ORDINANCE NO. 1891

ORDINANCE ADOPTING THE STATE MODEL WATER EFFICIENT LANDSCAPE ORDINANCE AND REPEALING THE CURRENT WATER EFFICIENT LANDSCAPE REQUIREMENTS

WHEREAS, having a reliable water supply is essential to the vitality of Vacaville; and

WHEREAS, water resources are of a limited supply and are subject to increasing demands; and

WHEREAS, the recent drought has emphasized the need to be prudent in the use and conservation of water; and

WHEREAS, in 1998 the City of Vacaville adopted Ordinance 1591, adopting the Vacaville Water Efficient Landscape Requirements; and

WHEREAS, pursuant Governor Brown's Drought Executive Order of April 1, 2015 (EO B-29-15), the California Water Commission approved an update the state's Model Water Efficient Landscape Ordinance; and

WHEREAS, the state requires the City to adopt the model ordinance or an ordinance that is at least as effective in conserving water; and

WHEREAS, to comply with state requirements, to provide consistency with other jurisdictions, and to ease use for applicants, the City desires to adopt the updated state Model Water Efficient Landscape Ordinance; and

WHEREAS, this project is exempt from the California Environmental Quality Act (CEQA) pursuant to Section 15307 of the State CEQA Guidelines (Actions by Regulatory Agencies for Protection of Natural Resources).

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF VACAVILLE DOES ORDAIN AS FOLLOWS:

Section 1. Repeal of Water Efficient Landscape Requirements.

The City of Vacaville Water Efficient Landscape Requirements adopted by Ordinance 1591 and added to Title 14 of the Vacaville Municipal Code as an appendix, is hereby repealed.

Section 2. Adoption of Division 14.27, Water Efficient Landscaping.

The following shall be added as Division 14.27 under Title 14 of the Vacaville Municipal Code.

DIVISION 14.27
WATER EFFICIENT LANDSCAPING

Chapters

Chapter 14.27.010
Title, Purpose, Applicability

14.27.010.010 Title

This division shall be known as the "Vacaville Water Efficient Landscape Ordinance," and may be so cited.

14.27.010.020 Purpose

A. The State Legislature has found:

1. that the waters of the state are of limited supply and are subject to ever increasing demands;

2. that the continuation of California's economic prosperity is dependent on the availability of adequate supplies of water for future uses;

3. that it is the policy of the State to promote the conservation and efficient use of water and to prevent the waste of this valuable resource;

4. that landscapes are essential to the quality of life in California by providing areas for active and passive recreation and as an enhancement to the environment by cleaning air and water, preventing erosion, offering fire protection, and replacing ecosystems lost to development;

5. that landscape design, installation, maintenance and management can and should be water efficient; and

6. that section 2 of Article X of the California Constitution specifies that the right to use water is limited to the amount reasonably required for the beneficial use to be served and the right does not and shall not extend to waste or unreasonable method of use.

B. Consistent with these legislative findings, the purpose of this ordinance is to:

1. promote the values and benefits of landscaping practices that integrate and go beyond the conservation and efficient use of water;

2. establish a structure for planning, designing, installing, maintaining and managing water efficient landscapes in new construction and rehabilitated projects by encouraging the use of a watershed approach that requires cross-sector collaboration of industry, government and property owners to achieve the many benefits possible;

3. establish provisions for water management practices and water waste prevention for existing landscapes;

4. use water efficiently without waste by setting a Maximum Applied Water Allowance as an upper limit for water use and reduce water use to the lowest practical amount; and

5. promote the benefits of consistent landscape ordinances with neighboring local and regional agencies.

C. Landscapes that are planned, designed, installed, managed and maintained with the watershed based approach can improve California's environmental conditions and provide benefits and realize sustainability goals. Such landscapes will make the urban environment resilient in the face of climatic extremes. Consistent with the legislative findings and purpose of the Ordinance, conditions in the urban setting will be improved by:

1. Creating the conditions to support life in the soil by reducing compaction, incorporating organic matter that increases water retention, and promoting productive plant growth that leads to more carbon storage, oxygen production, shade, habitat and esthetic benefits.

2. Minimizing energy use by reducing irrigation water requirements, reducing reliance on petroleum based fertilizers and pesticides, and planting climate appropriate shade trees in urban areas.

3. Conserving water by capturing and reusing rainwater and graywater wherever possible and selecting climate appropriate plants that need minimal supplemental water after establishment.

4. Protecting air and water quality by reducing power equipment use and landfill disposal trips, selecting recycled and locally sourced materials, and using compost, mulch and efficient irrigation equipment to prevent erosion.

5. Protecting existing habitat and creating new habitat by choosing local native plants, climate adapted non-natives and avoiding invasive plants. Utilizing integrated pest management with least toxic methods as the first course of action.

14.27.010.030 Applicability

A. After December 1, 2015, and consistent with Governor's Executive Order No. B-29-15, this ordinance shall apply to all of the following landscape projects:

1. new development projects with an aggregate landscape area equal to or greater than 500 square feet requiring a building or landscape permit, plan check or design review;

2. rehabilitated landscape projects with an aggregate landscape area equal to or greater than 2,500 square feet requiring a building or landscape permit, plan check, or design review;

3. existing landscapes limited to Chapter 14.27.040 and

4. cemeteries. Recognizing the special landscape management needs of cemeteries, new and rehabilitated cemeteries are limited to sections 14.27.030.050, 14.27.030.100, 14.27.030.110, and existing cemeteries are limited to Chapter 14.27.040.

C. Any project with an aggregate landscape area of 2,500 square feet or less may comply with the performance requirements of this ordinance or conform to the prescriptive measures contained in chapter 14.27.070.

D. For projects using treated or untreated graywater or rainwater captured on site, any lot or parcel within the project that has less than 2500 sq. ft of landscape and meets the lot or parcel's landscape water requirement (Estimated Total Water Use) entirely with treated or untreated graywater or through stored rainwater captured on site is subject only to section 14.27.070(B)(5).

E. This ordinance does not apply to:

1. registered local, state or federal historical sites;

2. ecological restoration projects that do not require a permanent irrigation system;

3. mined-land reclamation projects that do not require a permanent irrigation system; or

4. existing plant collections, as part of botanical gardens and arboretums open to the public.

14.27.010.040 Alternate methods and exceptions

The Director may approve an alternate method or exception to this ordinance where it can be demonstrated that the exception or alternate is at least as effective in conserving water as adherence to the provisions of this ordinance.

Chapter 14.27.020
Definitions

14.27.020.010 Definitions

The terms used in this ordinance have the meaning set forth below:

"Applied water" means the portion of water supplied by the irrigation system to the landscape.

"Automatic irrigation controller" means a timing device used to remotely control valves that operate an irrigation system. Automatic irrigation controllers are able to self-adjust and schedule irrigation events using either evapotranspiration (weather-based) or soil moisture data.

"Backflow prevention device" means a safety device used to prevent pollution or contamination of the water supply due to the reverse flow of water from the irrigation system.

"Certificate of Completion" means the document required under section 14.27.030.080.

"Certified irrigation designer" means a person certified to design irrigation systems by an accredited academic institution, a professional trade organization or other program such as the US Environmental Protection Agency's WaterSense irrigation designer certification program and Irrigation Association's Certified Irrigation Designer program.

"Certified landscape irrigation auditor" means a person certified to perform landscape irrigation audits by an accredited academic institution, a professional trade organization or other program such as the US Environmental Protection Agency's WaterSense irrigation auditor certification program and Irrigation Association's Certified Landscape Irrigation Auditor program.

"Check valve" or "anti-drain valve" means a valve located under a sprinkler head, or other location in the irrigation system, to hold water in the system to prevent drainage from sprinkler heads when the sprinkler is off.

"Common interest developments" means community apartment projects, condominium projects, planned developments and stock cooperatives per California Civil Code section 1351.

"Compost" means the safe and stable product of controlled biologic decomposition of organic materials that is beneficial to plant growth.

"Conversion factor (0.62)" means the number that converts acre-inches per acre per year to gallons per square foot per year.

"Director" means the Director of Community Development of the City of Vacaville or a person designated by the Director to assume some or all of the Director's duties.

"Distribution uniformity" means the measure of the uniformity of irrigation water over a defined area.

"Drip irrigation" means any non-spray low volume irrigation system utilizing emission devices with a flow rate measured in gallons per hour. Low volume irrigation systems are specifically designed to apply small volumes of water slowly at or near the root zone of plants.

"Ecological restoration project" means a project where the site is intentionally altered to establish a defined, indigenous, historic ecosystem.

"Effective precipitation" or "usable rainfall" (Eppt) means the portion of total precipitation which becomes available for plant growth.

"Emitter" means a drip irrigation emission device that delivers water slowly from the system to the soil.

"Established landscape" means the point at which plants in the landscape have developed significant root growth into the soil. Typically, most plants are established after one or two years of growth.

"Establishment period of the plants" means the first year after installing the plant in the landscape or the first two years if irrigation will be terminated after establishment. Typically, most plants are established after one or two years of growth. Native habitat mitigation areas and trees may need three to five years for establishment.

"Estimated Total Water Use" (ETWU) means the total water used for the landscape as described in section 14.27.030.050.

"ET adjustment factor" (ETAF) means a factor of 0.55 for residential areas and 0.45 for non-residential areas, that, when applied to reference evapotranspiration, adjusts for plant factors and irrigation efficiency, two major influences upon the amount of water that needs to be applied to the landscape. The ETAF for new and existing (non-rehabilitated) Special Landscape Areas shall not exceed 1.0. The ETAF for existing non-rehabilitated landscapes is 0.8.

"Evapotranspiration rate" means the quantity of water evaporated from adjacent soil and other surfaces and transpired by plants during a specified time.

"Flow rate" means the rate at which water flows through pipes, valves and emission devices, measured in gallons per minute, gallons per hour, or cubic feet per second.

"Flow sensor" means an inline device installed at the supply point of the irrigation system that produces a repeatable signal proportional to flow rate. Flow sensors must be connected to an automatic irrigation controller, or flow monitor capable of receiving flow signals and operating master valves. This combination flow sensor/controller may also function as a landscape water meter or submeter.

"Friable" means a soil condition that is easily crumbled or loosely compacted down to a minimum depth per planting material requirements, whereby the root structure of newly planted material will be allowed to spread unimpeded.

"Fuel Modification Plan Guideline" means guidelines from a local fire authority to assist residents and businesses that are developing land or building structures in a fire hazard severity zone.

"Graywater" means untreated wastewater that has not been contaminated by any toilet discharge, has not been affected by infectious, contaminated, or unhealthy bodily wastes, and does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. "Graywater" includes, but is not limited to, wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers. See California Health and Safety Code section 17922.12.

"Hardscapes" means any durable material (pervious and non-pervious).

"Hydrozone" means a portion of the landscaped area having plants with similar water needs and rooting depth. A hydrozone may be irrigated or non-irrigated.

"Infiltration rate" means the rate of water entry into the soil expressed as a depth of water per unit of time (e.g., inches per hour).

"Invasive plant species" means species of plants not historically found in California that spread outside cultivated areas and can damage environmental or economic resources. Invasive species may be regulated by county agricultural agencies as noxious species. Lists of invasive plants are maintained at the California Invasive Plant Inventory and USDA invasive and noxious weeds database.

"Irrigation audit" means an in-depth evaluation of the performance of an irrigation system conducted by a Certified Landscape Irrigation Auditor. An irrigation audit includes, but is not limited to: inspection, system tune-up, system test with distribution uniformity or emission uniformity, reporting overspray or runoff that causes overland flow, and preparation of an irrigation schedule. The audit must be conducted in a manner consistent with the Irrigation Association's Landscape Irrigation Auditor Certification program or other U.S. Environmental Protection Agency "Watersense" labeled auditing program.

"Irrigation efficiency" (IE) means the measurement of the amount of water beneficially used divided by the amount of water applied. Irrigation efficiency is derived from measurements and estimates of irrigation system characteristics and management practices. The irrigation efficiencies for purposes of this ordinance are 0.75 for overhead spray devices and 0.81 for drip systems.

"Irrigation survey" means an evaluation of an irrigation system that is less detailed than an irrigation audit. An irrigation survey includes, but is not limited to: inspection, system test, and written recommendations to improve performance of the irrigation system.

"Irrigation water use analysis" means a review of water use data based on meter readings and billing data.

"Landscape architect" means a person who holds a license to practice landscape architecture in the California Business and Professions Code, section 5615.

