

# APPENDIX EN-1

## ENERGY ESTIMATES SUMMARY REPORT





# Table of Contents

|  |    |
|--|----|
| 1. Introduction .....                    | 4  |
| 2. Methodology .....                     | 5  |
| Buildings .....                          | 5  |
| Site Lighting.....                       | 10 |
| Electric Vehicle Charging.....           | 13 |
| Water Supply .....                       | 13 |
| Wastewater .....                         | 15 |
| Stormwater.....                          | 17 |
| Groundwater Pumping (dewatering) .....   | 22 |
| 3. Results.....                          | 27 |
| 4. References.....                       | 35 |
| 5. Appendix – Supplementary Details..... | 36 |

## List of Tables

|  |    |
|--|----|
| Table 1: Land Use Summary Table .....  | 6  |
| Table 2: Residential Building Energy Use Assumptions.....  | 7  |
| Table 3: Commercial Building Energy Use Assumptions.....   | 8  |
| Table 4: Pool and Spa Assumptions .....  | 10 |
| Table 4: Parking Lot Assumptions.....  | 12 |
| Table 5: Single-Family EV Charging Assumptions.....  | 13 |
| Table 6: Water infrastructure Energy Use Intensity (EUI) .....   | 15 |
| Table 7: Wastewater Flows .....  | 16 |
| Table 8: Wastewater Infrastructure Energy Use Intensity (EUI) .....  | 17 |
| Table 9: Summary of Watershed Drainage Areas and Characteristics Used to Estimate Annual Runoff.....                           | 20 |
| Table 10: Detention Basin Parameters for Groundwater Infiltration Analysis.....  | 23 |
| Table 11: Groundwater Height (feet) Above Basin Bottom (Hydraulic Head).....   | 24 |
| Table 12: Annual Groundwater Infiltration into the Detention Basins.....   | 25 |
| Table 13: Summary of Total Annual Estimated Energy Use by Category.....  | 28 |
| Table 14: Estimated Building Annual Energy Use Results.....  | 29 |
| Table 15: Estimated Site Lighting Annual Energy Use Results .....  | 30 |
| Table 16: Estimated Electric Vehicle Charging Annual Energy Use Results.....   | 31 |
| Table 17: Estimated Water Supply Infrastructure Annual Energy Use Results.....   | 32 |
| Table 18: Estimated Wastewater Infrastructure Annual Energy Use Results.....   | 33 |
| Table 19: Estimated Stormwater Pumping Annual Energy Use Results.....  | 33 |
| Table 20: Estimated Annual Canal Aeration Energy Use .....   | 33 |
| Table 21: Estimated Annual Groundwater Pumping Energy Use Results for Varying Liner Conditions and Groundwater Elevations..... | 34 |
| Table 22: Building Model Prototype Applications by Land Use Type.....  | 36 |

## List of Figures

|  |    |
|--|----|
| Figure 1: Schematic of the stormwater drainage flows and pump/lift stations..... | 19 |
| Figure 2: Soil type (runoff potential) for the project site.....                 | 20 |
| Figure 3: Soil drainage characteristics for the project site. ....               | 21 |
| Figure 4: Historical groundwater elevations at the project site.....             | 24 |

# 1. INTRODUCTION

---

The Upper Westside Project is a master planned community located in the Natomas Basin of Sacramento County. The project will span approximately 2,000 acres and accommodate approximately 9,356 dwelling units (DUs) and 3,000,000 square feet of commercial space. The Upper Westside plan seeks to create a one-of-a-kind community equipped with an Urban Town Center, Urban Farm, Greenbelt, the Westside Canal, and many other features that will contribute to this goal. The plan will incorporate sustainability and energy efficiency into several areas of the development including buildings and transportation.

The objective of this analysis is to estimate annual operational energy loads for the Upper Westside community to support Sacramento County in development of the Draft Environmental Impact Report (DEIR) and the project approval process. Assumptions align with those in the Specific Plan and reflect the relevant California Building Standards Codes, (California Code of Regulations (CCR)), Title 24, Part 6 Energy Efficiency Standards for energy performance and Title 24, Part 11 California Green Building Standards (CALGreen) for green building), and current or anticipated future state and local requirements. Energy use estimates are based on project information provided by the Client (including building types, conditioned floor areas, facility infrastructure, etc.), and goals agreed upon by the Client Team.

Given the preliminary conceptual level of design of the project, the data provided in this report are estimates only and provide quantities for use in high-level greenhouse gas emissions estimates and other sustainability analyses. They specifically should not be used for any engineering or architectural design, equipment sizing, or related uses that require more detailed engineering analysis.

## 2. METHODOLOGY

---

Analysis is based on the preliminary land use plan dated November 2020 and assumptions agreed upon by the Client Team, unless otherwise noted. See Table 1 for a summary of proposed land use types.

### BUILDINGS

Annual operational community energy consumption is estimated for all buildings including single-family, multifamily, mixed use commercial buildings, and educational facilities. Estimates are based on the best available information for energy use intensity based on building type for the Sacramento area and factor in current and expect code requirements and project specific factors. The primary data source applied in this study are simulation results from California's compliance software tools using Title 24, Part 6 prototype building energy models. The Consultant team also referenced data from previous studies to supplement prototype data where necessary. No energy modeling of the proposed buildings in the Upper Westside community was conducted. Limited modeling of prototype buildings was conducted to develop energy use intensity (EUI) estimates.

Estimates are provided for the proposed project and compared to a business-as-usual base case.

---

### BUILDING END-USES

Table 2 and Table 3 present assumptions applied in this analysis for the residential and commercial building end-uses: Space heating, space cooling, lighting, water heating, appliances, plug loads, and process loads. Base case energy use reflects mixed-fuel buildings constructed to today's 2019 Title 24 Building Standards Code, assuming natural gas appliances for space heating, water heating, cooking and clothes drying. Solar photovoltaics (PV) are not included except for low-rise residential buildings (all single-family and multifamily 3-stories and fewer) where PV is required under the 2019 code. The 2019 code was selected as the base case since it was the code in effect at the time the project Notice of Preparation of a Draft Environmental Impact Report was issued.<sup>1</sup>

Proposed project energy use reflects the construction of all-electric buildings, with few exceptions for process gas uses in commercial buildings, built to the proposed 2022 Title 24. Policy at state and local levels across California is increasingly moving towards electrification as a primary means to meet climate action plans and achieve deep reductions in greenhouse gas (GHG) emissions. Eliminating fossil fuel consumption throughout most of Upper Westside is consistent with anticipated local future policy including Sacramento County's Draft Climate Action Plan (Ascent Environmental, 2021) and the City of Sacramento's proposed building ordinance (Electrification of New Construction, 2021).

Anticipated 2022 Title 24 code requirements are based on the California Energy Commission's (CEC's) draft Express Terms released in February of 2021 (California Energy Commission, 2021), which are scheduled to go into effect January 1, 2023. All buildings constructed at Upper Westside must meet the minimum code requirements in effect at time of building permit application. At minimum, the project will be subject to the final adopted 2022 code requirements. This analysis does not include assumptions for code changes beyond the 2022 code even though many buildings in the community will be subject to the requirements of subsequent code cycles as a result of the project's long development schedule.

---

<sup>1</sup> The Notice of Preparation was issues 10/5/2020. [https://planning.saccounty.net/PlansandProjectsIn-Progress/Documents/Notice%20of%20Preparation%20of%20an%20EIR\\_UpperWestside.pdf](https://planning.saccounty.net/PlansandProjectsIn-Progress/Documents/Notice%20of%20Preparation%20of%20an%20EIR_UpperWestside.pdf)

Table 1: Land Use Summary Table

| Land Use Type                         | Description                                   | Total DUs | Avg Square Foot / DU | Total Square Feet |
|---------------------------------------|---|-----------|----------------------|-------------------|
| VLDR (very low density residential)   | Single-family detached (1 acre to 85' x 120') | 161       | 3,500                | 563,500           |
| LDR (low density residential)         | Single-family detached (55' x 100')           | 2,351     | 2,500                | 5,877,500         |
| LMDR (low/medium density residential) | Single-family detached (45' x 80')            | 1,105     | 2,000                | 2,210,000         |
| MDR (medium density residential)      | Single-family detached/townhome               | 750       | 1,700                | 1,275,000         |
| HDR (high density residential)        | Apartment or rowhome (2-3 story)              | 910       | 1,200                | 1,092,000         |
| VHDR (very high density residential)  | Urban stacked flats (3-4 story)               | 791       | 900                  | 711,900           |
| CMU (commercial mixed use)            | Apartment over commercial (4-5 story)         | 3,288     | 800                  | 2,630,400         |
|                                       | Mid-rise office                               |           |                      | 1,040,213         |
|                                       | Specialized (medical school/labs)             |           |                      | 208,043           |
|                                       | Specialized (medical offices)                 |           |                      | 41,609            |
|                                       | Hotel   |           |                      | 312,032           |
|                                       | Entertainment (theater/gym/clubs)             |           |                      | 124,826           |
|                                       | Grocery                                       |           |                      | 15,000            |
|                                       | Restaurant (small-med restaurant)             |           |                      | 89,021            |
|                                       | Retail (small-medium retail)                  |           |                      | 145,630           |
|                                       | Institutional/religious                       |           |                      | 104,021           |
| EHC (employment highway commercial)   | Mid-rise office                               |           |                      | 532,610           |
|                                       | Hotel   |           |                      | 133,153           |
|                                       | Restaurant (small restaurant)                 |           |                      | 43,768            |
|                                       | Supermarket                                   |           |                      | 45,000            |
|                                       | Retail (small retail)                         |           |                      | 44,384            |
|                                       | Entertainment (theater/gym/clubs)             |           |                      | 44,384            |
|                                       | Institutional/religious                       |           |                      | 44,384            |
| S (schools)                           | (3) K-8 schools (800 students each)           |           |                      | 183,600           |
|                                       | High school (1,500 students)                  |           |                      | 142,500           |
|                                       | Community college (1,200-2,400 students)      |           |                      | 35,000            |

Table 2: Residential Building Energy Use Assumptions

| Land Use Type                    | Description                      | Base Case     |            |   | Proposed Project |              |                           |
|----------------------------------|----------------------------------|---------------|------------|---|------------------|--------------|---------------------------|
|                                  |                                  | Title 24 Code | Fuel Type  | Solar PV  | Title 24 Code    | Fuel Type    | Solar PV                  |
| <b>Single-Family Residential</b> |                                  |               |            |   |                  |              |                           |
| VLDR                             | Single-family detached           | 2019          | Mixed Fuel | Offset all end-uses except heating, water heating, cooking, clothes drying <sup>1</sup> | 2022             | All-electric | Same as base case         |
| LDR                              | Single-family detached           |               |            |   |                  |              |                           |
| LMDR                             | Single-family detached           |               |            |   |                  |              |                           |
| MDR                              | Single-family detached/townhome  |               |            |   |                  |              |                           |
| <b>Multifamily Residential</b>   |                                  |               |            |   |                  |              |                           |
| HDR                              | Apartment or rowhome             | 2019          | Mixed Fuel | Offset all end-uses except heating, water heating, cooking, clothes drying <sup>1</sup> | 2022             | All-electric | Same as base case         |
| VHDR                             | Urban stacked flats <sup>3</sup> |               |            | None  |                  |              | 2.21 W/Sq.Ft <sup>2</sup> |
| CMU                              | Apartment over commercial        |               |            | None  |                  |              | 2.21 W/Sq.Ft <sup>2</sup> |

<sup>1</sup>Based on 2019 Title 24, Part 6 code requirements which are not proposed to change for the 2022 Title 24 code.

<sup>2</sup>Based on proposed 2022 Title 24, Part 6 code requirements.

<sup>3</sup>For the purposes of the solar PV system the VHDR land use type is considered to be four-stories or greater.

