FEASIBILITY STUDY| JUNE 2025

MULTI BENEFIT RECHARGE PROJECT
SIMPSON ROAD, CORNING

PREPARED FOR

TEHAMA COUNTY FCWCD

AND CORNING SUBBASIN GSA

PREPARED BY

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
AF	Acre-foot
CIMIS	California Irrigation Management Information System
CWD	Corning Water District
ET	Evapotranspiration
GSA	Groundwater Sustainability Agency
TNC	The Nature Conservancy
tTEM	Towed Transient Electromagnetic

1. INTRODUCTION

This feasibility study was conducted as part of the Tehama County GSP Implementation Prop 68 Grant under the Multi Benefit Recharge task. The study site is located in the Corning Subbasin and consists of two fallow fields, one approximately 30 acres and the other approximately 73 acres on the south side of Thomes Creek (**Figure 1-1**). This study area was considered an ideal location for potential recharge and habitat enhancement as it satisfied the following criteria:

1) Currently fallow,
2) Access to water from Corning Water District (CWD),
3) Located in an area with little surface water during the late summer and early fall.

From May through November 2024, two pilot tests were conducted on the property to determine the feasibility of conducting multi-benefit recharge at the site. An initial, small-scale, pilot test was conducted from late May to early June to determine the viability of the site for infiltration. Following the positive results of the initial test, The Nature Conservancy (TNC) assisted in a second pilot test to further evaluate the site's potential to provide habitat for shorebird populations. The test occurred during the late summer and fall time period when shallow water habitat for shorebirds is limited. This scaled-up pilot test applied a larger volume of water over a larger area from September through November.

In January 2025, a geophysical study was conducted in and around the area of Pilot Test #2. The study consisted of a towed Transient Electromagnetic (tTEM) survey of the site conducted by Geophysical Imaging Partners. Results of the study were used to evaluate the fate of infiltrated water and identify subsurface flow paths beneath the site.

