

ALTERNATIVES ANALYSIS TAILWATER / RUNOFF CONTROL

Draft Final Version

January 20, 2022

Prepared for:



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EXECUTIVE SUMMARY

The purpose of this Alternatives Analysis Report is to assist Tuolumne City Sanitary District (TCSD) in deciding how to comply with Items 13 and 21, as well as Provision 1.b from Order R5-2019-0058 Waste Discharge Requirements (the Order) issued by the California Regional Water Quality Control Board (RWQCB) Central Valley Region on June 7, 2019 for the Baker Ranch. These items require TCSD to implement a Tailwater/Runoff Control System to prevent irrigation runoff from Baker Ranch from discharging into Turnback Creek (the Creek).

In 2020, Forsgren Associates, Inc. (Forsgren) prepared a Tailwater/Runoff Control Workplan (Workplan) for implementation of tailwater/runoff controls at the Baker Ranch Land Application Areas (LAAs) utilized by TCSD for the discharge of its effluent from its Wastewater Treatment Plant (WWTP). The workplan included a conceptual design for the construction of a series of berms and ditches that would intercept potential runoff from irrigation, thereby preventing the runoff from flowing into the Creek, and instead, facilitating its infiltration into groundwater. Subsequently, TCSD initiated preliminary environmental and cultural resources studies to help ascertain design limitations for the proposed tailwater/runoff control design.

As of summer 2021, TCSD does not have sufficient funds to complete either the engineering or the construction for the project. However, TCSD did proceed with preliminary environmental work on the project for three reasons: 1) TCSD wanted to demonstrate its commitment to complying with the RWQCB Order, 2) TCSD recognized that the environmental permitting process may be complex with a long timeframe, and wanted to get a “jump” on this effort, and 3) TCSD anticipated that issues identified during the environmental analysis could constrain the project, and wanted to identify these constraints before engineering its design.

During the environmental analysis, it was determined that significant cultural resources are present within the project area, and that the presence of these resources would significantly impact the project as currently conceived. The presence of these resources will dictate where construction can and cannot occur, and/or will increase the cost of construction due to mitigation of the resources.

With this in mind, TCSD tasked Forsgren with preparing an Alternatives Analysis to consider five alternatives with four sub-alternatives: 1) No Action, 2) Physical runoff barriers as conceived in the Workplan (four different runoff barrier alternatives were evaluated under this alternative), 3) Automatic operational runoff controls using sensors, shut-off valves, and monitoring cameras rather than physical barriers, 4) some combination of Alternatives 2 and 3, and 5) No Changes with Increased Monitoring.

A weighted decision matrix was developed to evaluate criteria that TCSD determined would be impactful to their implementation of a selected alternative. The monetary criteria used for evaluating the alternatives were capital cost, operational costs, and maintenance costs. Non-monetary evaluation criteria evaluated were impacts to the Baker Ranch, impacts to cultural resources, technical feasibility, constructability, permit compliance, schedule, impacts to environmental resources, and damage from cattle. The most favorable, and recommended alternative is Alternative 5: No Changes with Increased Monitoring. This alternative has the lowest cost implications, provides the least impacts to the Ranch and TCSD, has no additional environmental or cultural impacts, and can be implemented immediately if the RWQCB will accept this alternative as a Tailwater/Runoff Control System.

1. Introduction

The purpose of this Alternatives Analysis Report is to assist Tuolumne City Sanitary District (TCSD) in deciding how to comply with Items 13 and 21, as well as provision 1.b from Order R5-2019-0058 Waste Discharge Requirements issued by the California Regional Water Quality Control Board (RWQCB) Central Valley Region on June 7, 2019, for the Baker Ranch. These items require TCSD to implement a tailwater runoff control plan to protect the nearby Turnback Creek from potential surface water discharges caused by irrigation runoff from Baker Ranch.

During this Alternatives Analysis five alternatives were evaluated: 1) No Action, 2) Physical runoff barriers as conceived in the Workplan, 3) Automatic runoff controls using sensors, shut-off valves, and monitoring cameras rather than physical barriers, 4) some combination of Alternatives 2 and 3, and 5) No Changes with Increased Monitoring. The “No Action” alternative was evaluated as a standard CEQA formality and was not considered a viable alternative since it does not meet the requirements of the Order for implementation of a tailwater runoff control plan.

1.1 LAA Background

Since 1974, the TCSD Wastewater Treatment Plant has sent its treated undisinfected effluent to the Baker Ranch to be used for irrigation. The effluent is received in the Grinding Rock Reservoir, where it is blended with water from the Creek. From the Reservoir, the blended effluent is distributed by either pumped or gravity flow to several LAAs throughout the ranch. Most of the LAAs are irrigated by sprinkler systems except for one LAA that uses flood irrigation. The irrigation is used to grow grass that feed the non-dairy cattle that inhabit the ranch. The owner of the ranch, John Baker, inspects and operates the irrigation system daily to ensure the health of vegetation and his cattle. As the owner of the ranch and associated water rights, Mr. Baker has a strong incentive to maximize beneficial water use while minimizing wasted water and surface runoff. Since surface runoff and saturated soils create dangerous conditions for his cattle and make areas of his ranch difficult to access, Mr. Baker is incentivized to maintain the irrigation system in good working order and to immediately fix any leaks in the system. The LAAs have never had a reportable discharge into the Creek, due in large part to Mr. Baker’s responsible stewardship of the LAAs. The Creek is usually dry during the peak irrigation months from June through October. If there was a discharge during this time, the discharge would effectively be a ground water discharge into a dry creek bed rather than a surface water discharge into a flowing creek. Irrigation of the ranch requires an operator to manually turn on a pump or valve to start watering. Under the current configuration, excess surface runoff is controlled by turning off the valve or pump that supplies water to the zone in question.

1.2 Location

The Baker Ranch is in Tuolumne, California, on Apple Colony Road, approximately 1.5 miles southwest of the TCSD WWTP. Exhibit 1 in Appendix A shows the general layout of the Baker Ranch LAAs.

1.3 Condition of Existing Facilities

The existing irrigation system is in good and working order. Breaks in irrigation piping are repaired as soon as they are discovered, and the LAA has never had a reportable discharge into

the Creek. The irrigation areas are covered in tall grass for grazing. The reservoir is inspected annually by the California Department of Water Resources' Division of Safety of Dams (DSOD) and has no known structural or seepage issues.

1.4 Need for Project

This tailwater/runoff control project is needed for TCSD to comply with items 13 and 21, as well as provision 1.b from Order R5-2019-0058 issued by the California Regional Water Quality Control Board on June 7, 2019.

2. Evaluation Criteria

In preparing this alternatives analysis, the following criteria were developed to evaluate each alternative. These criteria were entered into a weighted decision matrix to assist TCSD with their decision-making process.

2.1 Capital Cost

Capital costs include estimates of one-time project costs that would be incurred for each alternative. These include construction, mobilization, and materials costs, as well as estimated consulting costs for biological and cultural surveys, environmental permitting, community outreach, engineering design, surveying, and construction management.

2.2 Annual Operation & Maintenance Cost

Annual Operation & Maintenance (O&M) costs include the estimated dollar costs to operate and maintain each alternative. These costs may include hiring new employees to maintain berms and valves, or additional hours for existing employees for annual environmental compliance activities. Additionally, these costs include estimated power, equipment replacement, and infrastructure maintenance costs.

2.3 Rancher Impact

Impacts to the Baker Ranch that were considered include operability and maintenance requirements as well as interference with cattle movement and ranching activities.

2.4 Impacts to Cultural Resources

The cultural resources impacts considered in this evaluation are related to prehistoric and historic features that were found or may be found in areas of proposed construction. A preliminary cultural resource survey was performed, and a map showing locations of cultural artifacts and site features is located in Appendix C. There is no way to predict cultural resources that could be unearthed during implementation of any of the alternatives, therefore impacts to the schedule could not be predicted either.

2.5 Technical Feasibility

In evaluating technical feasibility for this project, questions were asked such as: Have projects like this been done before? Does the required equipment exist and is it readily available? Are special technical skills required to construct the alternative?

2.6 Constructability

Constructability was evaluated to determine how easy it is to build each alternative. Steep hillsides, power line runs, transport of fill materials, and ability to get heavy equipment to the site were considered.

2.7 Permit Compliance

Compliance with the Waste Discharge Requirements (R5-2019-0058) was evaluated for each alternative. This was the most heavily weighted evaluation criteria since it is the primary reason for the project.

2.8 Schedule

Approximate construction timeframes, equipment lead times, permit documentation preparation time, and agency review times were evaluated for each alternative. Rudimentary schedules were built to reflect tentative timeframes for evaluation. Appendix B contains the preliminary schedules for each alternative that cannot be implemented immediately.

2.9 Impacts to Environmental Resources

Preliminary environmental investigations were performed to determine the environmental resources that would be affected by the project as well as possible environmental constraints.

2.10 Damage from Cattle

An evaluation was performed to determine how the Baker Ranch cattle would damage the effectiveness, infrastructure, equipment, and topography of each alternative.

3. Alternatives Considered

In preparing this Alternatives Analysis, five alternatives and four sub-alternatives were considered. These alternatives are described in detail in the following sections, and Exhibits for each alternative are located in Appendix A.

3.1 Alternative 1: No Action

Under this alternative, the existing system would remain unchanged.

3.2 Alternative 2: Physical Barriers to Surface Runoff

For Alternative 2, three different types of physical runoff barriers were evaluated, and a sub-Alternatives Analysis was performed to select the best configuration of physical barriers to evaluate. The purpose of these physical runoff barriers would be to direct and slow irrigation runoff and segregate flow areas allowing more time for the blended effluent to infiltrate into the soil thereby decreasing the risk of a surface discharge into the Creek. The soils on site are used for growing grass, and are generally favorable for infiltration, but each area where infiltration is proposed would need to be evaluated for bedrock depth and infiltration potential. The alternatives that were evaluated include berms and trenches, concrete curbing, straw wattles, and a combination thereof. These alternatives are described in more detail in the following sections.

3.2.1. Alternative 2A: Berms and Infiltration Trenches

This alternative consists of constructing a system of berms and infiltration trenches. 1-ft high berms would be constructed of onsite fill material and compacted in place for stability. The berms would maintain a 2:1 slope on each side for stability and would be constructed parallel to natural drainage gullies that lead to the Creek to prevent surface irrigation runoff from collecting in these channels and discharging to the Creek. To supplement the berms, 1-ft deep by 1-ft wide infiltration trenches would be constructed in low areas perpendicular to sheet flow drainage paths to capture sheet flow runoff and facilitate infiltration to keep these flows from reaching the Creek. These infiltration trenches would be filled with drain rock to prevent surface ponding and stabilize the trenches. The trench bottoms would remain uncompacted to facilitate infiltration. Exhibit 2A shows the conceptual Tailwater/Runoff Control design of Alternative 2A.

3.2.2 Alternative 2B: Concrete Curbing

This alternative consists of constructing concrete curbs at strategic locations throughout the site. A concrete curbing machine would be mobilized to the site, and 6-inch curbing would be placed in locations parallel to the Creek to prevent sheet flow runoff from entering the Creek. The curbs would be utilized to direct runoff and segregate flow areas. This separation of flows would slow runoff and allow more time for infiltration into the soil. In gullies where flows are concentrated, short concrete headwalls with infiltration galleries would be constructed. The infiltration galleries would be filled with drain rock to allow the trapped water to infiltrate into the soil upstream of the headwall. Not all the gullies at the Baker Ranch are ideal for this configuration. One of the gullies is fed by a ground water spring that flows throughout the year, and blocking this would interfere with natural drainage while potentially causing pooling. For this location, curbing would be placed parallel to the gully to minimize the risk of irrigation water entering the drainage channel. Exhibit 2B shows a conceptual tailwater/runoff control design of Alternative 2B.

3.2.3 Alternative 2C: Straw Wattles

This alternative consists of constructing a system of straw wattles. The straw wattles would be placed perpendicular to sheet flow drainage paths in parallel rows up the hillsides to slow runoff and provide time for infiltration into the soil. Exhibit 2C shows a conceptual Tailwater/Runoff Control design of Alternative 2C.

3.2.4 Alternative 2D: Combination

This alternative consists of constructing a combination of berms and trenches, and concrete curbing. Alternative 2D would combine several runoff mitigation barriers into one. The combination of features would slow runoff and allow time for infiltration into the soil. Exhibit 2D shows a conceptual design layout for Alternative 2D.

3.3 Alternative 3: Automated Runoff Controls

Rather than directing runoff and increasing infiltration times, the intent of Alternative 3 would be to provide operational controls that would stop irrigation completely in the event that irrigation water gets close to the Creek. This alternative involves the installation of instrumentation sensors measuring pressure and soil moisture, as well as automated valve and pump operation to control

flow to different irrigation zones. An array of soil sensors would be placed down-gradient from irrigated areas, and upgradient from the Creek. As these sensors detect a predetermined moisture content, flow to the irrigation zone contributing to the high soil moisture would automatically be shut off. Irrigation zones fed by gravity would be shut off by a flow control valve on the main pipeline that feeds the gravity flow irrigation zones. For pumped irrigation zones, the pump would be shut off to prevent flow when preset moisture parameters are exceeded. In addition to the automated controls, video cameras would be placed near the Creek in areas perceived to be at higher risk for discharge so that TCSD staff can monitor the Creek remotely. Exhibit 3 shows a conceptual tailwater/runoff control design for Alternative 3. Product brochures for soil moisture sensing equipment are located in Appendix D.

3.4 Alternative 4: Combination of Alternatives 2 and 3

This alternative consists of constructing a combination of physical runoff barriers as well as instrumentation to automate valve and pump control. The new features would be placed in areas that would minimize environmental and cultural disturbances. As in Alternative 3, irrigation times would be limited based on feedback from soil moisture sensing instrumentation. For this alternative, barriers would be constructed with the intent of increasing infiltration time in select areas, while allowing some surface flows to continue to flow as they have in the past. Irrigation zones fed by gravity would be shut off by a flow control valve on the main pipeline that feeds the gravity flow irrigation zones. For pumped irrigation zones, the pump would be shut off to prevent flow when preset moisture parameters are exceeded. Exhibit 4 shows a conceptual layout for the tailwater/runoff control design of Alternative 4.

3.5 Alternative 5: Increased Monitoring

This alternative includes increased monitoring of the existing LAAs by both TCSD and Baker Ranch. This would include documented weekly inspections and increased sampling frequency by TCSD. Additionally, cameras would be installed allowing TCSD to visually monitor areas near the Creek on a daily basis for potential surface discharges. Besides cameras and related network upgrades, no new infrastructure would be constructed or installed.

4. Alternatives Analysis

Section 4 summarizes the analysis of each alternative according to the evaluation criteria described in Section 2.

4.1 Alternative 1: No Action

4.1.1. Capital Cost

There are no capital costs associated with Alternative 1.

4.1.2. Annual Operation and Maintenance Cost

There are no new operation and maintenance costs associated with Alternative 1. Additional annual costs associated with this alternative would be potential punitive costs levied by the RWQCB.

4.1.3. Rancher Impact

The only impacts to Baker Ranch from Alternative 1 would be in the form of compliance issues associated with items 13 and 21, as well as provision 1.b from Order R5-2019-0058.

4.1.4. Impacts to Cultural Resources

Under this alternative, there would be no impact to cultural resources.

4.1.5. Technical Feasibility

There would be no technical feasibility issues under this alternative.

4.1.6. Constructability

There would be no constructability issues under this alternative.

4.1.7. Permit Compliance

Under this alternative, TCSD would not be in compliance with the permit requirement to implement tailwater /runoff controls.

4.1.8. Schedule

A schedule was not estimated for this alternative since this alternative would not involve any activities.

4.1.9. Impacts to Environmental Resources

Under this alternative, there would be no direct impacts to environmental resources as there would be no construction.

4.1.10. Damage from Cattle

Under this alternative, there would be potential for sprinkler and irrigation piping to be damaged by cattle, however, there would be no increase in risk and the risk is lower for Alternative 1 than for other alternatives that add additional infrastructure to the LAAs.

4.2 Alternative 2A: Berms and Infiltration Trenches

4.2.1 Capital Cost

This alternative would require that TCSD receive funding from outside funding agencies. Capital costs for this alternative would include earthwork in hilly terrain, large volumes of fill material that would likely need to be imported due to berms being installed on steep hillsides, and consulting costs. In preparing the capital cost estimate, it was assumed that berms would only be constructed in areas where the slope is less than 14%. There would be a significant cost to prepare the necessary Technical Reports and presumed Mitigated Negative Declaration. Capital costs for environmental consultants would be in the hundreds of thousands of dollars. Estimated capital costs for Alternative 2A are shown in Table 1. This alternative has the third highest estimated capital cost of alternatives 2A-2D.

Table 1: Estimated Capital Costs for Alternative 2A

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$30,000	\$30,000
2	Berm Construction (cut)	YD	350	\$8	\$2,800
3	Berm Construction (fill)	YD	350	\$10	\$3,500
4	Trench Construction (cut)	YD	220	\$8	\$1,760
5	Trench Construction (imported fill)	FT ³	6,000	\$20	\$120,000
6	Compaction Testing	LS	1	\$10,000	\$10,000
	Construction Subtotal				\$168,060
	Construction Contingency			30%	\$50,500
	Construction Management			20%	\$33,700
Construction Total:					\$252,300
1	Engineering	LS	1	\$100,000	\$100,000
	Environmental and Cultural				
1	Project Management	LS	1	\$5,100	\$5,100
2	Biology and Wetlands	LS	1	\$56,000	\$56,000
3	Cultural Resources	LS	1	\$333,970	\$333,970
4	Air Quality/Emissions	LS	1	\$8,000	\$8,000
5	CEQA - Mitigated Negative Declaration	LS	1	\$10,000	\$10,000
	Engineering/Environmental/Cultural Subtotal				\$513,070
	Engineering/Environmental/Cultural Contingency			30%	\$154,000
Engineering/Environmental/Cultural Total:					\$667,100
Total Estimated Project Cost:					\$919,400

4.2.2 Annual Operation and Maintenance Cost

Operations and maintenance for this alternative would include reconstruction of berms and trenches that are damaged throughout the year by cattle. For this evaluation, it was assumed that half of the berms would need to be reconstructed, and 25% of the trenches would need maintenance and reconstruction. Estimated operations and maintenance costs for Alternative 2A are shown in Table 2.

Table 2: Estimated O&M costs for Alternative 2A

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$10,000	\$10,000
2	Berm Reconstruction (cut)	YD	175	\$8	\$1,400
3	Berm Reconstruction (Fill)	YD	175	\$10	\$1,750
4	Trench Reconstruction (imported fill)	FT ³	1,500	\$20	\$30,000
5	Compaction Testing	LS	1	\$2,500	\$2,500
	Annual Operations & Maintenance Cost				\$45,650
	Construction Contingency			20%	\$9,200
	Total Cost				\$54,900

4.2.3 Rancher Impact

Impacts to the Baker Ranch would include maintenance of berms, changes in access routes, and risk of cattle injury due to the new topographic features.

4.2.4 Impacts to Cultural Resources

The proposed areas of excavation would be in sensitive tribal and cultural areas. Because of this, a cultural resources consultant would perform subsurface testing, prepare findings, and obtain permission to construct from the State Historical Preservation Office and Tribal Governments. During construction, tribal and/or archaeological observers would be required to be on site.

4.2.5 Technical Feasibility

Due to the hilly terrain of the LAA sites, controlling surface runoff with berms would present some technical challenges. To avoid importing large quantities of fill material, berm construction would be limited to areas where the slope is not prohibitively steep. For this analysis, it was determined that berms should not be constructed where the slope is greater than 14%. By nature, the areas with shallow slopes will allow for effective infiltration, thus, infiltration trenches would be utilized to facilitate infiltration more effectively and to contain acute flows due to ruptured pipes.

4.2.6 Constructability

Due to the hilly terrain of Baker Ranch, constructing berms on steep hillsides would present several constructability challenges. Earthwork on steep hillsides would introduce safety risks. Fill would need to be imported from other areas to construct the large berms on the hillsides. Due to environmental and cultural monitoring, construction progress could be delayed, and periodically halted as cultural resources were uncovered.

4.2.7 Permit Compliance

Under this alternative, TCSD would achieve compliance with the permit requirement to implement tailwater/runoff controls but would be out of compliance until the project was implemented.

4.2.8 Schedule

Alternative 2A would take approximately four years to implement. TCSD does not have the funds to pay for environmental consulting, design, and construction costs, thus, TCSD would request funding from the State Revolving Fund to complete this project. Approval of funding will require a mitigated negative declaration, and there is potential for an Environmental Impact Review depending on the result of preliminary cultural studies. Environmental studies are estimated to take up to 36 months for this alternative. The funding approval process can proceed concurrently with the Environmental Assessment and RWQCB review of the preferred project alternative. This Alternative is estimated to be completed late in 2026. A preliminary schedule for Alternative 2A is in Appendix B.

4.2.9 Impacts to Environmental Resources

Under this alternative, the proposed areas of excavation would be in some of the most sensitive environmental resources. In addition to the cultural issues described in 4.2.4, there would be the potential to impact biological resources, jurisdiction waterways and wetlands, and a need to evaluate air quality impacts. Potential permits required may include Section 404 Permit (US Army Corps), Section 1602 Streambed Alteration Agreement Permits (CDFW), Stormwater Construction General Permit, Encroachment Permit, Conditional Use Permit.

4.2.10 Damage from Cattle

There is high potential for berms and trenches to be damaged by cattle. For this evaluation, we have assumed that cattle could damage half of the installed berms and 25% of the trenches. Costs for reconstruction of berms and trenches were addressed as operations and maintenance costs in Section 4.2.2.

4.3 Alternative 2B: Concrete Curbing

4.3.1 Capital Cost

This alternative would require that TCSD receive funding from outside agencies. Capital costs for this alternative include curbing installation, concrete headwall placement, earthwork and site preparation, as well as importing of cement and other materials, and consulting costs. There would be a significant cost to prepare the Technical Reports and presumed Mitigated Negative Declaration. There would also be a significant capital cost for the environmental consultant. Estimated capital costs for Alternative 2B are shown in Table 3.