Table 3: Commercial Building Energy Use Assumptions

| Land Use Type | Description                       | Base Case     |            |          | Proposed Project |  |                       |
|---------------|-----------------------------------|---------------|------------|----------|------------------|--|-----------------------|
|               |                                   | Title 24 Code | Fuel Type  | Solar PV | Title 24 Code    | Fuel Type                                    | Solar PV <sup>1</sup> |
| CMU           | Mid-rise office                   | 2019          | Mixed Fuel | None     | 2022             | all-electric                                 | 3.13 W/Sq.Ft          |
|               | Specialized (medical school/labs) |               |            |          |                  | mixed fuel<br>gas for lab services only      | 0.44 W/Sq.Ft          |
|               | Specialized (medical offices)     |               |            |          |                  | all-electric                                 | 0.44 W/Sq.Ft          |
|               | Hotel                             |               |            |          |                  | all-electric                                 | 0.44 W/Sq.Ft          |
|               | Entertainment                     |               |            |          |                  | all-electric                                 | 0.44 W/Sq.Ft          |
|               | Grocery                           |               |            |          |                  | all-electric                                 | 2.91 W/Sq.Ft          |
|               | Restaurant                        |               |            |          |                  | mixed fuel<br>gas for cooking equipment only | 0.44 W/Sq.Ft          |
|               | Retail                            |               |            |          |                  | all-electric                                 | 2.91 W/Sq.Ft          |
|               | Institutional/religious           |               |            |          |                  | all-electric                                 | 0.44 W/Sq.Ft          |
| EHC           | Mid-rise office                   | 2019          | Mixed Fuel | None     | 2022             | all-electric                                 | 3.13 W/Sq.Ft          |
|               | Hotel                             |               |            |          |                  | all-electric                                 | 0.44 W/Sq.Ft          |
|               | Restaurant                        |               |            |          |                  | mixed fuel<br>gas for cooking equipment only | 0.44 W/Sq.Ft          |
|               | Supermarket                       |               |            |          |                  | all-electric                                 | 2.91 W/Sq.Ft          |
|               | Retail                            |               |            |          |                  | all-electric                                 | 4.62 W/Sq.Ft          |
|               | Entertainment                     |               |            |          |                  | all-electric                                 | 0.44 W/Sq.Ft          |
|               | Institutional/religious           |               |            |          |                  | all-electric                                 | 0.44 W/Sq.Ft          |
| S             | K-8 school                        | 2019          | Mixed Fuel | None     | 2022             | all-electric                                 | 1.78 W/Sq.Ft.         |
|               | High school                       |               |            |          |                  | all-electric                                 | 1.78 W/Sq.Ft.         |
|               | Community college                 |               |            |          |                  | all-electric                                 | 1.78 W/Sq.Ft.         |

<sup>1</sup>Based on proposed 2022 Title 24, Part 6 code requirements.

Energy use estimates are based on the CEC's residential and commercial building prototypes simulated in the latest research versions of the statewide compliance software: CBECC-Res 2022.0.1<sup>2</sup> for single-family and multifamily buildings and CBECC-Com 2022.0.1<sup>3</sup> for commercial buildings. Energy use estimates are also based on the latest weather files created for the 2022 software which capture changing climate conditions. The proposed land-use types at Upper Westside were matched to the most representative CEC prototype and energy use was calculated based on EUI of the prototype buildings. Where a representative prototype was not available for a few of the commercial land use types, slight changes were made to existing prototypes to better reflect the proposed land use. Table 23 in the Appendix lists which software and prototypes were used to estimate energy use for each land use type and what revisions were made.

EUIs for the residential buildings were based on the prototypes for both mixed-fuel and all-electric designs. Since the commercial prototypes assume mixed-fuel designs only, EUIs for all-electric and mostly electric designs were based on reach code studies conducted for the 2019 Title 24 code cycle which evaluated all-electric commercial prototypes ((Statewide Reach Code Team, 2019), (Statewide Reach Code Team, 2021)).

Multifamily buildings are being unified as part of the 2022 code cycle with an alignment between low-rise (three-stories and fewer) and high-rise (four-stories and greater) multifamily buildings. As a result, the energy use estimates in this analysis are based on the same assumptions regardless of building height. Multifamily energy use estimates are based on CBECC-Res algorithms and load assumptions, which are expected to be used for all multifamily buildings in 2022 as they generally are better reflective of residential load profiles. The one exception is for the PV systems as the 2022 code maintains a differentiation between the two building types for the PV requirement.

There are various proposed changes to energy requirements for commercial occupancies in the 2022 Express Terms (California Energy Commission, 2021). These proposed changes are not yet incorporated into the CEC's building prototypes. Savings for these measures relative to the 2019 code were estimated based on per square foot electricity and gas savings reported in the Codes and Standards Enhancement (CASE) reports developed by the Statewide CASE Team.<sup>4</sup>

---

## SWIMMING POOLS

The VLDR and LDR building types are anticipated to have swimming pools on some of the lots. It is estimated that 25 percent of the VLDR and 10 percent of the LDR will have an average 20,000 gallon pool. This analysis assumes that the pools are not heated and are used 7 months out of the year, roughly April through October.

Additionally, it's assumed there is a 150,000 gallon community pool and 4,000 gallon spa to serve residents at the multifamily buildings and a 500,000 Olympic size pool at the high school. These are expected to operate year-round and therefore will be heated in the winter. The energy use for community pool and spa are assigned to the HDR land use even though they may serve multiple land uses.

Pumping energy use is based on Title 24 and Title 20 requirements and assumes a variable speed motor which allows for filtration rates to be reduced during unoccupied times. Heating energy use assumes a minimum efficiency natural gas heater and no use of a pool cover. See Table 4 for a

---

<sup>2</sup> <http://www.bwilcox.com/BEES/cbecc2022.html>

<sup>3</sup> <http://bees.archenergy.com/software2022.html>

<sup>4</sup> <https://title24stakeholders.com/measures/building-types/nonresidential/2022/>

summary of assumptions and resultant annual energy use for pumping and heating. Energy use estimates for the base case and proposed project are the same.

*Table 4: Pool and Spa Assumptions*

| Land Use Type                 | Type | Volume (gallons)        | Heated | Annual Availability | Daily Availability | Annual Pumping kWh | Annual Heating therms |
|-------------------------------|------|-------------------------|--------|---------------------|--------------------|--------------------|-----------------------|
| VLDR – Single-family detached | Pool | 20,000 (at 25% of lots) | No     | 7 months/year       | 24-hours           | 5,356              | 0                     |
| LDR – Single-family detached  | Pool | 20,000 (at 10% of lots) | No     | 7 months/year       | 24-hours           | 5,356              | 0                     |
| HDR - apartments              | Pool | 150,000                 | Yes    | Year-round          | 18-hours           | 51,796             | 43,504                |
|                               | Spa  | 4,000                   | Yes    | Year-round          | 18-hours           | 18,737             | 4,835                 |
| High school                   | Pool | 500,000                 | Yes    | Year-round          | 18-hours           | 172,655            | 145,012               |

## SITE LIGHTING

### SURFACE & STRUCTURED PARKING

Table 5 presents parking assumptions for all buildings excluding single-family homes with private garages. Energy use for the single-family garages is included in the building energy estimates. All parking lighting is assumed to be light emitting diode (LED) technology meeting Title 24 requirements. Hardscape lighting requirements are proposed to be updated in the 2022 Title 24 code cycle. Base case energy use for the surface parking lots is based on the 2019 hardscape code requirements while the proposed project energy use is based on the 2022 code proposals. In all cases bi-level lighting with motion sensor and photosensor controls are assumed. Annual energy use calculations are based on 4,688 annual dark hours when the photosensor control will turn the lights on and 20 percent occupancy rate. The occupancy rate is based on data from the UC Davis California Lighting Technology Center and assumes that 20 percent of the time the area is occupied, and lights are on at full capacity. The remainder of the time the area is unoccupied and light levels are reduced to 40 percent of full capacity.

The structured parking is assumed to be enclosed and therefore ventilated and illuminated. Both base case and proposed energy use for the structured parking are estimated at the same value since there are no proposed changes for structured parking in the proposed 2022 code. Bi-level lighting with motion sensor and photosensor controls are assumed. Structured parking energy use estimates are based on 0.063 Watts per square foot and a blended occupancy rate of 55 percent to account for savings from lighting controls based on case study data.

Parking area is calculated as 350 square feet per parking space. Code allowances for hardscape parking are based on total area and total perimeter. Parking lot perimeter is estimated as 0.17 of the total surface parking area.

### PARKS

This analysis assumes that there is minimal illuminated area at each of the parks and urban farmland uses and illumination is limited to low-level pathway lighting. Total pathway lighting applied in the calculations assumes 500 feet of path for each of the major eight parks for a total of 4,000 feet and 500 feet in total for the urban farm. All lighting is assumed to be LED technology

meeting Title 24 requirements. Pathway lighting is subject to the Title 24 hardscape lighting requirements; however, in the Consultant Team's experience applying these requirements results in higher loads than are typical for narrow pathways. Therefore, a lighting density of 0.5 Watts per linear feet of path was used based on data from prior projects. Bi-level lighting with motion sensor and photosensor controls are assumed, and annual energy use calculations apply the same hours of operation, and light level reduction assumptions, as the surface parking lighting. Energy use estimates for the base case and proposed project are the same for parks and the urban farm land uses.

---

## PUBLIC ROADWAYS

Based on the land-use plan dated November 2020, 80,000 linear feet of roadway outside of the Ag-Buffer is estimated for this analysis. Public roadways are not regulated under the Title 24, Part 6 Energy Code. A lighting density of 0.23 Watts per linear feet of path was used based on LED data from prior projects. Annual energy use calculations assume a photosensor but no other controls. Energy use estimates for the base case and proposed project are the same. No energy use is estimated for roadway within the Ag-Buffer.

Table 5: Parking Lot Assumptions

| Land Use Type | Description                       | Estimated Spaces per Unit | Total Parking Spaces |         |
|---------------|-----------------------------------|---------------------------|----------------------|---------|
|               |                                   |                           | Structured           | Surface |
| HDR           | Apartment or rowhome              | 1.5 spaces/DU             |                      | 1,365   |
| VHDR          | Urban stacked flats               | 1 space/DU                | 791                  |         |
| CMU           | Apartment over commercial         | 1 space/DU                | 3,288                |         |
|               | Mid-rise office                   | 1 space/300Sq.Ft          | 3,467                |         |
|               | Specialized (medical school/labs) | 1 space/300Sq.Ft          | 693                  |         |
|               | Specialized (medical offices)     | 1 space/300Sq.Ft          | 139                  |         |
|               | Hotel                             | 1 space/300Sq.Ft          | 1,040                |         |
|               | Entertainment                     | 1 space/100Sq.Ft          | 1,248                |         |
|               | Grocery                           | 1 space/300Sq.Ft          | 50                   |         |
|               | Restaurant                        | 1 space/100Sq.Ft          | 890                  |         |
|               | Retail                            | 1 space/300Sq.Ft          | 485                  |         |
|               | Institutional/religious           | 1 space/100Sq.Ft          | 1,040                |         |
| EHC           | Mid-rise office                   | 1 space/300Sq.Ft          |                      | 1,775   |
|               | Hotel                             | 1 space/300Sq.Ft          |                      | 444     |
|               | Restaurant                        | 1 space/100Sq.Ft          |                      | 438     |
|               | Supermarket                       | 1 space/300Sq.Ft          |                      | 150     |
|               | Retail                            | 1 space/300Sq.Ft          |                      | 148     |
|               | Entertainment                     | 1 space/100Sq.Ft          |                      | 444     |
|               | Institutional/religious           | 1 space/100Sq.Ft          |                      | 444     |
| S             | K-8 school                        | 60 spaces/school          |                      | 180     |
|               | High school                       | 400 spaces/school         |                      | 400     |
|               | Community college                 | 200 spaces/school         |                      | 200     |

## ELECTRIC VEHICLE CHARGING

Level 2 electric vehicle (EV) charging is assumed at the single-family garages and at parking lots serving the multifamily and commercial land uses. Proposed project energy use estimates are based on one EV charger installed per each single-family garage space and EV chargers at 20 percent of multifamily and commercial parking spaces. Base case energy use reflects chargers at only one percent of spaces.