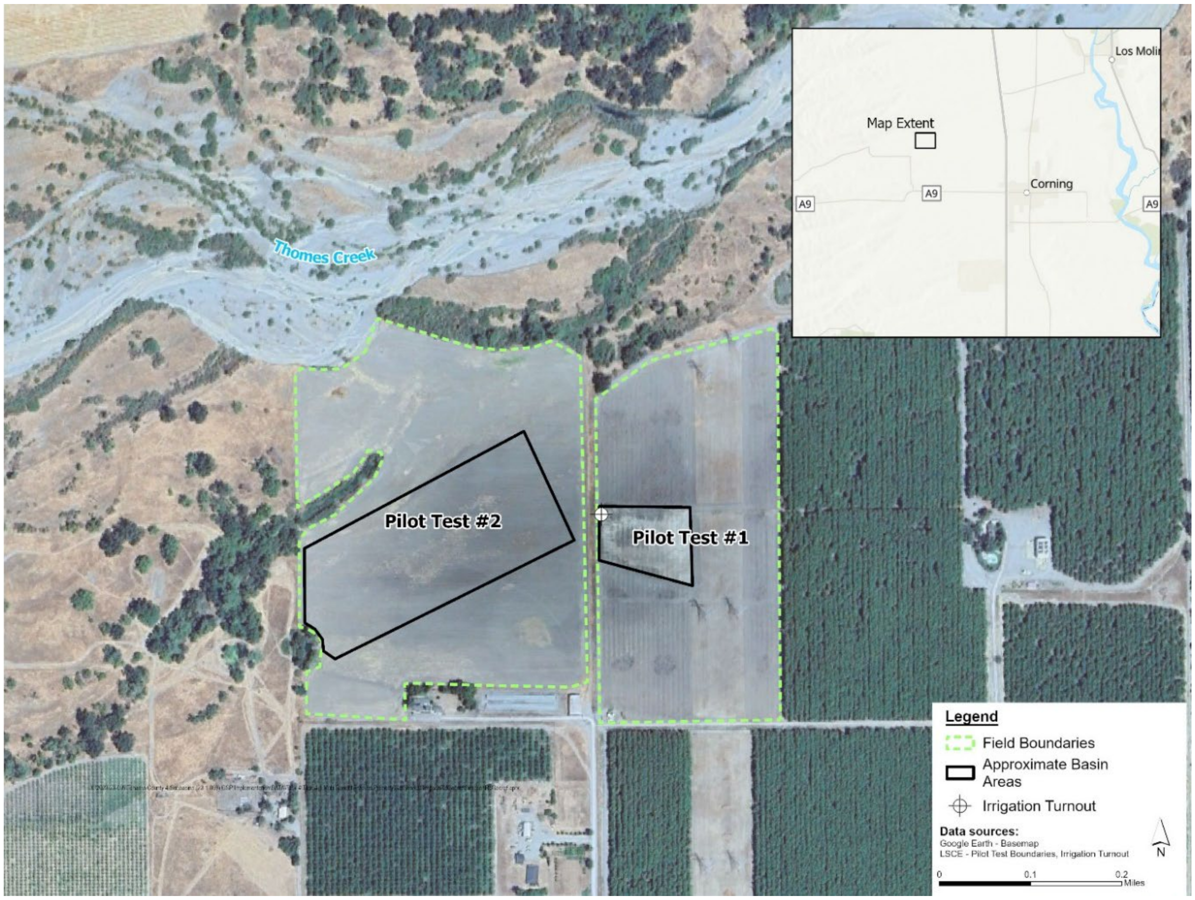

Figure 1-1. Recharge Pilot Test Areas

2. PILOT TEST #1

2.1. Site Information

The first pilot test took place on the 30-acre field on the eastern portion of the site. This field was historically planted with walnuts, but half the trees under high-voltage power lines were removed between 2013 and 2015 under an agreement with the power company. Later, between 2022 and 2024, the walnuts on the remaining portion of the field were removed as well. Since that time, the field has remained fallow, with periodic discing to control weeds. During the pilot test, the field had recently been disced and was generally free of vegetation. The field was not perfectly level during the pilot test, however the variation in elevation across the site varied only slightly. To keep water contained during the pilot test, a small basin of approximately 2.9 acres was created by a short berm (about 2 feet tall) immediately adjacent to the Corning Water District irrigation turnout (**Figure 2-1**).

Figure 2-1. Pilot Test #1 Basin Aerial View Looking Southeast

2.2. Water Application

For this pilot test, surface water obtained from CWD was directed into the basin from the existing turnout in the northwest corner of the basin. Water from the turnout was allowed to flow freely into the basin and spread (**Figure 2-2**). Due to the slight change in elevation across the site, the water tended to flow towards the eastern end of the basin. A total of 15 AF of water was applied during pilot test #1.

Figure 2-2. CWD Irrigation Infrastructure and Water Flowing into the Basin

2.3. Methods

2.3.1. Water Balance

A water balance method was employed to determine the percolation rate of the location. This method involves accounting for inflows and outflows and calculating the resulting change in water level in the pond. Inflows include applied water from the Corning Water District infrastructure, plus any precipitation. Outflows consist of infiltration of the water into the subsurface as well as evaporation. During this pilot test, inflows were accounted for by depth measurements, and precipitation was measured by a nearby California Irrigation Management Information System (CIMIS) station. Outflows were accounted for by the same depth measurements and evaporation was measured using data from OpenET. The total drawdown rate measured at the transducer, plus the rate of precipitation, minus the rate of evaporation, to yield the actual infiltration rate.

2.3.2. Depth Measurements

A water depth transducer within a slotted length of PVC pipe was installed at a location at the basin's anticipated deepest point.

On May 28, 2024, the valve on the irrigation turnout was opened, initiating the basin's first period of rapid filling. By the following day, May 29, 2024, the basin was partially drained to observe drawdown and evaluate its infiltration capacity from a dry state.

Subsequently, on May 30, 2024, the basin was refilled and maintained at near-full capacity until June 6, 2024, when it was fully drained. Complete drainage occurred by noon on June 7, 2024. During this period, drawdown was recorded again to assess infiltration under saturated conditions.

2.3.3. Precipitation and Evaporation

Precipitation during the pilot test was expected to be minimal to non-existent. A nearby CIMIS station, Gerber South #222, approximately 8.3 miles away, measured no precipitation during the initial filling and drawdown of the basin. During the second filling and drawdown period, a total of 0.01 inches of precipitation was recorded on June 3, 2024. As this precipitation did not occur during either of the two drawdown phases, it was not considered as an inflow in the results.

Evaporation data for the pilot test period was obtained from OpenET field summary data, which uses satellite imagery to calculate daily evapotranspiration (ET) rates. The basin area was selected via the website's user interface to determine the daily ET rate. This rate was then converted to an average hourly rate for comparison with water depth data. Since the basin was largely free of vegetation during the test, the ET rate is assumed to represent evaporation only, with no contribution from plant transpiration.

2.4. Data Analysis

2.4.1. Water Levels

Data collected from the transducer deployed at the deepest part of the basin was analyzed during the first and second drawdown events. Depth data were collected at 15-minute intervals and plotted (**Figure 2-3a and Figure 2-3b**). A best fit line was generated to determine the approximate water infiltration rate in both inches per hour and feet per day for both drawdown events. During the first drawdown under dry conditions, the drawdown rate was calculated at 0.93 in/hr or 1.86 ft/day. For the second drawdown under saturated conditions, the drawdown rate was calculated at 0.77 in/hr or 1.54 ft/day.