Table 3: Estimated Capital Costs for Alternative 2B

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$30,000	\$30,000
2	Ground Prep (cut)	FT	900	\$8	\$7,200
3	Curbing	LF	6,900	\$35	\$241,500
4	Headwall Excavation (cut)	YD	90	\$8	\$720
5	Headwall Concrete	LF	90	\$60	\$5,400
6	Infiltration Gallery Excavation (cut)	YD	15	\$8	\$120
7	Infiltration Gallery Imported Fill	FT ³	360	\$20	\$7,200
8	Compaction Testing	LS	1	\$5,000	\$5,000
	Construction Subtotal				\$297,140
	Construction Contingency			30%	\$89,200
	Construction Management			20%	\$59,500
Construction Total:					\$445,900
1	Engineering	LS	1	\$100,000	\$100,000
	Environmental and Cultural				
1	Project Management	LS	1	\$5,100	\$5,100
2	Biology and Wetlands	LS	1	\$56,000	\$56,000
3	Cultural Resources	LS	1	\$333,970	\$333,970
4	Air Quality/Emissions	LS	1	\$8,000	\$8,000

5	CEQA - Mitigated Negative Declaration	LS	1	\$10,000	\$10,000
	Engineering/Environmental/Cultural Subtotal				\$513,070
	Engineering/Environmental/Cultural Contingency			30%	\$154,000
	Engineering/Environmental/Cultural Total:				\$667,100
	Total Estimated Project Cost:				\$1,113,000

4.3.2 Annual Operation and Maintenance Cost

For this evaluation, it was assumed that 10% of the concrete curbing would need annual replacement due to damage from cattle. The headwalls and infiltration galleries are assumed to not need repair for 20 years. Estimated operations and maintenance costs for Alternative 2B are shown in Table 4.

Table 4: Estimated O&M costs for Alternative 2B

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$10,000	\$10,000
2	Ground Prep (cut)	YD	100	\$8	\$800
3	Curbing	FT	700	\$35	\$24,500
	Construction Subtotal				\$35,300
	Construction Contingency			20%	\$7,100
	Total Cost				\$42,400

4.3.3 Rancher Impact

Impacts to the Baker Ranch would be similar to alternative 2A and include maintenance of curbs, changes in access routes, and risk of cattle injury due to the new topographic features.

4.3.4 Impacts to Cultural Resources

Under this alternative, the proposed areas for curbing installation would have a less of an impact on the sensitive cultural areas compared to Alternative 2A. The ground preparation and earthwork required for installing the curbing would be less extensive than for Alternative 2A, however, there would still be an impact. Because of this, a cultural resources consultant would perform subsurface testing, prepare findings, and obtain permission to construct from the State Historical Preservation Office and Tribal Governments. During construction, tribal and/or archaeological observers would be required to be on site.

4.3.5 Technical Feasibility

Due to the hilly terrain of the LAA sites, controlling runoff present technical challenges; however, the use of a standard curbing machine and materials, minimal earthwork and site preparation makes this alternative more technically feasible than alternative 2A. Construction of headwalls and infiltration galleries are technically feasible, but site-specific investigations would need to be performed prior to infiltration gallery design to determine infiltration rates and depth to bedrock. There is a risk that bedrock depth may deem some of the infiltration galleries infeasible as conceived, in which case additional measures would be taken to prevent concentrated flows from entering the Creek.

4.3.6 Constructability

Due to the hilly terrain of Baker Ranch, alternative 2B presents similar constructability challenges as alternative 2A; however, these issues would be less severe than the previous alternative. Curbing machines would allow increased runoff mitigation to be constructed in areas with steep slopes. All earthwork in these areas would require safety protocol to be strictly followed. Cement and other materials would have to be imported from other areas to construct the curbs on steep hillsides. Due to environmental and cultural monitoring, construction progress could be delayed, and possibly halted if new cultural resources are uncovered. Headwalls would be constructed as formed cast-in-place concrete walls. Mobilizing equipment and materials to the construction areas would present a challenge, but it is not insurmountable.

4.3.7 Permit Compliance

Under this alternative, TCSD would be in compliance with the permit requirement to implement a tailwater /runoff control plan but would be out of compliance while the project was implemented.

4.3.8 Schedule

Alternative 2B would take several years to implement. TCSD does not have the funds to pay for environmental consulting, design, and construction costs, thus, TCSD would request funding from the State Revolving Fund to complete this project. Approval of funding would require a mitigated negative declaration, and there is potential for an Environmental Impact Review depending on the result of preliminary cultural studies. Environmental studies are estimated to take up to 36 months for this alternative. The funding approval process could proceed concurrently with the Environmental Assessment and RWQCB review of the preferred project alternative. This Alternative is estimated to be completed late in 2026. A preliminary schedule for Alternative 2B is in Appendix B.

4.3.9 Impacts to Environmental Resources

Under this alternative, the proposed areas of earthwork to install curbs would be in highly sensitive environmental areas. In addition to the cultural issues described in 4.3.4, there would be the potential to impact biological resources, jurisdiction waterways and wetlands, and a need to evaluate air quality impacts. Potential permits required may include Section 404 Permit (US Army Corps) Section 1602 Streambed Alteration Agreement Permits (CDFW), Stormwater Construction General Permit, Encroachment Permit, and Conditional Use Permit. Construction of headwalls and infiltration galleries would take place in natural drainage paths, which could lead to additional environmental impacts. Due to the smaller footprint of curbs, Alternative 2B will impose less environmental and cultural disturbance than construction of berms and trenches, but some of the work may take place in more sensitive areas.

4.3.10 Damage from Cattle

There is potential for sprinkler, irrigation piping and curbs to be damaged by cattle. For this analysis, it was assumed that cattle will damage approximately 10% of the curbing annually, and that the headwalls and infiltration galleries will not be extensively damaged by cattle.

4.4 Alternative 2C: Straw Wattle

4.4.1 Capital Cost

This alternative would have a sizable reduction in the overall capital cost. TCSD would potentially still have to receive funding from outside funding agencies. Costs would include procurement and installation of the straw wattle and stakes, and the cost for consulting. The presumed costs for environmental and cultural resource studies would be significantly lower than both Alternatives 2A and 2B due to the elimination of excavation for installation of the wattles. Estimated capital costs are shown in Table 5.

Table 5: Estimated Capital Costs for Alternative 2C

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$30,000	\$30,000
2	Straw Wattle Procurement and Installation	FT	31,000	\$5	\$155,000
	Construction Subtotal				\$185,000
	Construction Contingency			30%	\$55,500
	Construction Management			20%	\$37,000
Construction Total:					\$277,500
	Engineering	LS	1	\$50,000	\$50,000
	Environmental and Cultural				
1	Project Management	LS	1	\$2,550	\$2,550
2	Biology and Wetlands	LS	1	\$2,000	\$2,000
3	Cultural Resources	LS	1	\$188,970	\$188,970
4	Air Quality/Emissions	LS	1	\$8,000	\$8,000
5	CEQA – Mitigated Negative Declaration	LS	1	\$10,000	\$10,000
	Engineering/Environmental/Cultural Subtotal				\$261,520
	Engineering/Environmental/Cultural Contingency			30%	\$78,500
Engineering/Environmental/Cultural Total:					\$340,100
Total Estimated Project Cost:					\$617,600

4.4.2 Annual Operation and Maintenance Cost

Since straw wattles are generally considered temporary, estimated maintenance costs include annual replacement of all the wattles. Estimated operations and maintenance costs for Alternative 2C are shown in Table 6.

Table 6: Estimated O&M Costs for Alternative 2C

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$10,000	\$10,000
2	Straw Wattle Procurement and Installation	FT	31,000	\$5	\$155,000
	Construction Subtotal				\$165,000
	Construction Contingency			20%	\$33,000
	Total Cost				\$198,000

4.4.3 Rancher Impact

Under this alternative, the impact to the Baker Ranch could be high. The cattle on the ranch could eat the straw, constituting a change in diet. It has not been determined if this is a desirable dietary choice by Mr. Baker. Other impacts would include potential maintenance or replacement of straw wattles, and a risk of injury to either people or cattle from the stakes used to secure the wattles.

4.4.4 Cultural Resources

The impact to cultural resources from Alternative 2C would be the least invasive of the physical barrier alternatives. Although some straw wattles would be located in sensitive tribal and cultural areas, the procedure to install straw wattles is minimally invasive and non-distributive.

4.4.5 Technical Feasibility

While the construction of this alternative is technically feasible, straw wattles are generally used to control runoff erosion, not runoff. Because water could seep through the wattles, this alternative is ranked lower than the other alternatives since it does not meet the technical intent of the design.

4.4.7 Constructability

This alternative is considerably more constructable than the previous two alternatives. Installation of straw wattles requires little to no earthwork to properly stake the material in the desired location. The straw wattle that would be used for this alternative comes as an “off the shelf” item which would make procuring the material fast and easy, and installation does not require skilled labor.

4.4.8 Permit Compliance

Under this alternative, TCSD would possibly be in compliance with the permit requirement to implement a tailwater/runoff control plan, however, since wattles are not a robust runoff control mechanism, the state may not accept this alternative as a permanent solution.

4.4.9 Schedule

Alternative 2C would take approximately four years to implement. TCSD does not have the funds to pay for environmental consulting, design, and construction costs, thus, TCSD would request funding from the State Revolving Fund to complete this project. Approval of funding would require a mitigated negative declaration, and there would be potential for an Environmental Impact Review depending on the result of preliminary cultural studies. Environmental studies are estimated to take up to 24 months for this alternative. The funding approval process could proceed concurrently with the Environmental Assessment and RWQCB review of the preferred project alternative. Alternative 2C is estimated to be completed in 2025, and a preliminary schedule is in Appendix B.

4.4.10 Impacts to Environmental Resources

This alternative is the least environmentally invasive alternative of all the physical barriers evaluated. Disturbances from the installation of straw wattles would be located in less environmentally sensitive areas than the areas that would be disturbed in Alternatives 2A and 2B. The procedure to install straw wattle is minimally invasive and non-disruptive since wattle installation requires little to no excavation, Alternative 2C would impose far less environmental and cultural disturbance than construction of the other two alternatives.

4.4.11 Damage from Cattle

There is high potential for cattle to damage the straw wattles and stakes under this alternative. Wattles would likely need to be replaced annually due to damage from cattle.

4.5 Alternative 2D: Combination of Alternatives 2A and 2B

4.5.1 Capital Cost

This alternative would require that TCSD receive funding from outside funding agencies. Capital costs for this alternative include earthwork in hilly terrain, large volumes of fill material that may need to be imported due to berms being installed on steep hillsides, procurement of a curbing machine, earthwork, and site preparations, importing of cement and other materials, procurement of the straw wattle and stakes, and the cost for consulting. In preparing the capital cost estimate, it was assumed that berms would only be constructed in areas where the slope is less than 14%. There would be a significant cost to prepare the necessary Technical Reports and presumed Mitigated Negative Declaration. Capital costs for just environmental consultants should be budgeted in the hundreds of thousands of dollars. Estimated capital costs for Alternative 2D are shown in Table 7.

Table 7: Estimated Capital Costs for Alternative 2D

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$30,000	\$30,000
2	Berm Construction (cut)	YD	70	\$8	\$560
3	Berm Construction (fill)	YD	70	\$10	\$700
4	Trench Construction (cut)	YD	220	\$8	\$1,760
5	Trench Construction (imported fill)	FT ³	6,000	\$20	\$120,000
6	Curbing Ground Prep	YD	70	\$8	\$560
7	Curbing Construction	LF	560	35	\$19,600
8	Headwall Excavation (cut)	YD	90	\$8	\$720
9	Headwall Concrete	LF	90	\$60	\$5,400
10	Infiltration Gallery Excavation (cut)	YD	15	\$8	\$120
11	Infiltration Gallery Imported Fill	FT ³	360	\$20	\$7,200
12	Compaction Testing	LS	1	\$5,000	\$5,000
	Construction Subtotal				\$191,620
	Construction Contingency			30%	\$57,500
	Construction Management			20%	\$38,400
Construction Total:					\$287,600

	Engineering	LS	1	\$150,000	\$150,000
	Environmental and Cultural				
1	Project Management	LS	1	\$5,100	\$5,100
2	Biology and Wetlands	LS	1	\$56,000	\$56,000
3	Cultural Resources	LS	1	\$333,970	\$333,970
4	Air Quality/Emissions	LS	1	\$8,000	\$8,000
5	CEQA - Mitigated Negative Declaration	LS	1	\$10,000	\$10,000
	Engineering/Environmental/Cultural Subtotal				\$563,070
	Engineering/Environmental/Cultural Contingency			30%	\$169,000
Engineering/Environmental/Cultural Total:					\$732,100
Total Estimated Project Cost:					\$1,019,700

4.5.2 Annual Operation and Maintenance Cost

Operational costs for this alternative include annual reconstruction of half of the berms, 10% of the concrete curbs, and 25% of the trenches. The concrete headwalls and infiltration galleries are assumed to be maintenance free for approximately 20 years, however, maintenance costs for upkeep on berms, curbing, and trenches have been estimated in Table 8.

Table 8: Estimated O&M Costs for Alternative 2D

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$10,000	\$10,000
2	Berm Construction (cut)	YD	35	\$8	\$280
3	Berm Construction (fill)	YD	35	\$10	\$350
4	Trench Construction (cut)	YD	55	\$8	\$440
5	Trench Construction (imported fill)	FT ³	1,500	\$20	\$30,000
6	Curbing Ground Prep	YD	70	\$8	\$560
7	Curbing Construction	LF	60	35	\$2,100
8	Compaction Testing	LS	1	\$2,500	\$2,500
	Construction Subtotal				\$46,230
	Construction Contingency			20%	\$9,300
	Total Cost				\$55,600

4.5.3 Rancher Impact

Under this alternative, impacts to the Baker Ranch would include maintenance of berms, curbs, and trenches changes in access routes, and risk of cattle injury due to the new topographic features.

4.5.4 Cultural Resources

Under this alternative, the proposed areas of excavation would be in some of the most sensitive tribal and cultural areas. Because of this, a cultural resources consultant would do subsurface testing, prepare findings, and obtain permission to construct from the State Historical Preservation Office and Tribal Governments. During construction, tribal and/or archaeological observers would be on site to monitor for cultural disturbances.

4.5.5 Technical Feasibility

Due to the hilly terrain of the LAA sites, controlling surface runoff with berms presents some technical challenges. To avoid importing large quantities of fill material, berms construction should be limited to areas where the slope is not prohibitively steep. For this analysis, it was determined that berms should not be constructed where the slope is greater than 14%. By nature, the areas with shallow slopes will allow for effective infiltration, and berms may not be effective in these areas for increasing infiltration from surface water. Berms and curbs would be effective for containing acute flows due to ruptured pipes in shallow areas. In areas where berms and curbs were determined to not be constructed the use of infiltration trenches would facilitate infiltration of sheet flow runoff.

4.5.6 Constructability

Due to the hilly terrain of Baker Ranch, constructing berms on steep hillsides presents several constructability challenges, so berm construction would be kept to a minimum. Earthwork on steep hillsides would require safety protocols to be strictly followed. Fill would need to be imported from other areas to construct the large berms on the hillside. The use of a curbing machine will allow for increased runoff mitigation in areas with steep slopes. The addition of infiltration trenches down gradient from the irrigation area and upgradient from the Creek will allow for runoff mitigation. Due to environmental and cultural monitoring, construction progress would be hindered and possibly halted as new cultural resources are uncovered.

4.5.7 Permit Compliance

Under this alternative, TCSD would be in compliance with the permit requirement to implement a tailwater/runoff control plan, however, due to the amount of time it would take to complete the project, TCSD would be out of compliance until the project was implemented.

4.5.8 Schedule

Alternative 2D would take several years to implement. TCSD does not have the funds to pay for environmental consulting, design, and construction costs, thus, TCSD would request funding from the State Revolving Fund to complete this project. Approval of funding would require a mitigated negative declaration, and there is potential for an Environmental Impact Review depending on the result of preliminary cultural studies. Environmental studies are estimated to take up to 36 months for this alternative. The funding approval process could proceed concurrently with the Environmental Assessment and RWQCB review of the preferred project alternative. Alternative 2D is estimated to be completed late in 2026, and a preliminary schedule is in Appendix B.

4.5.9 Impacts to Environmental Resources

Under this alternative, the proposed areas of excavation would be in some of the most sensitive environmental resources. In addition to the cultural issues described in 4.5.5, there would be the potential to impact biological resources, jurisdiction waterways and wetlands, and a need to evaluate air quality impacts. Potential permits required may include Section 404 Permit (US Army Corps), Section 1602 Streambed Alteration Agreement Permits (CDFW), Stormwater Construction General Permit, Encroachment Permit, Conditional Use Permit.

4.5.10 Damage from Cattle

There is potential for sprinkler and irrigation piping, berms, curbs, and trenches to be damaged by cattle, however, for this alternative, berms have been minimized in lieu of trenches and curbs which are more robust, which would minimize damage from cattle. The operations and maintenance cost estimate takes damage from cattle into account.

4.6 Alternative 3: Automated Flow Control

4.6.1 Capital Cost

This alternative would require that TCSD receive funding from outside funding agencies. Capital costs for this alternative include installation of a flow control valve, pressure transducers, soil moisture sensors, and data communication stations as well as environmental studies, a cultural resource survey, engineering, and programming. This alternative includes significantly lower cost than Alternative 2 to prepare the necessary Technical Reports and Mitigation Negative Declaration. The cost for consultants would depend on specific areas of disturbance with the preference that previously disturbed areas be prioritized for new work. Estimated capital costs for Alternative 3 are shown in Table 9. These costs include 2 spare soil moisture sensors and a spare valve.

Table 9: Estimated Capital Costs for Alternative 3

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$30,000	\$30,000
2	Automated Butterfly Valve (installed)	EA	2	\$10,000	\$20,000
3	Soil Moisture Sensors	EA	17	\$800	\$13,600
4	Control and Transmitting Stations	EA	5	\$36,500	\$182,500
5	Buried Cable Trenching and Install	LF	2,200	\$10	\$22,000
6	Above Ground Cable Install	LF	2,800	\$5	\$14,000
7	Programming & Commissioning	LS	1	\$50,000	\$50,000
8	Power and Network Upgrades for Video Cameras	LS	1	\$75,000	\$75,000
9	Fencing	LS	1	\$10,000	\$10,000
	Construction Subtotal				\$417,100
	Construction Contingency			30%	\$125,200
	Construction Management			20%	\$83,500
Construction Total:					\$625,800
	Engineering	LS	1	\$50,000	\$50,000
	Environmental and Cultural				
1	Project Management	LS	1	\$2,550	\$2,550
2	Biology and Wetlands	LS	1	\$2,000	\$2,000
3	Cultural Resources	LS	1	\$153,970	\$153,970
4	Air Quality/Emissions	LS	1	\$8,000	\$8,000
5	CEQA - Mitigated Negative Declaration	LS	1	\$10,000	\$10,000
	Engineering/Environmental/Cultural Subtotal				\$226,520
	Engineering/Environmental/Cultural Contingency			30%	\$68,000
Engineering/Environmental/Cultural Total:					\$294,600

Total Estimated Project Cost: \$920,400

4.6.2 Annual Operation and Maintenance Cost

Annual operation and maintenance costs would increase under this alternative. Maintenance costs include expected costs for servicing automation equipment, as well as replacing equipment damaged by cattle. Operational costs include increased monitoring and calibration of monitoring equipment. Estimated operations and maintenance costs for Alternative 3 are shown in Table 10.

Table 10: Estimated O&M Costs for Alternative 3

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$5,000	\$5,000
2	Soil Moisture Sensors	EA	8	\$800	\$6,400
3	Control and Transmitting Stations	EA	2	\$36,500	\$73,000
	Construction Subtotal				\$84,400
	Construction Contingency			20%	\$16,900
	Equipment Operation and Maintenance	MH	120	\$60	\$7,200
	Total Cost				\$108,500

4.6.3 Rancher Impact

This alternative would prevent the ranch from overwatering in each zone, thereby conserving water. At the same time, the limitations imposed by automation may cause frustration for Mr. Baker, especially early in the implementation of this alternative before the system has been calibrated based on true operating conditions. Under this alternative, the primary impact to Baker Ranch is that his irrigation activities would be limited based on soil moisture. Ultimately, this could lead to a more effective use of irrigation water.

4.6.4 Cultural Resources

Under this alternative, the proposed areas of excavation would be significantly smaller than the other action alternatives. The areas disturbed would be tied closely to the location of existing irrigation pipe minimizing the amount of new disturbance. These areas are also assumed to be away from identified prehistoric and historic resources.

The placement of new soil moisture monitors would occur closer to the Creek in the more sensitive areas. These features would require closer scrutiny, but much less than a berm/ditch alternative. It is however, presumed that during construction, tribal and/or archaeological observers would be required to be onsite.

4.6.5 Technical Feasibility

This alternative is considerably more technically feasible than Alternative 2. The automation programming is feasible, and automated valves, sensors, and data loggers are all “off the shelf” items. Data monitors that monitor the moisture sensors would be solar powered and could communicate either by radio or cell signal.

4.6.6 Constructability

This alternative is considerably more constructable than Alternative 2. Installation of soil moisture sensors and data logging equipment is relatively simple to install by qualified contractors. An electric automated valve would be installed near the pump station power source, and pressure transducers would be installed in the force main somewhat close to the pump station to monitor pressure losses due to ruptured pipes.

4.6.7 Permit Compliance

Under this alternative, TCSD could be in compliance with the permit requirement to implement a tailwater /runoff control plan, however, discussions would need to be held with regulators to determine if an operational only control plan would be acceptable. Any discharge to the Creek would be due to operational issues such as broken lines or overwatering, which this alternative addresses.

4.6.8 Schedule

Alternative 3 would take approximately 2.5 years to implement. TCSD does not have the funds to pay for environmental consulting, design, and construction costs, thus, TCSD would request funding from the State Revolving Fund to complete this project. Approval of funding may require a mitigated negative declaration, although there is a possibility for a general rule exemption which would significantly reduce the project time. Environmental studies are estimated to take up to 6 months for this alternative. The funding approval process can proceed concurrently with the Environmental Assessment and RWQCB review of the preferred project alternative. Alternative 3 is estimated to be completed in 2024, and a preliminary schedule is in Appendix B.