Single-family homes EV charging estimates are based on data from the U.S. Environmental Protection Agency and Federal Highway Administration, resulting in an annual estimate of energy use per EV charger of 3,387 kWh (see Table 6). This aligns with SMUD's Integrated Resource Plan which claims that the average light-duty EV uses approximately 3 MWh per year (Sacramento Municipal Utility District, 2019).

*Table 6: Single-Family EV Charging Assumptions*

| Metric                             | Value  | Source   |
|------------------------------------|--------|--|
| Average EV efficiency kWh per mile | 0.3042 | EPA's fuel economy data for 2019 through 2021 model year mid-size EVs (U.S. Environmental Protection Agency, 2021).      |
| Average daily miles per vehicle    | 30.5   | National Household Travel Survey Best Estimate of Annual Vehicle Mileage for 2017 (Federal Highway Administration, 2021) |

The energy estimates for the public chargers at the commercial and multifamily parking lots assume three full-hours of daily charging with a Level 2 charger that draws 10 kW during operation. This results in an annual estimate of 10,950 kWh per charger. This annual use estimate is applied as an average across all the anticipated public chargers for the project. However, the use profile of the public chargers may vary widely. There is a potential for greater use at the employment highway commercial parking lots which may have fast chargers and receive highway traffic with frequent turn-over, and lower demand in the commercial core area.

EV charging technology and use profiles are changing rapidly. These estimates are based on the best available information at the time of the analysis.

## WATER SUPPLY

Annual energy consumption is estimated for the potable water supply only. All water use is assumed to be potable water. The use of recycled water or untreated irrigation water remains an option for some uses (e.g., irrigation of open space, landscape corridors, agricultural uses, and make-up water for the canal); however, these uses have not yet been determined, and are therefore not included in these water energy estimates.

The potable water energy estimates are based on the March 6, 2020 Water Infrastructure Conceptual Plan developed by Wood Rogers,<sup>5</sup> which is the basis of the *Upper Westside Specific Plan February 2021 Administrative Draft (UWSP)*. The Water Infrastructure Conceptual Plan estimates a total water demand, including 7.5 percent System Losses, of 3,879 acre-feet per year (AFY), or

---

<sup>5</sup> Wood Rogers, "Upper Westside – Water Infrastructure Feasibility Review Memo," March 6, 2020. Available online as of 4/15/2021 at <https://planningdocuments.saccounty.net/ViewProjectDetails.aspx?ControlNum=PLNP2018-00284>

1,264 million gallons per year (MGY). These estimates are based on the Sacramento County Water Agency's projection methodology and the project's proposed land uses.

The UWSP Water Infrastructure Conceptual Plan proposes a water treatment plant and 1.5 MG water storage tank site southwest of the intersection of Byrte Bend Road and San Juan Road, on the west side of the proposed 20 acre detention basin. The Water Infrastructure Conceptual Plan requires a retailer to deliver treated water to the plan area. The retailer would own, operate, and maintain the plant area transmission and distribution facilities. The retailer is anticipated to be one of the following three options:

- Option 1 - City of Sacramento - Department of Utilities
- Option 2 - Sacramento County Water Agency through an established of a water supply zone; or
- Option 3 - Creation of an independent water district or annexation to an existing water district.

In addition to who would serve as the water retailer (options 1-3 above), the UWSP outlines four different water supply alternatives for where potable water supply would come from:

1. Alternative 1: City of Sacramento  
The City has excess water rights and could convey water through its existing infrastructure system to the proposed on-site treatment and storage facility.
2. Alternative 2: NCMWC via City of Sacramento  
The Natomas Central Mutual Water Company (NCMWC) has significant water rights to the Sacramento River. The City of Sacramento could utilize the NCMWC water rights to distribute water to the project through its system. From the energy standpoint, this is the same as Alternative 1, as the same water treatment infrastructure would be used; the only difference is whose water rights are used.
3. Alternative 3: NCMWC  
Sacramento River water from NCMWC's Riverside Plant could be conveyed to a new onsite water treatment and storage facility. The system would be connected to the City of Sacramento's system for redundancy.
4. Alternative 4: Groundwater  
Deep wells could be drilled on the project site and used to feed a new onsite water treatment and storage facility. This is similar to Alternative 3 but uses ground water instead of surface water. Alternative 4 would have a higher energy use because deep groundwater pumping has a higher energy intensity than sourcing water from surface waters (e.g. Alternatives 1-3).

Per the *Water Infrastructure Conceptual Plan*, Alternative 1 is the preferred option and serves as the basis for this analysis. Alternative 2 would have the same energy use as Alternative 1. Alternative 3 would likely have lower water pumping conveyance energy use, but the scale of the added water treatment plant is smaller and may be more energy intensive due to its size. Alternative 3 needs further refinement before a meaningful energy analysis can be performed. Similarly, Alternative 4 requires further development. Alternative 4 could potentially require the greatest amount of energy due to the deep groundwater pumping; however, the exact amount of energy would depend on the depth of the wells.

---

## WATER SYSTEM ENERGY USE INTENSITY (EUI)

The Energy Use Intensity (EUI) of the water supply system is the total kWh of electricity used per gallon of water for extraction, diversion, conveyance, storage, treatment and distribution of potable water. Urban Water Management Plans (UWMPs) are to be prepared by California's urban water suppliers to support their long-term resource planning, and to ensure adequate water supplies are available to meet existing and future water needs. California Department of Water Resources (DWR) made reporting of local water system EUIs optional in its 2015 Urban Water Management

Plan. Urban Water Management Plans must be prepared every five years. The City of Sacramento did not report EUI data for its 2015 UWMP. However, the Sacramento County Water Agency did report its 2015 water EUI, which was 701.4 kWh/acre-foot of potable water delivered.<sup>6</sup> Water system EUI reporting is mandatory for the 2020 Urban Water Management Plan, for which reporting is due July 1, 2021. The Project Team corresponded with the City of Sacramento to obtain its EUI data before officially reported but was unable to get the EUI data. Sacramento's sustainability, climate, benchmarking and other public reporting data were reviewed; however, there was insufficient data to calculate water supply EUIs. A detailed literature review was conducted to identify other relevant EUI data for use in this analysis.

Stanford's Water in the West program has tabulated the most comprehensive set of water infrastructure EUI data, broken out by individual water infrastructure phases (extraction, diversion, conveyance, treatment and distribution)<sup>7</sup>. Using Water in the West EUI data resulted in a similar total water supply EUI as reported in the Sacramento County Water Agency's 2015 Urban Water Management Report, but with a larger range of variability.

Therefore, for this analysis, Sacramento County Water Agency's 2015 Urban Water Management Report's overall water system EUI of 701.4 kWh/acre-foot was used. This is the most current and representative EUI of the water supply that will eventually serve this project. The mix of surface and ground water supplies, depth to groundwater, raw water quality, distribution distances and topography, and other factors are similar. The Sacramento County Water Agency provides only a total water infrastructure EUI. Individual components of the water supply chain (extraction, treatment and distribution) are estimated from literature data and broken out for reference.

*Table 7: Water infrastructure Energy Use Intensity (EUI)*

| Water Supply Component                          | kWh/AF | Source Notes  |
|---|--------|---|
| Extraction<br>(Mix of surface and ground water) | 276.1  | Calculated.<br>Extraction = Total – Treatment – Distribution<br><i>In the range of benchmark data for a mix of surface and ground water</i> |
| Treatment                                       | 32.5   | Stanford, Water in the West, benchmark average  |
| Distribution                                    | 392.8  | Stanford, Water in the West, benchmark average  |
| Total   | 701.4  | Sacramento County Water Agency 2015 Urban Water Management Plan   |

## WASTEWATER

Annual energy consumption is estimated for the wastewater infrastructure. The wastewater energy estimates are based on Wood Roger's *Upper Westside Level 1/2 Sewer Study updated February 2021*, and the *Upper Westside Specific Plan February 2021 Administrative Draft (UWSP)*.

<sup>6</sup> Sacramento County Water Agency. "2015 Urban Water Management Plan," Section 6.10, Energy Efficiency, June 2016.

[https://waterresources.saccounty.net/scwa/Documents/Engineering%20Reports/Sac\\_CWA\\_2015\\_UWMP\\_6-28-2016.pdf](https://waterresources.saccounty.net/scwa/Documents/Engineering%20Reports/Sac_CWA_2015_UWMP_6-28-2016.pdf)

<sup>7</sup> Stanford University, Water in the West program, "Water and energy Nexus: A Literature Review." 2013.

[https://waterinthewest.stanford.edu/sites/default/files/Water-Energy\\_Lit\\_Review\\_0.pdf](https://waterinthewest.stanford.edu/sites/default/files/Water-Energy_Lit_Review_0.pdf)

---

## SEWER SYSTEM DESCRIPTION

The project is partially within the Sacramento Area Sewer District (SacSewer); the remaining project area is planned to be annexed into the District. SacSewer's standards were used for Wood Roger's Level 1/2 Sewer Study.

Approximately 2% of the project's wastewater ("Shed G" in the *Upper Westside Level 1/2 Sewer Study*) will flow by gravity to an existing gravity trunk at the intersection of El Centro and San Juan Road. These flows go to the Sacramento Regional County Sanitation District (Regional San) New Natomas Pump Station (NNPS). The remaining 98% of the project's wastewater will drain by gravity to a new onsite pump station that will convey the wastewater to the NNPS via a force main. From the NNPS, sewage is conveyed to the Regional San's wastewater treatment plant near Elk Grove through a combination of force mains and gravity conveyance. Treated water is discharged into the Sacramento River. Regional San is constructing a new wastewater treatment plant, the "EchoWater Project,"<sup>8</sup> which is adjacent to the existing wastewater treatment plant. The new EchoWater Project plant is expected to be operational by 2023 and is planned to treat the project's wastewater to tertiary standards using advanced wastewater treatment processes. This will include improved ammonia and nitrate removal, among other improvements. This will be a more energy intensive process than the current wastewater treatment plant. The new plant has a permitted capacity of 181 million gallon per day (MGD) average dry weather flow (ADWF).

Table 8 summarizes the project's estimated wastewater generation from Wood Roger's *Level 1/2 Sewer Study, updated February 2021*. The Average Dry Weather Flows (ADWF), in MGD, are multiplied by 365 to get the estimated annual wastewater flows in million gallons per year (MGY) for the energy calculations. Additional infiltration and inflow (I/I) flows are not included in the annual wastewater estimate. The Sacramento Area Sewer District's *System Capacity Plan Update 2020* models future development groundwater infiltration (GWI) rates as zero (i.e., no additional ground water infiltration than is already included in the 310 gpd per equivalent single-family dwelling (ESD) value used to calculate the ADWF)<sup>9</sup>. Modeling rainfall dependent infiltration/inflow (RDI/I) is beyond the scope of this analysis. RDI/I is not expected to be a significant contributor to total annual wastewater flows. Moreover, the annual wastewater generation estimates already exceed the estimated potable water consumption. This is due to the differing methodologies the different agencies use for estimating the respective flows. Thus, the annual wastewater generation estimate is conservative and likely overestimates actual wastewater flows.

