Appendix N

Madison-Related Project Proposal Outlines

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Technical Memorandum

To: Kristin Sicke, Yolo County Flood Control & Water Conservation District

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Subject: Yolo County Stormwater Resources Plan – Madison-Related Project Proposal Outlines

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Introduction

The Yolo Storm Water Resources Plan (YSWRP) included several projects that could benefit different entities and parts of the county in the future. Part of the YSRWP rallied around the challenge of frequently occurring impacts from flooding in western Yolo county, which lies in the floodplain. Of the towns impacted by flooding, Madison suffers impacts almost on an annual basis, from storm events with a frequency of 2 to 5 yr return periods. As a result, some of the YSWRP projects focused on improving conditions in and around Madison.

These projects covered possible solutions at three scales, all of which have been stated as contributing to flooding in and around Madison.

- Projects at the local scale concern drainage through Madison itself, in particular the Madison drain and associated culverts, and aspects (technical, financial and governance) concerning their maintenance.
- Surrounding Madison, are projects that concern aspects of on-field management of rain and runoff.
- At the larger scale, are projects that concern storm runoff and conveyance in upstream sloughs and canals.

Given the interwoven nature of water movement across these scales in western Yolo County, the intent of this document is (i) to synthesize some of these individual projects into a smaller number of comprehensive projects, and (ii) to provide more details regarding scope, activities and budgets. The synthesized projects fall in to two categories which are detailed below:

A. Storm runoff management in upstream watersheds of western Yolo County
B. On-farm/on-field management of rainfall and stormwater runoff

A. Storm runoff management in upstream watersheds of western Yolo County

Problem Statement

Although modeling studies and field reconnaissance indicate that western sloughs contribute to flood impacts further downstream, their quantification has been hampered by the lack of any measured flows

Objective

The objectives of this synthesized project are:

- To establish the feasibility and utility of constructing flow control measures in three sloughs, namely Lamb Valley Slough
- To understand the flow characteristics and contributions from these sloughs to downstream points
- To evaluate the feasibility of runoff control structures in the sloughs

Relationship to Yolo SWRP Projects

This project brings together the following SWRP projects, as they are tightly related:

8. Flood Monitoring Network Project
28. Western Sloughs Citizen Science Program
21. Upstream Flow Management to Prevent Madison Flooding and to facilitate GW Recharge

To a large degree, the individual projects above form the key activities of this proposed comprehensive project. The Problem Statement above provides the rationale for each.

Scope of Activities

Activity A.1 Establishing a flow monitoring network in western Yolo sloughs and canals

In order to quantify and understand the flow regime in the selected upstream sloughs, a combination of traditional flow gaging, and a citizen science component, are proposed.

Task A.1.1. Rainfall and flow measurements

- Staff gauges will be installed, and cross-sections surveyed in five locations in the slough reaches that interact with YCFCWCD's canal system.
- Precipitation gaging at nine locations to improve understanding of rainfall variability throughout the watersheds