"Landscape area" (LA) means all the planting areas, turf areas, and water features in a landscape design plan subject to the Maximum Applied Water Allowance calculation. The landscape area does not include footprints of buildings or structures, sidewalks, driveways, parking lots, decks, patios, gravel or stone walks, other pervious or non-pervious hardscapes, and other non-irrigated areas designated for non-development (e.g., open spaces and existing native vegetation).

"Landscape contractor" means a person licensed by the state of California to construct, maintain, repair, install, or subcontract the development of landscape systems.

"Landscape Documentation Package" means the documents required under section 14.27.030.040.

"Landscape project" means total area of landscape in a project as defined in "landscape area" for the purposes of this ordinance, meeting requirements under section 14.27.010.030.

"Landscape water meter" means an inline device installed at the irrigation supply point that measures the flow of water into the irrigation system and is connected to a totalizer to record water use.

"Lateral line" means the water delivery pipeline that supplies water to the emitters or sprinklers from the valve.

"Local water purveyor" means any entity, including a public agency, city, county, or private water company that provides retail water service.

"Low volume irrigation" means the application of irrigation water at low pressure through a system of tubing or lateral lines and low-volume emitters such as drip, drip lines, and bubblers. Low volume irrigation systems are specifically designed to apply small volumes of water slowly at or near the root zone of plants.

"Main line" means the pressurized pipeline that delivers water from the water source to the valve or outlet.

"Master shut-off valve" is an automatic valve installed at the irrigation supply point which controls water flow into the irrigation system. When this valve is closed water will not be supplied to the irrigation system. A master valve will greatly reduce any water loss due to a leaky station valve.

"Maximum Applied Water Allowance" (MAWA) means the upper limit of annual applied water for the established landscaped area as specified in section 14.127.030.040. It is based upon the area's reference evapotranspiration, the ET Adjustment Factor, and the size of the landscape area. The Estimated Total Water Use shall not exceed the Maximum Applied Water Allowance. Special Landscape Areas, including recreation areas, areas permanently and solely dedicated to edible plants such as orchards and vegetable gardens, and areas irrigated with recycled water are subject to the MAWA with an ETAF not to exceed 1.0. MAWA = (ETo) (0.62) [(ETAF x LA) + ((1-ETAF) x SLA)].

"Median" is an area between opposing lanes of traffic that may be unplanted or planted with trees, shrubs, perennials, and ornamental grasses.

"Microclimate" means the climate of a small, specific area that may contrast with the climate of the overall landscape area due to factors such as wind, sun exposure, plant density, or proximity to reflective surfaces.

"Mined-land reclamation projects" means any surface mining operation with a reclamation plan approved in accordance with the Surface Mining and Reclamation Act of 1975.

"Mulch" means any organic material such as leaves, bark, straw, compost, or inorganic mineral materials such as rocks, gravel, and or decomposed granite left loose and applied to the soil surface for the beneficial purposes of reducing evaporation, suppressing weeds, moderating soil temperature, and preventing soil erosion.

"New construction" means, for the purposes of this ordinance, a new building with a landscape or other new landscape, such as a park, playground, or greenbelt without an associated building.

"Non-residential landscape" means landscapes in commercial, institutional, industrial and public settings that may have areas designated for recreation or public assembly. It also includes portions of common areas of common interest developments with designated recreational areas.

"Operating pressure" means the pressure at which the parts of an irrigation system are designed by the manufacturer to operate.

"Overhead sprinkler irrigation systems" means systems that deliver water through the air (e.g., spray heads and rotors).

"Overspray" means the irrigation water which is delivered beyond the target area.

"Permit" means an authorizing document issued by local agencies for new construction or rehabilitated landscapes.

"Pervious" means any surface or material that allows the passage of water through the material and into the underlying soil.

"Plant factor" or "plant water use factor" is a factor, when multiplied by ETo, estimates the amount of water needed by plants. For purposes of this ordinance, the plant factor range for very low water use plants is 0 to 0.1, the plant factor range for low water use plants is 00.1 to 0.3, the plant factor range for moderate water use plants is 0.4 to 0.6, and the plant factor range for high water use plants is 0.7 to 1.0. Plant factors cited in this ordinance are derived from the Department of Water Resources 2000 publication "Water Use Classification of Landscape Species." Plant factors may also be obtained from horticultural researchers from academic institutions or professional associations as approved by the California Department of Water Resources (DWR).

"Project applicant" means the individual or entity submitting a Landscape Documentation Package required under section 14.27.030.040 to request a permit, plan check, or design review from the City of Vacaville. A project applicant may be the property owner or his or her designee.

"Rain sensor" or "rain sensing shutoff device" means a component which automatically suspends an irrigation event when it rains.

"Record drawing" or "as-builts" means a set of reproducible drawings which show significant changes in the work made during construction and which are usually based on drawings marked up in the field and other data furnished by the contractor.

"Recreational area" means areas, excluding private single family residential areas designated for active play, recreation or public assembly, in parks, sports fields, picnic grounds, amphitheaters and or golf course tees, fairways, roughs, surrounds and greens.

"Recycled water," "reclaimed water," or "treated sewage effluent water" means treated or recycled waste water of a quality suitable for non-potable uses such as landscape irrigation and water features. This water is not intended for human consumption.

"Reference evapotranspiration" or "ETo" means a standard measurement of environmental parameters which affect the water use of plants. ETo is expressed in inches per day, month, or year as represented in Table 14.27.030.01, and is an estimate of the evapotranspiration of a large field of four-to seven-inch tall, cool-season grass that is well

watered. Reference evapotranspiration is used as the basis of determining the Maximum Applied Water Allowance so that regional differences in climate can be accommodated.

"Rehabilitated landscape" means any re-landscaping project that requires a permit, plan check, or design review, meets the requirements of section 14.27.010.030, and the modified landscape area is equal to or greater than 2,500 square feet.

"Residential landscape" means landscapes surrounding single or multifamily homes.

"Runoff" means water which is not absorbed by the soil or landscape to which it is applied and flows from the landscape area. For example, runoff may result from water that is applied at too great a rate (application rate exceeds infiltration rate) or when there is a slope.

"Soil moisture sensing device" or "soil moisture sensor" means a device that measures the amount of water in the soil. The device may also suspend or initiate an irrigation event.

"Soil texture" means the classification of soil based on its percentage of sand, silt, and clay.

"Special Landscape Area" (SLA) means an area of the landscape dedicated solely to edible plants, recreational areas, areas irrigated with recycled water, or water features using recycled water.

"Sprinkler head" means a device which delivers water through a nozzle.

"Static water pressure" means the pipeline or municipal water supply pressure when water is not flowing.

"Station" means an area served by one valve or by a set of valves that operate simultaneously.

"Swing joint" means an irrigation component that provides a flexible, leak-free connection between the emission device and lateral pipeline to allow movement in any direction and to prevent equipment damage.

"Submeter" means a metering device to measure water applied to the landscape that is installed after the primary utility water meter.

"Turf" means a ground cover surface of mowed grass. Annual bluegrass, Kentucky bluegrass, Perennial ryegrass, Red fescue, and Tall fescue are cool-season grasses. Bermudagrass, Kikuyugrass, Seashore Paspalum, St. Augustinegrass, Zoysiagrass, and Buffalo grass are warm-season grasses.

"Valve" means a device used to control the flow of water in the irrigation system.

"Water conserving plant species" means a plant species identified as having a very low or low plant factor.

"Water feature" means a design element where open water performs an aesthetic or recreational function. Water features include ponds, lakes, waterfalls, fountains, artificial streams, spas, and swimming pools (where water is artificially supplied). The surface area of water

features is included in the high water use hydrozone of the landscape area. Constructed wetlands used for on-site wastewater treatment or stormwater best management practices that are not irrigated and used solely for water treatment or stormwater retention are not water features and, therefore, are not subject to the water budget calculation.

"Watering window" means the time of day irrigation is allowed.

"WUCOLS" means the Water Use Classification of Landscape Species published by the University of California Cooperative Extension and the Department of Water Resources 2014.

Chapter 14.27.030
Provisions for New Construction or Rehabilitated Landscapes

14.27.030.010 Designation of Implementation Agency.

The City of Vacaville may designate by mutual agreement, another agency, such as a water purveyor, to implement some or all of the requirements contained in this ordinance.

14.27.030.020 Compliance with Landscape Documentation Package.

A. Prior to construction, the Director of Community Development shall:

1. provide the project applicant with the ordinance and procedures for permits, plan checks, or design reviews;

2. review the Landscape Documentation Package submitted by the project applicant;

3. approve or deny the Landscape Documentation Package;

4. issue a permit or approve the plan check or design review for the project applicant; and

5. upon approval of the Landscape Documentation Package, submit a copy of the Water Efficient Landscape Worksheet to the local water purveyor if other than the City of Vacaville.

B. Prior to construction, the project applicant shall submit a Landscape Documentation Package to the Director

C. Upon approval of the Landscape Documentation Package by the Director, the project applicant shall:

1. receive a permit or approval of the plan check or design review and record the date of the permit in the Certificate of Completion;

2. submit a copy of the approved Landscape Documentation Package along with the record drawings, and any other information to the property owner or his/her designee; and

3. submit a copy of the Water Efficient Landscape Worksheet to the local water purveyor if other than the City of Vacaville.

14.27.030.030 Penalties

Violation of any provision of this division is subject to penalties as described in chapter 1.16 of the Vacaville Municipal Code and any other penalty or remedy to the extent permitted by law..

14.27.030.040 Elements of the Landscape Documentation Package.

A. The Landscape Documentation Package shall include the following six elements:

1. project information:

a. date

b. project applicant

c. project address (if available, parcel and/or lot number(s))

d. total landscape area (square feet)

e. project type (e.g., new, rehabilitated, public, private, cemetery, homeowner-installed)

f. water supply type (e.g., potable, recycled, well) and identify the local retail water purveyor if the applicant is not served by a private well

g. checklist of all documents in Landscape Documentation Package

h. project contacts to include contact information for the project applicant and property owner

2. Water Efficient Landscape Worksheet with water budget calculations, including Maximum Applied Water Allowance (MAWA) and Estimated Total Water Use (ETWU);

3. soil management report;

4. landscape design plan; and

5. irrigation design plan.

14.27.030.050 Water Efficient Landscape Worksheet.

A. A project applicant shall complete the Water Efficient Landscape Worksheet in Figure 27.030-1, or other worksheet that demonstrates compliance, which contains information on the plant factor, irrigation method, irrigation efficiency, and area associated with each hydrozone. Calculations are then made to show that the evapotranspiration adjustment factor (ETAF) for the landscape project does not exceed a factor of 0.55 for residential areas and 0.45 for non-residential areas, exclusive of Special Landscape Areas. The ETAF for a landscape project is based on the plant factors and irrigation methods selected. The Maximum Applied Water Allowance is calculated based on the maximum ETAF allowed (0.55 for residential areas and

0.45 for non-residential areas) and expressed as annual gallons required. The Estimated Total Water Use (ETWU) is calculated based on the plants used and irrigation method selected for the landscape design. ETWU must be below the MAWA. In calculating the Maximum Applied Water Allowance and Estimated Total Water Use, a project applicant shall use the ETo values from the Reference Evapotranspiration Table 14.27.030.01.

B. Water budget calculations shall adhere to the following requirements:

1. The plant factor used shall be from WUCOLS or from horticultural researchers with academic institutions or professional associations as approved by the California Department of Water Resources (DWR). The plant factor ranges from 0 to 0.1 for very low water using plants, 0.1 to 0.3 for low water use plants, from 0.4 to 0.6 for moderate water use plants, and from 0.7 to 1.0 for high water use plants.

2. All water features shall be included in the high water use hydrozone, and temporarily irrigated areas shall be included in the low water use hydrozone.

3. All Special Landscape Areas shall be identified and their water use calculated as shown in Figure 14.27.030-1.

4. ETAF for new and existing (non-rehabilitated) Special Landscape Areas shall not exceed 1.0.

TABLE 14.27.030.01
Reference Evapotranspiration (ETo)Table

	Month (Inches/month)												Total (Inches/ year)
Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Vacaville except Lagoon Valley	0.7	1.4	3.2	5.2	6.3	7.6	8.2	7.2	5.5	4.3	1.6	1.1	52.1
Lagoon Valley	1.1	1.7	2.8	4.0	5.5	6.1	7.8	6.0	4.8	3.1	1.4	0.9	45.2

Figure 14.27.030-1
Water Efficient Landscape Worksheet

This worksheet is filled out by the project applicant and it's a required element of the Landscape Documentation Package.