*Table 8: Wastewater Flows*

| Segment   | Shed G | Pump Station | Total |
|---|--------|--------------|-------|
| Q <sub>avg</sub> , Average Dry Weather Flow (ADWF), (MGD) | 0.09   | 4.19         | 4.28  |
| Q <sub>annual</sub> , Annual ADWF (MGY)                   | 33     | 1,529        | 1,562 |

---

<sup>8</sup> <https://www.regionalsan.com/echowater-project>

<sup>9</sup> Sacramento Area Sewer District, System Capacity Plan Update 2020, Section 3.1.2, p.16.  
[https://www.sacsewer.com/sites/main/files/file-attachments/2020\\_scp\\_final\\_report\\_20210108.pdf?1615570170](https://www.sacsewer.com/sites/main/files/file-attachments/2020_scp_final_report_20210108.pdf?1615570170)

---

## WASTEWATER INFRASTRUCTURE ENERGY USE INDICES

System-specific wastewater infrastructure energy use indices (EUIs) are not available from the various agencies involved in the wastewater collection and treatment processes serving this project. The City of Sacramento is in the process of benchmarking its wastewater treatment energy use, which shares much of the same wastewater treatment infrastructure, and these EUIs are not currently available. The EIR and other planning documents for Regional San’s new EchoWater treatment plant were reviewed for EUIs or performance data to calculate EUIs; however, these were also not available.

The best available EUI data for the wastewater treatment infrastructure serving this project is previous study data tabulated by Stanford’s Water in the West Program, “Water and Energy Nexus: A Literature Review.”<sup>10</sup> On average, wastewater collection consumes 150 kWh per million gallons (MG) for pumping. The pumping energy for the new pump station to be installed for the project is included in this system average, as well as the additional pumping energy required to get the wastewater from the NPPS to the wastewater treatment plant. Wastewater treatment is more variable, and depends upon the size of the plant, the level to which the wastewater is treated, and the treatment technology. The wastewater treatment EUI used for this analysis is based on characteristics for the Regional Sans’s new EchoWater wastewater treatment plant, in terms of size (>100 MGD capacity), treatment level (tertiary) and technology (advanced wastewater treatment technology with nitrification). Wastewater treatment will consume approximately 1,588 kWh per MG per year. Wastewater treatment EUIs for this project are summarized in Table 9. These EUIs are multiplied by the annual sewer flows to get the annual wastewater energy use, which is summarized in Table 19.

*Table 9: Wastewater Infrastructure Energy Use Intensity (EUI)*

| Component             | EUI (kWh/MG) |
|-----------------------|--------------|
| Wastewater Collection | 150          |
| Wastewater Treatment  | 1,588        |
| Total                 | 1,738        |

## STORMWATER

Annual community energy consumption for stormwater pumping is estimated for the project’s detention basins and regional stormwater pumping stations. The drainage pumping energy estimates are based on the March 6, 2020 drainage infrastructure conceptual plan developed by Wood Rogers,<sup>11</sup> and drainage plan preliminary design details provided by Wood Rogers on

---

<sup>10</sup> Stanford University, Water in the West program, “Water and Energy Nexus: A Literature Review,” Table 5: Unit Electricity Consumption for Wastewater Treatment by Size of Plant. 2013.

[https://waterinthewest.stanford.edu/sites/default/files/Water-Energy\\_Lit\\_Review\\_0.pdf](https://waterinthewest.stanford.edu/sites/default/files/Water-Energy_Lit_Review_0.pdf)

<sup>11</sup> Wood Rogers, “Upper Westside – Drainage Infrastructure Conceptual Feasibility Review Memo,” March 6, 2020. Available online as of 4/15/2021 at

<https://planningdocuments.saccounty.net/ViewProjectDetails.aspx?ControlNum=PLNP2018-00284>

4/13/2021<sup>12, 13</sup>. These details include refined drainage watershed areas, estimated watershed imperviousness, and refined basin drainage flows.

---

## DRAINAGE SYSTEM DESCRIPTION

The project is divided into 83 drainage watersheds, ranging in size from 3.5 acres to 94.4 acres. Stormwater runoff from most of the watersheds drain by gravity into one of four large detention basins: watersheds SOUT01-SOUT16, ROADS1, and ROADS2 drain into the south detention basin; watersheds WEST01-WEST13 drain into the west detention basin; watersheds NORT01-NORT12 drain into the north detention basin; and watersheds EAST01-EAST15, and ROADE1-ROADE3 drain into the east detention basin. The watersheds surrounding the canal (CENT01-CENT05) drain directly into the project's central canal water feature (the "CENTRAL" basin). This canal then drains via gravity into the east detention basin. Stormwater runoff from the agricultural land uses on the west side of the project along the river (watersheds OFFS01-OFFS05, OFFW01- OFFW08, OFFN01-OFFN03) do not drain into the basins, and there is no pumping currently planned for stormwater flows for these watersheds. Most areas dedicated to school land uses drain into one of the four detention basins; however, there is a single 65.5-acre watershed (SCHOOL) that occupies most of the area planned for the high school that does not directly drain into one of the four main detention basins. This high school watershed will have a separate on-site detention basin, which will likely be pumped. This site will be required to detain flows to existing condition flow rates and will be designed at a later date. The SCHOOL watershed is just west of the east detention basin. For purposes of this analysis, it is assumed that runoff from this SCHOOL watershed will flow into a shallower detention basin located within its watershed, which will then be pumped into the adjacent east detention basin. This detention basin has not yet been designed. It is estimated that the pump lift will be four feet to estimate its pumping power.

The Upper Westside project is located in an area that has a high groundwater table. Due to the high-water table, the four detention basins will be lined to minimize groundwater seepage. Therefore, there will be minimal stormwater infiltration from the basins, and all runoff entering the basins must be pumped out of the basins. Each basin will have a pump station. The basin pump stations are planned to be staggered four-pump systems, consistent with the City of Sacramento Stormwater Standards. The lowest pump will be a 1 cubic foot per second (cfs) low-flow pump set to maintain the stormwater quality pond depth in the event of minor flows. The three remaining pumps will be equally sized and placed at varied elevations.

Water flowing into the north basin is pumped into the Reclamation District 1000 (RD1000) Natomas West Drainage Canal. The north basin's pump station will be located at the site of the existing RD1000 Riverside Pump Station, but this pump station will have to be rebuilt to accommodate the new flows and will in effect be a new pump station. Stormwater flowing into the west basin is pumped out of the basin, where it then flows via gravity to the east basin. Stormwater flowing into the south basin is pumped out of the basin, where it then drains into the project's central canal. The canal is primarily a water feature, but it also serves as a gravity stormwater conveyance from the south basin to the east basin. Water from the south basin flows through the canal via gravity and drains into the east basin. All of the flows into the east basin are pumped into

---

<sup>12</sup> Wood Rogers, "Preliminary Backbone Storm Drain Exhibit, Upper Westside Master Drainage Study," January 2021. This document shows proposed watersheds and basin locations based on refined land use plan and drainage plans. The watershed names referenced in this report are based on this document.

<sup>13</sup> Wood Rogers, "Table 2.1 Proposed Percent Imperviousness Table", 4/13/2021. Preliminary table showing area of each watershed and the estimates of imperviousness for each watershed based on land use.

the RD1000 Natomas West Drainage Canal. The east basin is at the site of the RD1000 San Juan Pump Station; this will also need to be rebuilt to accommodate the new flows and will effectively be a new lift station.

Stormwater discharged into the Natomas West Drainage Canal flows into the Main Natomas Drainage Canal, which ends at the RD1000 Pumping Plant 1A and 1B. Only pumping plant 1B is operational. Pumping plant 1B pumps the water into the Sacramento River. The following figure summarizes the stormwater flows and pumping.

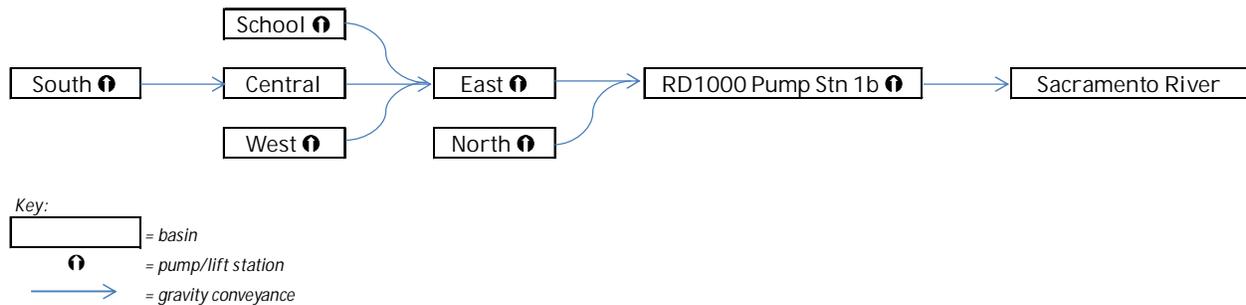


Figure 1: Schematic of the stormwater drainage flows and pump/lift stations.

## ANNUAL STORMWATER RUNOFF ESTIMATES

Stormwater runoff is influenced by the watershed areas feeding each detention basin and watershed imperviousness. The watershed areas and imperviousness are based on Wood Rogers' most recent (as of 4/13/2021) drainage system design.

Wood Rogers developed the conceptual drainage master plan and used peak storm events (200-year 10-day storm event, 100-year 10-day storm event, and a 10-year storm event) to size the drainage system to accommodate worst-case flows. To estimate annual pumping energy, annual stormwater generation for a typical meteorological year is required. The U.S. EPA's National Stormwater Calculator (SWC) was used to estimate annual stormwater flows. The SWC estimates the amount of stormwater runoff generated from a land parcel using long-term historical rainfall data, local soil conditions, land cover, and project-specific stormwater management design details. The SWC is designed for projects in the early phases of planning and design. The SWC uses the EPA's Storm Water Management Model (SWMM) as its computational engine. SWMM is a well-established, EPA developed model that has been used for over 40 years. The SWC accesses several national databases that provide soil, topography, rainfall, and evaporation information for a chosen site.

Table 10 identifies key data assumptions used to estimate the runoff from each watershed feeding the project's pumped detention basins. The watershed area and watershed imperviousness (the percent of the watershed area covered by roofs, roads, sidewalks, parking lots and driveways), come from the most recent (4/13/2021) drainage design data provided by Wood Rogers, aggregated to the detention-basin level. The "natural" land cover column represents the percent of the watershed area that is in a more natural, non-forested land cover with shrubs, scrub and some trees. This corresponds to the approximate area of the detention basins, landscape corridors, and wetland uses that are estimated to be in a more natural landscaped form. The "landscape" land cover column represents the watershed area covered in typical urban/suburban landscaping and grass. The SWC uses these variables to estimate runoff from different types of land cover. The Soil characteristics come from databases in the SWC. Figure 2 shows the soil type (runoff potential) for the site. The site has a uniform soil type C (moderately high runoff potential) in areas draining to the pumped detention basins. The site is fairly uniform except for an area (predominately in the

North watershed) that has a lower soil drainage characteristic. Precipitation data comes from historical Sacramento rain gauge "5 ESE" data (1970-2006); there is an average of 19.62 inches of precipitation per year. Evaporation data comes from the same weather station, but is based on 1970-2005 data, with an average evaporation rate of 0.22 inches/day. No climate change related modifications were made to the weather data used in the analysis. The last two columns show the calculated average annual runoff from each watershed, in inches and acre-feet.