4.6.9 Impacts to Environmental Resources

Besides the cultural issues described in 4.6.5, there would be minimal potential to impact biological resources and jurisdictional waterways and wetlands. Ground disturbance work would need to occur outside of bird breeding/nesting seasons and 25 to 50 feet away from drainages and waterways. Unburied signal cables may be placed across the Creek. Air quality impacts would still need to be evaluated as well as the potential for approval from the local municipality.

4.6.10 Damage from Cattle

There is high potential for damage to the sensors and transmitters. For this evaluation, it was assumed that 50% of the sensors would need to be replaced annually due to damage from cattle. Efforts would be made to install major equipment in locations where cattle would not be able to damage it. In locations where this cannot be prevented, fencing or other protective measures would be installed to protect the equipment from cattle damage. In areas where contact with cattle is inevitable, control and transmitting stations could be pole mounted above the height where cattle could damage them.

4.7 Alternative 4 Combination of Alternatives 2 and 3

4.7.1 Capital Cost

This alternative would require that TCSD receive funding from outside funding agencies. Under this alternative, the presumed costs for environmental and cultural resource studies would be significantly lower than Alternatives 2A-2C, and slightly higher than Alternative 3 to prepare the necessary Technical Reports and Mitigated Negative Declaration. The cost for consultants would depend on specific areas of disturbance with the preference that previously disturbed areas be prioritized for new work. Estimated capital costs for Alternative 4 are shown in Table 11. These costs include 2 spare soil moisture sensors and a spare valve.

Table 11: Estimated Capital Costs for Alternative 4

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$30,000	\$30,000
2	Berm Construction (cut)	YD	50	\$8	\$400
3	Berm Construction (fill)	YD	50	\$10	\$500
4	Trench Construction (cut)	YD	60	\$8	\$480
5	Trench Construction (imported fill)	FT ³	1,600	\$20	\$32,000
6	Compaction Testing	LS	1	\$5,000	\$5,000
7	Automated Butterfly Valve (installed)	EA	2	\$10,000	\$20,000
8	Soil Moisture Sensors	EA	11	\$800	\$8,800
9	Control and Transmitting Stations	EA	3	\$36,500	\$109,500
10	Buried Cable Trenching and Install	LF	3,000	\$10	\$30,000
11	Programming & Commissioning	LS	1	\$50,000	\$50,000
12	Fencing	LS	1	\$5,000	\$5,000
Construction Subtotal					\$291,680
	Construction Contingency			30%	\$87,600
	Construction Management			20%	\$58,400
Construction Total:					\$437,700
	Engineering	LS	1	\$100,000	\$100,000
	Environmental and Cultural				
1	Project Management	LS	1	\$5,100	\$5,100
2	Biology and Wetlands	LS	1	\$51,000	\$51,000
3	Cultural Resources	LS	1	\$333,970	\$333,970
4	Air Quality/Emissions	LS	1	\$8,000	\$8,000
5	CEQA - Mitigated Negative Declaration	LS	1	\$10,000	\$10,000
Engineering/Environmental/Cultural Subtotal					\$508,070
	Engineering/Environmental/Cultural Contingency			30%	\$152,500
Engineering/Environmental/Cultural Total:					\$660,600
Total Estimated Project Cost:					\$1,098,300

4.7.2 Annual Operation and Maintenance Cost

Annual operation and maintenance costs under this alternative include expected costs for servicing automation equipment, as well as replacing equipment that is damaged by cattle. In addition to equipment maintenance costs, this alternative includes costs for maintenance of berms as well as additional man hours for monitoring and calibrating automation equipment. Estimated operations and maintenance costs for Alternative 4 are shown in Table 12.

Table 12: Estimated O&M Costs for Alternative 4

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Contractor mobilization and general conditions	LS	1	\$10,000	\$10,000
2	Berm Construction (cut)	YD	25	\$8	\$200
3	Berm Construction (fill)	YD	25	\$10	\$250
6	Compaction Testing	LS	1	\$5,000	\$5,000
8	Soil Moisture Sensors	EA	4	\$800	\$3,200
9	Control and Transmitting Stations	EA	1	\$36,500	\$36,500
	Construction Subtotal				\$55,150
	Construction Contingency			20%	\$11,100
	Equipment Operation and Maintenance	MH	120	\$60	\$7,200
	Total Cost				\$73,500

4.7.3 Rancher Impact

This alternative may allow the ranch to conserve water by avoiding overwatering in each zone. At the same time, the limitations imposed by automation may cause frustration for Mr. Baker, especially early in the implementation of this alternative before the system has been calibrated based on true operating conditions. Under this alternative, the primary impact to Baker Ranch is that his irrigation activities will be limited based on soil moisture. Ultimately, this could lead to a more effective use of irrigation water. Additional Impacts include maintenance of berms, changes in access routes, and risk of cattle injury due to the new topographic features.

4.7.4 Cultural Resources

Under this alternative, the proposed areas of excavation would be significantly reduced from the disturbed areas under Alternative 2. However, the potential for impacts would be based on berms being placed in areas with low cultural sensitivity, such as the grass hillside southwest of the reservoir or near the higher elevations of the other irrigated fields.

For areas with significant disturbances, a cultural resources consultant would still need to do extensive subsurface testing, prepare findings, and obtain permission to construct from the State Historical Preservation Office and Tribal Governments. The time for these reviews would be dependent of the amount of disturbance, and tribal and/or archaeological observers would be required to be onsite during construction.

4.7.5 Technical Feasibility

This alternative is considerably more technically feasible than Alternative 2. The automation programming is feasible, and automated valves, sensors, and data loggers are all “off the shelf”

items. Data monitors that monitor the moisture sensors would be solar powered and could communicate either by radio or cell signal. Additionally, since berms would be constructed to direct flow, rather than contain runoff, they would be built in lower slope areas, and would tend to be parallel to the hillside slope, making them more technically feasible than the berms in Alternative 2.

4.7.6 Constructability

This alternative is considerably more constructable than Alternative 2. Installation of soil moisture sensors and data logging equipment is relatively simple to install by qualified contractors. An electric automated valve would be installed near the pump station power source. Construction of berms would take place in less hilly terrain than Alternative 2 and would be less extensive.

4.7.7 Permit Compliance

Under this alternative, TCSD would be in compliance with the permit requirement to implement a tailwater /runoff control plan.

4.7.8 Schedule

Alternative 4 would take approximately four years to implement. TCSD does not have the funds to pay for environmental consulting, design, and construction costs, thus, TCSD would request funding from the State Revolving Fund to complete this project. Approval of funding would require a mitigated negative declaration, and there is potential for an Environmental Impact Review depending on the result of preliminary cultural studies. Environmental studies are estimated to take up to 36 months for this alternative. The funding approval process can proceed concurrently with the Environmental Assessment and RWQCB review of the preferred project alternative. Alternative 4 is estimated to be completed in 2026, and a preliminary schedule is in Appendix B.

4.7.9 Impacts to Environmental Resources

In addition to the cultural issues described in 4.7.5, there would be the potential to impact biological resources, jurisdiction waterways and wetlands, and a need to evaluate air quality impacts. Potential permits required may include Section 404 Permit (US Army Corps), Section 1602 Streambed Alteration Agreement Permits (CDFW), Stormwater Construction General Permit, Encroachment Permit, Conditional Use Permit. The magnitude of these impacts would be based on where disturbance would occur.

4.7.10 Damage from Cattle

There is potential for damage to the sensors and berms and ditches. Berms would likely need to be 50% rebuilt annually, and approximately a third of the soil moisture sensors would need to be replaced annually. Transmitting stations could be installed with barriers to protect them from cattle.

4.8 Alternative 5 Increased Monitoring

4.8.1 Capital Cost

Capital costs associated with Alternative 5 are estimated to be \$75,000 for upgrades to the network and power supply to accommodate cameras. No other capital costs beyond this are foreseen.

4.8.2 Annual Operation and Maintenance Cost

This alternative would entail increased labor costs, as well as increased lab costs for monitoring and sampling. Estimated operations and maintenance costs for Alternative 5 are shown in Table 13.

Table 13: Estimated O&M Costs for Alternative 5

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Increased Sampling	MH	80	\$60	\$4,800
2	Increased Inspection and Reporting	MH	80	\$60	\$4,800
3	Additional Lab Fees	LS	1	\$5,000	\$5,000
	Total Cost				\$14,600

4.8.3 Rancher Impact

Impacts to the Baker Ranch under this alternative would include increased monitoring and inspection.

4.8.4 Cultural Resources

Under this alternative, there would be no impact to cultural resources.

4.8.5 Technical Feasibility

This alternative is within the technical capabilities of TCSD and is thus technically feasible.

4.8.6 Constructability

Since no construction is required under this alternative, there are no constructability issues.

4.8.7 Permit Compliance

Under this alternative, TCSD believes it could be in compliance with the intent of the permit requirement to implement a tailwater /runoff control plan if the RWQCB is amenable to this solution. While this alternative does not include construction of physical barriers or automated irrigation controls to control tailwater runoff, the increased monitoring, observation, and documentation is a method of controlling tailwater runoff.

4.8.8 Schedule

TCSD could begin implementing this alternative immediately.

4.8.9 Impacts to Environmental Resources

Under this alternative, there would be no direct impacts to environmental resources as there would be no construction. However, over time, the water quality in the Creek may degrade if the issues the tailwater runoff control system is intended to mitigate occur. The increased monitoring would assist in identifying and mitigating any compliance issues early.

4.8.10 Damage from Cattle

There would be potential for sprinkler and irrigation piping to be damaged by cattle, however, there is no increase in risk by implementing this alternative. This risk is lower than all Alternatives and the increased monitoring would help TCSD and the Baker Ranch identify concerns sooner.

5. Alternative Analysis Weighted Decision Matrices

After reviewing each alternative according to the evaluation criteria, each alternative was assigned a score from 1 to 5, with 5 being the most desirable outcome, and 1 being the least desirable outcome. A workshop was held with TCSD to discuss and agree on appropriate weighting for each of the criteria. A weighting score between 1 and 10 (0.1 to 1 for scaling purposes) was assigned to each criterion and was used to modify the score for each alternative relative to TCSD's priorities. The total scores and weighted scores were summed to quantitatively compare the alternatives.

A sub-Alternative Analysis of Alternatives 2A-2D was performed to select the most preferable option for physical runoff barriers to compare to the other alternatives. The preferred alternative from this analysis was then evaluated against the other alternatives to determine the most preferential overall alternative.

5.1 Sub-Alternatives Analysis of Alternatives 2A-2D

5.1.1 Direct Cost Comparison of Alternatives 2A-2D

Table 14 is a compilation of the estimated Capital and O&M costs for Alternatives 2A-2D.

Table 14: Capital and O&M Cost Comparison for Alternatives 2A-2D

Alternative	Capital Cost Estimate	O&M Cost Estimate
Alternative 2A Berms and Infiltration Trenches	\$ 919,400	\$ 54,900
Alternative 2B Concrete Curbing	\$ 1,113,000	\$ 42,400
Alternative 2C Straw Wattles	\$ 617,600	\$ 198,000
Alternative 2D Combination	\$ 1,019,700	\$ 55,600

5.1.2 Weighted Decision Matrix for Alternatives 2A-2D

Table 15 shows the Decision Matrix for evaluating Alternatives 2A-2D.

Table 15: Weighted Decision Matrix for Alternatives 2A - 2D

Evaluation Criteria	Weighting Factor	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Capital Cost	1	1	1	1	1
Annual O&M	9	4	3	1	3
Rancher Impact	2	4	4	5	4
Cultural Resources	7	1	1	5	1
Technical Feasibility	9	2	2	2	2
Constructability	8	1	2	5	3
Permit Compliance	10	5	5	1	5
Schedule	8	1	1	5	2
Impacts to Environmental Resources	7	1	1	5	3
Damage from cattle	7	5	5	1	5
Total Scoring		25	25	31	29
Weighted Score		17.8	17.7	20.5	20.7

5.1.3 Preferred Alternative of Alternatives 2A-2D

The preferred alternative from Alternatives 2A-2D was Alternative 2D: Combination of Alternatives 2A and 2B. This alternative scored the highest in the sub-Alternatives Analysis, as it allows for optimization of physical barriers and avoidance of several areas on the ranch that are rich in cultural resources. This alternative was selected to be evaluated against Alternatives 1 through 5.

5.2 Alternatives Analysis

5.2.1 Direct Cost Comparison of Alternatives 1-5

Table 16 compiles the estimated Capital and O&M costs of the preferred Alternative 2, and Alternatives 1, 3, 4, and 5 into a single table for direct comparison.

Table 16: Capital and O&M Cost Comparison for Alternatives 1-5

Alternative	Capital Cost Estimate	O&M Cost Estimate
Alternative 1 No Action	\$ 0.00	\$ 0.00
Alternative 2 Preferred Alternative 2	\$1,019,700	\$55,600
Alternative 3 Automation	\$ 920,400	\$ 108,500
Alternative 4 Combination of Alts. 2 and 4	\$ 1,098,300	\$ 73,500
Alternative 5 Increased Monitoring	\$ 75,000	\$ 14,600

5.2.2 Weighted Decision Matrix

Table 17 shows the decision matrix used to evaluate and rank all the alternatives.

Table 17: Weighted Decision Matrix

Evaluation Criteria	Weighting Factor	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Capital Cost	1	5	1	2	2	4
Annual O&M	9	5	3	1	2	4
Rancher Impact	2	5	2	2	2	3
Cultural Resources	7	5	1	4	2	5
Technical Feasibility	9	5	2	4	3	5
Constructability	8	5	2	4	3	5
Permit Compliance	10	0	5	5	5	4
Schedule	8	5	2	3	2	5
Impacts to Environmental Resources	7	5	1	4	2	5
Damage from cattle	7	5	2	4	3	5
Total Scoring		45	21	33	26	45
Weighted Score		29	16	24.1	19	31.6

6. Recommended Alternative

6.1 Recommended Alternative

The recommended alternative is Alternative 5, increased monitoring. This alternative could potentially meet the requirements of the RWQCB for a Tailwater/Runoff Control System, but it would require RWQCB approval.

If the RWQCB does not approve of increased monitoring as an acceptable Tailwater/Runoff Control System, we recommend that TCSD take steps to implement Alternative 3. Alternative 3 meets the intent of the Order by controlling tailwater/runoff.

6.2 Discussion

While the Order specifies that berms and ditches should be constructed as part of the tailwater/runoff controls, given the analysis presented herein, it is hoped that the RWQCB will be willing to accept an alternate method for controlling the tailwater/runoff that meets the intent of the Order, but is more feasible for TCSD to implement.

While Alternative 1 had the highest overall score, lowest cost, and lowest overall impacts, this alternative was only evaluated as a CEQA requirement, and does not comply with the requirements of Order R5-2019-0058.

If the RWQCB would be willing to accept increased monitoring as adequate for the tailwater/runoff controls, then TCSD could immediately take action to enact the additional monitoring which would place them in compliance with the Order. Alternative 5 is the least expensive, and most implementable plan.

Since tailwater/runoff, and the possibility of a leaking irrigation lines is a direct result of irrigation operations, a practical and cost-effective method of controlling the tailwater/runoff would be to build operational controls directly into the irrigation system (i.e., Alternative 3). When the irrigation system is not running, there is no tailwater/runoff to contain.

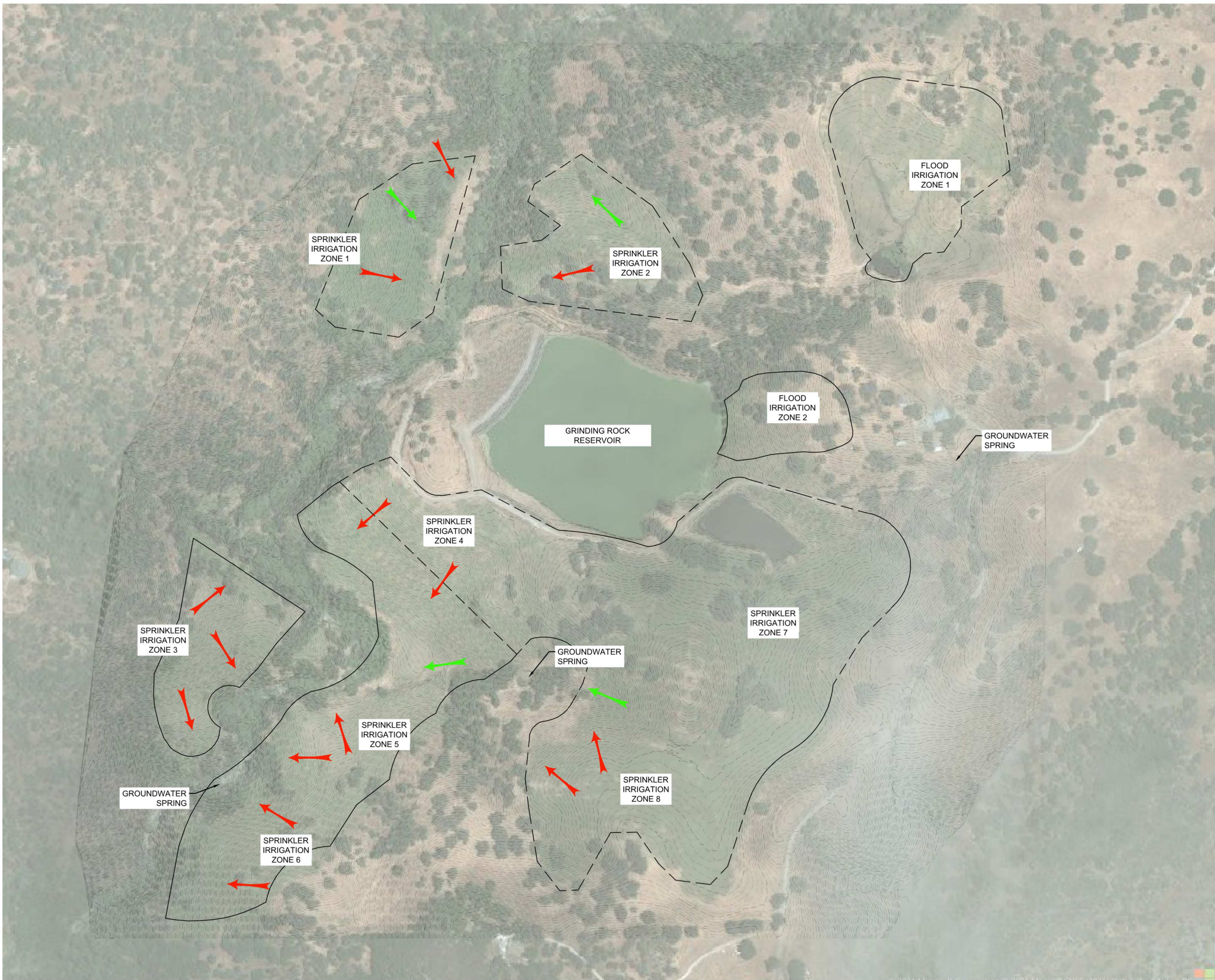
Constructing physical barriers to control runoff (i.e., Alternatives 2A, 2B, 2C, 2D) would comply more directly with the letter of the RWQCB Order, but would require extensive environmental and cultural mitigation and will change seasonal storm water runoff patterns that occur when the ranch is not irrigating.

7. Conclusions and Recommendations

Forsgren recommends that TCSD invite RWQCB representatives to meet with the TCSD team at the Baker Ranch in order to walk the terrain, gain a full understanding of the operational system, and discuss options for site-specific tailwater/runoff controls. If the RWQCB is not able to visit the site, or is not willing to accept additional monitoring as a viable means of controlling tailwater runoff, Forsgren recommends that TCSD commence with a detailed plan to implement Alternative 3.

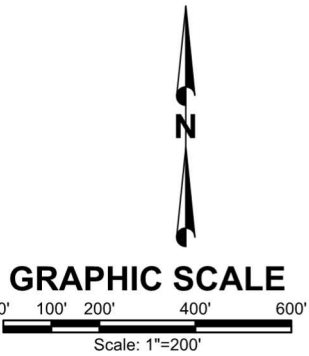
APPENDIX A

EXHIBITS



- NOTES
1. SPRINKLERS ARE ON A 40'X40' GRID
 2. IRRIGATION LINES BEGIN 25'-30' OFF THE IRRIGATION AREA BOUNDARY.