Reference Evapotranspiration (ETo) _____

Hydrozone # /Planting Description[a]	Plant Factor (PF)	Irrigation Method[b]	Irrigation Efficiency (IE)[c]	ETAF (PF/IE)	Landscape Area (sq. ft.)	ETAF x Area	Estimated Total Water Use (ETWU)[d]
Regular Landscape Areas							
				Totals	(A)	(B)	
Special Landscape Areas							
				1			
				1			
				1			
				Totals	(C)	(D)	
						ETWU Total	
						Maximum Allowed Water Allowance (MAWA)[e]	

[a] *Hydrozone #/Planting Description*
E.g
1) front lawn
2) low water use plantings
3) medium water use planting

[b] *Irrigation Method*
overhead spray
or drip

[c] *Irrigation Efficiency*
0.75 for spray head
0.81 for drip

[d] *ETWU* **(Annual Gallons Required)** =
Eto x 0.62 x ETAF x Area
where 0.62 is a conversion factor that acre-inches per acre per year to gallons per square foot per year.

[e] *MAWA (Annual Gallons Allowed) = (Eto) (0.62) [(ETAF x LA) + ((1-ETAF) x SLA)]*
where 0.62 is a conversion factor that acre-inches per acre per year to gallons per square foot per year, LA is the total landscape area in square feet, SLA is the total special landscape area in square feet,
and ETAF is .55 for residential areas and 0.45 for non-residential areas.

ETAF Calculations

Regular Landscape Areas

Total ETAF x Area	(B)
Total Area	(A)
Average ETAF	**B ÷ A**

Average ETAF for Regular Landscape Areas must be 0.55 or below for residential areas, and 0.45 or below for non-residential areas.

All Landscape Areas

Total ETAF x Area	(B+D)
Total Area	(A+C)
Sitewide ETAF	**(B+D) ÷ (A+C)**

14.27.030.060 Landscape Design Plan

A. For the efficient use of water, a landscape shall be carefully designed and planned for the intended function of the project. A landscape design plan meeting the following design criteria shall be submitted as part of the Landscape Documentation Package.

1. Plant Material

a. Any plant may be selected for the landscape providing the Estimated Total Water Use in the landscape area does not exceed the Maximum Applied Water Allowance and the selection complies with any other adopted landscaping requirements.

b. Each hydrozone shall have plant materials with similar water use, with the exception of hydrozones with plants of mixed water use, as specified in section 14.27.030.070(A)(2)(d).

c. Plants shall be selected and planted appropriately based upon their adaptability to the climatic, geologic, and topographical conditions of the project site. Methods to achieve water efficiency shall include one or more of the following:

i. use the Sunset Western Climate Zone System which takes into account temperature, humidity, elevation, terrain, latitude, and varying degrees of continental and marine influence on local climate;

ii. recognize the horticultural attributes of plants (i.e., mature plant size, invasive surface roots) to minimize damage to property or infrastructure [e.g., buildings, sidewalks, power lines]; allow for adequate soil volume for healthy root growth; and

iii. consider the solar orientation for plant placement to maximize summer shade and winter solar gain.

d. Turf is not allowed on slopes greater than 25% where the toe of the slope is adjacent to an impermeable hardscape and where 25% means 1 foot of vertical elevation change for every 4 feet of horizontal length (rise divided by run x 100 = slope percent).

e. High water use plants, characterized by a plant factor of 0.7 to 1.0, are prohibited in street medians.

f. A landscape design plan for projects in fire-prone areas shall address fire safety and prevention. A defensible space or zone around a building or structure is required per California Public Resources Code section 4291(a) and (b). Avoid fire-prone plant materials and highly flammable mulches. Refer to the local Fuel Modification Plan guidelines.

g. The use of invasive plant species, such as those listed by the California Invasive Plant Council, is strongly discouraged.

h. The architectural guidelines of a common interest development, which include community apartment projects, condominiums, planned developments, and stock

cooperatives, shall not prohibit or include conditions that have the effect of prohibiting the use of low-water use plants as a group.

2. Water Features

a. Recirculating water systems shall be used for water features.

b. Where available, recycled water shall be used as a source for decorative water features.

c. Surface area of a water feature shall be included in the high water use hydrozone area of the water budget calculation.

d. Pool and spa covers are highly recommended.

3. Soil Preparation, Mulch and Amendments

a. Prior to the planting of any materials, compacted soils shall be transformed to a friable condition. On engineered slopes, only amended planting holes need meet this requirement.

b. Soil amendments shall be incorporated according to recommendations of any soil report prepared and what is appropriate for the plants selected.

c. For landscape installations, compost at a rate of a minimum of four cubic yards per 1,000 square feet of permeable area shall be incorporated to a depth of six inches into the soil. Soils with greater than 6% organic matter in the top 6 inches of soil are exempt from adding compost and tilling.

d. A minimum three inch layer of mulch shall be applied on all exposed soil surfaces of planting areas except in turf areas, creeping or rooting groundcovers, or direct seeding applications where mulch is contraindicated. To provide habitat for beneficial insects and other wildlife, up to 5 % of the landscape area may be left without mulch. Designated insect habitat must be included in the landscape design plan as such.

e. Stabilizing mulching products shall be used on slopes that meet current engineering standards.

f. The mulching portion of the seed/mulch slurry in hydro-seeded applications shall meet the mulching requirement.

B. The landscape design plan, at a minimum, shall:

1. delineate and label each hydrozone by number, letter, or other method;

2. identify each hydrozone as low, moderate, high water, or mixed water use. Temporarily irrigated areas of the landscape shall be included in the low water use hydrozone for the water budget calculation;

3. identify recreational areas (for uses other than single family residential, if any);

4. identify areas permanently and solely dedicated to edible plants (if any);

5. identify areas irrigated with recycled water (if any);

6. identify type of mulch and application depth;

7. identify soil amendments, type, and quantity;

8. identify type and surface area of water features (if any);

9. identify hardscapes (pervious and non-pervious, if any);

10. bear the signature of a licensed landscape architect, licensed landscape contractor, or any other person authorized to design a landscape. (See sections 5500.1, 5615, 5641, 5641.1, 5641.2, 5641.3, 5641.4, 5641.5, 5641.6, 6701, 7027.5 of the California Business and Professions Code, section 832.27 of Title16 of the California Code of Regulations, and section 8721 of the California Food and Agriculture Code.)

14.27.030.070 Irrigation Design Plan.

A. This section applies to landscaped areas requiring permanent irrigation, not areas that require temporary irrigation solely for the plant establishment period. For the efficient use of water, an irrigation system shall meet all the requirements listed in this section and the manufacturers' recommendations. The irrigation system and its related components shall be planned and designed to allow for proper installation, management, and maintenance. An irrigation design plan meeting the following design criteria shall be submitted as part of the Landscape Documentation Package.

1. System

a. Landscape water meters, defined as either a dedicated water service meter or private submeter, shall be installed for all non-residential irrigated landscapes of 1,000 sq. ft. but not more than 5,000 sq.ft. (the level at which California Water Code section 535 applies) and residential irrigated landscapes of 5,000 sq. ft. or greater. A landscape water meter may be either:

i. a customer service meter dedicated to landscape use provided by the local water purveyor; or

ii. a privately owned meter or submeter.

b. Automatic irrigation controllers utilizing either evapotranspiration or soil moisture sensor data utilizing non-volatile memory shall be required for irrigation scheduling in all irrigation systems.

c. Sensors (rain, freeze, wind, etc.), either integral or auxiliary, that suspend or alter irrigation operation during unfavorable weather conditions shall be required on all

irrigation systems, as appropriate for local climatic conditions. Irrigation should be avoided during windy or freezing weather or during rain. d. Flow sensors that detect high flow conditions created by system damage or malfunction are required for all on non-residential landscapes and residential landscapes of 5000 sq. ft. or larger.

e. Master shut-off valves are required on all projects except landscapes that make use of technologies that allow for the individual control of sprinklers that are individually pressurized in a system equipped with low pressure shut down features.

f. The irrigation system shall be designed to prevent runoff, low head drainage, overspray, or other similar conditions where irrigation water flows onto non-targeted areas, such as adjacent property, non-irrigated areas, hardscapes, roadways, or structures.

g. Relevant information from the soil management plan, such as soil type and infiltration rate, shall be utilized when designing irrigation systems.

h. The design of the irrigation system shall conform to the hydrozones of the landscape design plan.

i. The irrigation system must be designed and installed to meet, at a minimum, the irrigation efficiency criteria as described in section 14.127.030.040 regarding the Maximum Applied Water Allowance.

j.All irrigation emission devices must meet the requirements set in the American National Standards Institute (ANSI) standard, American Society of Agricultural and Biological Engineers'/International Code Council's (ASABE/ICC) 802-2014 "Landscape Irrigation Sprinkler and Emitter Standard." All sprinkler heads installed in the landscape must document a distribution uniformity low quarter of 0.65 or higher using the protocol defined in ASABE/ICC 802-2014.

k. It is highly recommended that the project applicant or City of Vacaville inquire with the local water purveyor about peak water operating demands (on the water supply system) or water restrictions that may impact the effectiveness of the irrigation system.

l. In mulched planting areas, the use of low volume irrigation is required to maximize water infiltration into the root zone.

m. Sprinkler heads and other emission devices shall have matched precipitation rates, unless otherwise directed by the manufacturer's recommendations.

n. Head to head coverage is recommended. However, sprinkler spacing shall be designed to achieve the highest possible distribution uniformity using the manufacturer's recommendations.

o. Swing joints or other riser-protection components are required on all risers subject to damage that are adjacent to hardscapes or in high traffic areas of turfgrass.

p. Check valves or anti-drain valves are required on all sprinkler heads where low point drainage could occur.

q. Areas less than ten(10) feet in width in any direction shall be irrigated with subsurface irrigation or other means that produces no runoff or overspray.

r. Overhead irrigation shall not be permitted within 24 inches of any non-permeable surface. Allowable irrigation within the setback from non-permeable surfaces may include drip, drip line, or other low flow non-spray technology. The setback area may be planted or unplanted. The surfacing of the setback may be mulch, gravel, or other porous material. These restrictions may be modified if:

i. the landscape area is adjacent to permeable surfacing and no runoff occurs; or

ii. the adjacent non-permeable surfaces are designed and constructed to drain entirely to landscaping; or

iii. the irrigation designer specifies an alternative design or technology, as part of the Landscape Documentation Package and clearly demonstrates strict adherence to irrigation system design criteria in section 14.27.030.070 (A)(1)(f). Prevention of overspray and runoff must be confirmed during the irrigation audit.

s. Slopes greater than 25% shall not be irrigated with an irrigation system with a application rate exceeding 0.75 inches per hour. This restriction may be modified if the landscape designer specifies an alternative design or technology, as part of the Landscape Documentation Package, and clearly demonstrates no runoff or erosion will occur. Prevention of runoff and erosion must be confirmed during the irrigation audit.

2. Hydrozone

a. Each valve shall irrigate a hydrozone with similar site, slope, sun exposure, soil conditions, and plant materials with similar water use.

b. Sprinkler heads and other emission devices shall be selected based on what is appropriate for the plant type within that hydrozone.

c. Where feasible, trees shall be placed on separate valves from shrubs, groundcovers, and turf to facilitate the appropriate irrigation of trees. The mature size and extent of the root zone shall be considered when designing irrigation for the tree.

d. Individual hydrozones that mix plants of moderate and low water use, or moderate and high water use, may be allowed if:

i. plant factor calculation is based on the proportions of the respective plant water uses and their plant factor; or

ii. the plant factor of the higher water using plant is used for calculations.

e. Individual hydrozones that mix high and low water use plants shall not be permitted.

f. On the landscape design plan and irrigation design plan, hydrozone areas shall be designated by number, letter, or other designation. On the irrigation design plan, designate the areas irrigated by each valve, and assign a number to each valve. Use this valve number in the Hydrozone Information Table (see Figure 14.27.030-1). This table can also assist with the irrigation audit and programming the controller.

B. The irrigation design plan, at a minimum, shall contain:

1. location and size of separate water meters for landscape;

2. location, type and size of all components of the irrigation system, including controllers, main and lateral lines, valves, sprinkler heads, moisture sensing devices, rain switches, quick couplers, pressure regulators, and backflow prevention devices;

3. static water pressure at the point of connection to the public water supply;

4. flow rate (gallons per minute), application rate (inches per hour), and design operating pressure (pressure per square inch) for each station;

5. recycled water irrigation systems as specified in section 14.27.030.130; and

6. the signature of a licensed landscape architect, certified irrigation designer, licensed landscape contractor, or any other person authorized to design an irrigation system. (See sections 5500.1, 5615, 5641, 5641.1, 5641.2, 5641.3, 5641.4, 5641.5, 5641.6, 6701, 7027.5 of the California Business and Professions Code, section 832.27 of Title 16 of the California Code of Regulations, and section 6721 of the California Food and Agricultural Code.)