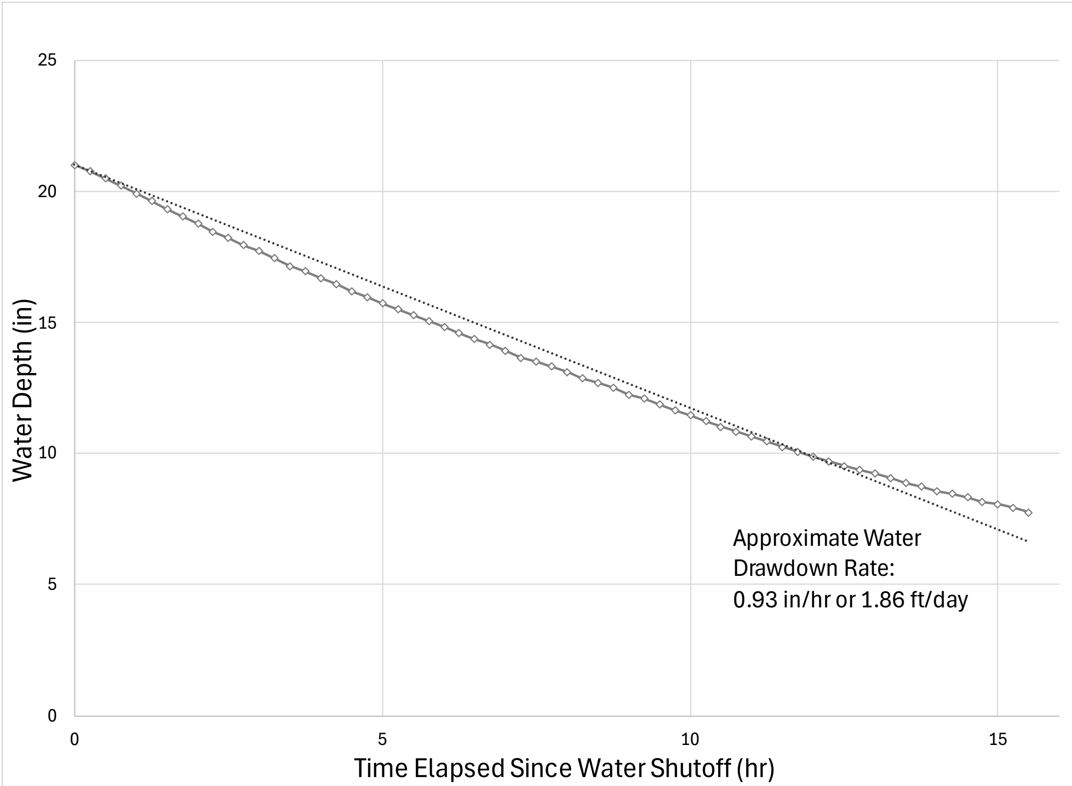

Figure 2-3a. Water Level During First Drawdown Event- May 29, 2024 to May 30, 2024