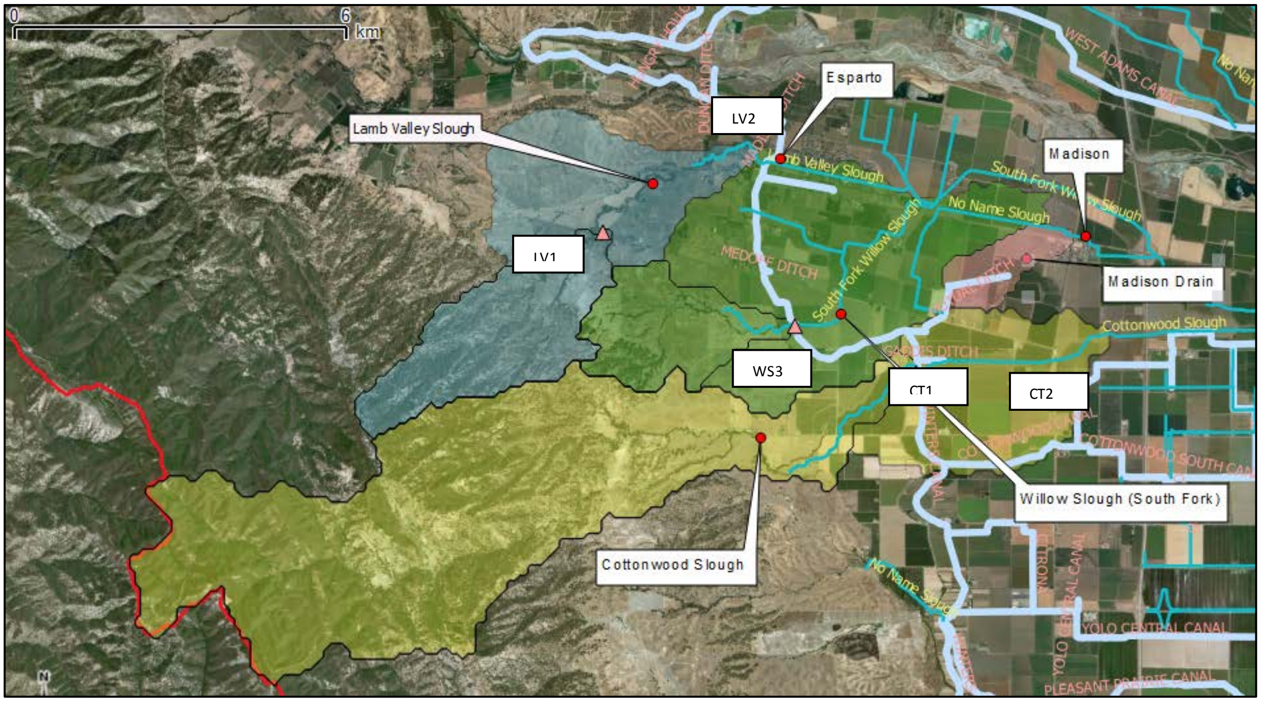
Table A.1 below identify the flow and rain measurement locations and Figure A. 1 below identifies the flow measurement locations which are extracted from the recommendations in the Yolo SWRP (SEI 2018)[1].

Table A. 1 Locations of proposed gages

Type	Description	Latitude	Longitude	Notes
Flow	Lamb Valley Slough, upstream at Rd 23 bridge	38.682785	122.069251	Access by road. LV1 in Figure A.1
Flow	Lamb Valley Slough, at culvert Rd 85B	38.696418	-122.038182	Access by road. LV2 in Figure A.1
Flow	South Fork Willow Slough and Winters Canal	38.667606	-122.029369	Off-road. WS3 in Figure A.1
Flow	Cottonwood Slough and Winters Canal	38.659988	-122.004253	Access by road. CT1 in Figure A.1
Flow	Cottonwood Slough at Rd 89	38.661362	-121.971626	Access by road.
Flow	Chickahominy Slough before it reaches Yolo County Airport	38.563729	-121.863087	
Rain	Capay dam	38.713345	-122.084863	
Rain	WIN 0727 (Ramos Check)	38.666279	-122.006006	
Rain	WIN 1119 (Fredericks Flume)	38.619167	-121.999526	
Rain	WIN 1601 (Chapman Reservoir)	38.560147	-121.984227	
Rain	YCFC&WCD HQ	38.669294	-121.872368	
Rain	YOC 0781 CR 27 Central Location	38.619620	-121.869106	
Rain	CR 31 South of Yolo County Airport	38.562395	-121.851082	
Rain	CR 30 and CR 105	38.575145	-121.676331	
Rain	CR 27 east of HWY 113	38.620089	-121.765079	

[1] The referenced report (Appendix I) is available at: http://www.yolowra.org/projects_swrp.html

Figure A.1 Location map of sloughs and proposed flow gaging sites



Task A.1.2. Citizen Science network

This task complements the traditional hydrologic monitoring task in A.1.1, by involving the community in data collection and knowledge creation among the local communities that live in the floodplain.

Community members and students will be involved via outreach activities in reporting information in various forms, such as through binary observations (flow/no flow), pictures, and flow measurements (e.g. recording flow depths on staff gauges).

Activity A.2. Feasibility study on appropriate runoff control structures

This activity involves establishing the utility and feasibility of implementing an appropriate runoff control structure (e.g check dam, detention basin, diversion etc) in specific reaches of Lamb Valley, South Fork Willow, and Cottonwood Sloughs. Note that Task A.1.1 is a necessary pre-condition or component to the feasibility study, since knowledge of flows is needed in order to design any structure and to validate any hydrology and hydraulics model.