14.27.030.080 Certificate of Completion.

A. The Certificate of Completion (see Figure 14.27.030-2 for a sample certificate) shall include the following six (6) elements:

1. project information sheet that contains:

a. date;

b. project name;

c. project applicant name, telephone, and mailing address;

d. project address and location; and

e. property owner name, telephone, and mailing address.

2. certification by either the signer of the landscape design plan, the signer of the irrigation design plan, or the licensed landscape contractor that the landscape project has been installed per the approved Landscape Documentation Package;

a. where there have been significant changes made in the field during construction, these "as-built" or record drawings shall be included with the certification;

b. A diagram of the irrigation plan showing hydrozones shall be kept with the irrigation controller for subsequent management purposes.

3. irrigation scheduling parameters used to set the controller (see section 14.27.030.090);

4. landscape and irrigation maintenance schedule (see section 14.27.030.100); and

5. irrigation audit report (see section 14.27.030.110).

B. The project applicant shall:

1. submit the signed Certificate of Completion to the Director for review;

2. ensure that copies of the approved Certificate of Completion are submitted to the local water purveyor if other than the City of Vacaville and property owner or his or her designee.

C. The Director shall:

1. receive the signed Certificate of Completion from the project applicant;

2. approve or deny the Certificate of Completion. If the Certificate of Completion is denied, the Director shall provide information to the project applicant regarding reapplication, appeal, or other assistance.

Figure 14.27.030-2
Sample Certificate of Completion

CERTIFICATE OF COMPLETION

This certificate is filled out by the project applicant upon completion of the landscape project.

PART 1. PROJECT INFORMATION SHEET

Date		
Project Name		
Name of Project Applicant	Telephone No.	
	Fax No.	
Title	Email Address	
Company	Street Address	
City	State	Zip Code

Project Address and Location:

Street Address		Parcel, tract or lot number, if available.
City		Latitude/Longitude (optional)
State	Zip Code	

Property Owner or his/her designee:

Name	Telephone No.	
	Fax No.	
Title	Email Address	
Company	Street Address	
City	State	Zip Code

Property Owner

"I/we certify that I/we have received copies of all the documents within the Landscape Documentation Package and the Certificate of Completion and that it is our responsibility to see that the project is maintained in accordance with the Landscape and Irrigation Maintenance Schedule."

_____

Property Owner Signature Date

Please answer the questions below:

1 Date the Landscape Documentation Package was submitted to the City of Vacaville _____
2 Date the Landscape Documentation Package was approved by the City of Vacaville _____
3 Date that a copy of the Water Efficient Landscape Worksheet (including the Water Budget Calculation) was submitted to the City of Vacaville_____

PART 2. CERTIFICATION OF INSTALLATION ACCORDING TO THE LANDSCAPE DOCUMENTATION PACKAGE

'I/we certify that based upon periodic site observations, the work has been completed in accordance with the Vacaville Water Efficient Landscape Ordinance and that the landscape planting and irrigation installation conform to the criteria and specifications of the approved Landscape Documentation Package.'

Signature*	Date	
Name (print)	Telephone No.	
	Fax No.	
Title	Email Address	
License No. or Certification No.		
Company	Street Address	
City	State	Zip Code

*Signer of the landscape design plan, signer of the irrigation plan, or a licensed landscape contractor.

PART 3. IRRIGATION SCHEDULING

Attach parameters for setting the irrigation schedule on controller per Vacaville Code 14.27.030.100.

PART 4. SCHEDULE OF LANDSCAPE AND IRRIGATION MAINTENANCE

Attach schedule of Landscape and Irrigation Maintenance per Vacaville Code 14.27.030.110.

PART 5. LANDSCAPE IRRIGATION AUDIT REPORT

Attach Landscape Irrigation Audit Report per Vacaville Code 14.27.030.120.

14.27.030.090 Irrigation Scheduling.

For the efficient use of water, all irrigation schedules shall be developed, managed, and evaluated to utilize the minimum amount of water required to maintain plant health. Irrigation schedules shall meet the following criteria:

A. Irrigation scheduling shall be regulated by automatic irrigation controllers.

B. Overhead irrigation shall be scheduled between 8:00 p.m. and 10:00 a.m. unless weather conditions prevent it. If allowable hours of irrigation differ from the local water purveyor, the stricter of the two shall apply. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.

C. For implementation of the irrigation schedule, particular attention must be paid to irrigation run times, emission device, flow rate, and current reference evapotranspiration, so that applied water meets the Estimated Total Water Use. Total annual applied water shall be less than or equal to Maximum Applied Water Allowance (MAWA). Actual irrigation schedules shall be regulated by automatic irrigation controllers using current reference evapotranspiration data (e.g., CIMIS) or soil moisture sensor data.

D. Parameters used to set the automatic controller shall be developed and submitted for each of the following:

1. the plant establishment period;
2. the established landscape; and
3. temporarily irrigated areas.

E. Each irrigation schedule shall consider for each station all of the following that apply:

1. irrigation interval (days between irrigation);
2. irrigation run times (hours or minutes per irrigation event to avoid runoff);
3. number of cycle starts required for each irrigation event to avoid runoff;
4. amount of applied water scheduled to be applied on a monthly basis;
5. application rate setting;
6. root depth setting;
7. plant type setting;
8. soil type;

9. slope factor setting;

10. shade factor setting; and

11. irrigation uniformity or efficiency setting.

14.27.030.100 Landscape and Irrigation Maintenance Schedule.

A. Landscapes shall be maintained to ensure water use efficiency. A regular maintenance schedule shall be submitted with the Certificate of Completion.

B. A regular maintenance schedule shall include, but not be limited to, routine inspection; auditing, adjustment and repair of the irrigation system and its components; aerating and dethatching turf areas; topdressing with compost, replenishing mulch; fertilizing; pruning; weeding in all landscape areas, and removing obstructions to emission devices. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.

C. Repair of all irrigation equipment shall be done with the originally installed components or their equivalents or with components with greater efficiency.

D. A project applicant is encouraged to implement established landscape industry sustainable Best Practices for all landscape maintenance activities.

14.27.030.110 Irrigation Audit, Irrigation Survey, and Irrigation Water Use Analysis.

A. All landscape irrigation audits shall be conducted by a third party certified landscape irrigation auditor. Landscape audits shall not be conducted by the person who designed the landscape or installed the landscape

B. In large projects or projects with multiple landscape installations (i.e. production home developments) an auditing rate of 1 in 7 lots or approximately 15% will satisfy this requirement.

C. For new construction and rehabilitated landscape projects installed after December 1, 2015, as described in section 14.27.010.030:

1. the project applicant shall submit an irrigation audit report with the Certificate of Completion to the local agency that may include, but is not limited to: inspection, system tune-up, system test with distribution uniformity, reporting overspray or run off that causes overland flow, and preparation of an irrigation schedule, including configuring irrigation controllers with application rate, soil types, plant factors, slope, exposure and any other factors necessary for accurate programming;

2. the City of Vacaville shall administer programs that may include, but not be limited to, irrigation water use analysis, irrigation audits, and irrigation surveys for compliance with the Maximum Applied Water Allowance.

14.27.030.120 Irrigation Efficiency.

For the purpose of determining Estimated Total Water Use, average irrigation efficiency is assumed to be 0.75 for overhead spray devices and 0.81 for drip system devices.

14.27.030.130 Recycled Water.

A. The installation of recycled water irrigation systems shall allow for the current and future use of recycled water.

B. All recycled water irrigation systems shall be designed and operated in accordance with all applicable local and State laws.

C. Landscapes using recycled water are considered Special Landscape Areas. The ET Adjustment Factor for new and existing (non-rehabilitated) Special Landscape Areas shall not exceed 1.0.

14.27.030.140 Graywater Systems.

Graywater systems promote the efficient use of water and are encouraged to assist in on-site landscape irrigation. All graywater systems shall conform to the California Plumbing Code (Title 24, Part 5, Chapter 16) and any standards adopted by the City of Vacaville. Refer to section 14.27.010.030 (d) for the applicability of this ordinance to landscape areas less than 2,500 square feet with the Estimated Total Water Use met entirely by graywater.

14.27.030.150 Stormwater Management and Rainwater Retention.

A. Stormwater management practices minimize runoff and increase infiltration which recharges groundwater and improves water quality. Implementing stormwater best management practices into the landscape and grading design plans to minimize runoff and to increase on-site rainwater retention and infiltration are encouraged.

B. Project applicants shall refer to the local agency or Regional Water Quality Control Board for information on any applicable stormwater technical requirements.

C. All planted landscape areas are required to have friable soil to maximize water retention and infiltration. Refer to section 14.27.030.060 (A)(3).

D. It is strongly recommended that landscape areas be designed for capture and infiltration capacity that is sufficient to prevent runoff from impervious surfaces (i.e. roof and paved areas) from either: the one inch, 24-hour rain event or (2) the 85th percentile, 24-hour rain event, and/or additional capacity as required by any applicable local, regional, state or federal regulation.

E. It is recommended that storm water projects incorporate any of the following elements to improve on-site storm water and dry weather runoff capture and use:

1. Grade impervious surfaces, such as driveways, during construction to drain to vegetated areas.

2. Minimize the area of impervious surfaces such as paved areas, roof and concrete driveways.

3. Incorporate pervious or porous surfaces (e.g., gravel, permeable pavers or blocks, pervious or porous concrete) that minimize runoff.

4. Direct runoff from paved surfaces and roof areas into planting beds or landscaped areas to maximize site water capture and reuse.

5. Incorporate rain gardens, cisterns, and other rain harvesting or catchment systems.

6. Incorporate infiltration beds, swales, basins and drywells to capture storm water and dry weather runoff and increase percolation into the soil.

7. Consider constructed wetlands and ponds that retain water, equalize excess flow, and filter pollutants.

14.27.030.160 Public Education.

A. Publications. Education is a critical component to promote the efficient use of water in landscapes. The use of appropriate principles of design, installation, management and maintenance that save water is encouraged in the community. The City of Vacaville shall provide information to owners of permitted renovations and new single-family residential homes regarding the design, installation, management, and maintenance of water efficient landscapes based on a water budget.

B. Model Homes. All model homes shall be landscaped and use signs and written information to demonstrate the principles of water efficient landscapes described in this ordinance.

1. Signs shall be used to identify the model as an example of a water efficient landscape featuring elements such as hydrozones, irrigation equipment, and others that contribute to the overall water efficient theme. Signage shall include information about the site water use; specify who designed and installed the water efficient landscape; and demonstrate low water use approaches to landscaping such as using native plants, graywater systems, and rainwater catchment systems.

2. Information shall be provided about designing, installing, managing, and maintaining water efficient landscapes

14.27.030.170 Environmental Review.

The City of Vacaville must comply with the California Environmental Quality Act (CEQA), as appropriate.

Chapter 14.27.040
Provisions for Existing Landscapes

14.27.040.010 Designation of Implementation Agency.

The City of Vacaville may by mutual agreement, designate another agency such as a water purveyor, to implement some or all of the requirements contained in this ordinance. Local agencies may collaborate with water purveyors to define each entity's specific responsibilities relating to this orcinance.

14.27.040.020 Irrigation Audit, Irrigation Survey, and Irrigation Water Use Analysis.

A. This section, 14.27.040.020, shall apply to all existing landscapes that were installed before December 1, 2015 and are over one acre in size.

1. For all landscapes in 14.27.040.020(A) that have a water meter, the City of Vacaville shall administer programs that may include, but not be limited to, irrigation water use analyses, irrigation surveys, and irrigation audits to evaluate water use and provide recommendations as necessary to reduce landscape water use to a level that does not exceed the Maximum Applied Water Allowance for existing landscapes. The Maximum Applied Water Allowance for existing landscapes shall be calculated as: MAWA = (0.8) (ETo)(LA)(0.62).

2. For all landscapes in 14.040.020(A) that do not have a meter, the City of Vacaville shall administer programs that may include, but not be limited to, irrigation surveys and irrigation audits to evaluate water use and provide recommendations as necessary in order to prevent water waste.

B. All landscape irrigation audits shall be conducted by a certified landscape irrigation auditor.

14.27.040.030 Water Waste Prevention.

Refer to Chapter 13.20 for required water conservation measures..