- LEGEND:
- GRAVITY FED IRRIGATION ZONE
 - PUMPED IRRIGATION ZONE
 - SHEET FLOW DRAINAGE DIRECTION
 - CONCENTRATED FLOW DRAINAGE DIRECTION



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OWNER		TCSD		BAKER RANCH					
TCSD TAILWATER ALT. ANALYSIS		ALTERNATIVE 1 NO ACTION							
SHEET NO. EXBT. 1		DATE: NOVEMBER 2021							
PAGE NO. 1 OF 7									

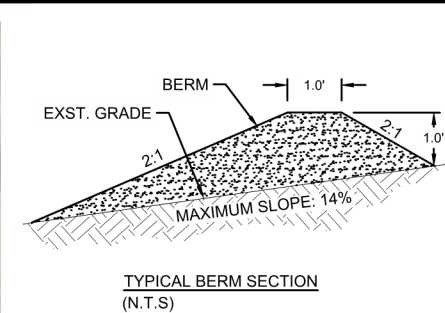
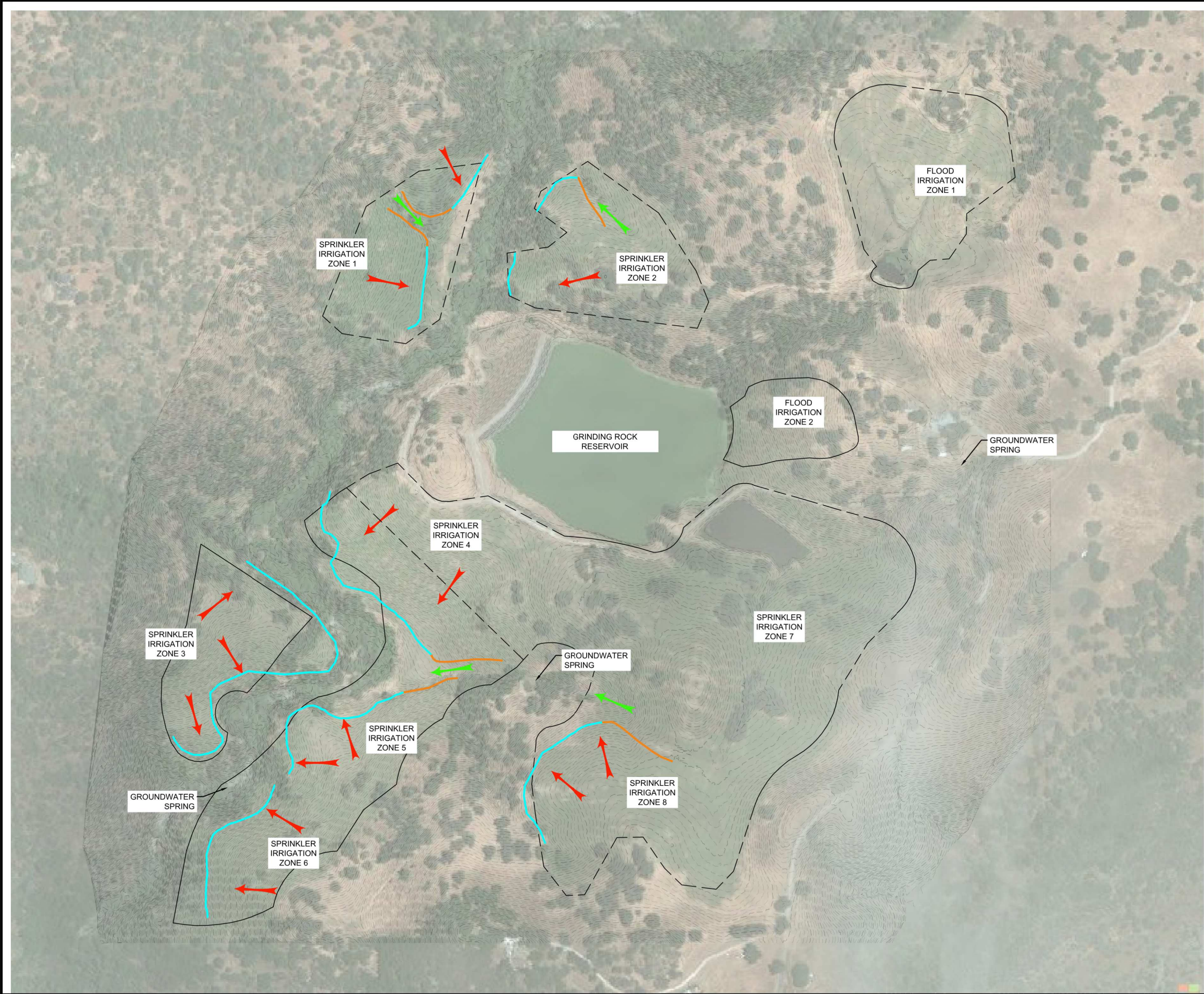
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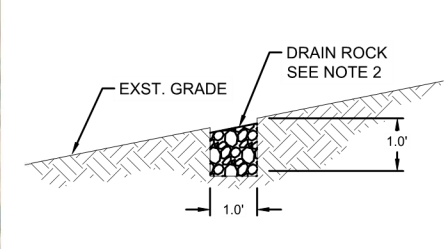
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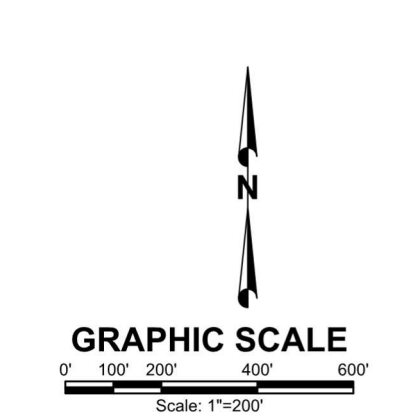
- BERM NOTES**
1. BERMS TO BE CONSTRUCTED USING NATIVE FILL MATERIAL AS MUCH AS PRACTICABLE.
 2. BERMS TO BE COMPACTED TO 90% OF MAXIMUM MODIFIED PROCTOR DENSITY.



- TRENCH NOTES**
1. AVOID COMPACTION OF TRENCH BOTTOM.
 2. DRAIN ROCK MATERIAL FOR INFILTRATION TRENCH SHALL BE WASHED COURSE GRAVEL WITH THE FOLLOWING GRADATION.

SIEVE SIZE	PERCENT PASSING
2-INCH	100
1-1/2 INCH	90-100
1-INCH	20-55
3/4-INCH	0-15
No. 200	0-3

- LEGEND:**
- GRAVITY FED IRRIGATION ZONE
 - PUMPED IRRIGATION ZONE
 - INFILTRATION TRENCH LOCATION
 - BERM LOCATION
 - SHEET FLOW DRAINAGE DIRECTION
 - CONCENTRATED FLOW DRAINAGE DIRECTION



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APPROVED BY AD	NO.
QA/QC BY PW	

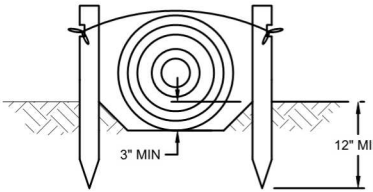
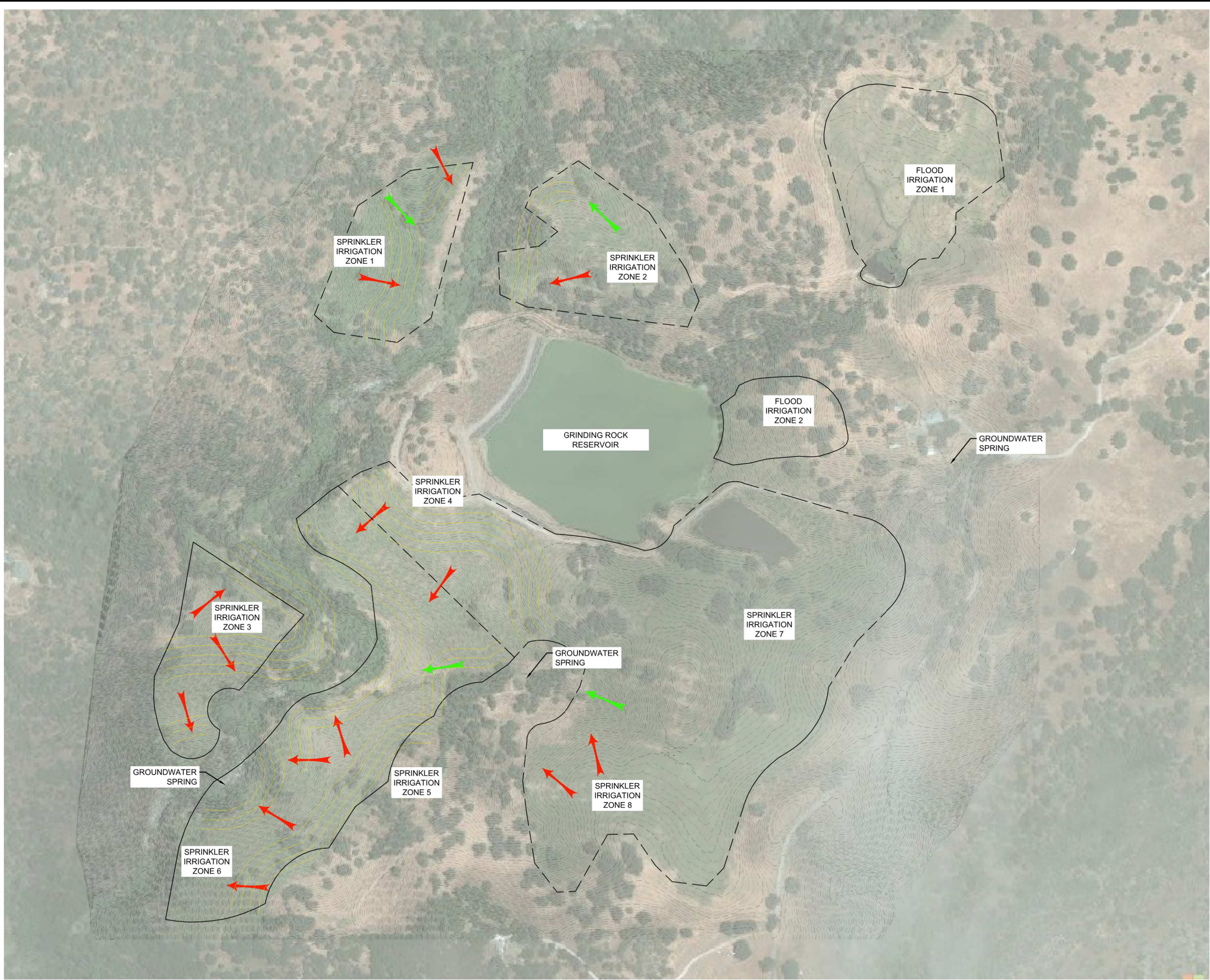
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TCSD TAILWATER ALT. ANALYSIS
ALTERNATIVE 2A
BERMS AND TRENCHES

SHEET NO: EXBT. 2A
DATE: NOVEMBER 2021
PAGE NO: 2 OF 7



TYPICAL STRAW WATTLE SECTION

- NOTES
- 1. WATTLES TO BE STAKED EVERY 4 FT.
 - 2. STAKES TO EXTEND 3" ABOVE WATTLE.

LEGEND:

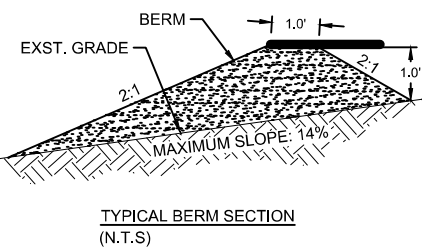
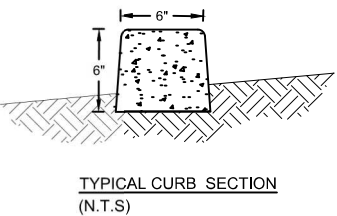
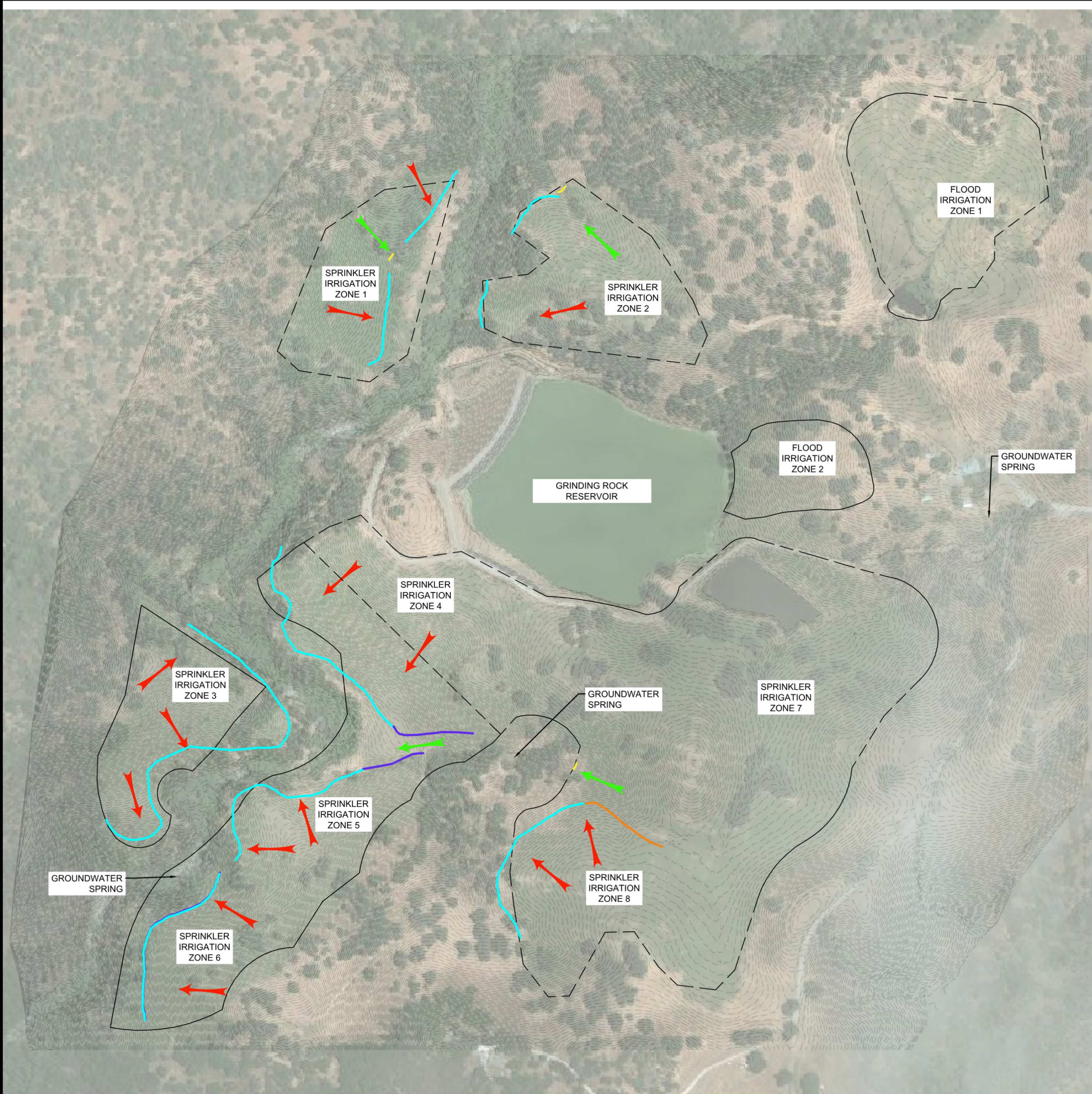
	GRAVITY FED IRRIGATION ZONE
	PUMPED IRRIGATION ZONE
	STRAW WATTLE LOCATION
	SHEET FLOW DRAINAGE DIRECTION
	CONCENTRATED FLOW DRAINAGE DIRECTION

GRAPHIC SCALE

0' 100' 200' 400' 600'

Scale: 1"=200'

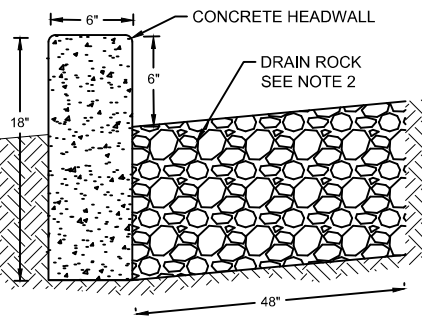
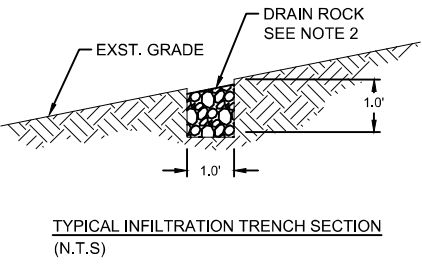
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TCSD TAILWATER ALT. ANALYSIS		SHEET NO: EXBT. 2C					
ALTERNATIVE 2C		DATE: NOVEMBER 2021					
STRAW WATTLES		PAGE NO: 4 OF 7					



LEGEND:

- GRAVITY FED IRRIGATION ZONE
- PUMPED IRRIGATION ZONE
- INFILTRATION TRENCH LOCATION
- BERM LOCATION
- CURB LOCATION
- HEADWALL/INFILTRATION GALLERY LOCATION
- SHEET FLOW DRAINAGE DIRECTION
- CONCENTRATED FLOW DRAINAGE DIRECTION

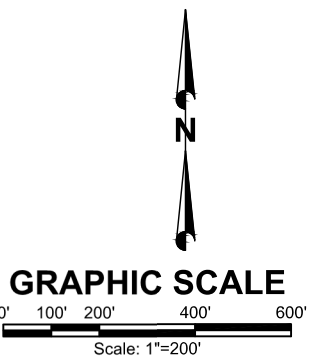
- BERM NOTES:
- BERMS TO BE CONSTRUCTED USING NATIVE FILL MATERIAL AS MUCH AS PRACTICABLE.
 - BERMS TO BE COMPACTED TO 90% OF MAXIMUM MODIFIED PROCTOR DENSITY.



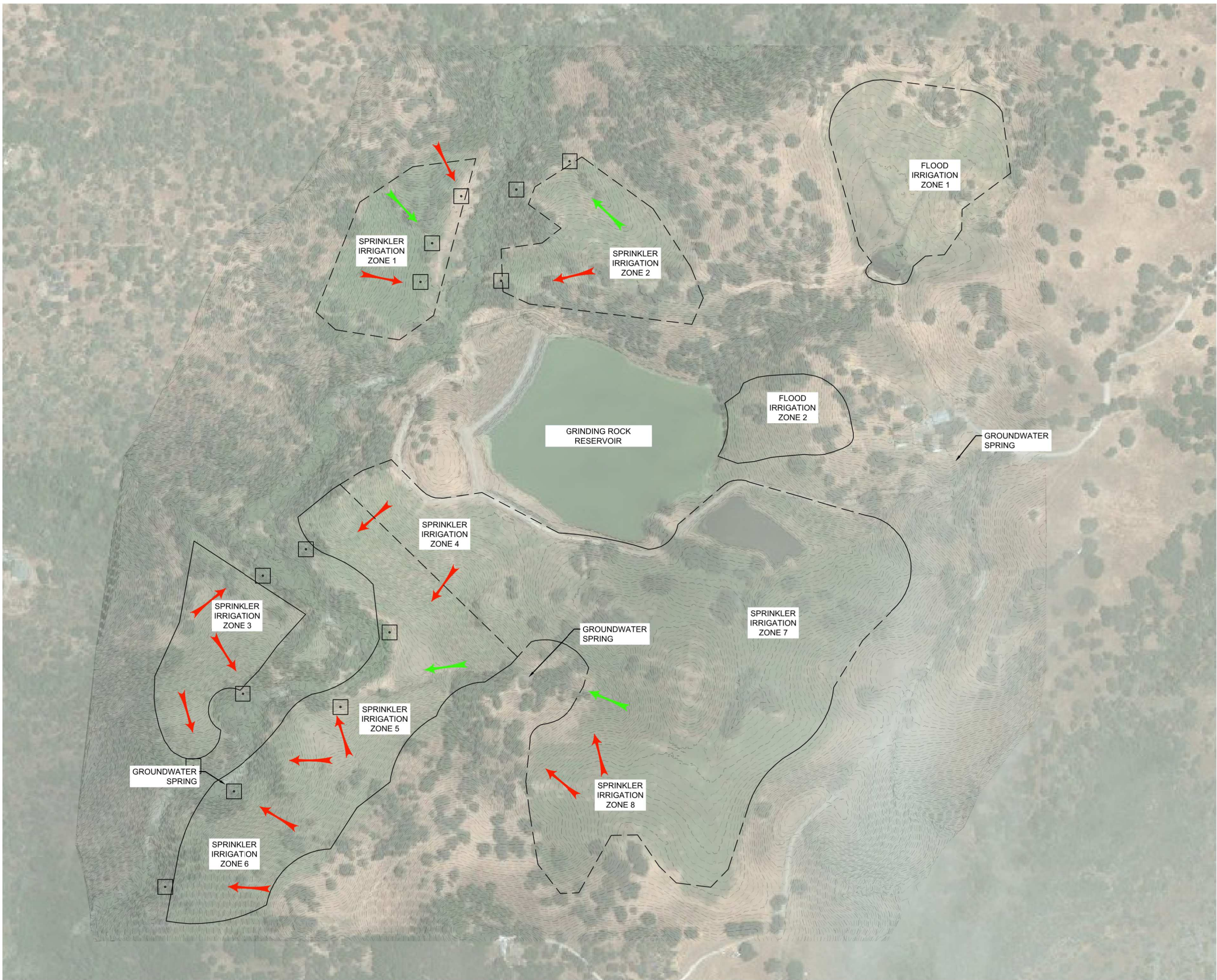
HEADWALL/ INFILTRATION GALLERY & TRENCH NOTES:

- AVOID COMPACTION OF INFILTRATION GALLERYAND TRENCH BOTTOM.
- DRAIN ROCK MATERIAL FOR INFILTRATION GALLERY AND TRENCH SHALL BE WASHED COURSE GRAVEL WITH THE FOLLOWING GRADATION.

SIEVE SIZE	PERCENT PASSING
2-INCH	100
1-1/2 INCH	90-100
1-INCH	20-55
3/4-INCH	0-15
No. 200	0-3



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TCSD TAILWATER ALT. ANALYSIS		ALTERNATIVE 2D		COMBINATION	
SHEET NO. EXBT. 2D		DATE: NOVEMBER 2021		PAGE NO. 5 OF 7	



LEGEND:

GRAVITY FED IRRIGATION ZONE

PUMPED IRRIGATION ZONE

SHEET FLOW
DRAINAGE DIRECTION

CONCENTRATED FLOW
DRAINAGE DIRECTION

SOIL MOISTURE SENSOR

- NOTES:**
1. MOISTURE SENSORS TO BE PLACED IN AREAS DOWN GRADIENT FROM IRRIGATION ZONES AND UP GRADIENT FROM TURNBACK CREEK WHERE EXCESS SURFACE DRAINAGE PRESENTS A RISK OF DISCHARGE TO TURNBACK CREEK.
 2. FLOW THAT IS PUMPED TO IRRIGATION ZONES WILL BE CONTROLLED BY MOISTURE SENSORS THAT SEND ALARMS TO SHUT OFF PUMP WHEN EXCESS SURFACE MOISTURE IS DETECTED.
 3. LEAK DETECTION OF FORCE MAINS WILL BE IMPLEMENTED BY PRESSURE TRANSDUCERS THAT WILL SEND ALARMS TO SHUT OFF PUMPS WHEN LOW PRESSURES ARE DETECTED DUE TO PIPE RUPTURES.
 4. FLOW TO GRAVITY IRRIGATION WILL BE CONTROLLED BY MOISTURE SENSORS THAT SEND ALARMS TO CLOSE AUTOMATIC VALVE WHEN EXCESS SURFACE MOISTURE IS DETECTED.