Task A.2.1. Geomorphologic survey

A geomorphologic survey is a first step to evaluating the feasibility of implementing a runoff control structure in a slough because if a waterway is already impacted by downcutting and channel degradation, introduction of a runoff control structure needs to be considered carefully and thoughtfully to not exacerbate existing conditions. In addition, introduction of an appropriate runoff control structure could in fact improve existing channel conditions as well as provide ecologic and environmental benefit. A high-level scope for a Geomorphologic survey is expected to include:

1. Review background info
2. Field visit –include both Lamb Valley and Willow Sloughs (estimated at up to 3 days)
    a. Evaluate geomorphologic characteristics of sloughs that could inform
        i. feasibility and
        ii. whether some type of structure could be beneficial/detrimental to the slough
    b. if deemed feasible, identify potential sites for runoff control structures; this could also inform the topographic survey focus locations
    c. Evaluate environmental/ecologic enhancement possibilities including improvements to soil conditions adjacent to sloughs for increased infiltration
3. Documentation of findings

Task A.2.2. Topographic survey

Topographic survey would supplement available LIDAR digital terrain modeling topography to refine the existing hydraulic model of the sloughs. If it is determined that runoff control structures appear feasible and/or beneficial, then topographic survey of the potential sites would also be performed. Up to 2 days of survey is included.

Activity A.3. Synthesis and final reporting

This activity involves synthesizing the outputs and findings from each component and making final conclusions and recommendations on (i) the contributions of upstream sloughs to flows causing flooding downstream in the Madison vicinity, and (ii) the feasibility and utility of flow control structures at selected reaches in the 3 sloughs.

Preliminary Cost Estimate

Task	**Cost**	**Notes/Cost basis**
A.1.1 Rain and flow gages	$350,000 - $400,000	Based on cost as listed in project form and could vary based on location and complexity of installation
A.1.2. Citizen Science network	$20,000-$30,000	Assuming 20-30 days of labor at $1,000 per day for program development and oversight
A.2.1 Topographic survey	$5,000- $10,000	Based on up to 3 field days with 2 person crew plus follow-up processing
A.2.2 Geomorphological survey	$20,000 - $40,000	Based on estimate from geomorphological consultant
Synthesis and final reporting	$15,000-$20,000	Assuming 15-20 days of labor at $1,000 per day
Estimated Total	$410,000-$500,000	

B. On-farm/on-field management of rainfall and stormwater runoff

Problem Statement

Runoff from farm fields around Madison is one of the contributors to flooding in and around Madison. Therefore, on-farm rainfall-runoff management options, like (i) capturing rainfall on the land through building of low berms, active flooding or winter irrigation of farm fields, (ii) and creating a large stromwater pond on available farm land, are options being considered.

Objective

The objectives of this proposed project are:

- To establish the feasibility of on-farm runoff prevention and/or winter irrigation/flooding of farm fields,
- To establish the feasibility of using a 466 acre plot north-east of Madison to create an appropriate 400-acre detention (dry) or retention (wet) pond.

Relationship to Yolo SWRP Projects

This project brings together the following SWRP project, “27. Madison Farmer Field SW Capture and GW Recharge”, and a project that is not yet included (the 400 acre stormwater detention pond) in the SWRP.