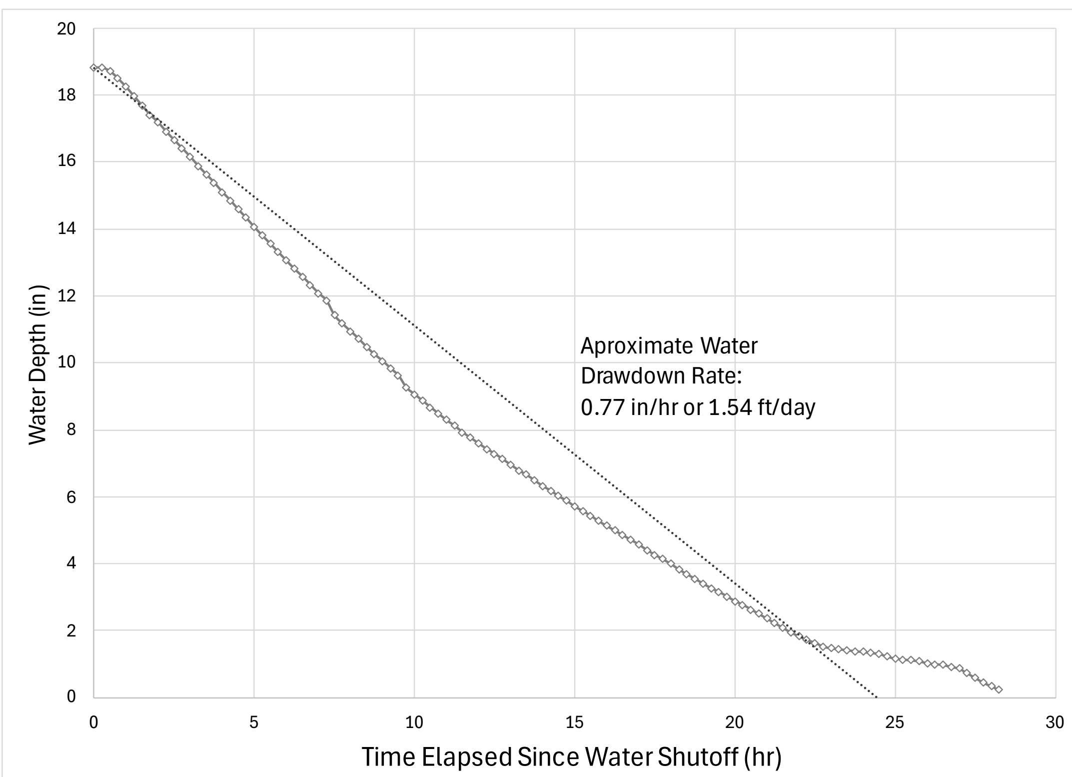

Figure 2-3b. Water Level During Second Drawdown Event- June 6, 2024 to June 7, 2024

2.4.2. Precipitation and Evaporation

As stated previously, precipitation during this pilot test was so slight that it was not considered as an inflow.

Evaporation data were obtained through the user interface on OpenET for the duration of the pilot test. Hourly evaporation rates for each day were calculated based on the daily rates obtained. **Table 2-3a** shows the daily and average hourly evaporation rate for each day of the pilot test. It is important to note that evaporation rates vary throughout the day, with higher rates experienced during the daytime hours and lower rates at night. However, this variation has a limited impact on final results. As both drawdown events occurred over the course of two days, the average ET over the course of each of those drawdown events were calculated, shown in **Table 2-3b**. The average daily and hourly evaporation rates for each drawdown event were subtracted from the infiltration rates derived from the best-fit lines to isolate the portion of the drawdown attributable to subsurface infiltration.

Table 2-3a OpenET Evaporation Rates

Date	ET Rate (in/hr)	ET Rate (ft/day)
5/28/2024	0.002676	0.00535105
5/29/2024	0.004313	0.008625328
5/30/2024	0.005792	0.011584646
5/31/2024	0.005335	0.010669291
6/1/2024	0.003133	0.006266404
6/2/2024	0.002754	0.00550853
6/3/2024	0.002744	0.005488845
6/4/2024	0.006117	0.012234252
6/5/2024	0.006362	0.012723097
6/6/2024	0.005105	0.010209974
6/7/2024	0.005402	0.010803806

Table 2-3b Drawdown Event Evaporation Rates

Drawdown Event	Average ET Rate (in/hr)	Average ET Rate (ft/day)
Event 1: 5/29/2024 – 5/30/2024	0.005052	0.010105
Event 2: 6/6/2024 – 6/7/2024	0.005253	0.010507

2.5. Results

As described in Section 2.3.1, the actual infiltration rate of water into the subsurface is determined by the measured drawdown rate at the transducer, plus the precipitation rate (in this case zero), minus the evaporation rate, yielding the final infiltration rate. The final infiltration rate for the first event, under dry conditions, was 0.92 in/hr or 1.85 ft/day. The infiltration rate for the second event, under saturated conditions, was 0.77 in/hr or 1.53 ft/day. The calculations for each of the two drawdown events are summarized in **Table 2-4** below. Overall, the rate of evaporation is minimal when compared to the overall drawdown rate, resulting in total infiltration being only slightly lower than the total drawdown rate, suggesting a high recharge potential at this location.

Table 2-4 Infiltration Rates

Drawdown Event	Drawdown Rate (in/hr)	Precipitation Rate (in/hr)	Evaporation Rate (in/hr)	Infiltration Rate (in/hr)	Infiltration Rate (ft/day)
Event 1: 5/29/2024 – 5/30/2024	0.928	0.00	0.005052	0.92	1.85
Event 2: 6/6/2024 – 6/7/2024	0.7704	0.00	0.005253	0.77	1.53

3. PILOT TEST #2

3.1. Site Information

The field for the second pilot test was approximately 42 acres and was located immediately to the west of the field used in pilot test #1. Based on a review of historical satellite imagery of the area, prior to 2015, this was utilized for grazing, with some cross fencing and scattered trees on the property. Since 2015, the field has remained fallow or has been planted in short-duration annual crops. At the start of the pilot test, the field had recently been disced and was largely free of vegetation. Like the field in pilot test #1, this site was uneven, sloping gently to the north toward Thomes Creek. This test site also had a basin created by a short berm, similar to pilot test #1. Furthermore, additional berms were created within the basin to address the change in elevation and help distribute water across the site. (**Figure 3-1**).

Prior to the start of the pilot test, TNC evaluated the site to determine if it was appropriate to provide habitat shorebird species. The site was located an appropriate distance from power lines and trees which could provide a perch for predator bird species such as hawks and falcons. Additionally, the timing of the pilot test in the late summer and early fall timeframe was selected to provide habitat during a season when shallow water is not widespread in the area.