GRAPHIC SCALE

0' 100' 200' 400' 600'

Scale: 1"=200'

GRAPHIC SCALE

0' 100' 200' 400' 600'

Scale: 1"=200'

PROJECT NO. 07-21-0085

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APPROVED BY AD

QA/QC BY PW

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TCSD

BAKER RANCH

TCSD TAILWATER ALT. ANALYSIS

ALTERNATIVE 3

AUTOMATED IRRIGATION

SHEET NO. EXBT. 3

DATE: NOVEMBER 2021

PAGE NO. 6 OF 7

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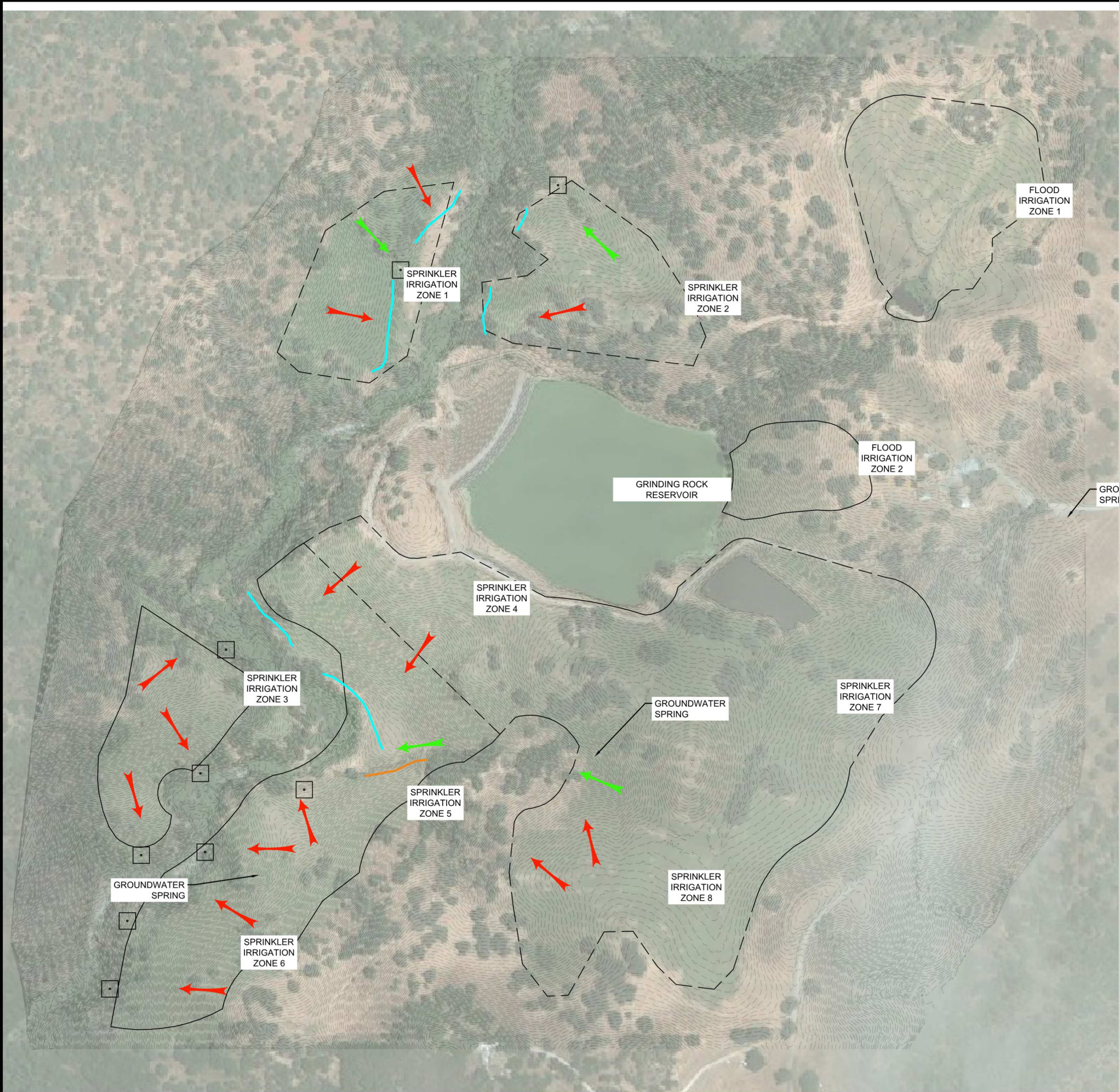
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REVISIONS

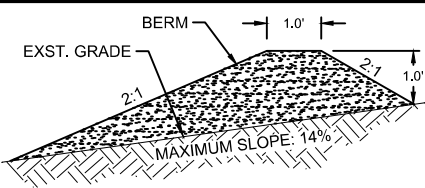
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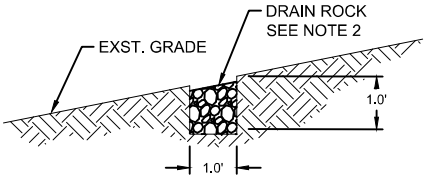
- NOTES:**
1. MOISTURE SENSORS TO BE PLACED IN AREAS DOWN GRADIENT FROM IRRIGATION ZONES AND UP GRADIENT FROM TURNBACK CREEK WHERE EXCESS SURFACE DRAINAGE PRESENTS A RISK OF DISCHARGE TO TURNBACK CREEK.
 2. FLOW THAT IS PUMPED TO IRRIGATION ZONES WILL BE CONTROLLED BY MOISTURE SENSORS THAT WILL SEND ALARMS TO SHUT OFF PUMP WHEN EXCESS SURFACE MOISTURE IS DETECTED.
 3. LEAK DETECTION OF FORCE MAINS WILL BE IMPLEMENTED BY PRESSURE TRANSDUCERS THAT WILL SEND ALARMS TO SHUT OFF PUMPS WHEN LOW PRESSURES ARE DETECTED DUE TO PIPE RUPTURES.
 4. FLOW TO GRAVITY IRRIGATION WILL BE CONTROLLED BY MOISTURE SENSORS THAT SEND ALARMS TO CLOSE AUTOMATIC VALVE WHEN EXCESS SURFACE MOISTURE IS DETECTED.



TYPICAL BERM SECTION
(N.T.S.)

BERM NOTES

1. BERMS TO BE CONSTRUCTED USING NATIVE FILL MATERIAL AS MUCH AS PRACTICABLE.
2. BERMS TO BE COMPACTED TO 90% OF MAXIMUM MODIFIED PROCTOR DENSITY.



TYPICAL INFILTRATION TRENCH SECTION
(N.T.S.)

TRENCH NOTES

1. AVOID COMPACTION OF TRENCH BOTTOM.
2. DRAIN ROCK MATERIAL FOR INFILTRATION TRENCH SHALL BE WASHED COURSE GRAVEL WITH THE FOLLOWING GRADATION.

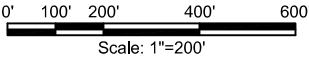
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2-INCH	100
1-1/2 INCH	90-100
1-INCH	20-55
3/4-INCH	0-15
No. 200	0-3

LEGEND:

- GRAVITY FED IRRIGATION ZONE
- PUMPED IRRIGATION ZONE
- SHEET FLOW DRAINAGE DIRECTION
- CONCENTRATED FLOW DRAINAGE DIRECTION
- INFILTRATION TRENCH LOCATION
- BERM LOCATION
- SOIL MOISTURE SENSOR



GRAPHIC SCALE



PROJECT NO. 07-21-0085		DATE	
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DESIGNED	DATE	REVISIONS	
APPROVED	DATE	NO.	
QA/QC	DATE	NO.	

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TCSD TAILWATER ALT. ANALYSIS
ALTERNATIVE 4
AUTOMATED IRRIGATION & BARRIERS

SHEET NO. EXBT. 4

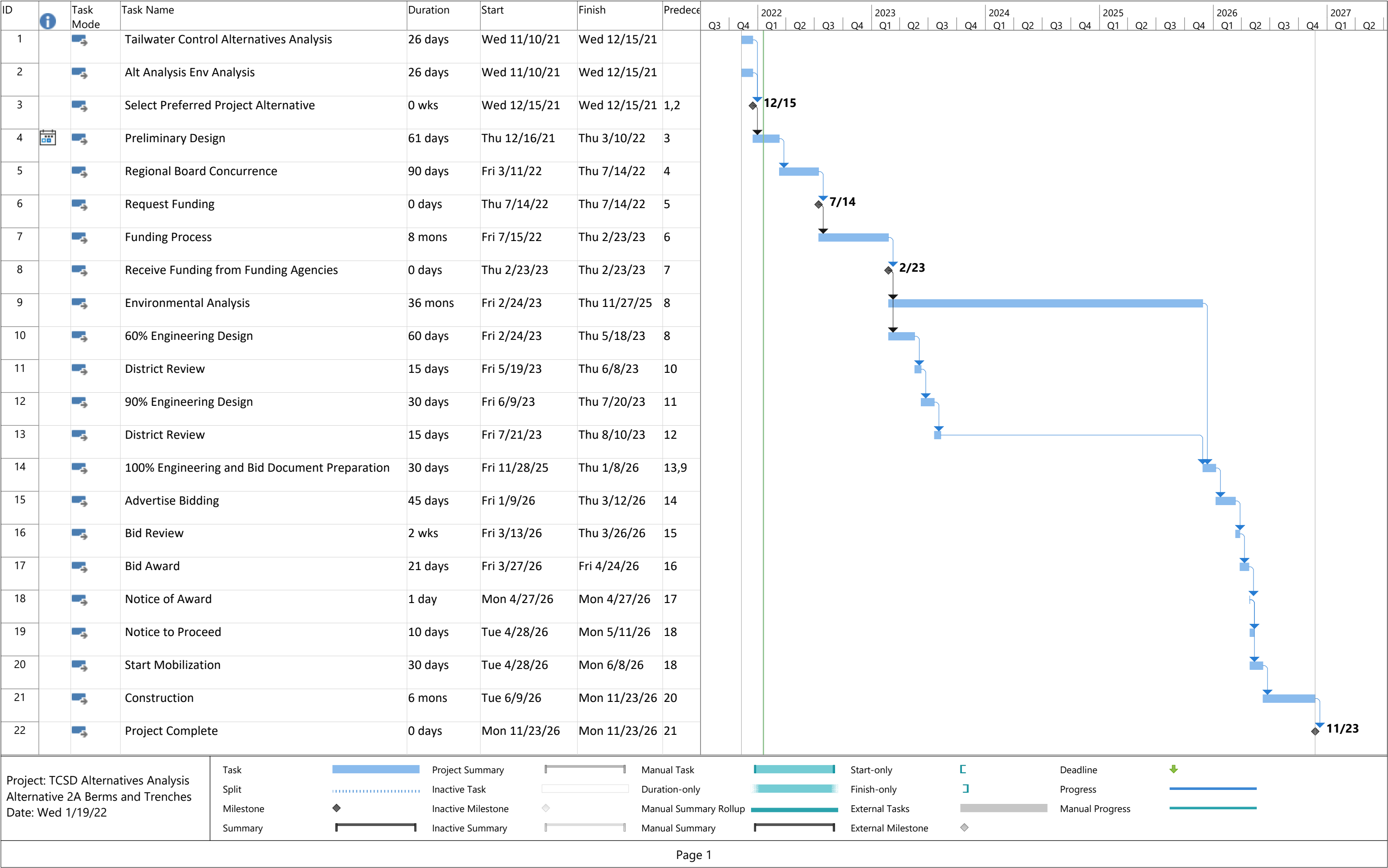
DATE: NOVEMBER 2021

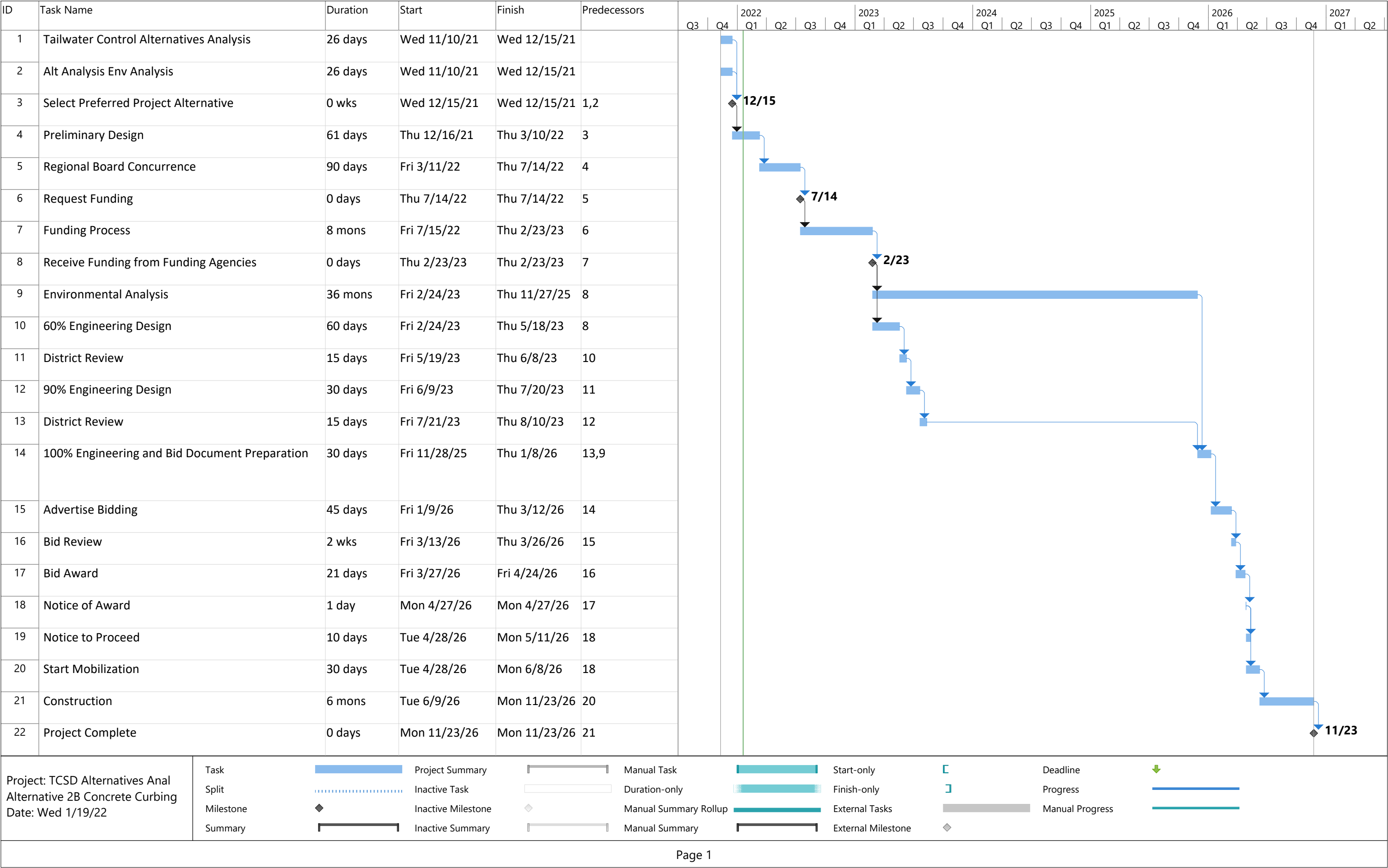
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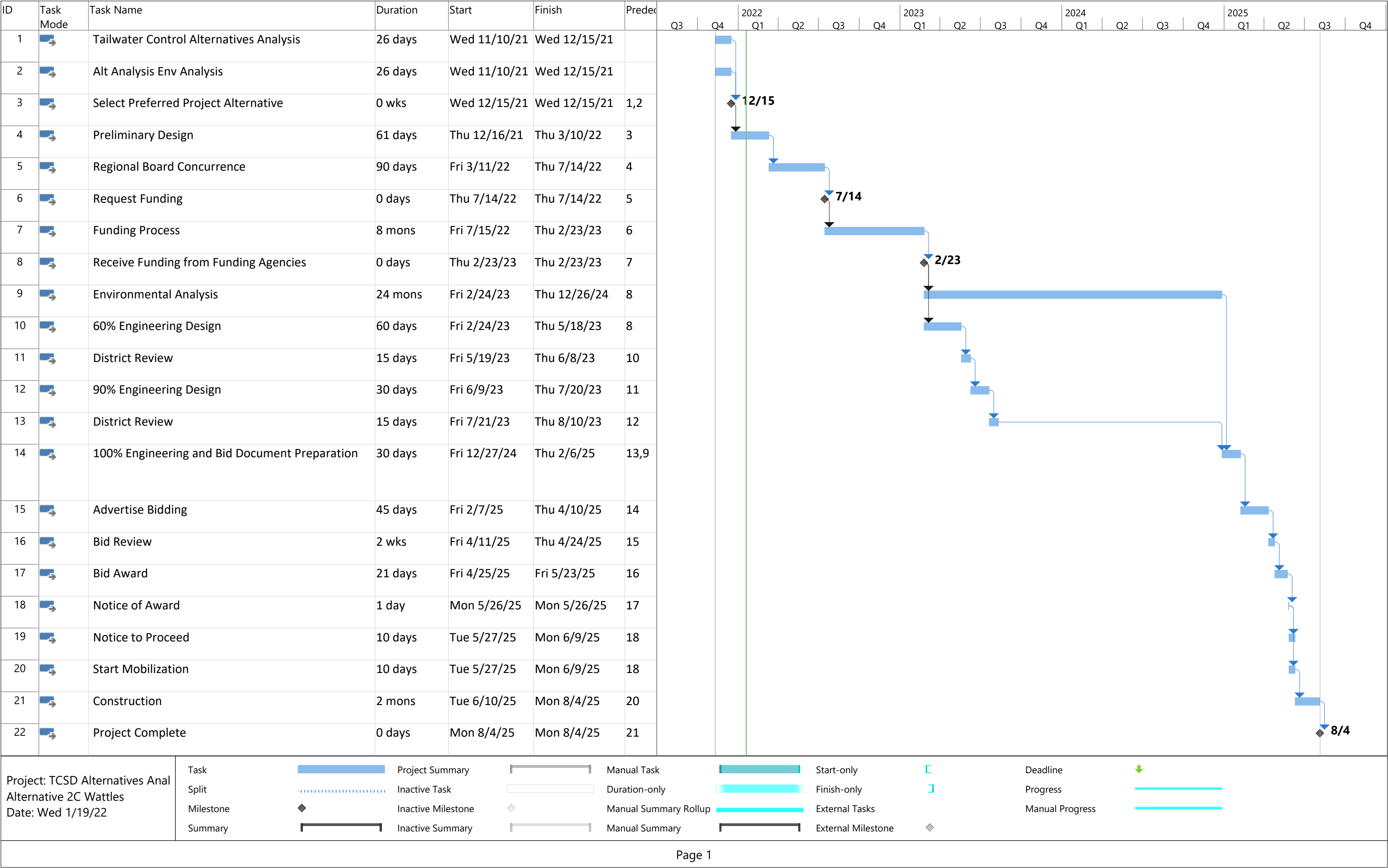
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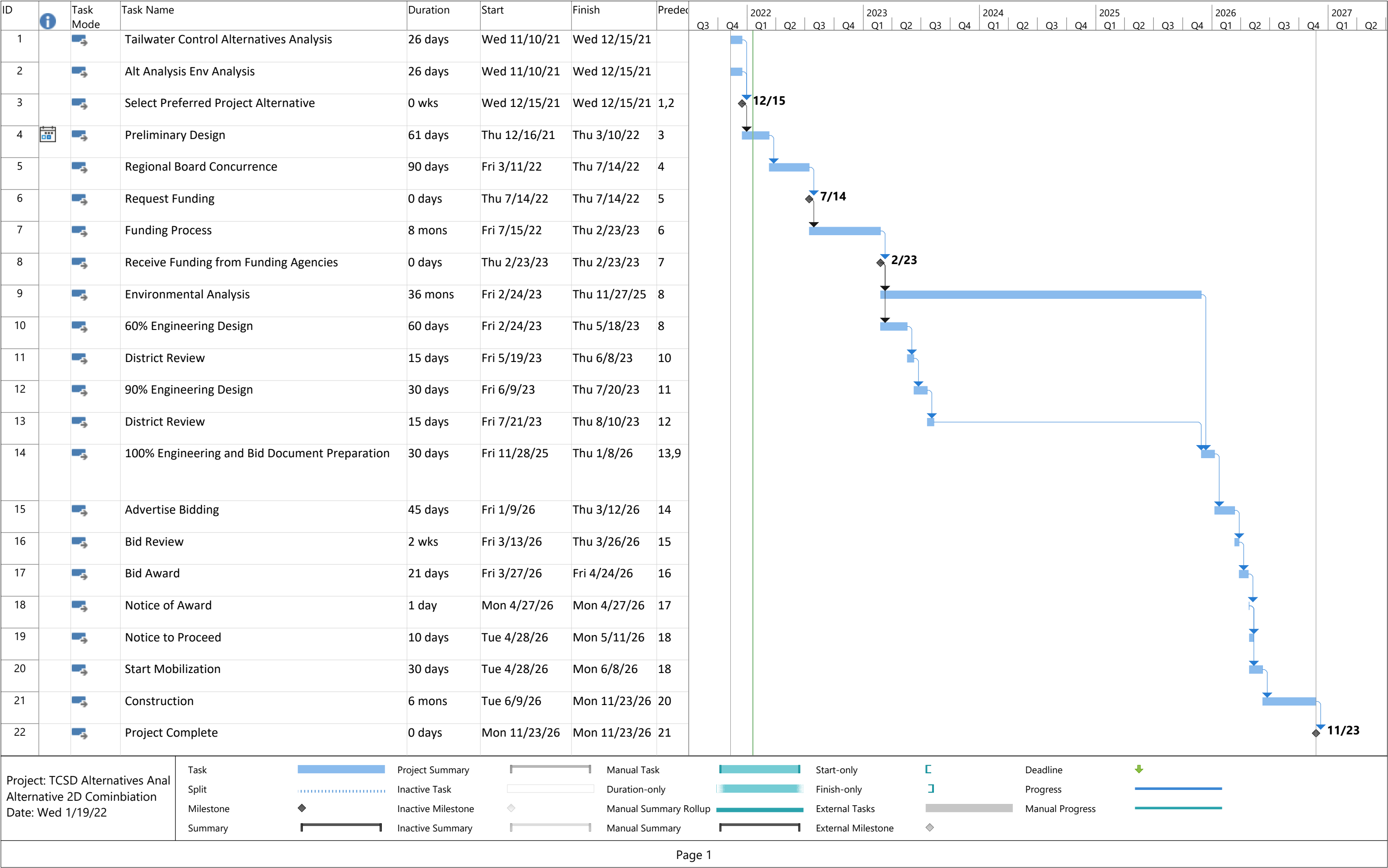
APPENDIX B