Scope of Activities

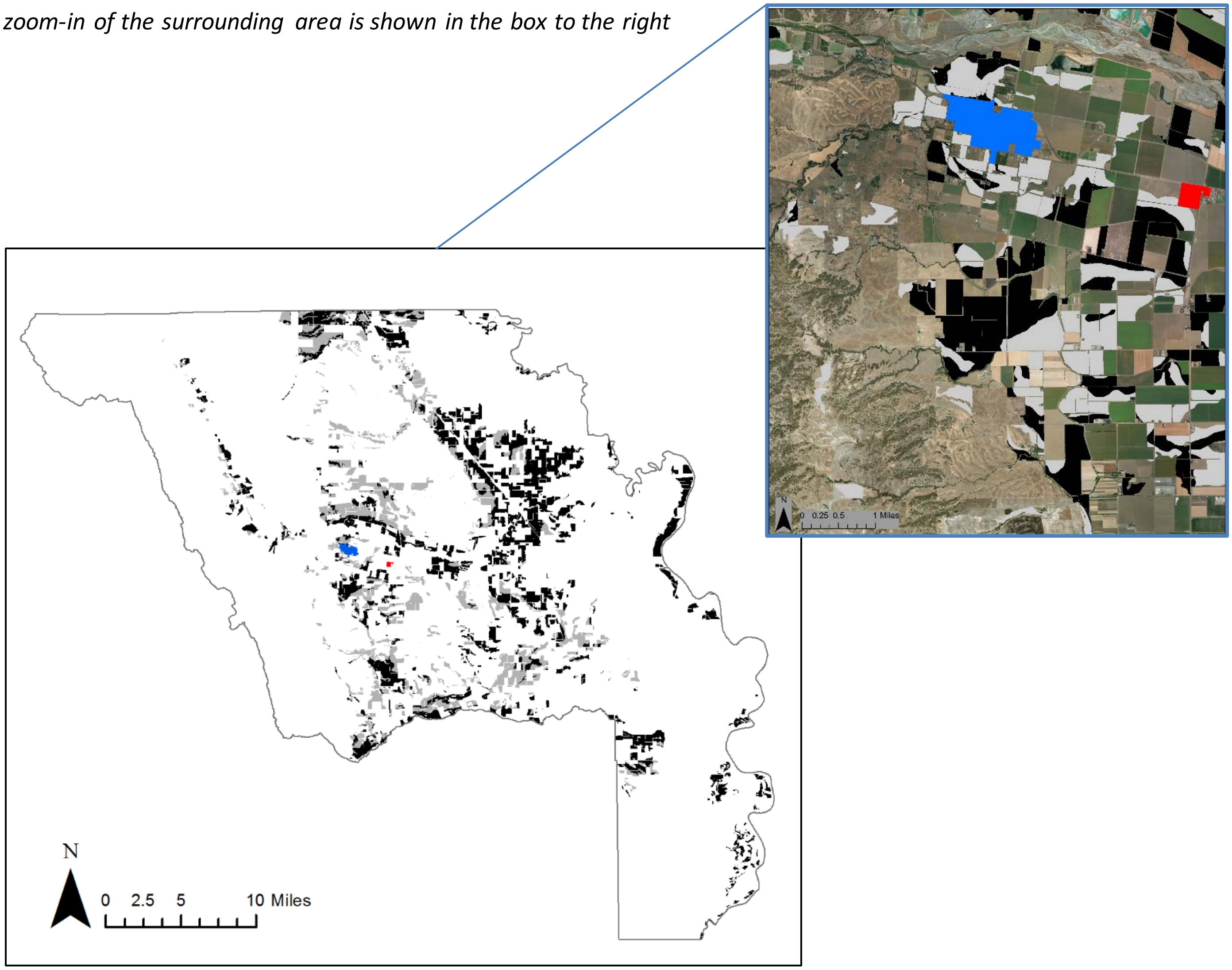
Activity B.1 On-farm stormwater management via rainfall capture and/or winter irrigation

Task B.1.1 Refining of candidate sites

This task will build on existing GIS-based selection of potential sites (SEI 2018)[1] as shown on Figure B.1, which is based on the SAGBI index and specific crops (SEI 2018)[1] and will be supplemented with other GIS information, such as, groundwater depths. Additional site criteria will emerge from an advisory committee (see B.1.1.b below), and be used to further select a refined pool of candidate sites.

Figure B.1 Potential fields for on-farm rainfall capture (Source: SEI 2018, Figure 2.4)

Areas included in a conservative scenario are shown in black. Additional areas added in a less conservative are shown in gray. Madison and Esparto are shown in red and blue, respectively and a zoom-in of the surrounding area is shown in the box to the right



Task B.1.2 Advisory committee

An advisory committee will be constituted to help inform Activity B.1. The advisory committee will be made up a small and diverse group of people with experience across technical, governance and land management domains. The advisory group will help provide a quick reality check at the early stages of the project, as well as help connect with key individuals in the county/study area who could help facilitate positive action.