Table 10: Summary of Watershed Drainage Areas and Characteristics Used to Estimate Annual Runoff

| Water-shed | AREA (ac) | Land Cover  |            |         | Soil Characteristics               |                       |                 | Runoff                  |                            |
|------------|-----------|-------------|------------|---------|------------------------------------|-----------------------|-----------------|-------------------------|----------------------------|
|            |           | Imper-vious | Land-scape | Natural | Soil Type (Runoff Potential)       | Soil Drainage (in/hr) | Slope           | Avg. Annual Runoff (in) | Avg. Annual Runoff (ac-ft) |
| Central    | 75.6      | 60.4%       | 39.6%      | 0.0%    | C-Moderately high runoff potential | 0.5                   | Flat (2% Slope) | 9.94                    | 63                         |
| School     | 65.5      | 50.0%       | 50.0%      | 0.0%    |                                    | 0.5                   |                 | 8.24                    | 45                         |
| South      | 404.1     | 53.4%       | 42.1%      | 4.5%    |                                    | 0.5                   |                 | 8.79                    | 296                        |
| West       | 342.8     | 42.9%       | 51.8%      | 5.3%    |                                    | 0.5                   |                 | 7.07                    | 202                        |
| East       | 408.6     | 55.0%       | 38.4%      | 6.7%    |                                    |                       |                 | 9.04                    | 308                        |
| North      | 348.4     | 25.6%       | 42.3%      | 32.1%   |                                    | 0.05                  |                 | 5.67                    | 165                        |

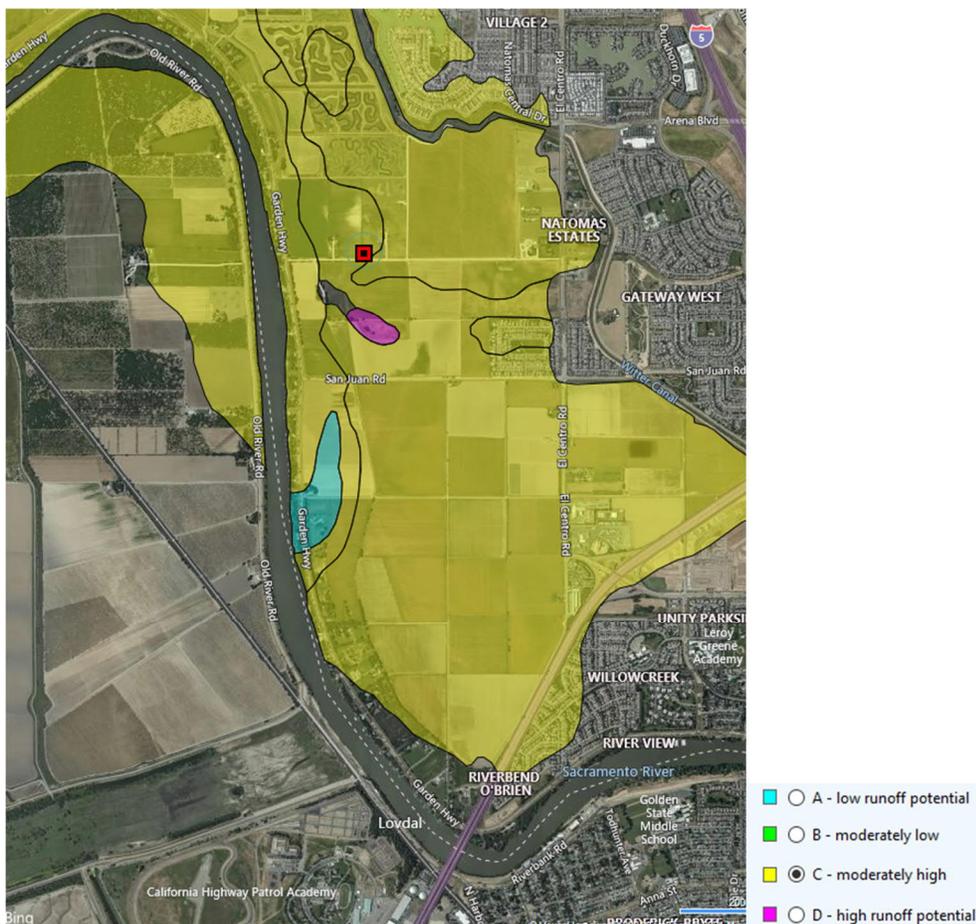


Figure 2: Soil type (runoff potential) for the project site.

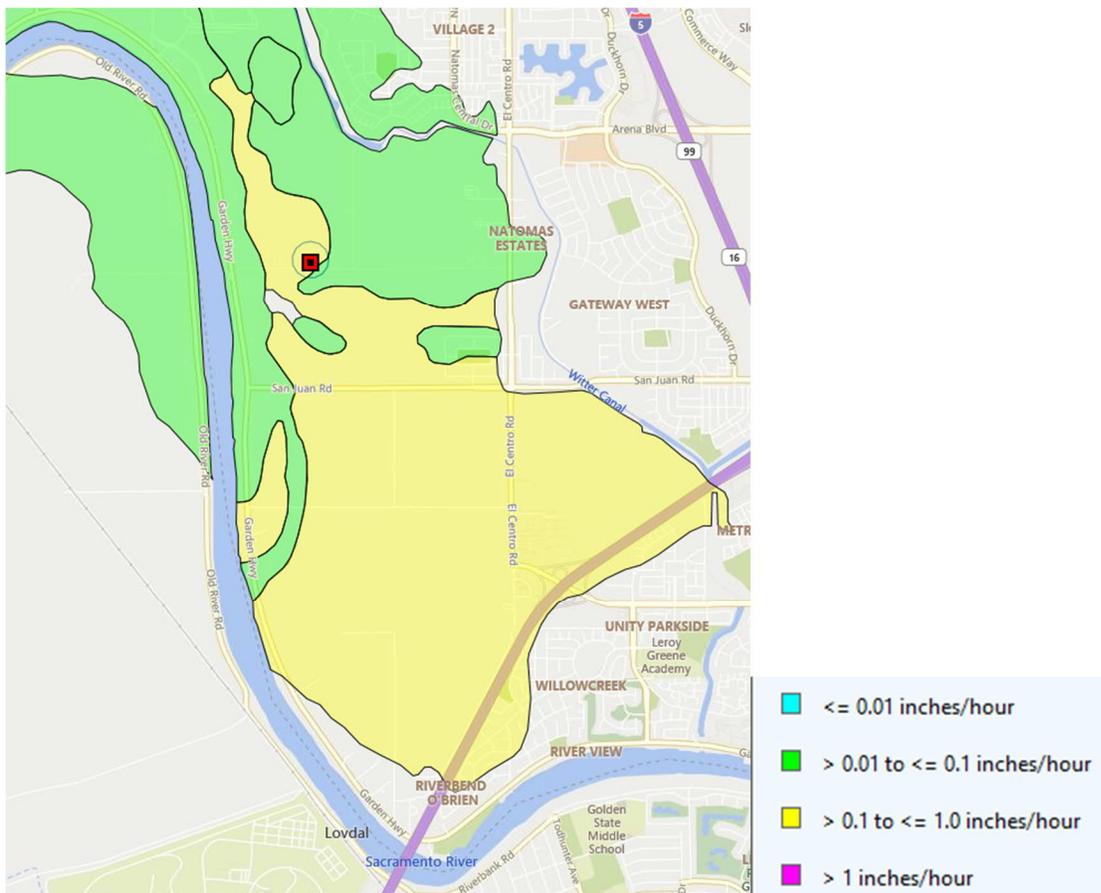


Figure 3: Soil drainage characteristics for the project site.

## PUMPING POWER—RD1000 PUMPING PLANT 1B

RD1000's Pumping Plant 1b consists of six 400 HP, 2,400 V vertically oriented mixed-flow pumps. Each pump has a capacity of 100 CFS. This pumping station was renovated in 2003. The pumps discharge into steel pipes that flow under the Garden Highway to the outfall structure on the Sacramento River.<sup>14</sup> Since rated horsepower and flow data are available, the pumping plant's energy use intensity is calculated: It is estimated that the 400 HP electric motors operate with a load factor of 1.1 at the design capacity of 100 CFS (i.e., power at rated flow = 400 HP/1.1), and that the motors have an electrical efficiency of 96%, which is a typical performance specification for this size/type/age of pump. This results in a specific power consumption of 32.0 kWh/acre-foot of water pumped. The project-related pumping power is calculated by multiplying this specific power by the total project runoff volume that enters the Natomas Drainage Canal. Pumping energy results are shown in Table 20.

<sup>14</sup> Reclamation District 1000, "Capital Improvement Program," Section 2: Description of Facilities, 8/2020. [https://www.rd1000.org/files/8218c0ca3/CIP\\_Update+2020\\_Final\\_09042020.pdf](https://www.rd1000.org/files/8218c0ca3/CIP_Update+2020_Final_09042020.pdf)

---

## PUMPING POWER—DETENTION BASINS

Basin pumping power is estimated from the following equation:

$$\text{Annual Pumping Energy (kWh)} = V * \rho * g * h / \eta_{\text{pump}} / \eta_{\text{motor}} / (3,600,000 \text{ J/kWh})$$

where: V = annual pumped water volume [m<sup>3</sup>]

$\rho$  = density of water = 997 kg/m<sup>3</sup>

g = gravitational constant = 9.8 m/s<sup>2</sup>

h = pump head (total static and frictional head), in m

$\eta_{\text{motor}}$  = motor efficiency, estimated at 92% average over the year

$\eta_{\text{pump}}$  = pump efficiency, estimated at 75% average over the year

33,600,000 J/kWh converts the pumping energy from Joules to kWh

The depths of the four main detention basins are all between 8-9 feet, with an estimated 9' static head (pump lift) for each basin. The SCHOOL detention basin is not yet designed, but it will not need to be as deep as the main basins. The pumping static head for this basin is conservatively estimated to be six feet. The dynamic (friction) head will be minimal since the horizontal runs are by surface gravity conveyance. Dynamic head is estimated to be 10% of the static head, rounded to the nearest foot. Pumping energy results are shown in Table 20. The South and West basins, along with the central canal (CENTRAL basin) and the school basin (SCHOOL) all drain to the East Basin, where the runoff must be pumped again into the Natomas Drainage Canal.

## GROUNDWATER PUMPING (DEWATERING)

The project site is in an area with a high groundwater table. The detention basins must be lined to minimize groundwater infiltration. However, even with the liners, there may still be some groundwater seepage into the basins, which must be pumped out. The pumping energy to remove this groundwater infiltration is estimated.

Table 11 shows the detention basin parameters used for the groundwater infiltration analysis. The existing site topography varies from an elevation of 10 to 20 feet above mean sea level (MSL), falling from west to east. The ground elevations for each basin are assumed equal to be the lowest planned street elevation (the top of the sewer system manhole rims) nearest each basin. Manhole rim elevations are taken from the Wood Rogers *Upper West Side Level 1/2 Sewer Study, Updated February 2021*. The basin depth and area data are from the Wood Rogers *3/6/2020 Drainage Infrastructure Conceptual Feasibility Study*<sup>15</sup>.

---

<sup>15</sup> An updated drainage infrastructure plan was not available for use with this analysis, but Wood Rogers reports no planned changes in basin depths from the 3/6/2020 study.

Table 11: Detention Basin Parameters for Groundwater Infiltration Analysis

| Detention Basin | Ground Elevation (ft MSL) | Basin Depth (ft) | Basin Bottom Elevation (ft MSL) | Basin Area (ac) |
|-----------------|---------------------------|------------------|---------------------------------|-----------------|
| N               | 11.7                      | 9                | 2.7                             | 20              |
| W               | 10.9                      | 8                | 2.9                             | 20              |
| E               | 10.2                      | 8                | 2.2                             | 20              |
| S               | 11.7                      | 8                | 3.7                             | 20              |

The groundwater level at the site is generally high with significant seasonal and annual variation. The groundwater is typically higher in the spring and lower in the fall. Wood Roger's 3/6/2020 *Drainage Conceptual Drainage Design Plan* notes that "the available groundwater level data in the vicinity of project suggests groundwater has ranged between ground surface and a depth of approximately 30 feet between 1960 and 2019." This is based on California SWRCB data from nearby groundwater contamination and cleanup wells, from which the groundwater depth ranged from 10-11 feet, 6 to 25 feet, ground surface to 30 feet, and 8 to 12 feet below the ground surface.