SCHEDULES



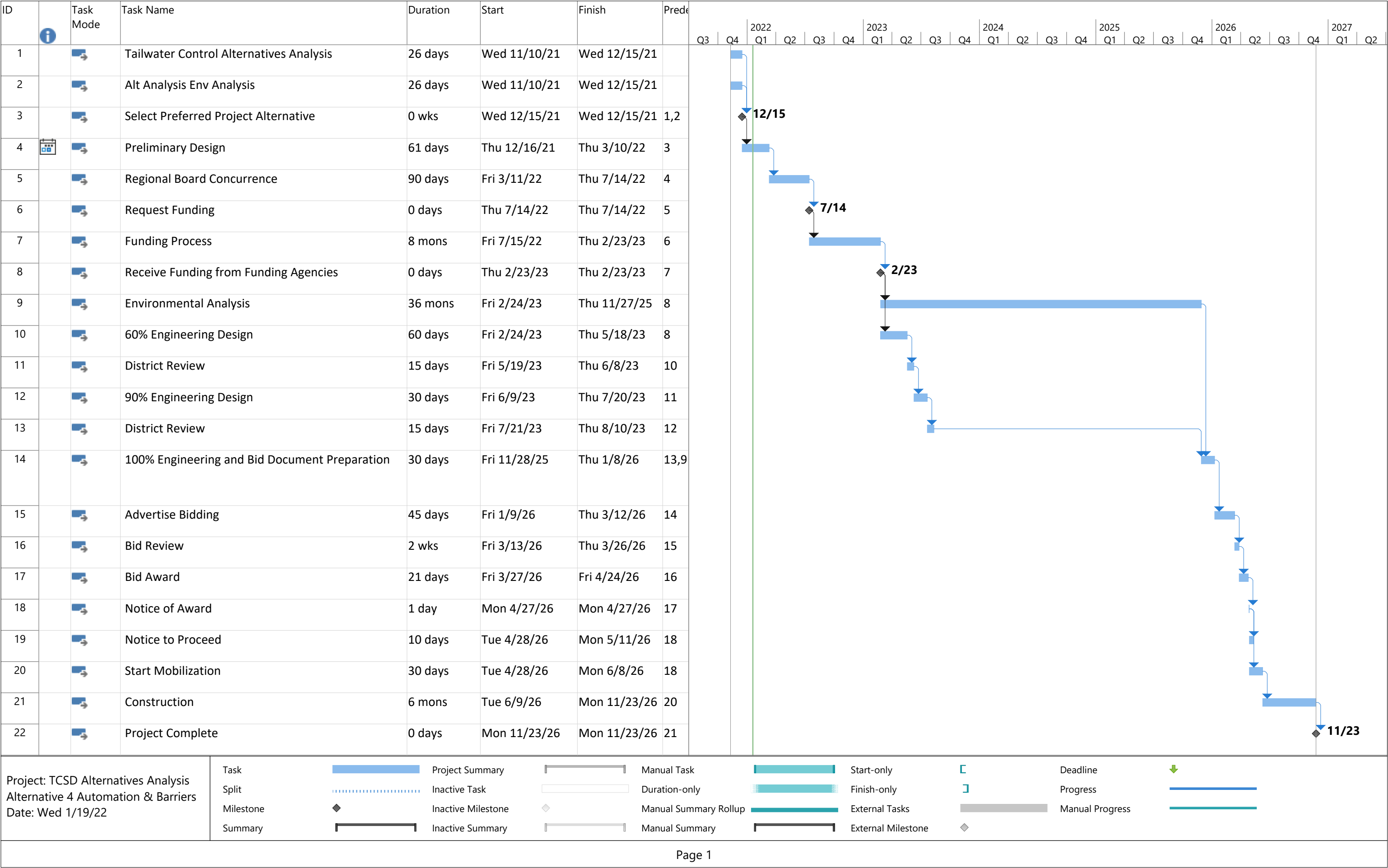




Start-onlyFinish-onlyExternal TasksExternal MilestoneDeadlineProgressManual Progress

Page 1

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors																												
1			Tailwater Control Alternatives Analysis	26 days	Wed 11/10/21	Wed 12/15/21																													
2			Alt Analysis Env Analysis	26 days	Wed 11/10/21	Wed 12/15/21																													
3			Select Preferred Project Alternative	0 wks	Wed 12/15/21	Wed 12/15/21	1,2																												
4			Preliminary Design	61 days	Thu 12/16/21	Thu 3/10/22	3																												
5			Regional Board Concurrence	90 days	Fri 3/11/22	Thu 7/14/22	4																												
6			Request Funding	0 days	Thu 7/14/22	Thu 7/14/22	5																												
7			Funding Process	8 mons	Fri 7/15/22	Thu 2/23/23	6																												
8			Receive Funding from Funding Agencies	0 days	Thu 2/23/23	Thu 2/23/23	7																												
9			Environmental Analysis	6 mons	Fri 2/24/23	Thu 8/10/23	8																												
10			60% Engineering Design	60 days	Fri 2/24/23	Thu 5/18/23	8																												
11			District Review	15 days	Fri 5/19/23	Thu 6/8/23	10																												
12			90% Engineering Design	30 days	Fri 6/9/23	Thu 7/20/23	11																												
13			District Review	15 days	Fri 7/21/23	Thu 8/10/23	12																												
14			100% Engineering and Bid Document Preparation	30 days	Fri 8/11/23	Thu 9/21/23	13,9																												
15			Advertise Bidding	45 days	Fri 9/22/23	Thu 11/23/23	14																												
16			Bid Review	2 wks	Fri 11/24/23	Thu 12/7/23	15																												
17			Bid Award	21 days	Fri 12/8/23	Fri 1/5/24	16																												
18			Notice of Award	1 day	Mon 1/8/24	Mon 1/8/24	17																												
19			Notice to Proceed	10 days	Tue 1/9/24	Mon 1/22/24	18																												
20			Start Mobilization	30 days	Tue 1/9/24	Mon 2/19/24	18																												
21			Construction	4 mons	Tue 2/20/24	Mon 6/10/24	20																												
22			Project Complete	0 days	Mon 6/10/24	Mon 6/10/24	21																												
Project: TCSD Alternatives Anal Alternative 3 Automation Date: Wed 1/19/22			Task Split Milestone Summary	 	Project Summary Inactive Task Inactive Milestone Inactive Summary	 	Manual Task Duration-only Manual Summary Rollup Manual Summary	 	Start-only Finish-only External Tasks External Milestone	 	Deadline Progress Manual Progress	 																							
Page 1																																			



APPENDIX C

PRELIMINARY CULTURAL SURVEY MAP

PATRICK GIS GROUP, INC.

April 9, 2021

Amy Augustine
Augustine Planning Associates, Inc.
270 Barretta St., Suite C
Sonora, CA 95370

Re: Tuolumne City Sanitary District and Baker Ranch Tailwater / Runoff Control Project

Dear Ms. Augustine,

This letter summarizes the preliminary results of our cultural resources constraints analysis conducted for the Tuolumne City Sanitary District and Baker Ranch Tailwater / Runoff Control Project (Project) in Tuolumne County, California. The Tuolumne City Sanitary District (TCSD, District) is proposing to control runoff of tailwater at its land application facility, Baker Ranch, near Tuolumne City as part of a new Permit issued by the California Regional Water Quality Control Board, Central Valley Region (RWQCB) as implemented under Order R5-2019-0058 (Water Discharge Requirements). Depending on the construction requirements for the project, as dictated by the final design, there will be a number of additional permits required which may include, but are not limited to the following:

- Approval of Plans (Division of Dam Safety)
- Section 404 Permit (US Army Corps)
- Stormwater Construction General Permit
- Encroachment Permit
- Conditional Use Permit
- Section 1602 Streambed Alteration Agreement Permits (CDFW)

The undertaking is subject to compliance with Section 106 of the National Historic Preservation Act of 1966 (16 USC 470) and the implementing regulations set forth in 36 CFR 60 and 36 CFR 800. As such, compliance with Section 106 shall satisfy the requirements of CEQA Sections 21083.2 and 21084.1 as written in the Public Resources Code (PRC) Sections 21000 et seq. and the Guidelines for implementing the statute codified in the California Code of Regulations (CCR), Title 14, Chapter 3, Section 15000 et seq., if necessary.

The scope of work included a records search at the Central California Information Center, California State University, Stanislaus to identify previously recorded resources and studies in and within a one-quarter mile radius of the project area; coordination with the Native American Heritage Commission (NAHC) and parties listed on the Native American Contact List (the latter shall be conducted by Augustine Planning

and Associates, Inc. [Augustine] and the District to satisfy Section 106 and AB52 obligations with the assistance of Patrick GIS); pre-field meeting with Augustine and the District on-site; meetings; an intensive pedestrian survey of the Project area (approximately 100 acres) and preliminary recordation of cultural resources; and preparation of this letter report.

Once the final route and Area of Direct Impact (ADI) for the Project has been identified, Patrick GIS will make a return visit to cultural resources identified within the ADI to complete a formal documentation of the resources and prepare an Archaeological Survey Report to be submitted to the District.

Records Search

Record search requests were submitted on December 4 and December 11, 2020 as the project boundary was modified and required additional areas be included in the record search. One historic resource, P-55-003863 an historic-era ditch, was identified within the parcel but is located west of the project area. Seven resources were identified within one quarter mile of the project area: P-55-001394, -1395, -2267, -2268, -3861, -3682, and -4511. Three reports were identified in the project area: TO-01572, -07479, -08597. One report was identified within the one quarter mile radius of the project area, TO-06012. The 1876 General Land Office Plat indicates a house on the parcel and Simpsons Enclosure intersecting the project area. No evidence of the 1876 resources was observed. (Attachment 1)

Native American Outreach

Patrick GIS requested a Sacred Lands File Search and a contact list of tribal representatives on file with the Native American Heritage Commission (Commission) on December 4, 2020. The results were negative. Letters dated February 12, 2021 were sent to representatives on the contact list to request preliminary information relevant to the project. Follow-up consultation and outreach will be conducted by Augustine Planning on behalf of the District.

Survey

The field inventory was conducted on February 18, 20, and March 10, 2021 by Senior Archaeologist and GIS Analyst, Ian Patrick of Patrick GIS. Twenty-five features were identified, within the boundary of the historic-era Baker Ranch complex, which intersects the Project Area (Table 1). An additional eight artifacts were noted. With regards to the features, nine were prehistoric features and the remainder were historic-era in nature. All of the prehistoric features were comprised of bedrock mortars with no visible surface artifacts; however, dense vegetation impeded visibility in some areas and previous agricultural modification indicated portions of the Project area has been disturbed. Historic-era resources all appear to be associated with the Baker Ranch and/or possibly mining activity (e.g. ditches). In addition, 10 isolated finds were encountered of indeterminate age. Further archival research may determine two of these to be historic-era linear resources (i.e. ditches and roads). It should also be noted that two additional bedrock mortars were identified adjacent to the Project area.

Findings and Interpretations

Upon initial findings, it should be noted that the boundaries of the prehistoric resources cannot be determined without further analysis. Additional studies may refine several loci (concentrations of activity)

within the Baker Ranch or prove to be separate sites; however, at this time, it appears that the area is a large prehistoric complex and has been treated as such.

As for the Baker Ranch, features and artifacts likely represent continued use of the site dating to various periods in history, including modern use. Features and artifacts associated with a potentially eligible site must be viewed in light of the whole resource and requires further study.

Recommendations: Extended Identification Efforts and Evaluations

The following recommendations are contingent upon design plans and impacts. Dependent upon the findings and results of supplemental archival research and additional field visits, the Consultant(s) may recommend extended identification efforts to determine the presence/absence of subsurface deposits and/or delineate site boundaries. Prehistoric resources should be studied in more detail, surface survey is not indicative of subsurface deposits and will likely require excavation efforts to define the extent of any potential deposits. This would entail Extended Phase I exploration to identify if intact subsurface deposits are present. If so, a Phase II testing evaluation effort may ensue if resources cannot be avoided. For the historic-era Baker Ranch, we recommend an evaluation of the resources present within the Project area to identify if they are contributing elements of a potentially eligible historic property. This task is not included in the current budget. No evaluations of resources are included at this time. A separate budget will be prepared upon completion of the survey if resources cannot be avoided.

Task 4. Technical Report(s)

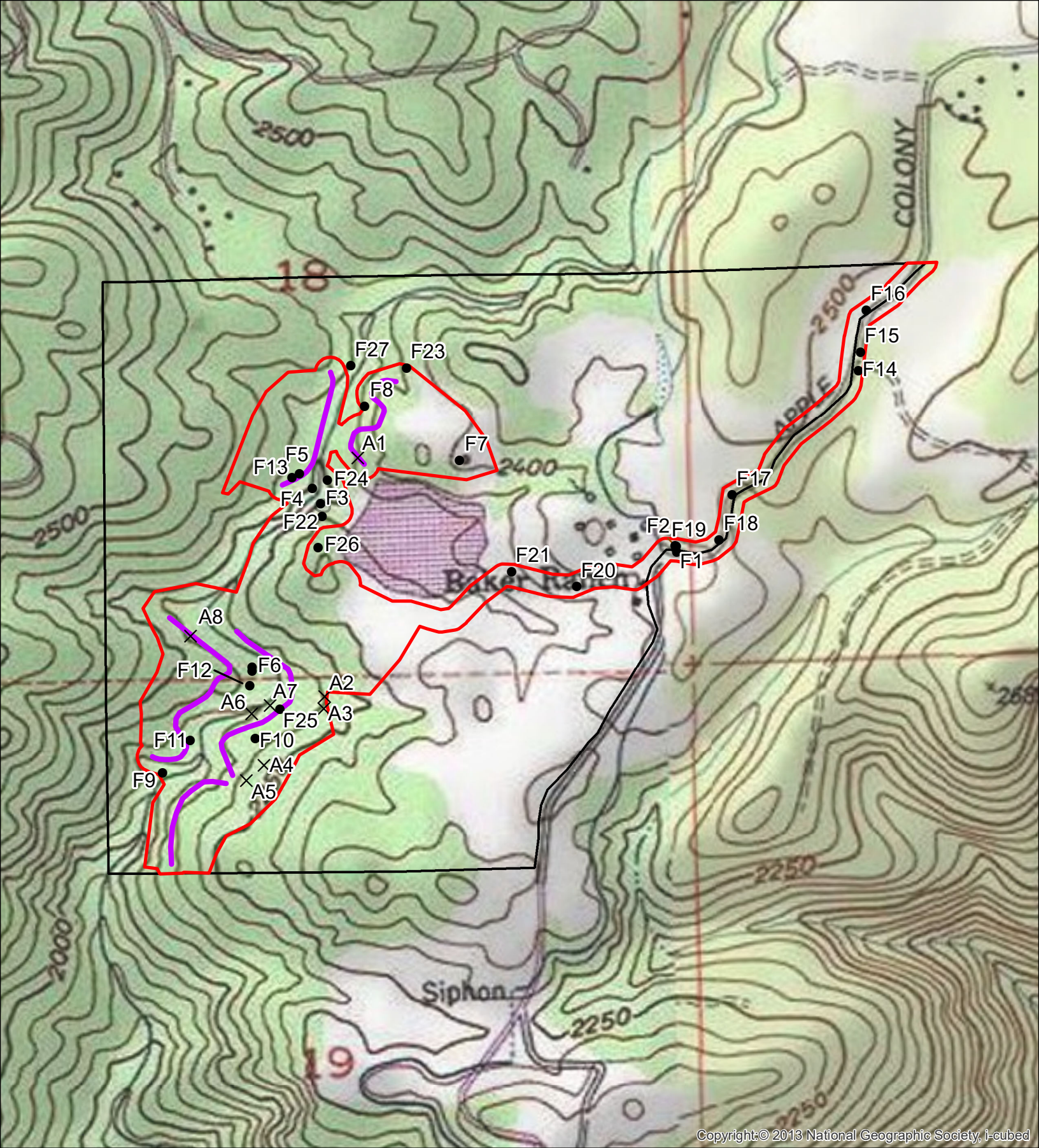
The Consultant(s) will prepare a Cultural Resources Inventory Report, commensurate with the project findings. Deliverables will include electronic copies of the draft reports and attachments via email or Dropbox to the Client and Lead Agency. A total of one draft and the final will be prepared, allowing for the Client and the Agency one review. The final report will be submitted electronically unless otherwise requested. One unbound report copy will be provided to the CCalC as required by their research agreement.

If you have any questions or concerns please feel free to contact me.

Sincerely,



Melinda Patrick, Principal

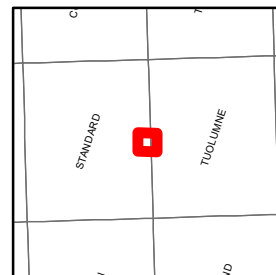
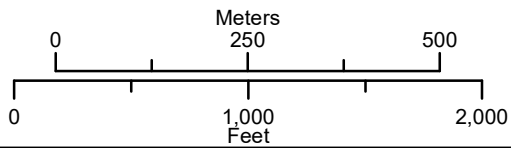


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Tuolumne City Tailwater/ Runoff Control System,
Standard (1987), Tuolumne (1979) USGS Quadrangle,
T1N R16E Sec. 17,18,19 MDBM
Tuolumne County, CA

- × Artifact in site
- Feature in site
- Study Area
- Proposed Berms

1 inch = 250 meters



Map by Patrick GIS Group, Inc. (2021)

APPENDIX D

ENVIRONMENTAL ANALYSIS PROPOSAL



Augustine Planning Associates, Inc.

Proposal to Prepare Environmental Analysis for for Tailwater / Runoff Control Alternatives Tuolumne City Sanitary District

A. UNDERSTANDING

The following proposal is based on “Alternatives Analysis Tailwater / Runoff Control Draft Version 2” dated November 10, 2021, by Forsgren Associates, Inc. for the Tuolumne City Sanitary District (TCSD).

The purpose of the Alternatives Analysis is to assist TCSD in deciding how to comply with Items 13 and 21, as well as Provision 1.b from Order R5-2019-0058 Waste Discharge Requirements issued by the California Regional Water Quality Control Board (RWQCB) Central Valley Region on June 7, 2019, for the Baker Ranch. These items require TCSD to implement a tailwater runoff control system intended to prevent irrigation runoff from Baker Ranch from discharging into Turnback Creek.

The following alternatives are being considered:

Alternative 1: No action

Alternative 2: Physical runoff barriers
2A Berms and infiltration trenches
2B Concrete curbing
2C Straw wattles
2D Combination of above

Alternative 3: Automatic operational runoff controls using sensors, shut-off valves, and monitoring cameras rather than physical barriers (requires trenching for sensors)

Alternative 4: Combination of Alternatives 2, 3 (and possibly 5).

Alternative 5: No changes with increased monitoring.

One or a combination of the preceding will be adopted and become the project design.

It is assumed that TCSD will be the CEQA Lead Agency for the project and that the RWQCB will be a CEQA Responsible Agency. It is further assumed that environmental evaluation will not be required for Alternatives 1 and 5.

Should funding sources secured for the project include federal funds, APA anticipates preparing a CEQA Plus document (federal crossover checklist and documentation) in addition to the identified

environmental document.

The APA Team includes:

Task Description	APA Team Member
Project Management	Augustine Planning Associates, Inc. (APA)
Biological Studies	Augustine Planning Associates, Inc. (APA)
CEQA Documentation	Augustine Planning Associates, Inc. (APE)
Wetlands Delineations, Studies, Permitting	Area West Environmental (AWE)
Air Quality/Greenhouse Gas Study	KdAnderson Transportation Engineers (KDA)
Cultural Resources	Far Western Anthropological Research Group, Inc. with Foothill Resources Ltd. (FW)

B. SCOPE OF WORK

Task 1.0 Project Initiation/Project Management (Alternatives 2-4)

Subtask 1.1 Ongoing Meetings (APA)

APA will meet with Forsgren/TCSD to identify any potential changes in the project scope and finalize the scope and budget for the proposed project (up to 2 meetings). Upon preparation of a project scope, ongoing meetings will be held between APA and Forsgren/TCSD (this scope provides for up to 3 additional meetings).

Subtask 1.2 Coordination (APA)

APA will be responsible for overseeing the completion of work by all subconsultants.

Task 2.0 Biological (Alternatives 2-4)/Wetlands (As needed)

Subtask 2.1 Background Data - Biological Study (APA)

APA will refresh background data gathered in preparing the Draft Biological Study (i.e., obtain updated US Fish and Wildlife Service, California Department of Fish and Wildlife, and California Native Plant Society species lists. This task assumes no significant new or different information will be identified (e.g., newly listed species). The Draft Biological Study will be updated accordingly.

Subtask 2.2 Wetlands and Other Waters of the United States (AWE) - Aquatic Resources Delineation

If the project encroaches within any portion of wetlands or other waters of the United States (WOTUS) or jurisdictional areas governed by the California Department of Fish and Wildlife (including riparian zones adjacent to wetlands and other waters of the US); then Area West Environmental shall:

AWE biologists will complete aquatic resource delineation fieldwork and prepare an aquatic resource delineation report. Aquatic resources delineation surveys will be conducted according to current state and federal guidelines to identify and map potential wetlands and waters of the U.S. and State, to determine the extent of regulatory jurisdiction for the U.S. Army Corps of Engineers (Corps), Central Valley Regional Water Quality Control Board (CVRWQCB), and California Department of Fish and Wildlife (CDFW). AWE's first task will be to define the delineation study area and provide a map to be approved by TCSD. We have assumed that the delineation area will be approximately 150 acres.

Field surveys will be used to collect data to complete wetland delineation field survey forms and prepare maps that document the ordinary high-water mark and the presence or absence of positive indicators of

hydrophytic vegetation, hydric soil, and hydrology of aquatic resources. These forms will provide the data and interpretation rationale that will be used in determining the boundaries of agency jurisdiction. Identification and mapping of wetlands will be conducted using the 1987 Corps' wetland delineation manual. Jurisdictional areas will be categorized by habitat type.