Task B.1.3 Landowner outreach

Since this activity involves recruiting landowners/growers, outreach and interaction with this community will be a crucial task. Project team will be facilitated by YCFC connections in the area, as well as by the advisory committee.

Task B.1.4 Technical feasibility

This task involves preliminary engineering such as review of available topographic data of the agricultural lands as well as geophysical survey described below to establish the feasibility of capturing rainwater and/or active winter stormwater application (winter irrigation or shallow flooding) on the selected fields. The result will be a report analyzing the benefits and risks of implementation.

Geophysical Survey

Near the final stages of identifying potential fields for recharge, the top three candidates will have a geophysical survey performed to assess the infiltration potential based on lithology from 20 to 30 feet below ground surface (bgs).

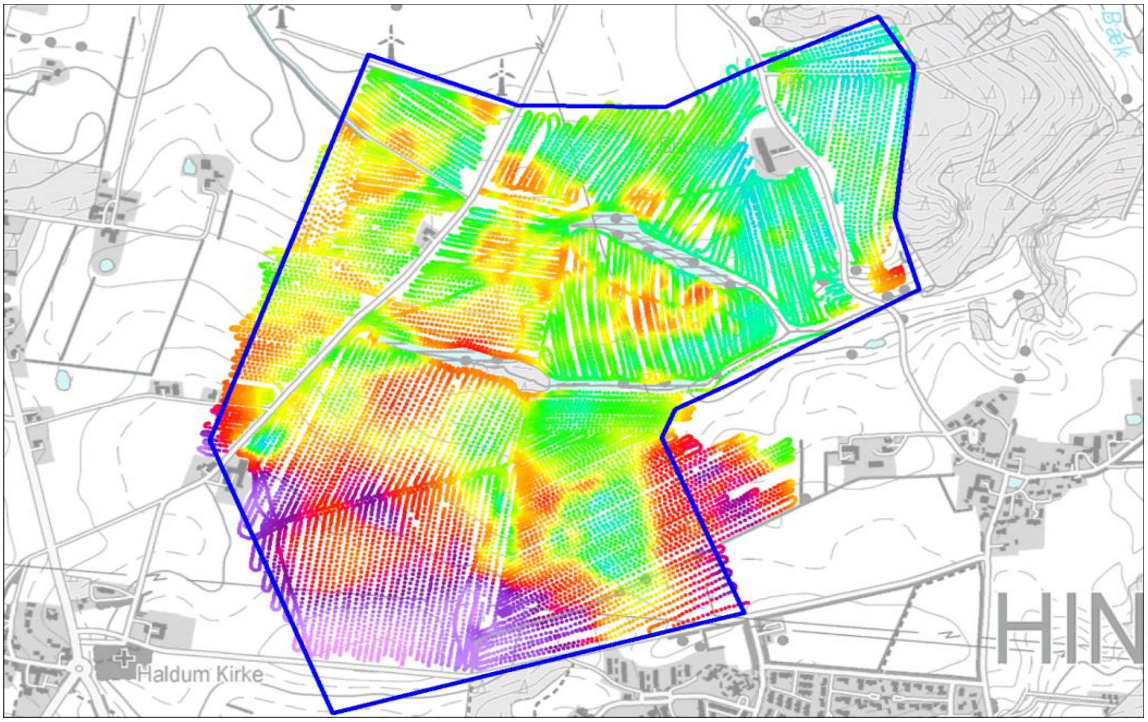
The geophysical method that we propose is the DUALEM system, which is considered state of art for Ground Conductivity Meter (GCM) instruments. It consists of a 13-foot-long sensor and two small batteries, GPS receiver and light weight Toughbook computer used for navigation and data storage, cables. Collected data are synchronized with GPS time provided by GPS system. The GPS (Trimble SPS850 or equivalent) will be used for the survey. Figure B.2, shows the ATV pulling the DUALEM system.