Chapter 14.27.050
Effective Precipitation

14.27.050.010 Effective Precipitation.

The City of Vacaville may consider Effective Precipitation (25% of annual precipitation) in tracking water use and may use the following equation to calculate Maximum Applied Water Allowance: MAWA= (ETo -Eppt) (0.62) [(0.55 x LA) + (0.45 x SLA)] for residential areas, MAWA= (ETo -Eppt) (0.62) [(0.45 x LA) + (0.55 x SLA)] for non-residential areas.

Chapter 14.27.060
Reporting

14.27.060.010 Reporting.

The Director shall report to the California Department of Water Resources by January 31st of each year following the requirements of California Code of Regulations Title 23, Division 2, Chapter 2.7, section 495.

Chapter 14.27.070
Prescriptive Compliance Option

14.27.070.010 Prescriptive Compliance Option

A. This chapter contains prescriptive requirements which may be used as a compliance option to the Model Water Efficient Landscape Ordinance.

B. Compliance with the following items is mandatory and must be documented on a landscape plan in order to use the prescriptive compliance option:

1. Submit a Landscape Documentation Package which includes the following elements:

a. date

b. project applicant

c. project address (if available, parcel and/or lot number(s))

d. total landscape area (square feet), including a breakdown of turf and plant material

e. project type (e.g., new, rehabilitated, public, private, cemetery, homeowner-installed)

f. water supply type (e.g., potable, recycled, well) and identify the local retail water purveyor if the applicant is not served by a private well

g. contact information for the project applicant and property owner

h. applicant signature and date.

2. Incorporate compost at a rate of at least four cubic yards per 1,000 square feet to a depth of six inches into landscape area (unless contra-indicated by a soil test);

3. Plant material shall comply with all of the following;

a. For residential areas, install climate adapted plants that require occasional, little or no summer water (average WUCOLS plant factor 0.3) for 75% of the plant area excluding

edibles and areas using recycled water; For non-residential areas, install climate adapted plants that require occasional, little or no summer water (average WUCOLS plant factor 0.3) for 100% of the plant area excluding edibles and areas using recycled water;

b. A minimum three inch (3") layer of mulch shall be applied on all exposed soil surfaces of planting areas except in turf areas, creeping or rooting groundcovers, or direct seeding applications where mulch is contraindicated.

4. Turf shall comply with all of the following:

a. Turf shall not exceed 25% of the landscape area in residential areas, and there shall be no turf in non-residential areas;

b. Turf shall not be planted on sloped areas which exceed 25%;

c. Turf is prohibited in parkways less than 10 feet wide, unless the parkway is adjacent to a parking strip and used to enter and exit vehicles. Any turf in parkways must be irrigated by subsurface irrigation or by other technology that creates no overspray or runoff.

5. Irrigation systems shall comply with the following:

a. Automatic irrigation controllers are required and must use evapotranspiration or soil moisture sensor data.

b. Irrigation controllers shall be of a type which does not lose programming date in the event the primary power source is interrupted.

c. Pressure regulators shall be installed on the irrigation system to ensure the dynamic pressure of the system is within the manufacturers recommended pressure range.

d. Manual shut-off valves (such as a gate valve, ball valve, or butterfly valve) shall be installed as close as possible to the point of connection of the water supply.

e. All irrigation emission devices must meet the requirements set in the ANSI standard, ASABE/ICC 802-2014. "Landscape Irrigation Sprinkler and Emitter Standard," All sprinkler heads installed in the landscape must document a distribution uniformity low quarter of 0.65 or higher using the protocol defined in ASABE/ICC 802-2014.

C. At the time of final inspection, the permit applicant must provide the owner of the property with a certificate of completion, certificate of installation, irrigation schedule and a schedule of landscape and irrigation maintenance.

Section 3. Severability.

If any section, subsection, phrase or clause of this ordinance is for any reason held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this ordinance. The City Council hereby declares that it would have passed this ordinance and each section, subsection, phrase, or clause thereof irrespective of the fact that any one or more sections, subsections, phrases, or clauses be declared unconstitutional.

Section 4. Effective Date.

This ordinance shall take effect December 1, 2015.

Section 5. Publication.

This ordinance shall be published in accordance with the provisions of Government Code section 36933.

I HEREBY CERTIFY that this ordinance was introduced at a regular meeting of the City Council of the City of Vacaville, held on the 13th day of October, 2015, and **ADOPTED AND PASSED** at a regular meeting of the City Council of the City of Vacaville held on the 27th day of October, 2015 by the following vote:

AYES:	Council members Mashburn and Rowlett, and Mayor Augustine
NOES:	None
ABSENT:	Councilmember Harris, Vice-Mayor Hunt

ATTEST:

Michelle Thornbrugh, City Clerk

Dated: Oct. 29, 2015

APPROVED:

Leonard J. Augustine, Mayor

APPENDIX B

Geotechnical Exploration Report

GEOTECHNICAL EXPLORATION REPORT
on
ROBERTS' RANCH RESIDENTIAL SUBDIVISION
at
Leisure Town Road & Fry Road
Vacaville, California
for
SARES REGIS GROUP

By

KC ENGINEERING COMPANY

Project No. VV4006

15 April 2016

865 Cotting Lane, Suite A
Vacaville, California 95688
(707) 447-4025, fax 447-4143

8798 Airport Road
Redding, California 96002
(530) 222-0832, fax 222-1611

KC ENGINEERING COMPANY
A SUBSIDIARY OF MATERIALS TESTING, INC.

Project No. VV4006
15 April 2016

Mr. Bob Holmes
Sares Regis Group
1990 Third Street, Suite 400
Sacramento, CA 95811

Subject: Proposed Roberts' Ranch Residential Subdivision
Leisure Town Road & Fry Road
Vacaville, California
GEOTECHNICAL EXPLORATION REPORT

Dear Mr. Holmes:

In accordance with your authorization, **KC ENGINEERING COMPANY** has explored the geotechnical conditions of the surface and subsurface soils of the proposed Roberts' Ranch residential subdivision to be constructed at the northeast corner of Leisure Town Road and Fry Road in Vacaville, California.

The accompanying report presents our conclusions and recommendations based on our exploration. Our findings indicate that the proposed subdivision is geotechnically feasible for construction on the subject site provided the recommendations of this report are carefully followed and are incorporated into the project plans and specifications.

Should you have any questions relating to the contents of this report or should you require additional information, please contact our office at your convenience.

Reviewed By;

David V. Cymanski, G.E.
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
DAVID V. CYMANSKI
GE 2585
EXP. 6-30-16
GEOTECHNICAL
STATE OF CALIFORNIA

Respectfully Submitted,
KC ENGINEERING CO.

Eric S. Smith, P.E.
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
ERIC S. SMITH
NO. C82116
EXP. 03-31-18
CIVIL
STATE OF CALIFORNIA

Copies:1 email to Client & Haddox

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GEOTECHNICAL EXPLORATION

Purpose and Scope

The purpose of the geotechnical exploration for the proposed residential subdivision to be located on the northeast corner of Leisure Town Road and Fry Road in Vacaville, California was to determine the surface and subsurface soil conditions at the subject site. Based on the results of the exploration, geotechnical criteria were established for the grading of the site, the design of foundations, retaining walls, pavements, drainage, and the construction of other related facilities on the property.

In accordance with your authorization, our exploration services included the following tasks:

a. A review of available geotechnical and geologic literature concerning the site and vicinity;
b. Site reconnaissance by the Geotechnical Engineer to observe and map surface conditions;
c. Drilling and logging of 24 exploratory test borings and sampling of the subsurface soils;
d. Laboratory testing of the samples obtained to determine their classification and engineering characteristics;
e. Analysis of the data and formulation of conclusions and recommendations; and
f. Preparation of this written report.

Site Location and Description

The subject site consists of several parcels of land identified as APN's 0138-030-090, -100, -110, and -120, located in the southeastern portion of the City of Vacaville, California as shown on Figure 1, "Aerial Vicinity Map". The 240+/- acre site is located on the northeast intersection of Leisure Town Road and Fry Road and is bounded by agricultural fields and the Brighton Landing subdivision on the north, railroad tracks and a detention basin on the east, Fry Road on the south, and Leisure Town Road on the west. The east edge of the subdivision area is bounded by PG&E overhead transmission power lines. The property appears relatively flat, but has a gentle down gradient to the east with an overall elevation relief of about 10 feet. The property has historically been utilized for agricultural farming purposes and currently has been plowed in east-west trending rows for crop planting. A series of irrigation canals run primarily through the center of the site in the north-south and east-west direction crossing a central point. The channels are approximately 15 feet wide and 5 to 10 feet deep with 1H:1V (horizontal to vertical) side slopes. The canals contain intake/discharge points at the perimeter containing control valves and underground culverts. A series of concrete

bridge structures and dirt roads are located throughout the site for access around the fields. Vegetation across the site consists of native grasses and weeds.

The above description is based on a reconnaissance of the site by the Geotechnical Engineer, a review of a Google aerial image dated 4/1/15 and a "Proposed Subdivision Layout" prepared by Haddox Consulting Engineers dated 1/26/16. The Google Aerial image was used as the basis for our "Aerial Vicinity Map" and the Proposed Layout was use for the "Site Plan" included as Figure 1 and 2, respectively in the Appendix of this report.

Recently a Phase I Environmental Site Assessment was completed and report prepared by KC Engineering, dated 15 March 2016. The study incorporated the entire 240-acre proposed development area. The report concluded no current or historic recognized environmental conditions (REC's) were identified.

Proposed Construction

The proposed construction at the subject site is a planned single-family residential subdivision. Based on our review of the preliminary Roberts Ranch Subdivision layout by Haddox Consulting Engineers, we understand that the site is planned to consist of 785+/- single-family residential homes with five neighborhood parks and a future public school site. The future public school will require a separate geotechnical and geohazard study per the Division of State Architect requirements. The single-family residential structures are anticipated to consist of one and two-story wood-framed homes with post-tension slab foundations. Structural loads are expected to be typical for this type of construction. Grading for the development is expected to consist of cuts and fills of less than 5 vertical feet, generally with the streets in cut and fill on the pads. Additional site improvements will consist of typical underground utilities, streets, pathways, and the neighborhood parks.

Field Exploration

Our field exploration was performed on 2, 3, 4 & 23 March 2016 and included a reconnaissance of the site and the drilling of 24 exploratory borings at the approximate location shown on Figure 2, "Site Plan" included in the Appendix. Representative bulk samples of the near surface soils were also obtained for laboratory R-value and soil corrosivity testing. The location of these samples are also shown on Figure 2.

The borings were drilled to a maximum depth of 40 feet below the existing ground surface. The drilling was performed with truck-mounted Mobile B24 rig using a power-driven, 4-inch diameter continuous flight solid augers. Visual classifications were made from the auger cuttings and the

samples in the field. As the drilling proceeded, relatively undisturbed tube samples were obtained by driving a 3-inch O.D., California Modified split-tube sampler, containing thin brass liners, into the boring bottom in accordance with ASTM D3550. Disturbed samples were also obtained by driving a 2-inch O.D., split-barrel SPT sampler into the boring bottom in accordance with ASTM D1586. The samplers were driven into the in-situ soils under the impact of a 140 pound hammer having a free fall of 30 inches. The number of blows required to advance the sampler 12 inches into the soil were adjusted to the standard penetration resistance (N-Value). The raw blow counts obtained using the California sampler were corrected to equivalent N-Values using Burmister's (1948) energy and diameter correction formula. When the sampler was withdrawn from the boring bottom, the brass liners containing the relatively undisturbed samples were removed, examined for identification purposes, labeled and sealed to preserve the natural or in-situ moisture content.

The samples were then transported to our laboratory for testing. Classifications made in the field were verified in the laboratory after further examination and testing. The stratification of the soils, descriptions, location of undisturbed soil samples and standard penetration resistance are shown on the respective "Log of Test Boring" contained within the Appendix.

Laboratory Testing

The laboratory testing program was directed towards providing sufficient information for the determination of the engineering characteristics of the site soils so that the recommendations outlined in this report could be formulated. The laboratory test results are presented in the Appendix.

Moisture content and dry density tests (ASTM D2937) were performed on representative relatively undisturbed soil samples in order to determine the consistency of the soil and the moisture variation throughout the explored soil profile as well as estimate the compressibility of the underlying soils.

The strength parameters of the foundation soils were determined from unconfined compression tests (ATSTM D2166) and direct shear tests (ATSTM D3080) performed on selected relatively undisturbed soil samples. Standard field penetration resistance (N-Values) and pocket penetrometer readings also assisted in the determination of strength and bearing capacity. The test results, standard penetration resistances readings and penetrometer readings are recorded on the respective "Log of Test Boring".