Based on the results of field surveys, a set of maps and tables will be prepared that identifies the agency jurisdiction (Corps, CVRWCB, and CDFW) of each aquatic feature delineated in the survey area. Additionally, AWE will prepare an aquatic resources delineation report for submission to the Corps that addresses waters of the U.S. The report will describe field survey methods and results and discuss the type of aquatic resources at the site. The report will contain field survey data sheets and documentation of observations and interpretation rationale used to determine the locations and boundaries of Waters of the U.S., including wetlands, occurring on site. The report will also contain maps depicting the boundaries of the Waters of the U.S., including wetlands, occurring on the Project site and location of sample points. The report and map will be submitted to Augustine Planning Associates, Inc. and TCSD for review and suggested revisions will be made as appropriate.

The wetland delineation will then be submitted to the Corps for verification. AWE wetland scientist's will be available to assist the Corps during verification of the delineation, which typically requires a field visit with the Corps representative. If the Corps requests any changes to the delineation map, those changes would be incorporated and included into a final delineation report.

Subtask 2.3 Optional Future Task – Wetlands Permitting Assistance

As needed in the future, AWE can assist in preparing and submitting applications for the following permit issuance:

- Preconstruction Notification (PCN) package to the Corps for Clean Water Act Section 404;
- Water Quality Certification to the CVRWQCB under Section 401 of the Clean Water Act and/or Porter-Cologne Water Quality Control Act; and
- Streambed Alteration Agreement (SAA) to CDFW under Section 1602 of the Fish and Game Code.

AWE will prepare a PCN to be submitted to the Corps requesting concurrence that the Project qualifies for authorization under a Nationwide Permit. For inclusion in the permit applications, AWE will coordinate with the Project team to include a project description, design drawings, and a mitigation plan to describe how the Project will offset impact to Waters of the U.S.

AWE will prepare a Water Quality Certification application to be submitted to the CVRWQCB. The permit package will include a project location map, design plans, mitigation plans to compensate for losses of waters to the State, and evidence of CEQA approval. As currently required, AWE will submit a request and attend a preapplication meeting with the CVRWQCB. AWE will incorporate best management practices (BMPs) to avoid and minimize effects on water quality.

AWE will prepare a SAA application to be submitted to CDFW. In addition to the items listed above, the permit package will include recommended mitigation to address impacts to streambed and riparian vegetation.

Task 3.0 Cultural Resources (FW) – Alternatives 2-4

Based on preliminary cultural review of the project area, Alternatives 2-4 have the possibility of impacting cultural resources identified within Baker Ranch.¹ While no previously recorded precontact or historic-era

¹ Patrick, Melinda (2021). Tuolumne City Sanitary District and Baker Ranch Tailwater/Runoff Control Project. Prepared by Patrick GIS Group, Inc., Manteca, California. Submitted to Augustine Planning Associates, Inc., Sonora, California

archaeological resources have been documented within the project area, intensive pedestrian survey resulted in the identification of 25 features associated with the Baker Ranch Complex. All features date to the historic period, with the exception of nine bedrock mortars. This cultural study recommended presence/absence testing to identify intact subsurface deposits and, if so, evaluation of those deposits for listing on the National Register of Historic Places (National Register).²

In communication with APA, TCSD would like a cost estimate for the testing/evaluation of all features affected by each of the alternatives. However, testing of all features would be unnecessarily costly, as a preferred alternative has not been selected and many of the features may not be impacted. Therefore, Far Western has prepared Unit Costs to correlate to the number of features that may be impacted by the preferred alternative.

The undertaking is subject to compliance with Section 106 of the National Historic Preservation Act of 1966 (16 USC 470) and the implementing regulations set forth in 36 CFR 60 and 36 CFR 800. As such, compliance with Section 106 shall satisfy the requirements of the California Environmental Policy Act Sections 21083.2 and 21084.1 as written in the Public Resources Code (PRC) Sections 21000 et seq. and the Guidelines for implementing the statute codified in the California Code of Regulations, Title 14, Chapter 3, Section 15000 et seq., if necessary.

Far Western proposes the seven following tasks to complete archaeological testing/evaluation of features along the preferred alternative: (1) Project Management; (2) Research Design; (3) Native American Coordination; (4) Prefield Preparation; (5) Fieldwork; (6) Laboratory Analysis; and (7) Reporting.

Task 3.1: Project Management

The Far Western project manager will oversee quality control, scheduling, adherence to regulatory guidelines, costs, project administration, staff coordination, and billing.

Task 3.2: Research Design

Far Western will prepare a Research Design prior to implementing fieldwork. The Research Design will describe the regulatory nexus; goals of the proposed archaeological work; character and condition of the features in the project area; provide background information, including environment, ethnography, archaeology, and history; research topics relevant to the sites; and the specific methods and techniques used to meet those objectives. The Research Design will undergo up to one round of review with the Client and TCSD.

Subtask 3.3: Native American Coordination

Patrick GIS Group, Inc., coordinated initial Native American consultations regarding the proposed project, which included a review of the Native American Heritage Commission's (Commission) Sacred Lands File and outreach letters to those individuals listed as interested parties by the Commission in 2021. APA was responsible for follow-up outreach efforts on behalf of TCSD.³ Far Western assumes APA will continue coordination efforts for this project, with minimal correspondence required by Far Western to schedule a tribal representative during the field effort.

Task 3.4: Prefield Preparation

² Patrick 2021:3

³ Patrick 2021:2

After approval of the Research Design, an Archaeological Technician will visit the project site to mark locations slated for testing for the underground service alert (USA) ticket. Marking for utilities will also ensure there are no accessibility issues prior to field team mobilization.

This task also includes preparation of GIS-generated field maps, logistics coordination, field staffing, and equipment preparation.

Far Western will also subcontract Judith Marvin (Foothill Resources, Ltd). to complete an evaluation of the Baker Ranch Complex for listing on the National Register. Ms. Marvin will complete all archival research and evaluate the complex, with documentation completed by Far Western for inclusion in the Technical Report (Task 3.7).

Task 3.5: Fieldwork

For each feature, fieldwork will begin with a close-examination of the feature surface, with the team walking the site in five-meter transects and watching for concentrations of artifacts. Several hand-excavation techniques may be employed during the archaeological investigation. Excavation may include Test Excavation Units (0.5 x 1.0-meter or 1.0 x 1.0-meter, depending on what the excavation environment allows or is appropriate to the location being excavated), Shovel Test Units (STU; 0.5 x 0.5-meter square units), and, for presence/absence testing only, 50-centimeter round shovel probes (STP) may be used. Auger bores will be placed in the bottom of some STUs or STPs. It is generally recommended that excavated sediments be screened through 1/8-inch (3-millimeter) mesh to recover small artifacts; in some cases, samples will be collected for finer screening in the lab. All units will be excavated using vertical and horizontal control, usually in the form of arbitrary 10- or 20- centimeter levels. In the absence of a unit wall from which to measure depth and horizontal location (for example, with larger exposures) spatial control will be maintained using appropriate mapping equipment such as a theodolite or total station. This equipment will also be used to plot the excavation units onto the site map.

Should historic-era features be identified in areas of planned disturbance, Far Western historical archaeologists will cross section features to determine composition and integrity of the deposits. An attempt will be made to create an association between the deposits and the historic context, research design, and period of significance so archaeologists can define their eligibility.

Task 3.6: Laboratory Analysis

After fieldwork, the collection will be transported to Far Western's Davis laboratory. The analysis of prehistoric materials generally entails classification, sorting, counting, measuring, weighing, and tabulating according to context (typically unit and level). As appropriate, Far Western will collect obsidian samples for hydration dating and charcoal/shell for radiocarbon dating. If possible, data generated from these analyses will be to examine the distribution (or lack thereof) of data from the feature. Far Western assumes we will recover historical archaeological materials during testing. Materials from significant historical features will be inventoried in the field, as appropriate. Artifact assemblages will be taken to the Far Western laboratory where they will be cleaned then sorted, primarily by the archaeological feature in which they were found, then by layer (level) and material type, and labeled with appropriate provenience information. Artifacts will then be grouped by type and catalogued. Materials will be catalogued following currently accepted functional categories consistent with other relevant projects to facilitate comparisons with the results from other contemporary historical archaeological sites. Digital photographs will be taken of artifacts collected from features that constitute either an important phase or a functional artifact category. Photographs may

also be taken of entire features assemblages, and/or archaeological contexts group together by functional artifact categories. Sediment samples for flotation analysis will be collected, as appropriate, from discrete historical features to obtain additional information to further answer research questions and contribute to data requirements for evaluation.

Upon completion of laboratory analyses and final report documentation, materials for long-term curation will be placed in archival quality, long-term storage packing materials, including acid-free boxes, inert polyethylene plastic bags, and acid-free paper labels. Documentary materials, such as photographs, computer disc files, field notes, other pertinent records, and the final report will also be permanently stored at the curation facility. Copies of final reports and relevant field notes will be printed on acid-free paper for storage.

Task 3.7: Reporting

Once all analyses and special studies have been completed, draft and final technical reports will be prepared. The technical report will fully document the results of field and laboratory investigations. The report will include the following elements: executive or management summary; statement of scope, including project location and setting; background contexts or summaries; summary of previous research, historical and archaeological; research goals and themes; field and laboratory methodologies; descriptions of recovered materials; findings and interpretations, referencing research goals; conclusions; references cited; and appendices. Tables will be provided that clearly: (1) list all recovery units organized by type showing sampling techniques, depth, and size and volume of sediment recovered; and (2) list artifacts and ecofacts divided into major categories and organized by component, and within that by recovery unit. Selected diagnostic artifacts, representative or unique tool types, and intact features will be photographed. Most appendices will be digital and include all catalogues (artifacts, vertebrates, invertebrates, macrobotanical), radiocarbon dating documentation provided by the laboratory, special studies, digital imagery, GIS and all geospatial data, and other information relevant to the project and findings. Site records (Department of Parks and Recreation 523) will be used to document work, following Instructions for Recording Historical Resources (Office of Historic Preservation 1995). The technical report will be subject to review by the Client and TCSD. Far Western anticipates up to two rounds of review (i.e., DRAFT Report, DRAFT FINAL Report). Revised draft reports will be submitted 30 days of receipt of consolidated comments.

Task 4 Air Quality/Greenhouse Gas (KDA) – Alternatives 2-4

KDA will conduct an air quality and GHG analysis using approaches consistent with recent environmental documents prepared for projects in Tuolumne County. KDA will analyze the following issues:

- short-term construction-related emissions,
- naturally occurring asbestos, and
- long-term operational emissions.

Construction-Related Emissions. KDA will quantify short-term construction-related emissions using the Road Construction Emissions Model. KDA will quantify the following emissions:

- reactive organic gases (ROG),
- carbon monoxide (CO),
- nitrogen oxides (NO_x),

- inhalable particulate matter less than 10 micrometers in diameter (PM₁₀),
- fine particulate matter less than 2.5 micrometers in diameter (PM_{2.5}),
- carbon dioxide (CO₂),
- methane (CH₄), and
- nitrous oxide (N₂O).

KDA will quantify construction-related emissions for the preferred alternative.

For the criteria pollutant emissions ROG, NO_x, PM₁₀, and CO, the significance of construction-related emissions will be determined using significance thresholds presented by the Tuolumne County Air Pollution Control District (APCD) in the *CEQA Thresholds of Significance* (<http://www.co.tuolumne.ca.us/DocumentCenter/View/1072>). The APCD does not present significance thresholds for PM_{2.5}.

The *CEQA Thresholds of Significance* does not present significance thresholds for GHG emissions. KDA will consult with the project team to identify appropriate and defensible significance thresholds for GHG emissions.

KDA will analyze construction-related emissions associated with the project. This proposal assumes KDA will be provided with a schedule of project construction activities, a description of construction activity (e.g., the type and amount of equipment use during each construction phase), and the area of soil disturbance.

Construction-Related Naturally Occurring Asbestos. Portions of Tuolumne County contain a type of rock referred to as “ultramafic”. As a result, these areas are considered to be “more likely to contain naturally occurring asbestos” (NOA). Emissions of NOA have been attributed to soil-disturbing activities, including construction activities.

KDA will conduct a screening evaluation of potential impacts associated with NOA. KDA will review the California Department of Conservation, Division of Mines and Geology, map A General Location Guide for Ultramafic Rocks in California – Areas More Likely to Contain Naturally Occurring Asbestos (ftp://ftp.consrv.ca.gov/pub/dmg/pubs/ofr/ofr_2000-019.pdf).

If the screening evaluation indicates an elevated likelihood of NOA being on the project site, additional on-site investigation may be needed, which would lead to development of appropriate site-specific mitigation measures. The additional on-site investigation would require a separate contractor (e.g., for geological studies), work plan and budget.

Operational Emissions. Our understanding is the project is that it would not change the capacity of the sewer system. As a result, the project is not expected to result in a change to long-term operational emissions from the system. KDA will document the lack of change to the system capacity in the air quality and GHG report.

Alternatives. KDA will qualitatively assess potential impacts of the preferred project alternative only. This proposal does not include quantification of emissions associated with all alternatives. KDA will compare the size and approximate amount of construction activity associated with the preferred project alternative to determine whether the alternatives would result in fewer or greater amounts of emissions, compared to the proposed project.

Federal General Conformity Rule for the Federal Clean Air Act (CAA)

For the area of the project site, KDA will describe the federal attainment status for the following air quality standards:

- ozone,
- NO_x,
- sulfur dioxide,
- PM₁₀,
- PM_{2.5} , and
- CO.

KDA will assess the applicability of the general conformity rule for the federal CAA. KDA will conduct this assessment by calculating project-related emissions and comparing these emission levels to “de minimis” levels established in the federal general conformity rule.

This proposal assumes project-related emissions will be below the de minimis levels and less than 10 percent of the countywide emissions inventory for the applicable pollutants. If emissions are found to be higher, modification of this scope of work and cost estimate may be needed.

Deliverables

KDA will submit a completed air quality section of the SRF *Environmental Package* form for the project.

KDA will prepare an air quality and GHG letter report presenting the results of the criteria pollutant and GHG emissions analysis. This proposal does not include preparation of a full environmental impact report (EIR)-level air quality study. The draft letter report will be submitted for review and comments by the project team. The letter report will document the assumptions and methods used in the analysis. Road Construction Emissions Model output files will be enclosed as appendices to the report.

KDA will prepare a final air quality and GHG letter report, responding to comments on the draft report. This proposal assumes KDA will receive one consolidated set of comments on the draft report, and also assumes no new analysis will be needed to respond to comments on the draft report.

This proposal does not include preparation of a Fugitive Dust Mitigation Plan or an Asbestos Dust Mitigation Plan.

This proposal does not include preparation of a quantitative assessment of NOA emissions, and does not include preparation of a health risk assessment (HRA).

It is not possible to know the number and magnitude of public comments on the environmental documents for the project. Therefore, this proposal does not include responding to public comments on the environmental documents. Responding to these comments would require a contract amendment, or may be conducted on a time-and-materials basis.

Task 5.0 Prepare Negative Declaration/Mitigated Negative (MND) - APA – Alternatives 2-3; Possibly Alternative 4

Subtask 5.1 Administrative Draft IS/MND (CEQA)

Prepare one administrative draft negative declaration/mitigated negative declaration for review by TCSD/State.

Subtask 5.2 Administrative Draft CE (NEPA)

Prepare one administrative draft CE for review by TCSD/State.

Subtask 5.3 Draft IS/MND and Mitigation Monitoring & Reporting Plan (CEQA)

Prepare a draft negative declaration/mitigated negative declaration in response to comments received pursuant to Subtask 5.2.

Subtask 5.4 Legal Notice of Intent to Adopt IS/MND and Submit to Clearinghouse

Draft legal notice of Intent to Adopt a Negative Declaration/Mitigated Negative Declaration and coordinate publication. Distribute notices to interested parties. Prepare and submit State Clearinghouse package for 30-day review.

Subtask 5.5 Response to Comments/Final Environmental Document

Respond to comments received from the State Clearinghouse. Prepare Final Negative Declaration/Mitigated Negative Declaration and Mitigation Monitoring and Reporting Plan.

Subtask 5.6 Public Hearing Notices/Staff Report

Draft notice of public hearing, coordinate publication. Draft staff report for public hearing.

Subtask 5.7 Public Hearings

Attend public hearing(s). Attend one TCSD public hearing to consider MND approval.

Subtask 5.8 File Notice of Determination

Prepare and file Notice of Determination (NOD) with Tuolumne County and the State Clearinghouse for the MND.

C . COST PROPOSAL

For Far Western (All Task 3 items herein):

Due to the complexity of alternatives that may present and until a more detailed project description is available, Far Western proposes a combination of Time and Materials and Unit Costs for this project. Time and Materials costs will apply to Tasks 3.1-3.4, while Tasks 3.5-3.7 will be unit costs based on which of the alternatives are selected and the corresponding number of features along that alignment (i.e., 1-5, 6- 10, 11-20, and 21-25 features). Separate unit costs for presence/absence testing and National Register evaluations have been provided with associated laboratory costs (Tasks 3.5-3.6), along with unit costs for final reporting (Task 3.7). **See attached Far Western Cost Estimate for additional details (Attachment A).**

Task #	Task Description	Most Likely Cost Range			Most Likely Cost Range			Alt 4 (Various)
		Alt 2 Low Impact (6-10 cultural features impacted, Avoids all wetlands, Construction outside nest season)	Alt 2 Medium Impact (11-15 cultural features impacted, impacts wetlands, moderate biological monitoring)	Alt 2 High Impact (21-25 features, impacts wetlands, high biological monitoring)	Alt 3 Low Impact (0 cultural features impacted, avoids all wetlands, construction outside of nesting)	Alt 3 Medium Impact (1-5 cultural features impacted, avoids all wetlands, low biological monitoring)	Alt 3 High Impact (6-10 cultural features impacted, impacts wetlands, high biological monitoring)	
Task 1.0	Project Initiation/Management	\$2,550	\$5,100	\$5,100	\$2,550	\$5,100	\$5,100	?
1.1	Ongoing Meetings/Coordination	\$2,550	\$5,100	\$5,100	\$2,550	\$5,100	\$5,100	?
1.2	Project Management							
Task 2.0	Biology and Wetlands	\$2,000	\$51,000	\$56,000	\$2,000	\$3,000	\$51,000	?
2.1	Update Biological Study; pre-construction and construction monitoring	\$2,000	\$8,000	\$13,000	\$2,000	\$3,000	\$8,000	?
2.2-2.3	Wetlands Delineation and Permitting	\$0.00	\$43,000	\$43,000	\$0.00	\$0	\$43,000	?
Task 3.0	Cultural Resources	\$188,970	\$243,970	\$333,970	\$28,970	\$153,970	\$188,970	?
3.1	Project Management	\$28,970	\$28,970.00	\$28,970	\$28,970.00	\$28,970	\$28,970	\$28,970
3.2	Research and Design							
3.3	Native American Coordination							
3.4	Pre-field work							
3.5	Field work	\$160,000	\$215,000.00	\$305,000	\$0.00	\$125,000	\$160,000	?
3.6	Lab Analysis							
3.7	Reporting							
Task 4.0	Air Quality/Emissions	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000
4.1	Air Quality / Emissions Study, Report	\$8,000	\$,8000.00	\$8,000	\$8,000	\$8,000	\$8,000.	\$8,000
Task 5.0	CEQA – Mitigated Negative Declaration (MND)	\$10,000	\$10,000	\$10,000	\$2,000	\$10,000	\$10,000	\$10,000
5.1-5.8	Prepare mitigated negative declaration, draft, final, public hearing, noticing, filing NOD	\$10,000	\$10,000.00	\$10,000	\$2,000/a/	\$10,000	\$10,000	\$10,000
	Totals/b/	\$211,520	\$318,080	\$413,070	\$43,520	\$180,070	\$263,070	Undetermined

/a/ Potential CEQA General Rule Exemption

/b/ Excludes legal notice costs for publishing in Union Democrat (Notice of Availability/Intent and public hearing) – estimated @ \$750.00; Excludes CA Fish and Wildlife Filing Fees (As of 1/1/2022 = \$2,548+ \$50 clerk filing fee

D. PROPOSED DELIVERY SCHEDULE

Delivery schedule will vary based on which alternative is pursued. Alternative 2 is likely to take approximately 18 – 36 months (with potential reduction if all wetlands are avoided). Alternative 3 has the potential to be completed within 6-18 months (with potential reduced time if all wetlands are avoided).

E. ASSUMPTIONS & EXCLUSIONS

- Any preapplication meetings for wetlands or cultural resources will be a virtual (web) meeting, not an in-person meeting.
- Impacts to Waters of the State will be minimal and the alternatives analysis required will be limited to onsite alternatives.
- Offsite mitigation will be used (in-lieu fee or mitigation bank). On onsite restoration will be limited to identification of an erosion control seed mix to minimize erosion. An onsite restoration wetland, waters, or riparian plan will not be required.
- The Client will pay all permit application fees and mitigation costs for wetland permitting; AWE will provide back-up documentation for the permit and mitigation costs.
- The Project will qualify for a Nationwide Permit (wetlands).
- No California Endangered Species Act or federal Endangered Species Act incidental take permit authorization will be required for the project. If required, AWE can provide those services as a subsequent phase.
- A two-day field survey conducted by two biologists will be sufficient to collect all necessary information for the Corps, CDFW, and CVRWQCB for the aquatic resource delineation.
- Access to the property would be provided by the TCSD at the time of the site visit. Any issues arising from inaccessibility to portions of the property or Project location resulting in delay of field surveys will bear additional cost if follow up visits are required.
- The level of CEQA Environmental Review is anticipated to be an IS/MND for Tasks 2-4. This proposal does not include preparation of an Environmental Impact Report (EIR). Should an Environmental Impact Report (EIR) be necessary, APA can provide a separate cost and scope.
- The project description will be drafted once the design has reached at least 35%. Changes to the project design that result in modifications to technical studies or the environmental document may require modification to the scope or cost estimate.
- The project description provided at the start of the project will not change significantly. Changes to the project description after submittal of administrative draft documents to TCSD that trigger the need for revisions to the documents may require modification to the scope or cost estimate.
- Forsgren will provide electronic copies of draft project exhibits and drawings.
- Forsgren/TCSD will identify all trees to be removed or for which work will be done within

the root zone of the tree, on project site plans.