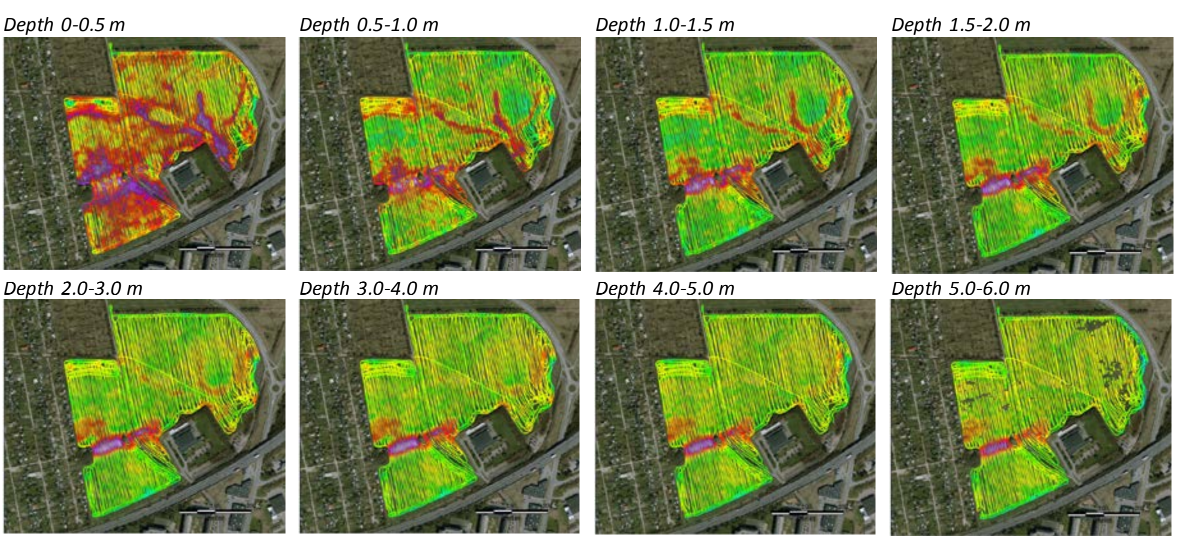
The data gathered from the DUALEM surveys can be presented as a surface on maps and shown in different horizonal slices representing the resistivity with depth as shown on Figure B.3. The large map on Figure B.3 shows an area over which DUALEM data were gathered. The purple and red colors indicate higher resistivity, coarser sediments, and the lighter green and yellow indicates clays and silts. The variation in resistivity with depth is important to understand. The higher resistivity, the coarser the sediments which is indicative of higher infiltration rates are likely. Since excavating material for infiltration basins is expensive, the DUALEM data will show the best preferential pathways based on resistivity and depth of about 30 feet bgs. It can also show if portions of the parcel consist of finer sediments at surface and at depth, which would reduce the benefit of recharge. Knowing this information is valuable for selecting and purchasing parcels for recharge. The geophysics data may show that only a portion of the parcel is viable for recharge which can be used to purchase less property and/or to build recharge basins that are appropriately sized.

Figure B.2 - DUALEM421s sensor pulled behind ATV

Ramboll introduced the DUALEM system in early 2013. For the last 5 years Ramboll has executed more than 100 projects, where DUALEM has been included for mapping the sub-surface. Projects vary from pre-geotechnical investigations, mapping of subsurface conditions related to infiltration of rainwater, mapping of contaminated sites, macro archaeological investigations and UXO's. Clients have included contractors, municipalities, and national authorities.

Figure B.3 Presentation of Results include several horizontal slices representing the variations in resistivity with depth. Higher resistivity represents coarser material (sand and gravel) and lower resistivity represents finer material (silt and clay).





The DUALEM survey is based on 'line-miles' traveled and depending on the surveyed terrain, about 15 to 50 miles can be surveyed in a day. The parcels are typically surveyed on a dense grid with about 30-foot spacing between lines to gather high resolution data for infiltration potential and to map small geomorphological features. During this task, we propose to use a spacing of 150-feet to gather data from the three parcels as a preliminary assessment. If one of the parcels appears to have a higher potential for recharge, we can then resurvey the parcel by filling in the space between the original 150-foot interval at 30-foot spacing.

A critical element when interpreting geophysical data is having lithologic information at the site for calibration. If a drillers log is available near the site then that may be sufficient for the calibration, however, if data aren't available, we propose to use a small drill rig to gather the data. A GeoProbe drill rig would be utilized to collect multiple soil samples to a depth of 30 feet at the site to confirm the geophysical interpretation. This calibration would only need to be performed on the site that has been determined to have the highest potential to be a valuable site for recharge. The GeoProbe drilling method is quick, has a small footprint, and small environmental impact. The boreholes are about 2-inches in diameter and water is not required for drilling which leads to a small amount of wastes for disposal.