In order to assist in the identification and classification of the subsurface soils, sieve analysis and hydrometer tests (ASTM D6913) (ASTM D422) and Atterberg Limits tests (ASTM D4318) were

performed on selected soil samples. The Atterberg Limits test results were used to estimate the expansion potential of the near surface soils. The results also aided in our liquefaction analysis.

Two Laboratory consolidation tests (ASTM D2435) were performed on samples of the underlying soil deposits to determine its compressibility characteristics. The results were used to estimate the potential settlement due to the anticipated structure loads.

Three R-Value tests (Cal Test 301) were performed on bulk samples to assist in pavement section design. The bulk samples were obtained from the upper 2 feet of the anticipated street subgrade at the locations shown on Figure 2.

Representative bulk samples of the near-surface pad soils were obtained and tested to evaluate the presence and concentration of water-soluble sulfates in accordance with California Test Method 417. These test results were used to identify the corrosion potential of the soils to at or below grade concrete. Additional corrosivity indicator tests were performed including soil pH, minimum resistivity and chlorides.

Subsurface Conditions

Based on our field exploration and laboratory testing, the subsurface soil profile was found to be relatively uniform across the site comprising layered alluvial deposits. In general, the near surface materials consist of soft to very stiff, highly expansive sandy and silty clays in the upper 2 to 7 feet, underlain by variable layers and thicknesses of moderately to highly expansive, stiff to hard sandy clays and clayey silts, and loose to medium dense clayey and silty sands. It is noted that the upper 12 to 24 inches across the site was loose and soft from recent and prior farm related disking.

In Borings 18 and 19, a potentially compressible layer of soft to firm sandy clay and clayey sand was encountered between 10 to 24 feet below the surface. Laboratory consolidation tests and settlement analysis were performed on collected samples, and is further discussed in the "Settlement" section of this report. Potentially liquefiable sand deposits were also identified in some of the borings as discussed in the "Liquefaction" section herein.

Groundwater was encountered in the borings at depths ranging from 10.0 to 17.5 feet below the ground surface at the time of drilling. Fluctuations in the groundwater conditions can occur with variations in seasonal rainfall, irrigation on the site and adjacent parcels, and variations in subsurface stratification.

A more thorough description and stratification of the soils encountered along with the results of the laboratory tests are presented on the respective "Log of Test Boring" in the Appendix. The approximate locations of the borings are shown on Figure 2, "Site Plan".

Soil Corrosivity

Four representative bag samples of the near surface soil were collected and transported to Sunland Analytical in Rancho Cordova for soil corrosivity testing. The testing indicates sulfate contents ranging from 13.6 to 27.8 ppm (mg/kg), chloride contents of 8.6 to 16.7 ppm, minimum resistivity of 990 to 1,630 ohm-cm, and soil pH levels of 6.99 to 7.56 for the samples collected.

It is noted that the sulfate test results indicate "not-applicable" or "S0" sulfate exposure to concrete as identified in Section 1904 of the 2013 California Building Code and Tables 4.2.1 and 4.3.1 of ACI 318-11 Building Code Requirements for Structural Concrete. No cement type restriction is required, however, we do recommend that a Type I/II cement be utilized.

The Caltrans Corrosion Guidelines[1] defines a corrosive site as one where the soil and/or water has a sulfate concentration of 2,000 ppm or more, a chloride concentration of 500 ppm or more, a pH of 5.5 or less, and a minimum resistivity less than 1,000 ohm-cm. According to the Electrical Design, Cathodic Protection Manual[2], soil corrosion is not likely if the minimum resistivity is above 30,000 ohm-cm. If the resistivity is between 10,000 and 30,000 ohm-cm the corrosivity is mild, between 2,000 and 10,000 the corrosivity is moderate to severe, and lower than 2,000 it is severe. Based on the resistivity criteria, the soils at the site are considered to have a severe corrosion potential to buried metal.

KC Engineering Company is not a corrosion engineering firm. Therefore, to further define the soil corrosion potential and interpret the above test results, or to design cathodic protection or grounding systems, a licensed Corrosion Engineer should be consulted.

Site Geology

The geologic materials underlying the site are mapped as Holocene aged fine-grained Alluvial Fan Deposits as shown on the Geologic Map of Northeastern San Francisco Bay Region[3]. The fine-

[1] California Department of Transportation Corrosion Technology Branch, Materials Engineering and Testing Services, *Corrosion Guidelines*, Version 2.0, November 2012.
[2] Technical Manual TM 5-811-7, *Electrical Design, Cathodic Protection*, prepared by Headquarters, Department of the Army, dated 22 April 1985 also known as UFC 3-570-02A, *Cathodic Protection*, by Department of Defense.
[3] Graymer, R.W., Jones, D.L., and Brabb, E.E., 2002, *Geologic Map and Map Database of Northeastern San Francisco Bay Region, California*, United States Geological Survey, Miscellaneous Field Studies Map, MF-2403, Version 1.0

grained alluvial fan deposits consist of varying layers of sands, gravels, silts and clays. The subsurface deposits encountered during our exploration resemble the mapped deposits.

Geo-Hazards

Seismicity

The site is not located within an Alquist-Priolo Earthquake Fault Zone[4]. There are no known active faults crossing the site as mapped and/or recognized by the State of California. Vacaville is located in a seismically-active region and earthquake related ground shaking should be expected during the design life of structures constructed on the site. The California Geological Survey has defined an active fault as one that has had surface displacement in the last 11,000 years, or has experienced earthquakes in recorded history.

Based on our review of the Fault Activity Map of California[5] and the USGS National Seismic Hazard Maps-Source Parameters[6], the nearest active faults are the Great Valley Fault, the Cordelia Fault, the Green Valley Fault, and the West Napa Fault, located approximately 2.6 miles east, 11.6 miles west, 13.8 miles west, and 21.0 miles west of the site, respectively.

Structures at the site should be designed to withstand the anticipated ground accelerations. Based on the USGS Seismic Design Maps[7] website and ASCE 7-10, the 2013 CBC earthquake design values are as follows. The detailed USGS report is presented in the Appendix.

Site Class: F*
Design Spectral Response Accelerations: S_{DS} = 1.021; S_{D1} = 0.527g

* The provided values are based on a stiff soil profile or Site Class D. A Site Class F is noted because liquefiable layers are present (ASCE 7-10, Section 20.3.1). However, due to the average stiff to hard surficial clays and the deeper dense sands, along with our experience in the area, we judge that an average shear wave velocity greater than 600 ft/s is present within the upper 100 feet which would indicate a Site Class D. We anticipate that a site-specific response analysis will not be required since

[4] Hart, E.W. and Bryant, W.A., 1997, *Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps*, California Department of Conservation, Division of Mines and Geology, Special Publication 42, Interim Revision 2007.
[5] Jennings, C.W. and Bryant, W.A., 2010, *Fault Activity Map of California*, California Geological Survey Geologic Data Map No. 6, scale 1:750,000
[6] U.S. Geological Survey, 2008 National Seismic Hazards Maps – Source Parameters, accessed 4/11/16, from USGS web site: http://geohazards.usgs.gov/cfusion/hazfaults_2008_search/query_main.cfm
[7] http://earthquake.usgs.gov/designmaps/us/application.php, accessed 4/11/16

the proposed structures are anticipated to have a fundamental period of vibration equal to or less than 0.5 seconds. This must be evaluated by the Structural Engineer.

Fault Rupture

The site is not located within an Alquist-Priolo Earthquake Fault Zone. Based on our review of geologic maps, no known active or inactive faults cross or project toward the subject site. In addition, no evidence of active faulting was visible on the site during our site reconnaissance. Therefore, it is our opinion that there is no potential for fault-related surface rupture at the subject site.

Landsliding

The subject site and immediate vicinity is relatively flat and level, and therefore not subject to seismically induced landslide hazards.

Liquefaction

Soil liquefaction is a phenomenon in which loose and saturated cohesionless soils are subject to a temporary, but essentially total loss of shear strength, due to pore pressure build-up under the reversing cyclic shear stresses associated with earthquakes. Soils typically found most susceptible to liquefaction are saturated and loose, fine to medium grained sand having a uniform particle range and less than 35% fines passing the No. 200 sieve, and a corrected standard penetration blow count $(N_1)_{60}$ less than 30. According to Special Publication 117A by the California Geological Society, the assessment of hazards associated with potential liquefaction of soil deposits at a site must consider translational site instability (i.e. lateral spreading, etc.) and more localized hazards such as bearing failure and settlement. The acceptable factor of safety against liquefaction is recommended in SP117 to be 1.3 or greater.

The data used for evaluating liquefaction potential of the subsurface soils consisted of the in-situ Standard Penetration Resistance values $(N_1)_{60}$ values, the unit weights, gradations, in-situ moisture contents, the groundwater level, and the location of the site to the nearest active fault and the predicted ground surface acceleration. Based on our field and laboratory data, potentially liquefiable layers were identified in Boring 4 below 15 feet, Boring 6 between 9 to 13 feet, Boring 7 between 11 to 31 feet, and Boring 18 below 24 feet. Liquefaction analysis were performed using the data from our field and lab exploration per the recommended analysis methods of the NCEER report[8]. The groundwater modeled in the analysis was 5 feet below the

[8] Youd, T. Leslie and Idriss, Izzat M., 1997, "Summary Report from the Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils," Technical Report NCEER 97-0022, December 31, 1997

ground surface, based on the historic high level recorded in the nearest water well listed on the Department of Water Resources, Water Data Library website. The geometric mean peak ground acceleration of 0.6 g was used in our analysis. A maximum moment magnitude of 6.8 was also used from the nearby Great Valley Fault.

Based on our analysis, the noted layers in Borings 4, 7 and 18 were found to be susceptible to liquefaction with a factor of safety less than 1.3. The potential liquefaction induced total settlements were calculated for these layers utilizing the volumetric strain relationship developed by Tokimatsu and Seed[9]. The results indicate total liquefaction induced settlements of 1.7, 3.8 and 1.3 inches for Borings for Borings 4, 7 and 18, respectively. Differential settlement is estimated to be half of the total, but will likely occur over a wide area.

According to Ishihara[10], the potential for surface manifestation (i.e. sand boils, ground fissures, etc...) is very low due to the thickness of the non-liquefiable clay soils overlying the potentially liquefiable soils. Since the site is relatively flat, there are no open face slopes adjacent to the site which bisects the sand, the potential for lateral spreading at the site is considered very low. In our opinion, the anticipated total and differential settlement from seismically induced liquefaction and/or strain softening may be mitigated by the use of thickened post-tension slab foundations.

Settlement

From our field investigation and exploratory test borings, we found relatively soft to firm sandy clay in Borings 18 at 10 to 24 feet, and loose clayey sands in Boring 19 below 10 feet. These materials may consolidate upon loading and or soften and settle during seismic events. Laboratory consolidation tests reveal the materials to be normally to over-consolidated and not subject to significant settlements. However, we estimate that 1 to 1.5 inches of long-term settlement may be possible.

[9] Tokimatsu, K. and Seed, H.B., 1987, *Evaluation of Settlements in Sands Due to Earthquake Shaking*, Journal of the Geotechnical Engineering Division, ASCE, Volume 113, No. 8, August 1987.
[10] Ishihara, K., 1985, *Stability of Natural Deposits During Earthquakes,* Proceedings of the Eleventh International Conference on Soil Mechanics and Foundation Engineering, San Francisco, CA, Volume 1, p. 321-376, August.

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

General

From a geotechnical point of view, the proposed residential subdivision and associated improvements are considered to be feasible for construction on the subject site provided the recommendations presented in this report are incorporated into the project plans and specifications.

All grading and foundation plans for the development should be reviewed by ***KC ENGINEERING CO.*** prior to contract bidding or submittal to governmental agencies to ensure that the geotechnical recommendations contained herein are incorporated and utilized in design.

KC ENGINEERING CO. should be notified at least two working days prior to site clearing, grading, and/or foundation operations on the property. This will give the Soil Engineer ample time to discuss the geotechnical characteristics of the site that may be encountered in the field.

Field observation and testing during the grading and/or foundation operations shall be provided by representatives of ***KC ENGINEERING CO.*** to enable them to form an opinion regarding the adequacy of the site preparation, the acceptability of fill materials, and the extent to which the earthwork construction and the degree of compaction comply with the specification requirements. Any work related to the grading and/or foundation operations performed without the full knowledge and under the direct observation of the Soil Engineer will render the recommendations of this report invalid.