The Sacramento County Department of Water Resources maintained historical groundwater elevation contour maps for fall and spring from 1968 to 2007<sup>16</sup>. From 2007, the wells in the western region of the Sacramento Groundwater Authority (SGA), where the project is situated, have been read more sporadically, and the groundwater elevation contour maps have not been produced on a regular basis. SGA reports indicate that there have not been significant changes in groundwater levels from historical data, with the exception of abnormally dry periods. To estimate groundwater elevation at the project site for pumping energy estimates, the Sacramento County and SGA groundwater contour maps<sup>17, 18</sup> from 1998-2007, 2010, 2014, and 2016 were interpolated to get spring and fall groundwater levels at the project site. Average spring and fall groundwater elevations were then calculated. Figure 4 shows the historical groundwater elevations and the spring/fall calculated averages at the project site. The ground surface elevations at the detention basin locations and the elevations of the bottom of the detention basins are also indicated. As can be seen, the groundwater varies significantly both on a seasonal basis and over longer multi-year periods. The groundwater elevation is typically below or slightly above the bottom of the detention basins. Only on two occasions during the analysis period has the groundwater come near the ground surface; spring 1998 and fall 2006. For estimating annual pumping power, the site's typical monthly groundwater elevation is assumed to oscillate sinusoidally between the average spring elevation of 3.2 feet MSL and the average fall groundwater level of 2.8 feet MSL. The height of the groundwater above the bottom of each basin is the hydraulic head on the liner. Since each basin is situated at a slightly different ground elevation and the basins have different depths, the leakage into each basin is analyzed individually.

<sup>16</sup> Sacramento County Department of Water Resources. Ground Water Elevation Contour Maps, 1968-2007. <https://waterresources.saccounty.net/Pages/ContourMaps.aspx> Accessed 4/1/2021.

<sup>17</sup> Sacramento Groundwater Authority (SGA). "SGA Basin Management Report – 2016 Update." 2016 <https://www.sgah2o.org/wp-content/uploads/2017/01/pub-bmreport-2015.pdf>

<sup>18</sup> Sacramento Groundwater Authority (SGA). "SGA Basin Management Report – 2011 Update." 2011 <https://www.sgah2o.org/wp-content/uploads/2016/06/pub-bmreport-2011.pdf>

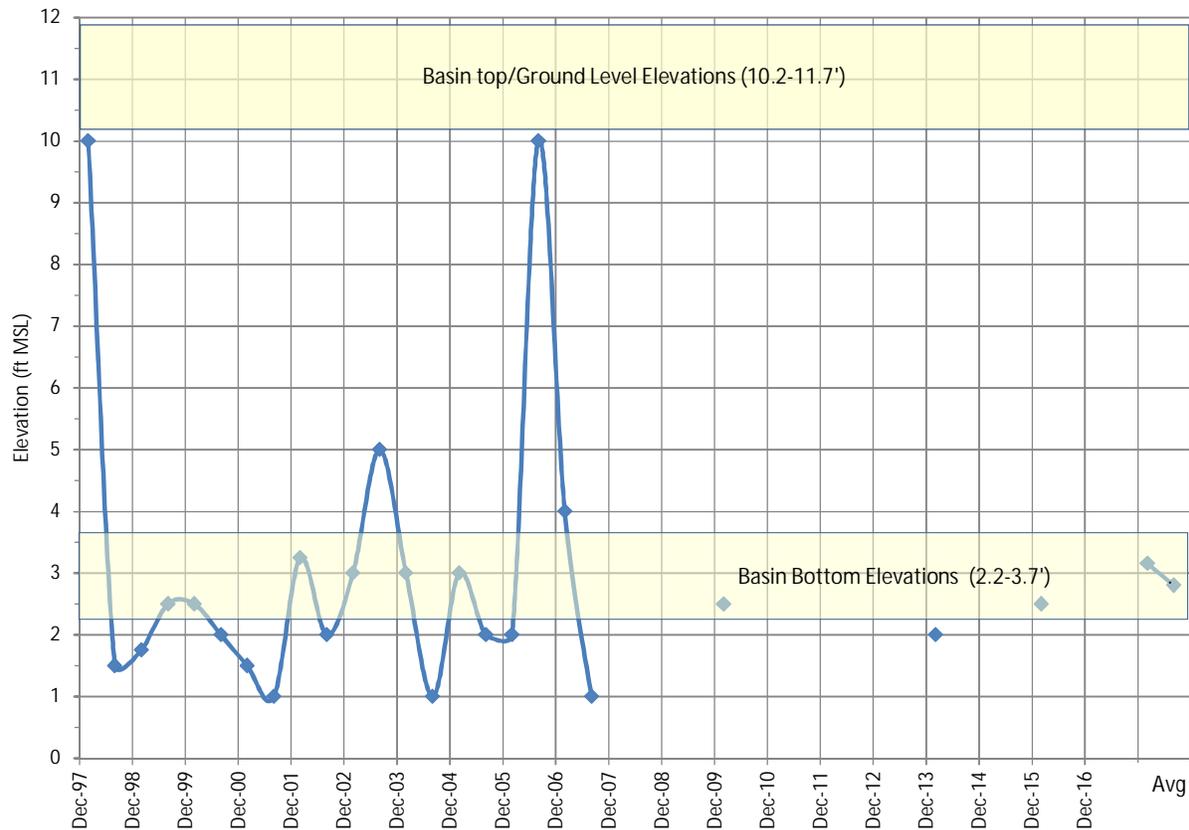


Figure 4: Historical groundwater elevations at the project site.

Table 12 shows the estimated monthly groundwater height above the bottom of each basin. This is the estimated hydraulic head driving groundwater infiltration through the basin liners. The average groundwater elevation is below the bottom of the south basin for all months; therefore, there will be no groundwater leakage into the south basin.

Table 12: Groundwater Height (feet) Above Basin Bottom (Hydraulic Head)

| Month       | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| South Basin | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| West Basin  | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| East Basin  | 0.9 | 1.0 | 0.9 | 0.9 | 0.8 | 0.7 | 0.6 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 |
| North Basin | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 |

Although not yet designed, it is assumed that the detention basins will be lined with a typical geotextile liner (e.g., HDPE). Giraud and Bonaparte's correlations for the leakage rate through geotextile liners vs. hydraulic head<sup>19</sup> are used to estimate the amount of groundwater that will leak through the basin geotextile liners. Analysis is performed for each basin and its hydraulic head with the liner in a range of conditions: no holes (permeation only), small holes (one 3.1-mm<sup>2</sup> hole

<sup>19</sup> Giroud, J. & R. Bonaparte. "Leakage through Liners Constructed with Geomembranes," Elsevier Science Publishers, Journal of Geotextiles and Geomembranes, Vol. 8, pp 27-67, 1989.

per acre), and large holes (one 1-cm<sup>2</sup> hole per acre)<sup>20</sup>. Large holes result in significant leakage. The no-hole condition (leakage is through water permeation through the membrane only) results in very minimal groundwater infiltration and no significant pumping power. The “small holes” condition is the most likely leakage scenario which is used for the final tabulated pumping power summary.

Additionally, analysis is made for both the “average” groundwater elevations and a “worst-case” scenario where groundwater levels are close to the surface. Fall 2006 and spring 2007 groundwater elevations (10’ and 4’ MSL, respectively) are used for the worst-case analysis, and result a situation where the groundwater is always above the bottom of the basins. The “best-case” conditions result in zero groundwater infiltration and occur when the groundwater elevations are below the basin bottoms for the entire year (i.e., 2000).

Table 13 summarizes the annual groundwater leakage into the basins for the range of liner conditions and groundwater elevations. Table 21 in the results section shows the estimated pumping energy for each of these conditions. The same methodology used for estimating stormwater pumping from the basins is used to estimate groundwater pumping from the basins. The results illustrate the significant range of possible groundwater infiltration into the basins and related pumping energy depending on the liner condition and groundwater levels. Overall, with the liner in good condition without major leaks, groundwater infiltration into the basins is expected to be small compared to the stormwater runoff entering the basins, even at high groundwater levels. Damage to the membrane (i.e., the “large holes” liner condition) is the most significant factor impacting groundwater pumping from the basins. This illustrates the importance of careful installation and protection of the detention basin liners to minimize liner damage.

*Table 13: Annual Groundwater Infiltration into the Detention Basins*

| Basin       | Groundwater Infiltration (ac-ft) |             |             |                                     |             |             |
|-------------|----------------------------------|-------------|-------------|-------------------------------------|-------------|-------------|
|             | "Average" Groundwater Elevations |             |             | "Worst-Case" Groundwater Elevations |             |             |
|             | No Leaks                         | Small Leaks | Large Leaks | No Leaks                            | Small Leaks | Large Leaks |
| South Basin | 0                                | 0           | 0           | 0                                   | 0           | 0           |
| West Basin  | 0                                | 2           | 11          | 0                                   | 14          | 454         |
| East Basin  | 0                                | 6           | 86          | 0                                   | 15          | 532         |
| North Basin | 0                                | 4           | 31          | 0                                   | 14          | 476         |
| Total       | 0                                | 11          | 128         | 0                                   | 42          | 1,463       |

## CANAL AERATION

The central canal may need to be aerated for water quality. The canal has an approximate length of 2,500 feet and width of 90 feet, for an area of 5.2 acres. It will have a shallow water depth. There are a variety of ways to aerate the canal—a single large compressor station, or multiple smaller pumps. For shallow pond aeration, a series of smaller aeration pumps is often used. Performance

<sup>20</sup> Giroud and Bonapart analyzed membranes with a range of damage expected in the field due to stress on the membrane, poor installation, etc. Two hole sizes were analyzed (3.1 mm<sup>2</sup> and 1 cm<sup>2</sup>), each at a frequency of 1 hole per acre.

specifications of several systems were reviewed, and average performance data was used to estimate aeration energy needs for the canal.

For the canal, a typical smaller-scale aeration pump used for this application can serve ½ an acre. This will necessitate approximately 11 pumps. Typical pumps have a power consumption of 126.5 W, and will operate continuously, for 1108 kWh/year/pump. For 11 pumps, this totals 12,190 kWh/year.

### 3. RESULTS

---

Table 14 summarizes annual energy use for each evaluated category. Table 15 through Table 22 present results from this analysis for each category of project energy use evaluated.

Estimated building energy use in Table 15 compares site gas and electricity use (including swimming pools) by building type. Shifting to all-electric or mostly-electric buildings significantly reduces on-site natural gas use by 81 percent but increases total building electricity use by 10 percent. When total energy is converted to GHG emissions, total emissions are reduced substantially in the proposed design.

Site lighting energy use presented in Table 16 shows a small difference between the base case and proposed estimates for surface parking lot lighting due to the change in code requirements between the 2019 and 2022 code and no difference for the other site lighting applications.

Table 17 presents EV charging energy use. This analysis covers estimated vehicle operational use for EVs only and not transportation energy holistically across the community. As a result, the proposed energy estimates are significantly higher than the base case. The project is proposing EV infrastructure above minimum code requirements and there is an anticipated market shift from gasoline to electric vehicles over the build-out of the project. Once total transportation energy is accounted for, total emissions are reduced substantially for the proposed design.

Table 18 summarizes the energy consumption related to the project's water supply system. All water use is assumed to be potable water, per discussion in the assumptions section. Energy use estimates for each component of the water supply system (extraction, treatment, and distribution) are provided.

Table 19 summarizes the annual energy consumption for the project's wastewater collection and treatment. Breakouts are provided for both the "Shed G" section of the project which drains to existing sewer infrastructure, and for rest of the project which will drain to a new wastewater pump station and force main.

