analysis can be. We do encourage those who have knowledge of events or processes which may have affected the site to let Balance Hydrologics know at the first available opportunity.

As is customary, we note that readers should recognize that interpretation and evaluation of subsurface conditions and physical factors affecting the hydrologic context of any site is a difficult and inexact art. Judgments leading to conclusions and recommendations are generally made with an incomplete knowledge of the conditions present. More extensive or extended studies can reduce the inherent uncertainties associated with such studies.

Concepts, findings, and interpretations contained in this memo are intended for the exclusive use of Environmental Science Associates and the East Contra Costa County Habitat Conservancy, under the conditions presently prevailing except where noted otherwise. Their use beyond the boundaries of the north parcel site could lead to environmental or structural damage, and/or to noncompliance with water-quality policies, regulations or permits. Data developed or used in this report were collected and interpreted solely for developing an understanding of the hydrologic context at the site as an aid to conceptual planning and channel and wetland restoration design. They should not be used for other purposes without great care, updating, review of sampling and analytical methods used, and consultation with Balance staff familiar with the site. In particular, Balance Hydrologics, Inc. should be consulted prior to applying the contents of this report to

geotechnical or facility design, routine wetland management, sale or exchange of land, or for other purposes not specifically cited in this report.

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Enclosures: 2 Tables
5 Figures