Figure 3-1. Pilot Test #2 Basin Aerial View Looking Northwest

3.2. Water Application

Water delivery followed a similar method as in the first test, using the same CWD irrigation turnout. A temporary pipeline with multiple outlet points directed water from the irrigation turnout to the site and distributed it across the basin (**Figure 3-2**). During this pilot test, 271 acre-feet of surface water procured from CWD was applied to the site. The cost of the water applied during the pilot test was $21,737.60. The funding to purchase the water from CWD was provided by TNC.

Figure 3-2. Pilot Test #2 Basin Showing Pipeline and Outlets

3.3. Methods

3.3.1. Water Balance

A similar water balance method to the first pilot test was employed to determine the infiltration rate during this subsequent test. As before, this method involved accounting for inflows and outflows to the basin. Inflows include applied water from the Corning Water District infrastructure, plus any precipitation. Outflows consisted of subsurface water infiltration and evaporation. During this pilot test, inflows were accounted for by meter readings from the Corning water District infrastructure, and precipitation was measured by the same California Irrigation Management Information System (CIMIS) station as the previous test. Outflows were accounted for by determining evaporation using data from OpenET, with the remainder attributed to subsurface infiltration.

3.3.2. Inflow Measurements

During this test, the water within the basin was to be kept shallow to provide ideal habitat for selected bird species. Due to the shallow water, measuring water level with transducers was not practical. Meter readings were taken at the beginning and end of the test to determine the total volume of water applied, measured in acre-feet (see **Figure 3-3**). Water was applied continuously to the site from September 13, 2024 through November 13, 2024. However, there were a few instances of the water flow rate into the basin being increased, decreased, or fully stopped to allow for maintenance of the berm surrounding the basin.

Figure 3-3. Corning Water District Meter

3.3.3. Precipitation and Evaporation

Precipitation during this second pilot test was again expected to be slight. The same nearby CIMIS station, Gerber South #222, was used to determine precipitation amounts. Precipitation rates from CIMIS were provided in inches per day. To determine the total volume (in acre-feet) of precipitation into the basin, this rate was multiplied by the total size of the wetted area of the basin. The size of the wetted area was calculated by utilizing Sentinel-2 satellite imagery.

Evaporation data for the time period of the pilot test was obtained through the OpenET field user interface. In this test, the daily ET values were totaled over the duration of the pilot test to determine the total evaporation from the basin. Similarly to precipitation, the total volume of water evaporated from the basin was calculated by multiplying the ET rate (in inches per day) by the wetted area (in acres). In this test, it was assumed that the ET rate includes both evaporation and transpiration from vegetation that began growing around the perimeter soon after the water was applied to the basin.

3.4. Data Analysis

3.4.1. Precipitation and Evaporation

The nearby CIMIS station, Gerber South #222, was used to determine precipitation amounts into the basin. Precipitation rates from CIMIS were multiplied by the total size of the wetted area in the basin, which was calculated by utilizing Sentinel-2 satellite imagery. The size of the wetted area varied over the course of the pilot test, so the average of the wetted area from September 20, 2024, October 13, 2024 and November 7, 2024 was used for the calculations. The calculated volume for precipitation into the basin over the period of the test was 0.69 acre-feet and is summarized in **Table 3-3a** below.

Table 3-3a Precipitation Volume			
Time Period	**Total Precipitation (ft)**	**Wetted Area (acres)**	**Total Precipitation Volume (ac-ft)**
9/13/2024 – 11/13/2024	0.1575	4.36	0.69

ET data were obtained through the user interface on OpenET for the duration of the pilot test. The total ET (in feet) was calculated by summing ET from September 13, 2024, through November 13, 2024. This value was multiplied by the average wetted area to determine the total volume of water lost to ET, which was 0.92 acre-feet and is summarized in **Table 3-3b** below.

Table 3-3b Evapotranspiration (ET) Volume			
Time Period	**Total ET (ft)**	**Wetted Area (acres)**	**Total ET Volume (ac-ft)**
9/13/2024 – 11/13/2024	0.211	4.36	0.92

3.5. Results

As stated previously, determining the total infiltration and the infiltration rate for the second pilot test involved accounting for inflows and outflows to the basin. Inflows included applied water from the Corning Water District infrastructure, plus any precipitation. Outflows consisted of infiltration of the water into the subsurface as well as evaporation. Therefore, the total volume of water infiltrated into the subsurface was calculated by adding the total volume of water applied as measured at the meter and the volume of water from precipitation and subtracting the volume of water lost to ET. These values are summarized in **Table 3.4a**. The total amount infiltrated over the course of the pilot test was 270.77 acre-feet. As the pilot test ran for a total of 62 days, this volume yielded a rate of 4.37 ac-ft/day (or 1.0 ft/day over 4.36 acres). The 62-day time frame utilized for the infiltration rate calculation included several days with no flow into the basin. Thus, the actual infiltration rate is expected to be slightly higher than the calculated rate.