Table 20 summarizes the annual energy consumption for stormwater pumping. Due to the project site's high groundwater tables, all runoff flowing into the project's detention basins must be pumped into the West Natomas Drainage Canal. Natomas Drainage Canal flows are then pumped into the Sacramento River. Pumping energy for both of these are estimated.

Table 21 summarizes the annual energy consumption estimated for aerating the project's central canal water feature to maintain water quality. Due to the project site's high groundwater table, the detention basins must be lined. However, even with the lining, some water will still leak into the basins. This water must be pumped out. Table 22 summarizes the range of water pumping energy that will be required to remove groundwater leaking into the project's four detention basins. As with the stormwater pumping, both the basin pumping power and the Natomas Drainage Canal pumping power is included in these estimates. This category of energy use has a large range of potential variability, depending on groundwater depth and liner condition. In some years, the groundwater is always below the basin bottom and there will be no groundwater leakage. In other years, the groundwater is always above the basin bottom and there will be leakage year-round. This is the "worst case" groundwater level. In typical years, the groundwater level is above the basin bottom for some months and then below the basin bottom for the remaining months. This is the "average" groundwater level condition. The other major factor impacting groundwater leakage into the basins is the liner condition. Leakage rates are shown for the liner in new condition (i.e., no leaks), small leaks (presumed typical condition), and large leaks (significant liner damage). The liner condition has the largest impact on groundwater leakage. Damage to the liner can result in significant leakage, particularly during high groundwater levels. For comparison purposes, the "typical" leakage rate is that which occurs for "average" groundwater levels and small leaks.

Table 14: Summary of Total Annual Estimated Energy Use by Category

| Category            | Base Case    |                   | Proposed     |                   |
|---------------------|--------------|-------------------|--------------|-------------------|
|                     | Gas (therms) | Electricity (MWh) | Gas (therms) | Electricity (MWh) |
| Buildings           | 3,168,566    | 47,985.3          | 588,173      | 52,842.1          |
| Site Lighting       | 0            | 3,807.6           | 0            | 3,741.1           |
| EV Charging         | 0            | 1,751.2           | 0            | 58,690.8          |
| Water Supply        | 0            | 2,720.7           | 0            | 2,720.7           |
| Wastewater          | 0            | 2,480.8           | 0            | 2,480.8           |
| Stormwater          | 0            | 114.8             | 0            | 114.8             |
| Canal Aeration      | 0            | 12.2              | 0            | 12.2              |
| Groundwater Pumping | 0            | 0.630             | 0            | 0.630             |
| Total               | 3,168,566    | 58,873.2          | 588,173      | 120,603.1         |

Table 15: Estimated Building Annual Energy Use Results

| Land Use |                                   | Base Case               |                         |                     |                       | Proposed     |                         |                     |                       |
|----------|-----------------------------------|-------------------------|-------------------------|---------------------|-----------------------|--------------|-------------------------|---------------------|-----------------------|
|          |                                   | Gas (therms)            | Gross Electricity (MWh) | PV Production (MWh) | Net Electricity (MWh) | Gas (therms) | Gross Electricity (MWh) | PV Production (MWh) | Net Electricity (MWh) |
| VLDR     | Single-family detached            | 69,679                  | 1,194.1                 | -978.5              | 215.6                 | 0            | 1,972.0                 | -978.5              | 993.4                 |
| LDR      | Single-family detached            | 755,661                 | 14,105.8                | -12,846.5           | 1,259.2               | 0            | 22,869.6                | -12,846.5           | 10,023.1              |
| LMDR     | Single-family detached            | 324,452                 | 5,095.4                 | -5,095.4            | 0.0                   | 0            | 8,906.0                 | -5,095.4            | 3,810.5               |
| MDR      | Single-family detached/ townhome  | 191,768                 | 3,326.0                 | -3,326.0            | 0.0                   | 0            | 5,630.5                 | -3,326.0            | 2,304.4               |
| HDR      | Apartment or rowhome              | 222,900                 | 3,797.1                 | -3,726.6            | 70.5                  | 48,339       | 5,978.3                 | -3,726.6            | 2,251.7               |
| VHDR     | Urban stacked flats               | 120,870                 | 2,728.4                 | 0.0                 | 2,728.4               | 0            | 4,329.9                 | -2,519.4            | 1,810.5               |
| CMU      | Apartment over commercial         | 461,033                 | 11,093.0                | 0.0                 | 11,093.0              | 0            | 17,347.5                | -9,308.9            | 8,038.7               |
|          | Mid-rise office                   | 68,975                  | 8,967.7                 | 0.0                 | 8,967.7               | 0            | 8,866.6                 | -5,213.7            | 3,652.9               |
|          | Specialized (medical school/labs) | 80,773                  | 2,453.3                 | 0.0                 | 2,453.3               | 18,918       | 2,363.6                 | -146.6              | 2,217.0               |
|          | Specialized (medical offices)     | 2,759                   | 358.7                   | 0.0                 | 358.7                 | 0            | 354.7                   | -29.3               | 325.4                 |
|          | Hotel                             | 64,908                  | 1,508.5                 | 0.0                 | 1,508.5               | 0            | 2,206.3                 | -219.9              | 1,986.5               |
|          | Entertainment                     | 19,609                  | 1,000.3                 | 0.0                 | 1,000.3               | 0            | 1,002.2                 | -88.0               | 914.2                 |
|          | Grocery                           | 1,473                   | 765.4                   | 0.0                 | 765.4                 | 0            | 762.4                   | -69.9               | 692.5                 |
|          | Restaurant                        | 323,206                 | 2,223.6                 | 0.0                 | 2,223.6               | 245,405      | 3,246.3                 | -62.7               | 3,183.6               |
|          | Retail                            | 9,509                   | 1,506.8                 | 0.0                 | 1,506.8               | 0            | 1,441.5                 | -678.6              | 762.9                 |
|          | Institutional/religious           | 6,667                   | 1,084.1                 | 0.0                 | 1,084.1               | 0            | 1,053.2                 | -73.3               | 979.9                 |
| EHC      | Mid-rise office                   | 35,316                  | 4,591.6                 | 0.0                 | 4,591.6               | 0            | 4,539.9                 | -2,669.5            | 1,870.3               |
|          | Hotel                             | 27,698                  | 643.7                   | 0.0                 | 643.7                 | 0            | 941.5                   | -93.8               | 847.7                 |
|          | Restaurant                        | 165,939                 | 1,232.4                 | 0.0                 | 1,232.4               | 130,499      | 1,698.9                 | -30.8               | 1,668.1               |
|          | Supermarket                       | 4,600                   | 2,429.7                 | 0.0                 | 2,429.7               | 0            | 2,409.7                 | -209.7              | 2,200.0               |
|          | Retail                            | 2,936                   | 535.9                   | 0.0                 | 535.9                 | 0            | 514.2                   | -328.4              | 185.9                 |
|          | Entertainment                     | 6,972                   | 355.7                   | 0.0                 | 355.7                 | 0            | 356.3                   | -31.3               | 325.1                 |
|          |                                   | Institutional/religious | 2,845                   | 462.6               | 0.0                   | 462.6        | 0                       | 449.4               | -31.3                 |
| S        | K-8 school                        | 27,492                  | 1,431.6                 | 0.0                 | 1,431.6               | 0            | 1,320.1                 | -523.3              | 796.8                 |
|          | High school                       | 165,495                 | 890.6                   | 0.0                 | 890.6                 | 145,012      | 908.4                   | -406.2              | 502.2                 |
|          | Community college                 | 5,031                   | 176.3                   | 0.0                 | 176.3                 | 0            | 180.7                   | -99.8               | 80.9                  |

Table 16: Estimated Site Lighting Annual Energy Use Results

| Land Use                        |                                   | Base Case Electricity (MWh) | Proposed Electricity (MWh) |
|---------------------------------|-----------------------------------|-----------------------------|----------------------------|
| HDR                             | Apartment or rowhome              | 79.4                        | 64.6                       |
| VHDR                            | Urban stacked flats               | 190.9                       | 190.9                      |
| CMU                             | Apartment over commercial         | 793.7                       | 793.7                      |
|                                 | Mid-rise office                   | 1,004.4                     | 1,004.4                    |
|                                 | Specialized (medical school/labs) | 200.9                       | 200.9                      |
|                                 | Specialized (medical offices)     | 40.2                        | 40.2                       |
|                                 | Hotel                             | 301.3                       | 301.3                      |
|                                 | Entertainment                     | 301.3                       | 301.3                      |
|                                 | Grocery                           | 14.5                        | 14.5                       |
|                                 | Restaurant                        | 214.9                       | 214.9                      |
|                                 | Retail                            | 140.6                       | 140.6                      |
|                                 | Institutional/religious           | 251.1                       | 251.1                      |
| EHC                             | Mid-rise office                   | 103.0                       | 83.8                       |
|                                 | Hotel                             | 26.4                        | 21.4                       |
|                                 | Restaurant                        | 26.0                        | 21.1                       |
|                                 | Supermarket                       | 9.5                         | 7.6                        |
|                                 | Retail                            | 9.4                         | 7.5                        |
|                                 | Entertainment                     | 26.4                        | 21.4                       |
|                                 | Institutional/religious           | 26.4                        | 21.4                       |
| S                               | K-8 school                        | 11.2                        | 9.0                        |
|                                 | High school                       | 23.9                        | 19.4                       |
|                                 | Community college                 | 12.4                        | 10.0                       |
| Parks & urban farm              |                                   | 5.5                         | 5.5                        |
| Major roads (outside ag buffer) |                                   | 84.7                        | 84.7                       |

Table 17: Estimated Electric Vehicle Charging Annual Energy Use Results

| Land Use |                                   | Base Case<br>Electricity (MWh) | Proposed<br>Electricity (MWh) |
|----------|-----------------------------------|--------------------------------|-------------------------------|
| VLDR     | Single-family detached            | 10.9                           | 1,090.7                       |
| LDR      | Single-family detached            | 159.3                          | 15,926.4                      |
| LMDR     | Single-family detached            | 74.9                           | 7,485.6                       |
| MDR      | Single-family detached/ townhome  | 50.8                           | 5,080.7                       |
| HDR      | Apartment or rowhome              | 95.5                           | 1,910.3                       |
| VHDR     | Urban stacked flats               | 55.3                           | 1,107.0                       |
| CMU      | Apartment over commercial         | 230.1                          | 4,601.5                       |
|          | Mid-rise office                   | 291.2                          | 5,823.0                       |
|          | Specialized (medical school/labs) | 58.2                           | 1,164.6                       |
|          | Specialized (medical offices)     | 11.6                           | 232.9                         |
|          | Hotel                             | 87.3                           | 1,746.7                       |
|          | Entertainment                     | 87.3                           | 1,746.9                       |
|          | Grocery                           | 4.2                            | 84.0                          |
|          | Restaurant                        | 62.3                           | 1,245.8                       |
|          | Retail                            | 40.8                           | 815.2                         |
|          | Institutional/religious           | 72.8                           | 1,455.7                       |
| EHC      | Mid-rise office                   | 149.1                          | 2,981.5                       |
|          | Hotel                             | 37.3                           | 745.4                         |
|          | Restaurant                        | 30.6                           | 612.5                         |
|          | Supermarket                       | 12.6                           | 251.9                         |
|          | Retail                            | 12.4                           | 248.5                         |
|          | Entertainment                     | 31.1                           | 621.1                         |
|          | Institutional/religious           | 31.1                           | 621.1                         |
| S        | K-8 school                        | 12.6                           | 251.9                         |
|          | High school                       | 28.0                           | 559.8                         |
|          | Community college                 | 14.0                           | 279.9                         |