Geotechnical Considerations

The primary geotechnical considerations for the site are the presence of relatively soft near-surface highly expansive clays and potentially liquefiable and compressible soils beneath the site. The upper 1.5 to 2 feet of loose and soft near surface soils are a result of agricultural farming and disking operations. These soft near surface soils will require mitigation in the form of over-excavation, processing and compaction as recommended in the Grading section herein.

Based on the results of the field exploration and laboratory testing, the site's near surface existing foundation soils are also considered highly expansive and prone to heave and shrink movements with changes in moisture content and, consequently, must be carefully considered in the design of foundations, drainage, and landscaping. In addition, variable subsurface loose to medium dense sandy deposits across the site may be subject to seismically induce liquefaction settlement which can result in total settlements ranging from 1.3 to 3.8 inches in localized areas across the

site. In addition, consolidation settlement and/or seismic softening settlement of 1 to 1.5 inches may occur in the northeast quadrant of the property.

Based on the highly expansive near surface soils and the potential for settlement in localized areas across the site, it is the opinion of **KC ENGINEERING CO.** that the single-family residential structures be founded on properly designed and constructed thickened post-tensioned slab foundation systems. Specific grading, drainage and foundation recommendations are provided herein.

Demolition

As previously noted, the site contains a series of irrigation canals including concrete bridge structures and intake/discharge locations, as well as underground irrigation piping. Demolition should include the complete removal of all surface and subsurface structures and pipelines. Demolition operations should consist of removing all the concrete bridge structures and abutments, pipelines any concrete flat work used for lining the canals and culverts. At the intake/discharge locations removal of pipelines, valve gates, underground concrete structures and flat work should be expected. In addition, all underground structures must be located on the grading plans so that proper removal may be carried out. It is vital that ***KC ENGINEERING CO.***, intermittently observe the demolition operations and be notified in ample time to ensure that subsurface structures are not covered.

Excavations made by the removal of any structure should be left open by the demolition contractor for backfill in accordance with the requirements for engineered fill. The removal of any underground structures should be done under the observation of the Soil Engineer to assure adequacy of the removal and that subsoils are left in proper condition for placement of engineered fills. Any soil exposed by the demolition operations, which are deemed soft or unsuitable by the Soil Engineer, shall be excavated as uncompacted fill soil and be removed as required by the Soil Engineer during grading. The demolition operation should be approved by the Soil Engineer prior to commencing grading operations. Any resulting excavations should be properly backfilled with engineered fill under the observation of the Soil Engineer. Should the location of any localized excavation be found to underlie any structure, backfill should be compacted to a minimum relative compaction of 95% or the excavation widened to extend 5 feet beyond the footprint of the structure and backfilled to the specifications for engineered fill as recommended in the "Grading" section herein.

Grading

We anticipate that grading for the site will primarily consist of cutting in the street section areas and filling on the building pads, as well as filling in the existing irrigation ditches. Grading activities during the rainy season may be hampered by excessive moisture. Grading activities may be performed during the rainy season, however, achieving proper compaction may be difficult due to excessive moisture; and require the use of lime treatment such as in roadway sections. Grading performed during the dry months will minimize the occurrence of the above problems. When project grading plans become available for our review, supplemental grading recommendations may be required.

The surface of the site in areas to be graded should be stripped to remove all existing surface vegetation and/or other deleterious materials. It is estimated that stripping depths of approximately 2 inches may be necessary depending on actual conditions at the time of development. If vegetation is minimal, disking may be employed as determined by the Geotechnical Engineer at the time of planned grading. Any material that is deemed to be topsoil and requiring stripping may not be used as engineered fill but may be stockpiled and used later for landscaping purposes. Where any loose or soft soils are encountered, such as the identified upper loose crop zone, they must be over-excavated to undisturbed native ground. Excavated soil materials may be used as engineered fill with the approval of the Soils Engineer provided they do not contain excessive organics.

The recently and likely annually disked site is relatively level and minimal grading (± 5 feet) is anticipated to achieve building pad and street elevations. However, agricultural use over the years has resulted in a loose surface condition in the upper 2 feet. Due to this condition, it is recommended that the existing loose/soft ground surface materials be over-excavated 1 foot, the exposed bottom scarified an additional 1 foot and then processed as engineered fill as described herein. This will minimize the settlement potential of loose/soft surface soils. Where the upper 2 feet is removed by planned grading, then over-excavation is not required, just typical processing and compaction as noted herein.

After stripping, clearing, over-excavation and any required demolition as noted above, the exposed surface soils should be scarified to a depth of 12 inches, moisture conditioned as necessary to 3 or more percent above optimum moisture content, and compacted to a minimum of 90% relative compaction as determined by ASTM D1557. The site may then be filled to the desired finished grades by placing engineered fill in lifts of 8 inches in uncompacted thickness and compacting to a relative compaction of 90% at 3% or more above optimum in accordance with the aforementioned test procedure.

All fill material should be approved by the Soil Engineer. The material should be a soil or soil-rock mixture which is free from excessive organic matter or other deleterious substances. The fill material should not contain rocks or lumps over 6 inches in greatest dimension and not more than 15% larger than 2-½ inches. All soils encountered during our investigation would be suitable for use as engineered fill when placed and compacted as recommended.

Should import material be used to establish the proper grading for the proposed development, the import material should be approved by the Soil Engineer before it is brought to the site. If select import soil is used within the upper 3 feet of the pad, it should meet the following requirements:

a. Have an R-Value of not less than 25;
b. Have a Plasticity Index not higher than 15;
c. Not more than 15% passing the No. 200 sieve;
d. No rocks larger than 6 inches in maximum size;

Prior to compaction, each layer should be spread evenly and should be thoroughly blade mixed during the spreading to obtain uniformity of material in each layer. The fill should be brought to a water content that will permit proper compaction by either (a) aerating the material if it is too wet, or (b) spraying the material with water if it is too dry. Compaction should be performed by footed rollers or other types of approved compaction equipment and methods. Compaction equipment should be of such design that they will be able to compact the fill to the specified density. Rolling of each layer should be continuous over its entire area and the equipment should make sufficient trips to ensure that the required density has been obtained. No ponding or jetting is permitted.

The standard test used to define maximum densities and optimum moisture content of all compaction work shall be the Laboratory Test procedure ASTM D1557 and field tests shall be expressed as a relative compaction in terms of the maximum dry density and optimum moisture content obtained in the laboratory by the foregoing standard procedure. Field density and moisture tests shall be made in each compacted layer by the Soil Engineer in accordance with Laboratory Test Procedure ASTM D6938, respectively. When footed rollers are used for compaction, the density and moisture tests shall be taken in the compacted material below the surface disturbed by the roller. When these tests indicate that the compaction requirements on any layer of fill, or portion thereof, have not been met, the particular layer, or portion thereof, shall be reworked until the compaction requirements have been met.

The site is relatively level, however cut and fill slopes are anticipated. Maximum cut and fill slopes of 2:1 (horizontal to vertical) may be utilized within the subdivision. All cut slopes should not be

steeper than 3:1 (horizontal to vertical) for outfall and flow ditches. Slopes should be rounded at the upper extremities. Graded slopes should not be left exposed through a winter season without the completion of erosion control measures.

Surface Drainage

A very important factor affecting the performance of structures and surrounding flatwork is the proper design, implementation, and maintenance of surface drainage, as well as maintaining uniform moisture conditions around the structures and improvements. The site soils are considered to be highly expansive and subject to volume changes due to variations in moisture content. Ponded water will cause swelling and/or loss of soil strength and may also seep under structures. Should surface water be allowed to seep under the structures, differential foundation movement resulting in structural damage and/or standing water under the slab will occur. This may cause dampness to the floor which may result in mildew, staining, and/or warping of floor coverings. To minimize the potential for the above problems, dampproofing, waterproofing and foundation drainage should be provided as required by Section 1805 of the 2013 CBC. In addition, the following surface drainage measures are recommended and must be maintained by the property owner in perpetuity:

a) The existing building pad slopes and drainage must be constructed to remove all storm water from the pad and to prevent storm and/or irrigation water from ponding adjacent to the structure foundations. The finished pad grade around the structures should be compacted and sloped 5% away from the exterior foundations as required in Section 1804.3 of the 2013 CBC.

b) Enclosed or trapped planter areas adjacent to the structure foundations should be avoided if possible. Where enclosed planter areas are constructed, these areas must be provided with adequate measures to drain surface water (irrigation and rainfall) away from the foundation. Positive surface gradients and/or controlled drainage area inlets should be provided. Care should be taken to adequately slope surface grades away from the structure foundations and into area inlets. Drainage area inlets should be piped to a suitable discharge facility.

c) Adequate measures for storm water discharge from the roof gutter downspouts must be provided by the project Civil Engineer and maintained by the property owners at all times, such that no water is allowed to pond next to the structure. Closed pipe discharge lines should be connected to downspouts and discharged into a suitable drainage facility. It is important not to allow concentrated discharge on the surface of any slope so as to prevent erosion.

d) Site drainage should be designed by the project Civil Engineer. Civil engineering, hydraulic engineering, and surveying expertise are necessary to design proper surface drainage to assure that the flow of water is directed away from the foundations.

e) Over-irrigation of plants is a common source of water migrating beneath a structure. Consequently, the amount of irrigation should not be any more than the amount necessary to support growth of the plants. Foliage requiring little irrigation (drip system) is recommended for the areas immediately adjacent to the structures.

f) Landscape mounds or concrete flatwork should not be constructed to block or obstruct the surface drainage paths. The Landscape Architect or other landscaper should be made aware of these landscaping recommendations and should implement them as designed. The surface drainage facilities should be constructed by the contractor as designed by the Civil Engineer.

Foundations

Based on the results of the field and laboratory investigation, the site's foundation soils are considered to be highly expansive and subject to differential heave and shrink movements, as well as localized settlement from seismically induced liquefaction and consolidation. Provided that the residential building pads are constructed in accordance with the grading section noted above, the structures should be supported by properly designed and constructed thickened post-tensioned slab foundation systems. Foundation recommendations are presented below.

Post-tensioned slabs should be a minimum 10 inches in thickness (for uniform thickness slabs) and designed using the following criteria which is based on the design method of the "Standard Requirements for Design of Shallow Post-Tensioned Concrete Foundations on Expansive Soils", dated May 2008, Third Edition, prepared by the Post Tensioning Institute:

Edge Moisture Variation Distance:

e_m (Edge Lift)	=	4.1 feet
e_m (Center Lift)	=	7.7 feet

Differential Movement:

y_m (Edge Lift)	=	1.55 inches
y_m (Center Lift)	=	-1.05 inches

Estimated Differential Settlement: = 1.0 inches

In addition to the recommendations and guidelines in the Third Edition by the PTI, the following recommendations should also be incorporated into the design and construction for the above structural mat foundation systems:

a) An allowable bearing capacity of 1,000 p.s.f. may be utilized and may be increased by one-third to resist short-term wind and seismic loading.

b) To resist lateral loading, a coefficient of friction between the perimeter concrete thickened edge and the soil of 0.30 may be used.

c) All areas to receive slabs should be thoroughly wetted to over optimum moisture content and to seal any desiccation cracks prior to placing the underslab components. This work should be performed under the observation of the Soil Engineer and approved prior to concrete placement.

d) The reinforcement and/or cables shall be placed in the center of the slab unless otherwise designated by the Structural Engineer.

e) A vapor retarder membrane should be installed between the prepared building pad and the interior slab to minimize moisture condensation under the floor coverings and/or upward vapor transmission. The vapor barrier membrane should be a minimum 15-mil extruded polyolefin plastic that complies with ASTM E1745 Class A and have a permeance of less than 0.01 perms per ASTM E96 or ASTM F1249. It is noted that polyethylene films (visqueen) do not meet these specifications. The vapor barrier must be adequately lapped and taped/sealed at penetrations and seems in accordance with ASTM E1643 and the manufacturer's specifications. The vapor retarder must be placed continuously across the slab area.

f) The slabs should be thickened a minimum of 12 inches wide at the edges and extend below pad grade at least 4 inches to create frictional resistance for lateral loading, to provide additional edge rigidity, and to minimize moisture infiltration under the slab.

g) Water vapor migrating to the surface of the concrete can adversely affect floor covering adhesives. Provisions should be provided in the concrete mix design to minimize moisture emissions. This should include the selection of a water-cement ratio which inhibits water permeation (0.45 max). Additional suitable admixtures to limit water transmission may also be utilized. The slabs should not be subjected to rainfall or cleaning water prior to placement of the floor coverings. In addition, we

recommend that a Type I/II cement be utilized in the concrete mix to provide an additional protection against sulfate attack.

h) Exterior porches, garages and attached covered patios areas should also be designed as part of the same post-tension foundation system.

i) We recommend that appropriate provisions be provided by the Structural Engineer and Contractor to minimize slab cracking, such as curing measures and/or admixtures to minimize concrete shrinkage and curling. American Concrete Institute methods and guidelines of curing, such as wet curing or membrane curing, are recommended to minimize drying shrinkage cracking.

j) The foundation plans, specifications, calculations and concrete mix designs should be provided to the Structural Engineer and us for review prior to construction to ensure conformance with the above recommendations.