Table 3-4a Infiltration Volume and Rate				
Applied Water Volume (ac-ft)	**Precipitation Volume (ac-ft)**	**ET Volume (ac-ft)**	**Infiltration Volume (ac-ft)**	**Infiltration Rate (ac-ft/day)**
271.0	0.69	0.92	270.77	4.37

4. GEOPHYSICAL STUDY

4.1. Methods

Following the successful completion of Pilot Tests 1 and 2, a geophysical study of the area was conducted. The study consisted of a towed Transient Electromagnetic (tTEM) survey of the site conducted by Geophysical Imaging Partners. The tTEM system utilizes a sled towed behind an all-terrain vehicle which induces an electromagnetic field into the ground and subsequently measures the electrical resistivity of the subsurface materials. The sled was pulled across the property in east-west trending parallel lines spaced approximately 30m (~100ft) apart to characterize the subsurface across the entire property. Additional readings were also taken in dry portions of Thomes Creek for comparison as shown in **Figure 4-1**. The resistivity of the subsurface materials gives an indication of the granularity of the materials. Areas of high resistivity generally having more coarse-grained materials (sands and gravels), and areas with low resistivity having fine-grained materials (silts and clays). A detailed description of the methods used in the survey can be found in the Introduction and Field Operations sections of **Appendix A: tTEM Geophysical surveys Esteve Property, Corning, California**.

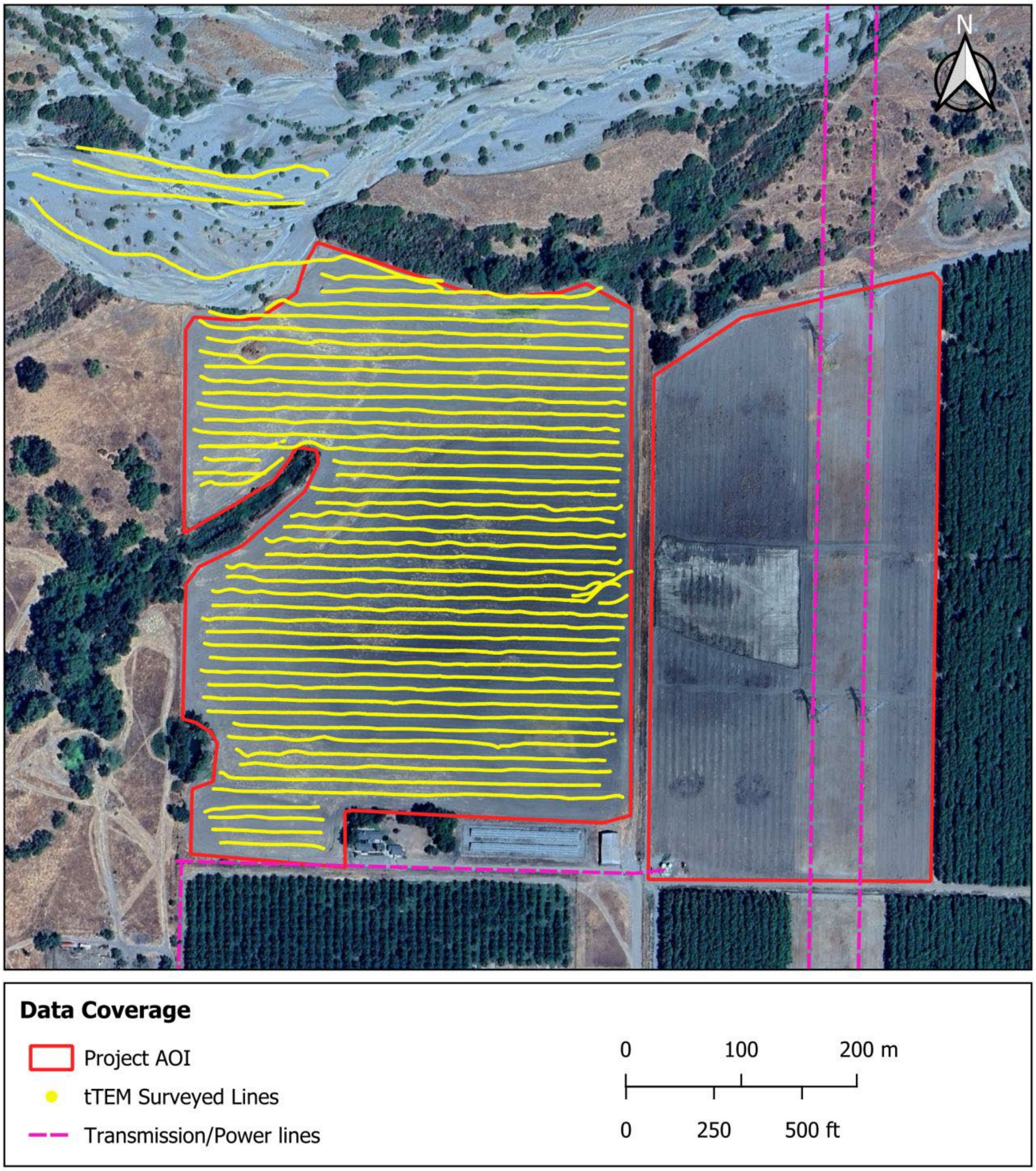

Figure 4-1. tTEM Survey Lines (from Geophysical Imaging Partners)