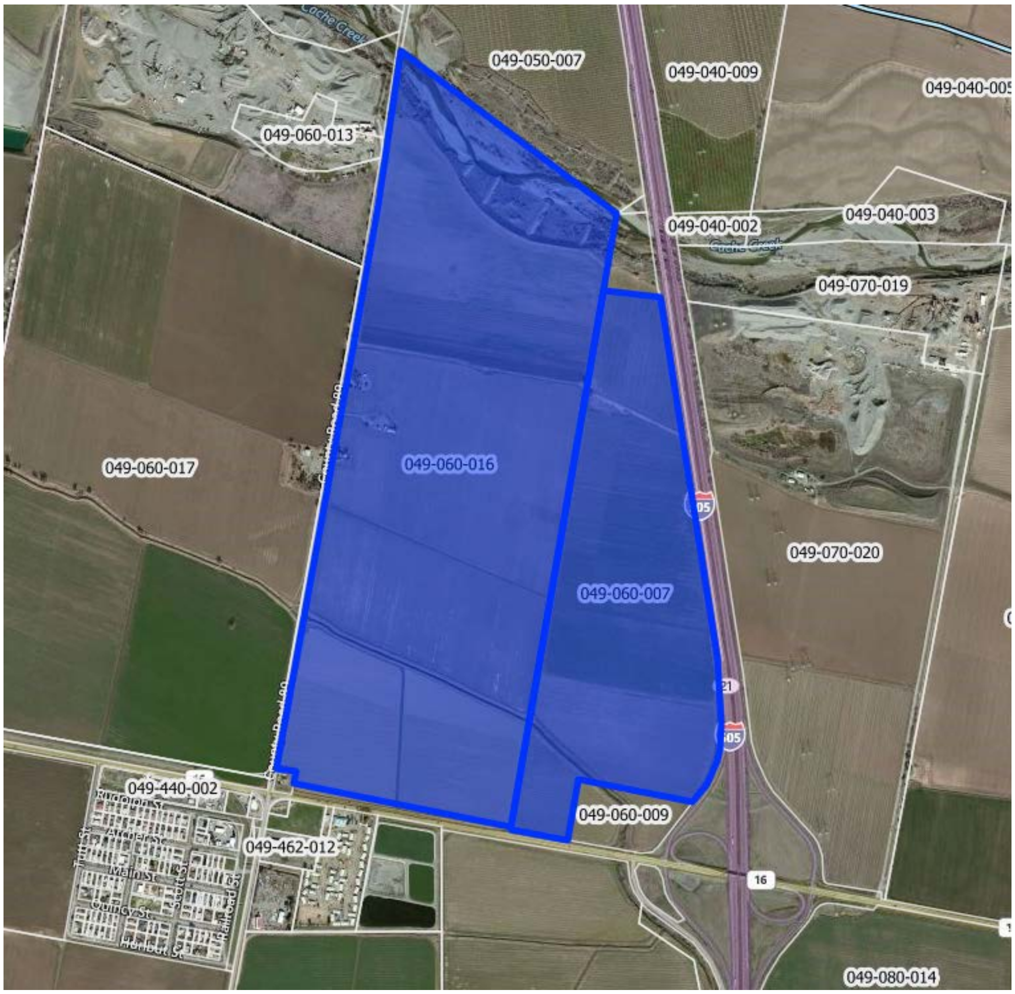
After the site has been characterized by the use of geophysics and confirmation sampling has been performed by the GeoProbe method, we will select locations on the site to perform infiltration testing. The selection of sites for the infiltration testing will be determined by comparing the lithology and geophysics data and the pre-design outline of the proposed basin location. The tests will be conducted using a double ring infiltrometer using the ASTM D 3385-09, constant-head method for directly measuring the soil infiltration rate at the site. At least one test, but up to three will be performed on the site, depending on the size of the selected site.