Slab-on-Grade Construction

Exterior concrete slabs/flatwork, including sidewalks, driveways and non-structural detached patios and general flatwork may experience some cracking due to finishing and curing methods as well as moisture variations within the underlying soils. To reduce the potential cracking of the slabs-on-grade, the following recommendations are made:

a) All areas to receive slabs should be thoroughly wetted to seal any desiccation cracks prior to placing concrete. This work should be done under the observation of the Soil Engineer.

b) Slabs should be underlain by a minimum of 4 inches of angular gravel or clean crushed rock material placed between the finished subgrade and the slabs to serve as a capillary break between the subsoil and the slab. The gravel should not have more that 10% passing the No. 4 sieve per CBC Section 1805.4.1.

c) Exterior slabs/flatwork and driveways should be a minimum of 5 inches thick and reinforced with a minimum of No. 4 rebar spaced 18 inches center to center, each way. It is noted that where heavy loading is anticipated such as alleys or street areas where garbage trucks are anticipated, we recommend to construct a 6 inch thick slab section. Additional concrete pavement recommendations are provided in the "Pavement Areas" section of this report. The actual slab thickness and reinforcement should be determined by the project structural engineer in

accordance with the structural requirements and the anticipated loading conditions. The reinforcement shall be placed in the center of the slab unless otherwise designated by the design engineer.

d) Slabs for driveways, and exterior flatwork should be placed structurally independent of the foundations. A 30-pound felt strip, expansion joint material, or other positive separator should be provided around the edge of all floating slabs to prevent bonding to the foundation. As an added measure to minimize vertical deflections between the foundation and exterior slabs, rebar doweling can be provided. Details should be provided by the Structural Engineer.

e) Slabs should be provided with crack control saw cut joints, tool joints or other methods to allow for expansion and contraction of the concrete. In general, contraction joints should be spaced no more than 20 times the slab thickness in each direction. The layout of the joints should be determined by the project Structural Engineer and/or Architect.

f) To minimize moisture infiltration under slabs and to add edge rigidity, we recommend that slabs be thickened at the edges to extend below the aggregate base layer to the soil subgrade for a minimum width of 6 inches.

g) Curing of slabs should follow the guidelines provided by the American Concrete Institute and the CBC to minimize shrinkage cracking.

Pavement Areas

The roadways are anticipated to consist of either asphalt concrete (AC) or Portland cement concrete (PCC) surfaces. Recommendations for both pavement surfaces are presented below. We emphasize that the performance of the pavement is critically dependent upon adequate and uniform compaction of the subgrade soils, as well as engineered fill and utility trench backfill within the limits of pavements. Pavements will typically have poor performance and shorter life where water is allowed to migrate into the aggregate base and subgrade soils. The main source of water into a pavement section is landscape planters constructed within or adjacent to pavement areas. Where this is planned, it is recommended to extend the curbs into the soil subgrade at least 2 inches. The construction of all pavements should conform to the requirements set forth by the latest Standard Specifications of the Department of Transportation of the State of California (Caltrans) and the City of Vacaville.

R-Value: Bulk samples were obtained of the near surface soils within the planned roadways that are relatively representative of the anticipated subgrade soils. Sample locations are shown on Figure 2. The samples were tested in accordance with the California Test Method 301 to determine the R-Value for the site soils. R-Values of 5, 6 and 8 were determined for the three samples obtained as shown in the Appendix. Due to anticipated soil variations, we recommend the minimum R-Value of 5 for design.

Preparation of Subgrade: After underground utilities have been placed in the areas to receive pavement and removal of excess material has been completed, the upper 8 inches of the subgrade soil shall be scarified, moisture conditioned and compacted to a minimum relative compaction of 95% at a moisture content at 3% or more above optimum in accordance with the grading recommendations specified in this report. Prior to placement of aggregate baserock, it is recommended that the subgrade be proof rolled and observed for deflection by the Soils Engineer. Should deflection and/or pumping conditions be encountered, stabilization recommendations will be provided by the Geotechnical Engineer based on field conditions. Geotextile subgrade separation fabric is required to be placed over the subgrade prior to aggregate base placement per section CS 7-02 in the City of Vacaville Standards.

Aggregate Base: All aggregate base material placed subsequently should also be compacted to a minimum relative compaction of 95% based on the ASTM Test Procedure D1557. Aggregate base should meet the minimum requirements of Caltrans Class 2 per Section 26. The recommended aggregate base thicknesses for asphalt concrete pavements are noted in the table below. The minimum aggregate base thickness for PCC roadway pavements is 6 compacted inches.

Asphalt Concrete: Bulk samples of the surface soils were obtained from the proposed roadway locations for R-Value testing (California Test Method 301). Based on the lowest R-Value of 5 and a range of traffic indices provided by the City Table DS 3-1, the recommended pavement sections were calculated in accordance with Topic 608 of the California Department of Transportation Highway Design Manual. The appropriate traffic index (TI) and any minimum pavement sections should be determined by the Civil Engineer in conformance with the City of Vacaville Specifications.

Traffic Condition	Traffic Index (TI)	Asphalt Concrete (inches)	Class II Aggregate Base[1] (inches)
Residential Cul-de-Sac	6.0	3.5	12.5
Residential Streets	6.0	3.5	12.5
Collector	8.0	4.5	18.5
Arterial	10.0	6.0	23.5

NOTES:
(1) Minimum R-Value = 78 per Caltrans Section 26.
(2) All layers in compacted thickness to CalTrans Standard Specifications.

Portland Cement Concrete: Where PCC pavement areas are utilized, the concrete should be poured on the compacted aggregate base layer. The concrete section should be designed by the project Structural Engineer. We recommend a minimum of 6 inches thick PCC reinforced with a minimum of No. 4 rebar spaced at 16 inches on center, each way, underlain by 6 inches of compacted Class 2 aggregate base. Additional reinforcement may be required by the Structural Engineer.

Retaining Walls/Sound Walls

Any retaining walls that are to be incorporated into the project should be designed to resist lateral pressures exerted from a media having an equivalent fluid weight as follows:

Gradient of Back Slope	Equivalent Fluid Weight (p.c.f.)			Coefficient of Friction
	Unrestrained Condition (Active)	Restrained Condition (At Rest)	Passive Resistance	
Horizontal	60	80	250	0.30
2:1	80	100	250	0.30

It should be noted that the effects of any surcharge or compaction loads behind the walls must be accounted for in the design of the walls. In addition, an earthquake load of $13H^2$ applied at 0.6H where H = wall height, from the bottom of the wall is applicable. Restrained conditions should be used where framing or other structural members rests on top or is connected to the top of walls.

Low height retaining walls (less than 5 feet) may be founded on continuous spread footings that extend to a minimum depth of 24 inches below lowest adjacent pad grade (i.e., trenching depth). At this depth, the recommended design bearing pressure for continuous and isolated footings should not exceed 2,000 p.s.f. due to dead plus live loads. The above allowable pressures may be increased by 1/3 due to all loads which include wind and seismic. All foundations must be adequately reinforced to provide structural continuity and resist the anticipated loads as determined by the project Structural Engineer. To accommodate lateral building loads, the passive resistance of the foundation soil can be utilized. The passive soil pressures can be assumed to act against the front face of the footing below a depth of 1 foot below the ground surface. It is recommended that a passive pressure equivalent to that of a fluid weighing 200 p.c.f. be used. For design purposes, an allowable friction coefficient of 0.30 can be assumed at the base of the spread footings. These two modes of resistance should not be added unless the

frictional component is reduced by 50 percent since the mobilization of the passive resistance requires some horizontal movement, effectively reducing the frictional resistance.

The above criteria are based on fully drained conditions. In order to achieve fully-drained conditions, a drainage filter blanket should be placed behind the wall. The blanket should be a minimum of 12 inches thick and should extend the full height of the wall. If the excavated area behind the wall exceeds 12 inches, the entire excavated space behind the 12-inch blanket should consist of compacted engineered fill or blanket material. The gravel drainage blanket material may consist of either granular crushed rock or drain pipe fully encapsulated in geotextile filter fabric (Mirafi 140N or equivalent) or Class II permeable material that meets CalTrans Specification, Section 68. A 4-inch diameter SDR35 perforated drain pipe should be installed in the bottom of the drainage blanket and should be underlain by 4 inches of filter type material. Piping with a minimum gradient of 2% shall be provided to discharge water that collects behind the walls to an adequately controlled discharge system away from the structure foundations.

If mechanically stabilized earth, segmental retaining walls such as Keystone walls are utilized, the design and construction of these proposed flexible modular retaining wall systems should conform to the recommendations of the manufacturer and/or Keystone Retaining Wall Systems or the National Concrete Masonry Association (NCMA). The following soil parameters would be applicable for design using on-site soil materials within the reinforced, retained and bearing zones: $\varphi = 28$ degrees, $c = 0$ p.s.f., $\gamma = 115$ p.c.f. The wall backfill within the reinforced zone may consist of the on-site soil materials provided it has a maximum Liquid Limit of 40 and a maximum Plasticity Index of 20. The wall embedment should conform to the recommendations by Keystone or NCMA.

Non-mortared dry stacked masonry block retaining walls and/or any free standing conventional CMU sound walls should be founded on pier foundations with inter-connecting, reinforced tie beams. Piers should be a minimum of 12 inch diameter and 8 feet deep designed on the basis of skin friction acting between the soil and that portion of the pier that extends below a depth of 2 feet below finished grade. For the soils at the site, an allowable skin friction value of 400 p.s.f. can be used for combined dead and live loads, below the upper 2 feet from grade. This value can be increased by one-third for total loads which include wind or seismic forces. Spacing should be determined as required by the load distribution, but minimum spacing should not be less than 3 pier diameters, center to center. Maximum spacing and the minimum depth of piers is to be determined by the Structural Engineer. To resist lateral loads, the passive resistance of the soil can be used. The soil passive pressures can be assumed to act against the lateral projected area of the pier described by the vertical dimension of twice the pier diameter. It is recommended that a passive pressure equivalent of that of a fluid weighing 200 p.c.f. be used below 2 feet.

Underground Utility and Excavations

Groundwater was encountered at depths ranging from 10 to 17 feet below the existing ground surface. Therefore, depending on the time of year of underground construction groundwater will likely be encountered, especially in deeper utilities. Temporary dewatering and shoring are the responsibility of the Contractor.

Should groundwater be encountered, the utility construction should begin at its lowest point and proceed uphill. The utility trench should be over-excavated 6 to 12 inches below the Vacaville required pipe bedding material. Open-graded 1.5-inch crushed aggregate should be placed in the bottom of the trench followed by the City standard bedding material. A sump area should be excavated at the lowest point of the open excavation/trench to facilitate pumping of collected water. The collected water should be pumped to a City approved discharge facility.

Utility excavations extending underneath all traffic areas must be backfilled with native or approved import material and compacted to relative compaction of 90% to within 8 inches of the subgrade. The upper 8 inches should be compacted to 95% relative compaction in accordance with Laboratory Test Procedure ASTM D1557. Backfilling and compaction of these excavations must meet the requirements set forth by the City of Vacaville, Department of Public Works.

Applicable safety standards require that excavations in excess of 5 feet must be properly shored or that the walls of the excavation slope back to provide safety for installation of lines. If excavation wall sloping is performed, the inclination should vary with the soil type. The soils at the site are considered to be OSHA Type B. However, should groundwater be encountered, a Type C soil should be used. During excavation operations, the underground contractor should consult with the Soil Engineer for additional recommendations as deemed necessary.

With respect to state-of-the-art construction or local requirements, utility lines are generally bedded with granular materials. These materials can convey surface or subsurface water beneath the structures. It is, therefore, recommended that all utility trenches which possess the potential to transport water be sealed with a compacted impervious cohesive soil material or lean concrete where the trench enters/exits the building perimeter. This impervious seal should extend a minimum of 2 feet away from the building perimeter.