4.2. Data Analysis

Data collected during the survey were processed by Geophysical Imaging Partners following collection on the site. Resistivity data collected across the site was processed using software and manual review to remove noisy and erroneous data. Resistivity values are measured in ohm-m and correspond with various particle sizes. Values around 10 ohm-m generally correspond to clays with particle sizes increasing up to about 100 ohm-m, which corresponds with coarse sands and gravels. The data were then organized and visualized utilizing the color scale shown in **Figure 4-2**. Data were then presented in two ways: a series of mean resistivity plan-view maps for various depth intervals, and a series of vertical sections covering the site which can be viewed in three dimensions. A detailed description the data processing steps can be found in the Data Processing and Inversion and Quality Control sections of **Appendix A: tTEM Geophysical surveys Esteve Property, Corning, California**.

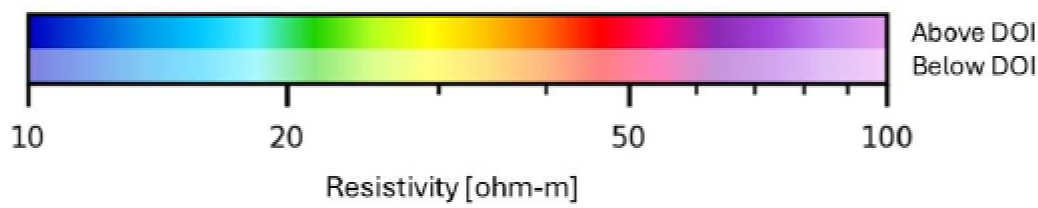

Figure 4-2. Scale Used to Represent Resistivity Values in Report (from Geophysical Imaging Partners, DOI refers to Depth of Investigation)

4.3. Results

Resistivity values across the site ranged from about 10 ohm-m to about 100 ohm-m. With 10 ohm-m values representing the finest grained materials and 100 ohm-m values representing the most coarse grained materials. Generally, resistivity values were highest in the northern portion of the site (nearest Thomes Creek) from the surface down to about 30m (~100ft). This indicates that materials are generally more coarse grained in that area. At depths between 30m and 50m (100ft and 165ft) the coarsest grained materials are generally seen in the more central area of the site. Finally, at depths greater than 50m (165ft), the coarsest materials are seen in the southern portion of the site. See **Figure 4-3** for the mean resistivity plan-view map series. Water applied during groundwater recharge follows preferential paths through the most coarse-grained materials, either laterally or vertically. Thus, the pattern of resistivity observed in the data indicates that water applied to the surface of the site will rapidly infiltrate downwards to a depth of about 30m (150ft), then more slowly downwards and to the south at depths greater than 30m (150ft). This indicates that water applied at the site will flow away from Thomes Creek at depth and will likely eventually enter the deeper portions of the aquifer.