Activity B.2 Stormwater pond

This activity focuses on evaluating a 466 acre property that is north of Madison, which was suggested by the Madison Community Service District's water manager as a possible site for further investigation. The outcome of this activity will be to assess the feasibility of this site for a 400 acre stormwater detention pond. An approximate impact of a 4 foot impoundment is 1,600 acre-feet in flooding impact mitigation in the vicinity.

Ideally, the stormwater detention pond would also serve as a groundwater recharge basin to maximize groundwater resources in the area by appropriately storing excess storm flows. The feasibility analysis of a stormwater detention pond would investigate 1) property acquisition details and ownership arrangements; 2) infrastructure needed for routing flows (inlet structure) into the pond, properly storing flows overtime, and releasing flows (outlet structure) from the pond into Cache Creek (if needed); 3) any necessary permitting; 4) relevant outreach activities; and 5) a preliminary cost analysis

Figure B.4 Location of the candidate land parcel (highlighted in blue)



Task B.2.1 Technical feasibility

The main question that this task will answer is whether this parcel is suitable from a technical standpoint: i.e. from the point of view of infiltration, groundwater depths, lithology, etc.

The method for evaluating the selected parcel is the same DUALEM method as described in *Task B.1.4. Technical Feasibility.* Instead of evaluating three parcels, only one selected parcel will be evaluated and a dense grid spacing of 30-feet will be utilized. After the geophysical survey has been completed a GeoProbe rig will be utilized for one day to calibrate the geophysical data with the lithology. A geophysical report will be completed showing the varying lithology with depth throughout the assessed parcel.

After the site has been characterized by the use of geophysics and confirmation sampling has been performed by the GeoProbe method, we will select locations on the site to perform infiltration testing. The selection of sites for the infiltration testing will be determined by comparing the lithology and geophysics data and the pre-design outline of the proposed basin location. The tests will be conducted using a double ring infiltrometer using the ASTM D 3385-09, constant-head method for directly measuring the soil infiltration rate at the site. At least one test, but up to three will be performed on the site, depending on the size of the selected site.

Additionally, this task will decide if a detention or retention structure is most appropriate. Corresponding planning-level cost estimates for the infrastructure choice will be included in the final report for this task.

Task B.2.2 Stakeholder outreach and permitting

This task will focus on the non-technical aspects of seeing this to implementation phase. These include permitting (e.g. State Board) and other governance aspects, and interactions with neighboring landowners and farmers.

Preliminary Cost Estimate

Task	Cost($)	Notes	Cost basis
B.1.1 Refining of candidate sites	$15,000-$20,000	Includes GIS work and follow-up from B.1.2 below	Assuming 15-20 days of labor at $1000 per person-day
B.1.2 Advisory committee	$10,000	Includes time for setting up of committee, and 3 half-day meetings with same.	Assuming 10 days of labor at $1000 per person-day
B.1.3 Landowner outreach	$15,000	Assumes YCFC guidance.	Assuming 10 days of labor at $1000 per person-day
B.1.4 Technical feasibility: a) Geophysical survey	$42,000-$45,000	Includes Mob/demob, field work, processing, inversion and a data report and GeoProbe	Assuming 5 days of fieldwork @$7K/day plus $7K for GeoProbe Sub.
b) Infiltration tests	$11,000-$15,000	Includes double-ring infiltrometer instrument rental, field work and technical report	Assuming up to 3 days of field work
B.2.1a Technical feasibility: Geophysical	$28,000-$35,000	Mob/demob, field work, processing, inversion and a data report and GeoProbe	Assuming up to 4 days of fieldwork @$7K/day plus $7K for GeoProbe Sub.

B.2.1b Technical feasibility: Infiltration tests	$11,000-$15,000	Includes double-ring infiltrometer instrument rental, field work and technical report	Assuming up to 3 days of field work
B.2.1c Technical feasibility: Design considerations	$20,000-$23,000	Inlet and outlet, design and infrastructure considerations	Assuming 20-23 days of work for $1000 a day
B.2.2 Stakeholder outreach and permitting	$10,000	Assumes YCFC lead and consultant supporting role	Assuming up to 10 days of labor at $1000 per person-day of consultant time
B.2.3 Preliminary Cost Analysis	$7,000-10,000	Planning-level costs with +30% - 50% accuracy	Assuming up to 10 days of labor at $1000 per person-day
Total Cost	$169,000--$198,000		