- This proposal does not include preparation of a NPDES Permit for submittal to the Regional Water Quality Control Board.
- A cost-of-living increase of up to 4.0% will be applied for tasks completed after September 30, 2022.
- Changes to the project area/design alternatives after the start of Research Design task for Cultural Resources preparation will result in additional costs.
- Does not include the recordation or evaluation of built environment resources.
- Far Western will subcontract a Native American monitor during subsurface testing fieldwork.
- The draft Research Design (cultural) will undergo one round of edits with the Client and TCSD. The Technical Report will undergo up to two rounds of edits with the Client and TCSD.
- Up to three hard copies of the Final Technical Report (Cultural) will be produced. All other drafts and the Research Design will be submitted electronically in a print-ready file format transmitted via secure file transfer.
- Writing sections for any environmental document other than the Research Design and Technical Report is not included under the Cultural Resources tasks.
- No project meetings are included for cultural resources tasks.
- No additional identification efforts, evaluation or mitigation proposals, resource evaluation, or data recovery investigations are included in the attached cost estimate for cultural resources tasks.
- The Client shall provide all necessary permits and address all access issues to the project area

This proposal remains in effect through December 31, 2022, subject to identified Cost of Living Increases; or until a contract is executed or a notice to proceed approved, whichever occurs first.

Attachment A
Far Western Cost Breakdown



COST ESTIMATE SUMMARY

Project Title: Baker Ranch Tailwater Runoff Alternatives Analysis Project
Task: Archaeological testing and, if necessary, evaluation.

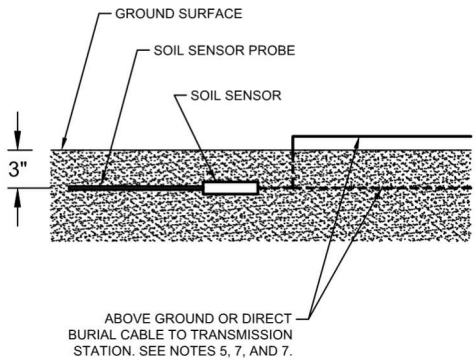
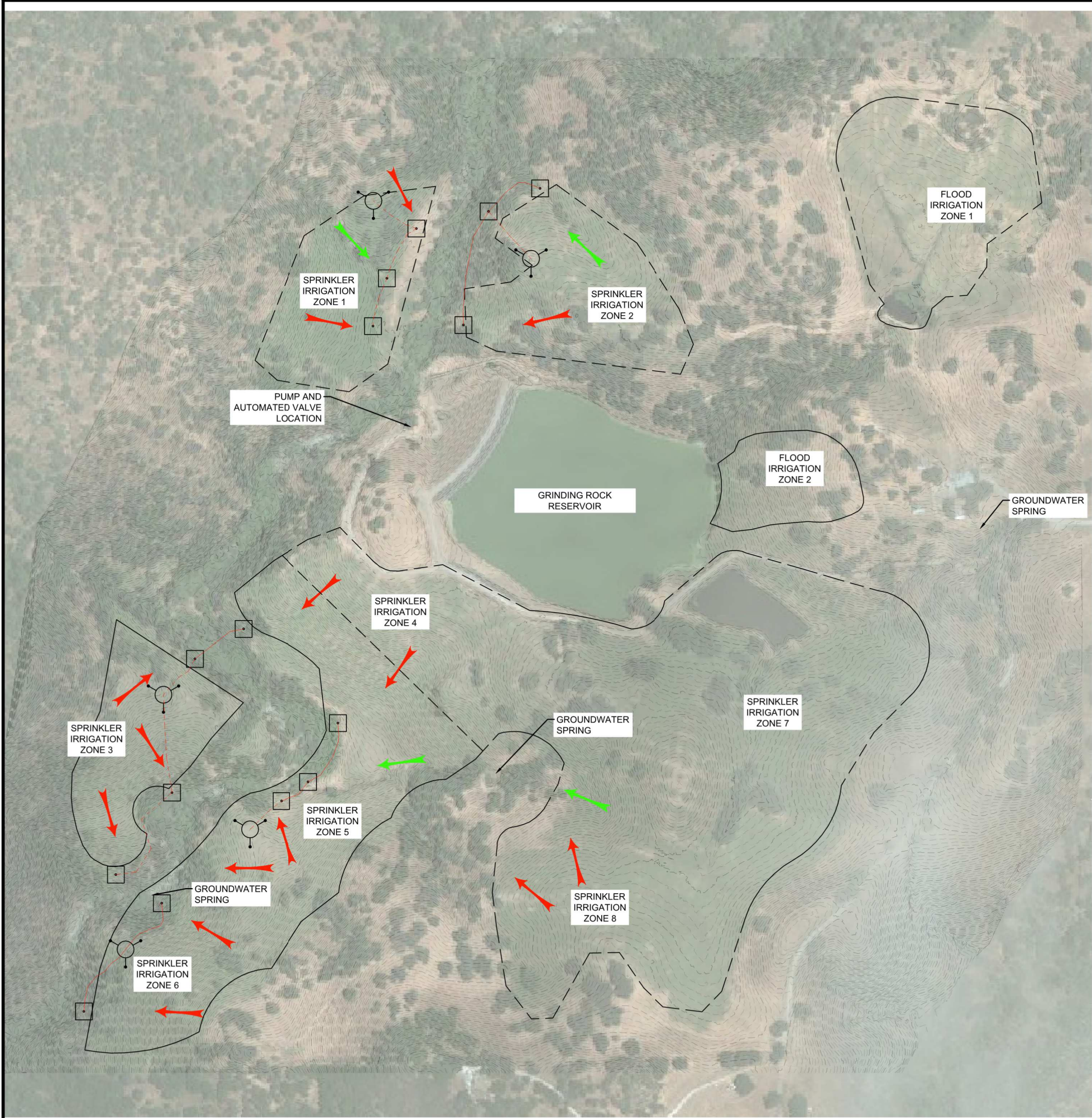
Client Name: Augustine Planning Associates, Inc.
Contact: Amy Augustine

TASK						
<i>Time and Materials Tasks</i>	Labor Hours	Labor Cost	Travel Expenses	Other Direct Costs	Subconsultants	Subtotal
TASK 1: PROJECT MANAGEMENT	44	\$ 4,937	\$ -	\$ -	\$ -	\$ 4,937
TASK 2: RESEARCH DESIGN	109	\$ 11,926	\$ -	\$ -	\$ -	\$ 11,926
TASK 3: N. AMER COORDINATION	10	\$ 1,278	\$ -	\$ -	\$ -	\$ 1,278
TASK 4: PREFIELD	20	\$ 1,880	\$ 149	\$ -	\$ 8,800	\$ 10,829
<i>Subtotal Time and Materials Tasks</i>					\$	28,970

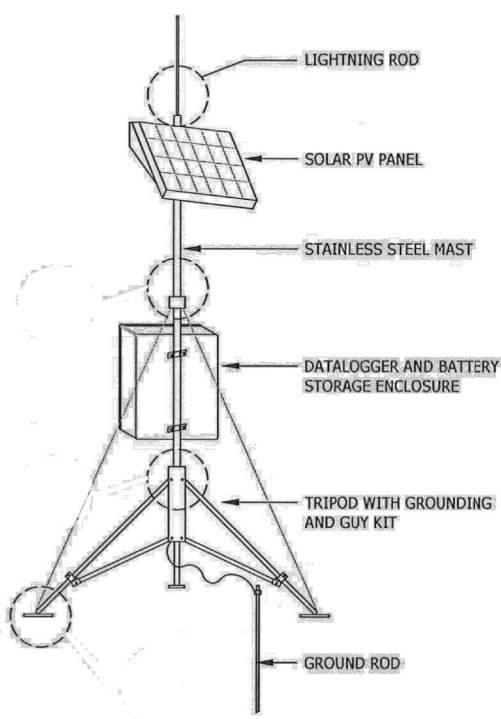
<i>Unit Costs</i>	Unit Price	No. of Units	Subtotal
PRESENCE/ABSENCE TESTING 1-5 FEATURES	\$45,000	1	\$ 45,000
PRESENCE/ABSENCE TESTING 6-10 FEATURES	\$60,000	1	\$ 60,000
PRESENCE/ABSENCE TESTING 11-15 FEATURES	\$75,000	1	\$ 75,000
PRESENCE/ABSENCE TESTING 16-20 FEATURES	\$90,000	1	\$ 90,000
PRESENCE/ABSENCE TESTING 21-25 FEATURES	\$105,000	1	\$ 105,000
ELIGIBILITY EVALUATION 1-5 FEATURES	\$60,000	1	\$ 60,000
ELIGIBILITY EVALUATION 6-10 FEATURES	\$80,000	1	\$ 80,000
ELIGIBILITY EVALUATION 11-15 FEATURES	\$100,000	1	\$ 100,000
ELIGIBILITY EVALUATION 16-20 FEATURES	\$120,000	1	\$ 120,000
ELIGIBILITY EVALUATION 21-25 FEATURES	\$140,000	1	\$ 140,000
PRESENCE/ABSENCE AND EVALUATION REPORTING 1-10 FEATURES	\$20,000	1	\$ 20,000
PRESENCE/ABSENCE AND EVALUATION REPORTING 11-20 FEATURES	\$40,000	1	\$ 40,000
PRESENCE/ABSENCE AND EVALUATION REPORTING 20-25 FEATURES	\$60,000	1	\$ 60,000

APPENDIX E

CONCEPTUAL DESIGN OF PREFERRED ALTERNATIVE



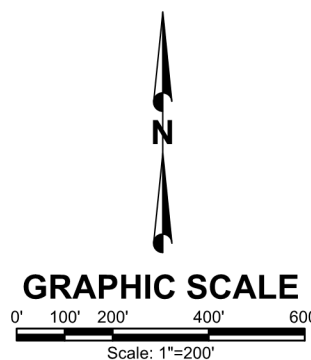
SOIL MOISTURE SENSOR
PLACEMENT DETAIL
N.T.S.



TRIPOD MOUNTED
TRANSMISSION STATION
(FOR ILLUSTRATION ONLY)
N.T.S.

- LEGEND:**
- GRAVITY FED IRRIGATION ZONE
 - PUMPED IRRIGATION ZONE
 - SHEET FLOW DRAINAGE DIRECTION
 - CONCENTRATED FLOW DRAINAGE DIRECTION
 - SOIL MOISTURE SENSOR (SEE DETAIL 1)
 - TRIPOD OR POLE MOUNTED TRANSMISSION STATION
 - ABOVE GROUND SIGNAL CABLE
 - BURIED SIGNAL CABLE

- NOTES:**
- MOISTURE SENSORS TO BE PLACED IN AREAS DOWN GRADIENT FROM IRRIGATION ZONES AND UP GRADIENT FROM TURNBACK CREEK WHERE EXCESS SURFACE DRAINAGE PRESENTS A RISK OF DISCHARGE TO TURNBACK CREEK.
 - FLOW THAT IS PUMPED TO IRRIGATION ZONES WILL BE CONTROLLED BY MOISTURE SENSORS THAT SEND ALARMS TO SHUT OFF PUMP WHEN EXCESS SURFACE MOISTURE IS DETECTED.
 - LEAK DETECTION OF FORCE MAINS WILL BE IMPLEMENTED BY PRESSURE TRANSDUCERS THAT WILL SEND ALARMS TO SHUT OFF PUMPS WHEN LOW PRESSURES ARE DETECTED DUE TO PIPE RUPTURES.
 - FLOW TO GRAVITY IRRIGATION WILL BE CONTROLLED BY MOISTURE SENSORS THAT SEND ALARMS TO CLOSE AUTOMATIC VALVE WHEN EXCESS SURFACE MOISTURE IS DETECTED.
 - SIGNAL CABLE TO BE BURIED IN AREAS DISTURBED BY CATTLE.
 - ALL CABLE INSTALLED IN WETLANDS NEAR TURNBACK CREEK SHALL BE ABOVE GROUND.
 - BURIED CABLE NEAR TURNBACK CREEK BANK TO BE PLACED OUTSIDE OF WETLANDS ABOVE THE HIGH WATER FLOOD LEVEL.
 - TRANSMISSION STATIONS LOCATED IN AREAS DISTURBED BY CATTLE SHALL BE EITHER POLE MOUNTED OR SURROUNDED BY PROTECTIVE FENCING.
 - TRANSMISSION STATION TO COMMUNICATE W/TCSD CONTROL SYSTEM VIA WIRELESS COMMUNICATION.



PROJECT NO. 07-21-0085		DRAWN BY MV		DESIGNED BY BG		APPROVED BY AD		QA/QC BY PW	
OWNER		TCSD		BAKER RANCH		TCSO TAILWATER RUNOFF CONTROL		AUTOMATED IRRIGATION SYSTEM LAYOUT	
SHEET NO. C-100		DATE: JANUARY 2022		PAGE NO. 1 OF 1		FORSGREN Associates Inc.		200 S Virginia St, 8th Flr, Reno, NV 89501 PH: 775.399.0024	
NO.		REVISIONS		BY		DATE		This document or any part thereof in detail or design concept is the property of Forsgren Associates Inc. and shall not be reproduced without the written authorization of Forsgren Associates Inc.	

APPENDIX F

AUTOMATED SENSING EQUIPMENT CUT SHEETS

**253-L**

Soil Matric Potential Block for Multiplexer Use



Reliable Soil Water Measurements

No maintenance required

Overview

The 253, manufactured by Watermark, is a solid-state, electrical-resistance sensing device with a granular matrix that estimates soil water potential from 0 to -200 kPa (typically,

wetter or irrigated soils). It connects to your datalogger via an AM16/32-series multiplexer and is intended for applications where you will be monitoring a larger number of sensors.

Benefits and Features

- › Survives freeze-thaw cycles
- › Compatible with AM16/32-series multiplexers, allowing measurement of multiple sensors
- › Multiplexer connection prevents electrolysis from prematurely destroying the probe
- › Rugged, long-lasting sensor
- › Buffers salts in soil
- › Compatible with most Campbell Scientific dataloggers

Detailed Description

When the amount of water in the soil surrounding the sensor changes, a difference in water potential between the soil and the sensor material is established. This gradient in potential causes a water flux between the two materials. For example, an irrigation or precipitation event results in movement of soil water into the 253 until equilibrium in water potential between the sensor and the soil occurs. An increase in the amount of water in the sensor reduces the electrical resistance between the sensor electrodes.

The datalogger measures the resistance between electrodes, and then converts the resistance measurement to soil water potential by using calibration values supplied with the sensor.

The 253 consists of two concentric electrodes embedded in a reference matrix material. The matrix material is surrounded by a synthetic membrane for protection against deterioration. An internal gypsum tablet buffers against the salinity levels found in irrigated soils. The cable jacket is made of Santoprene rubber, which is resistant to temperature extremes, water, and UV degradation.

The 253's construction can allow the sensor (in some circumstances) to be left in the soil all year, eliminating the need to remove the sensor during fallow periods.

The 253 connects to a datalogger via an AM16/32-series multiplexer. Because the multiplexer contacts close only



during measurement, electrical currents leading to premature

degradation of the 253 are eliminated.

Specifications

Measurement Range	0 to -200 kPa
Diameter	1.91 cm (0.75 in.)

Length	8.26 cm (3.25 in.)
Weight	360 g (0.8 lb)

For comprehensive details, visit: www.campbellsci.com/253-l 



Campbell Scientific, Inc. | 815 W 1800 N | Logan, UT 84321-1784 | (435) 227-9120 | www.campbellsci.com
AUSTRALIA | BRAZIL | CANADA | CHINA | COSTA RICA | FRANCE | GERMANY | THAILAND | SOUTH AFRICA | SPAIN | UK | [USA](#)



CS650 and CS655

Soil Water Content Reflectometers

CS655 Reflectometer
with 12 cm Rods

CS650 Reflectometer
with 30 cm rods

Innovative
More accurate in soils
with high bulk EC

Overview

The CS650 and CS655 soil water content reflectometers use innovative techniques to monitor soil volumetric water content, bulk electrical conductivity, and temperature. They consist of two stainless-steel rods connected to a printed circuit board. The

CS650 has 30 cm rods, and the CS655 has 12 cm rods. The probe's circuit board is encapsulated in epoxy and a shielded cable is attached to the circuit board for datalogger connection.

Benefits and Features

- More accurate water content measurements in soils with solution EC ≤ 3 dS m⁻¹ (CS650) or ≤ 8 dS m⁻¹ (CS655) without performing a soil-specific calibration
- Larger sample volume reduces error
- Measurement corrected for effects of soil texture and electrical conductivity
- Estimates soil-water content for a wide range of mineral soils
- Versatile sensor—measures dielectric permittivity, bulk electrical conductivity (EC), and soil temperature

Options and Accessories^a

Options

- Cable lengths (ft): 10, 17, 33, 50 or user-defined
- Cable termination options: tinned leads that attach directly to the datalogger or a connector that attaches to a prewired enclosure
- SDI-12 address options: SDI-12 address set to 0 or SDI-12 address set to the last digit of the probe's serial number

CS650G Rod
Insertion Guide



Accessories

- CS650G Rod Insertion Guide Tool with Pilot Rod that helps maintain the proper spacing and parallel orientation of the rods during probe insertion. It also helps the insertion of the probe in high density or rocky soils.
- A200 Sensor-to-PC Interface (for configuring sensor)
- Din Rail Accessories that can facilitate wiring when several reflectometers need to be connected to one terminal. A complete configuration consists of the Din Rail Mounting Kit (pn 25458), terminal strips (pn 15920), end plates (pn 15907), and jumpers (pn 15909)

^aFor more information about the options and accessories, refer to: www.campbellsci.com/order/cs650 or www.campbellsci.com/order/cs655.

questions & quotes: 435.227.9120

www.campbellsci.com/cs650



Measurement Method

The CS650 and CS655 measure propagation time, signal attenuation, and temperature. Dielectric permittivity, volumetric water content, and bulk electrical conductivity are then derived from these raw values.

Measured signal attenuation is used to correct for the loss effect on reflection detection and thus propagation time measurement. This loss-effect correction allows accurate water content measurements in soils with solution EC ≤ 3 dS m⁻¹ (CS650) or ≤ 8 dS m⁻¹ (CS655)

Specifications

- › Sensing Volume^b: 7800 cm³ (CS650), 3600 cm³ (CS655)
- › Ingress Protection Rating: IP68
- › Maximum Cable Length: 610 m (2000 ft) combined length for up to 25 sensors connected to the same datalogger control port.
- › Probe Head Dimensions: 85 x 63 x 18 mm (3.3 x 2.5 x 0.7 in)
- › Rod Diameter: 3.2 mm (0.13 in)
- › Rod Spacing: 32 mm (1.3 in)

Rod Length

- › CS650: 300 mm (11.8 in)
- › CS655: 120 mm (4.72 in)

Weight

- › CS650 without cable: 280 g (9.9 oz)
- › CS655 without cable: 240 g (8.5 oz)
- › Cable: 35 g per m (0.38 oz per ft)

Soil Temperature

- › Measurement Range: -50° to + 70°C
- › Accuracy^c: $\pm 0.1^\circ\text{C}$ (for typical soil temperatures [0° to 40°C] when probe body is buried in soil), $\pm 0.5^\circ\text{C}$ for full temperature range
- › Precision^d: $\pm 0.02^\circ\text{C}$

Volumetric Water Content Measurements

- › Range: 0% to 100% (with **M4!** SDI-12 command)
- › Precision^d: $< 0.05\%$

Accuracy^c

- › CS650: $\pm 1\%$ (with soil specific calibration), $\pm 3\%$ (typical with factory VWC model) where solution EC < 3 dS m⁻¹
- › CS655: $\pm 1\%$ (with soil specific calibration), $\pm 3\%$ (typical with factory VWC model) where solution EC < 10 dS m⁻¹

Electrical Conductivity Measurements

- › Range

	CS650	CS655
Solution EC	0 to 3 dS m ⁻¹	0 to 8 dS m ⁻¹
Bulk EC	0 to 3 dS m ⁻¹	0 to 8 dS m ⁻¹

- › Accuracy^c: $\pm(5\%$ of reading + 0.05
- › Precision^d: 0.5% of BEC

without performing a soil specific calibration. Soil bulk electrical conductivity is also calculated from the attenuation measurement.

A thermistor in thermal contact with a probe rod near the epoxy surface measures temperature. Horizontal installation of the sensor provides accurate soil temperature measurement at the same depth as the water content. Temperature measurement in other orientations will be that of the region near the rod entrance into the epoxy body.

Relative Dielectric Permittivity Measurements

- › Range: 1 to 81
- › Accuracy^c

Range	CS650	CS655
1 to 40	$\pm(2\%$ of reading + 0.6) for solution EC ≤ 3 dS m ⁻¹	$\pm(3\%$ of reading + 0.8) for solution EC ≤ 8 dS m ⁻¹
40 to 81	± 1.4 for solution EC ≤ 1 dS m ⁻¹	± 2 for solution EC ≤ 2.8 dS m ⁻¹

- › Precision^d: < 0.02

Electrical

- › Sensor Output: SDI-12; serial RS-232.
- › Warmup Time: 3 s
- › Measurement Time: 3 ms to measure; 600 ms to complete SDI-12 command
- › Power Supply Requirements: 6 Vdc to 18 Vdc; must be able to supply 45 mA @ 12 Vdc
- › Electromagnetic: External RF sources can affect the probe's operation. Therefore, the probe should be located away from significant sources of RF such as ac power lines and motors.
- › EU Declaration of Conformity document available at: www.campbellsci.com/cs650
- › Interprobe Interference: Multiple reflectometers can be installed within 4 inches of each other when using the standard datalogger SDI-12 **M!** command. The SDI-12 **M!** command allows only one reflectometer to be enabled at a time.

Current Drain (see graph in manual)

- › Active (3 ms): 45 mA typical @ 12 Vdc (80 mA @ 6 Vdc, 35 mA @ 18 Vdc)
- › Quiescent: 135 μA typical @ 12 Vdc
- › Average: $I = 0.09n + [3.5 + 0.024(n-1)]n/s$
Where,
I = average current in milliamps
n = number of probes
s = number of seconds between measurement

^b Approximately 7.5 cm radius around each probe rod and 4.5 cm beyond the end of the rods.

^c Accuracy specifications are based on laboratory measurements in a series of solutions with dielectric permittivities ranging from 1 to 81 and solution electrical conductivities ranging from 0 to 3 dS m⁻¹.

^d Precision describes the repeatability of a measurement. It is determined for the reflectometer by taking repeated measurements in the same material.