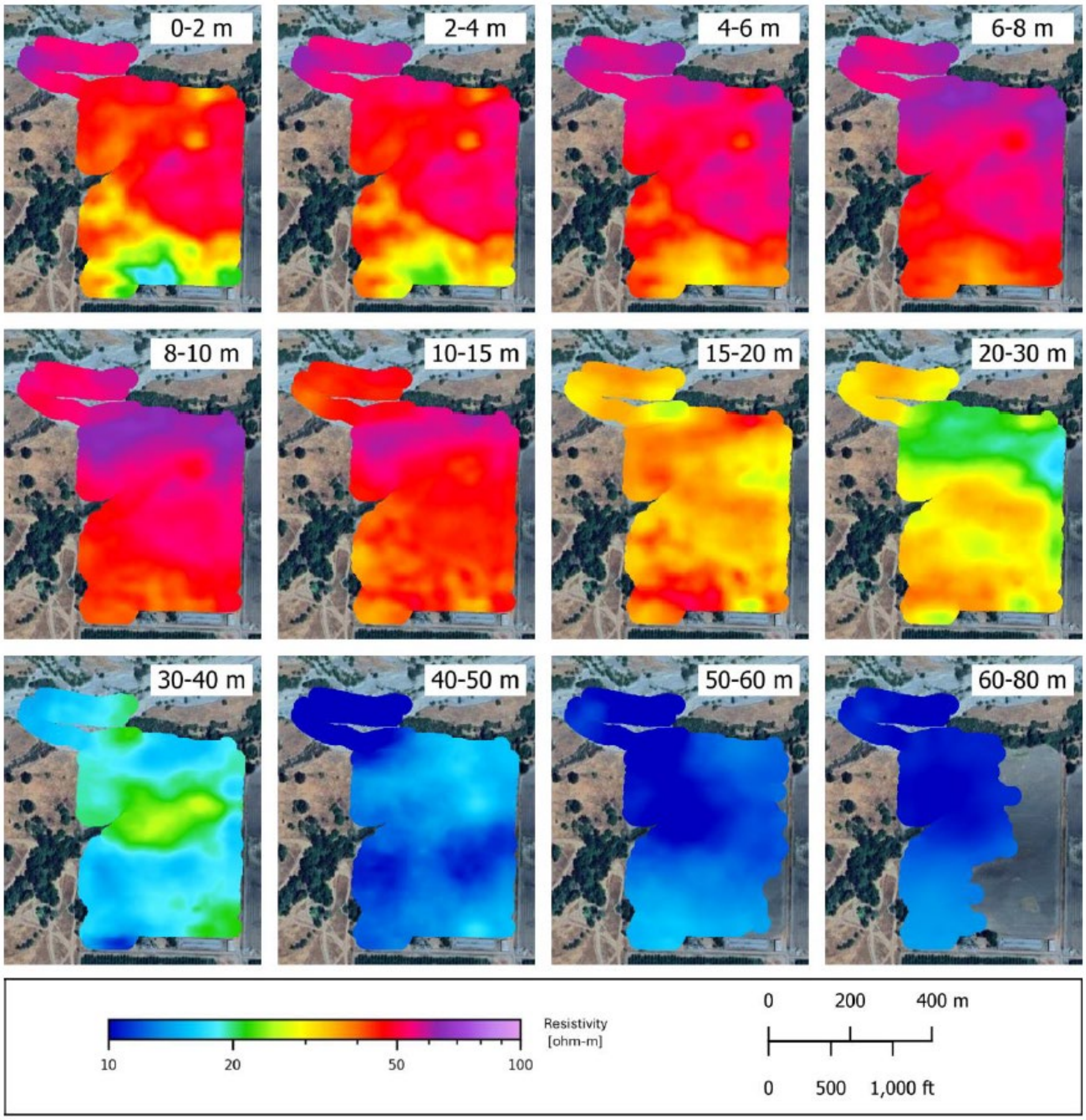

Figure 4-3 Mean Resistivity Plan-view Map Series (from Geophysical Imaging Partners)

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The pilot groundwater recharge tests aimed to evaluate the feasibility of using this site for efficient infiltration and to assess potential multi-benefit outcomes, including support for wildlife habitats. Additionally, the geophysical study attempted to identify possible subsurface flow paths of applied surface water. The results yielded the following conclusions:

- The location demonstrates an infiltration rate of 1.0 to 1.5 feet/day under saturated conditions, indicating high potential for groundwater recharge.
- Proximity to the Corning Water District distribution infrastructure ensures easy access to surface water, enhancing the site's viability for recharge operations.
- Recharge basins observed during the pilot tests supported various wildlife species, highlighting the site's potential for multi-benefit applications.
- Pilot Test #2, conducted over a longer duration, allowed for plant growth that further attracted numerous bird species, underscoring the ecological benefits of sustained recharge efforts (**Appendix B: Vegetation and Wildlife Photos)**.
- The geophysical study indicates that applied water can rapidly infiltrate the subsurface to a depth of about 30m (150ft). Following that largely vertical infiltration, water will continue to slowly move downwards and to the south and make its way to deeper portions aquifer.

5.2. Recommendations

The following recommendations build on these key findings and guide future implementation:

- Landowner engagement for long term recharge: landowner feedback from the studies has been favorable. Further landowner engagement can help identify any obstacles to establishing a long-term recharge site.
- Establish funding for water: funding for purchases of water from CWD for recharge is crucial in converting this pilot site into a long-term recharge site. Establishing a source of funding for water would secure recharge benefits in the long term. Alternatively, this site could also be operated for recharge purposes via diversions from Thomes Creek under a temporary or permanent appropriative water right.
- Create infrastructure: improvements to the site including site leveling and larger, more substantial, berms around the infiltration area would increase the area available to apply water. This would allow more rapid infiltration of applied water, more total water infiltrated, or both.
- Assess monitoring options: The analysis in pilot test #2 was conducted using satellite imagery data. This methodology can continue to be employed to assess recharge amounts. In the future, existing nearby wells or dedicated monitoring wells should also be explored to help quantify benefits to water levels in the subbasin.