Table 18: Estimated Water Supply Infrastructure Annual Energy Use Results

| Land Use Type | Description                | Total Demand Including 7.5% System Losses (AFY) | Water Infrastructure Energy Use (kWh/yr) |           |              |           |
|---------------|----------------------------|---|--|-----------|--------------|-----------|
|               |                            |   | Extraction                               | Treatment | Distribution | Total     |
| VLDR          | SFD (1 acre to 85' x 120') | 368   | 101,605                                  | 11,955    | 144,555      | 258,115   |
| LDR           | SFD (55' x 100')           | 999   | 275,823                                  | 32,455    | 392,421      | 700,699   |
| LMDR          | SFD (45' x 80')            | 320   | 88,352                                   | 10,396    | 125,700      | 224,448   |
| MDR           | SFD/Townhome               | 152   | 41,967                                   | 4,938     | 59,708       | 106,613   |
| HDR           | Apartment or rowhome       | 145   | 40,034                                   | 4,711     | 56,958       | 101,703   |
| VHDR          | Urban stacked flats        | 89  | 24,573                                   | 2,891     | 34,960       | 62,425    |
| CMU           | Apartment over commercial  | 170   | 46,937                                   | 5,523     | 66,778       | 119,238   |
| CC            | Civic/Commercial (FS)      | 1   | 276                                      | 32        | 393          | 701       |
| E/HC          | Mid-rise office            | 111   | 30,647                                   | 3,606     | 43,602       | 77,855    |
| S             | K-8 (800 students)         | 443   | 122,312                                  | 14,392    | 174,016      | 310,720   |
| OS            | Open Space                 | 0   | 0  | 0         | 0            | 0         |
| AG            | Ag-Cropland                | 162   | 44,728                                   | 5,263     | 63,636       | 113,627   |
| AR            | Ag-Residential             | 124   | 34,236                                   | 4,028     | 48,709       | 86,974    |
| UF            | Urban farm                 | 103   | 28,438                                   | 3,346     | 40,460       | 72,244    |
| P             | Parks                      | 220   | 60,742                                   | 7,147     | 86,419       | 154,308   |
| W             | Water (basins/Canal)       | 279   | 77,032                                   | 9,064     | 109,595      | 195,691   |
| LC            | Landscape Corridor         | 168   | 46,385                                   | 5,458     | 65,993       | 117,835   |
| Roads         | Major Roads                | 25  | 6,902                                    | 812       | 9,820        | 17,535    |
| Total         |                            | 3,879   | 1,070,989                                | 126,018   | 1,523,723    | 2,720,731 |

Table 19: Estimated Wastewater Infrastructure Annual Energy Use Results

| Segment   | Shed G | Pump Station | Total     |
|---|--------|--------------|-----------|
| Average Dry Weather Flow (ADWF) (MGD)               | 0.09   | 4.19         | 4.28      |
| Annual Wastewater Generation (MGY)                  | 33     | 1,529        | 1,562     |
| Wastewater Collection Energy Use (kWh/yr)           | 4,928  | 229,403      | 234,330   |
| Wastewater Treatment Energy Use (kWh/yr)            | 52,166 | 2,428,608    | 2,480,774 |
| Total Wastewater Infrastructure Energy Use (kWh/yr) | 52,166 | 2,428,608    | 2,480,774 |

Table 20: Estimated Stormwater Pumping Annual Energy Use Results

| Basin/ Pump Station    | Runoff from watersheds (acre-ft) | Pumped Volumes (ac/ft) | Pumped Volumes (m <sup>3</sup> ) | Pump Static Head (ft) | Pump Friction Head (ft) | Pump Total Head (Ft) | Pump Total Head (m) | Pumping Energy Intensity (kWH/ac-ft) | Annual Pumping Energy (kWh) |
|------------------------|----------------------------------|------------------------|----------------------------------|-----------------------|-------------------------|----------------------|---------------------|--------------------------------------|-----------------------------|
| Central Canal          | 63                               | no pumping             |                                  |                       |                         |                      |                     |                                      |                             |
| High School Site       | 45                               | 45                     | 55,478                           | 6                     | 1                       | 7                    | 2                   | n/a                                  | 1,528                       |
| South Basin            | 296                              | 296                    | 365,114                          | 9                     | 1                       | 10                   | 3                   | n/a                                  | 14,361                      |
| West Basin             | 202                              | 202                    | 249,121                          | 9                     | 1                       | 10                   | 3                   | n/a                                  | 9,799                       |
| East Basin             | 308                              | 913                    | 1,126,636                        | 9                     | 1                       | 10                   | 3                   | n/a                                  | 44,315                      |
| North Basin            | 165                              | 165                    | 203,054                          | 9                     | 1                       | 10                   | 3                   | n/a                                  | 7,987                       |
| RD1000 Pump Station 1b | n/a                              | 1,078                  | 1,329,691                        | n/a                   | n/a                     | n/a                  | n/a                 | 32                                   | 36,859                      |
| Total                  | 1,078                            | 2,699                  | 3,329,094                        |                       |                         |                      |                     |                                      | 114,849                     |

Table 21: Estimated Annual Canal Aeration Energy Use

| Category       | Annual Energy Use (kWh) |
|----------------|-------------------------|
| Canal Aeration | 12,190                  |

Table 22: Estimated Annual Groundwater Pumping Energy Use Results for Varying Liner Conditions and Groundwater Elevations

| Groundwater Elevation         | Pumping Energy (kWh) |             |             |
|-------------------------------|----------------------|-------------|-------------|
|                               | No Leaks             | Small Leaks | Large Leaks |
| Average Groundwater Levels    | 0                    | 630         | 6,775       |
| Worst-Case Groundwater Levels | 11                   | 4,608       | 95,202      |

## 4. REFERENCES

---

- Ascent Environmental. 2021. Sacramento County Public Draft Climate Action Plan. Prepared for Sacramento County. March 2021. <https://planning.saccounty.net/PlansandProjectsIn-Progress/Documents/Sacramento%20County%20Draft%20Communitywide%20Climate%20Action%20Plan.pdf>.
- California Energy Commission. February 22, 2021. Draft 2022 Energy Code Express Terms. <https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency>.
- Electrification of New Construction. April 10, 2021. Retrieved from City of Sacramento Website: [https://www.cityofsacramento.org/Community-Development/Planning/Major-Projects/General-Plan/About-The-Project/Climate\\_Change/Electrification-Ordinance](https://www.cityofsacramento.org/Community-Development/Planning/Major-Projects/General-Plan/About-The-Project/Climate_Change/Electrification-Ordinance).
- Federal Highway Administration. 2021. *Developing a Best Estimate of Annual Vehicle Mileage for 2017 NGTS Vehicles*. Retrieved from National Household Travel Survey: [https://nhts.ornl.gov/assets/2017BESTMILE\\_Documentation.pdf](https://nhts.ornl.gov/assets/2017BESTMILE_Documentation.pdf).
- Giroud, J. & R. Bonaparte. "Leakage through Liners Constructed with Geomembranes," Elsevier Science Publishers, Journal of Geotextiles and Geomembranes, Vol. 8, pp 27-67, 1989.
- Sacramento Area Sewer District, *System Capacity Plan Update 2020*, Section 3.1.2, p.16. [https://www.sacsewer.com/sites/main/files/file-attachments/2020\\_scp\\_final\\_report\\_20210108.pdf?1615570170](https://www.sacsewer.com/sites/main/files/file-attachments/2020_scp_final_report_20210108.pdf?1615570170)
- Sacramento County Department of Water Resources. Ground Water Elevation Contour Maps, 1968-2007. <https://waterresources.saccounty.net/Pages/ContourMaps.aspx> Accessed 4/1/2021.
- Sacramento County Water Agency. "2015 Urban Water Management Plan," Section 6.10, Energy Efficiency. June 2016. [https://waterresources.saccounty.net/scwa/Documents/Engineering%20Reports/Sac\\_CWA\\_2015\\_UWMP\\_6-28-2016.pdf](https://waterresources.saccounty.net/scwa/Documents/Engineering%20Reports/Sac_CWA_2015_UWMP_6-28-2016.pdf)
- Sacramento Groundwater Authority (SGA). "SGA Basin Management Report – 2011 Update." 2011 <https://www.sgah2o.org/wp-content/uploads/2016/06/pub-bmreport-2011.pdf>
- Sacramento Groundwater Authority (SGA). "SGA Basin Management Report – 2016 Update." 2016 <https://www.sgah2o.org/wp-content/uploads/2017/01/pub-bmreport-2015.pdf>
- Stanford University, Water in the West program, "Water and Energy Nexus: A Literature Review." 2013. [https://waterinthewest.stanford.edu/sites/default/files/Water-Energy\\_Lit\\_Review\\_0.pdf](https://waterinthewest.stanford.edu/sites/default/files/Water-Energy_Lit_Review_0.pdf)  
<https://www.sgah2o.org/wp-content/uploads/2017/01/pub-bmreport-2015.pdf>
- Statewide Reach Code Team. 2019. 2019 Nonresidential New Construction Reach Code Cost Effectiveness Study. Prepared by TRC. [https://localenergycodes.com/download/74/file\\_path/fieldList/2019%20NR%20NC%20Cost%20Effectiveness%20Report.pdf](https://localenergycodes.com/download/74/file_path/fieldList/2019%20NR%20NC%20Cost%20Effectiveness%20Report.pdf).
- Statewide Reach Code Team. 2021. DRAFT 2020 Reach Code Cost-Effectiveness Analysis Quick-Service and Full-Service Restaurants and Large Office. Prepared by TRC. Report not yet published.
- U.S. Environmental Protection Agency. April 9, 2021. *Download Fuel Economy Data - Datasets for all Model Years (1984-2021)*. Retrieved from EPA Fueleconomy.gov: <https://www.fueleconomy.gov/feg/download.shtml>.
- Sacramento Municipal Utility District. April 2019. Resource planning report. IRP filing report for submission to the California Energy Commission. <https://www.smud.org/-/media/Documents/Corporate/Environmental-Leadership/Integrated-Resource-Plan.ashx>.

## 5. APPENDIX – SUPPLEMENTARY DETAILS

Table 23: Building Model Prototype Applications by Land Use Type

| Land Use Type | Description                       | Software                | CEC Prototype <sup>1</sup>  | Revised Prototype / Notes (if applicable)   |
|---------------|-----------------------------------|-------------------------|---|---|
| VLDR          | Single-family detached            | CBECC-Res               | 2-story single-family   |   |
| LDR           | Single-family detached            |                         | 2-story single-family   |   |
| LMDR          | Single-family detached            |                         | 1-story single-family   |   |
| MDR           | Single-family detached/townhome   |                         | 1-story single-family   |   |
| HDR           | Apartment or rowhome              |                         | 8-unit MF prototype   |   |
| VHDR          | Urban stacked flats               |                         | 8-unit MF prototype   |   |
| CMU           | Apt over ground floor commercial  |                         | 8-unit MF prototype   |   |
| CMU           | Mid-rise office                   | CBECC-Com               | Medium Office   |   |
|               | Specialized (medical school/labs) |                         | Medium Office Lab   |   |
|               | Specialized (medical offices)     |                         | Medium Office   |   |
|               | Hotel                             |                         | Small Hotel   |   |
|               | Entertainment                     |                         | Small Retail (revised)  | Applied a mix of gym, theater, and locker room occupancy  |
|               | Grocery                           |                         | Small Retail (revised)  | Applied grocery sales occupancy   |
|               | Restaurant                        |                         | Small Restaurant & Medium Restaurant  | Medium Restaurant prototype from reach code work (Statewide Reach Code Team, 2021)  |
|               | Retail                            |                         | Medium Retail & Small Retail  |   |
|               | Institutional/religious           |                         | Medium Office (revised)   | Applied a mix of conference, worship area, and civic meeting place occupancy to 1 <sup>st</sup> floor, leave floors 2-5 as office |
| E/HC          | Mid-rise office                   |                         | Medium Office   |   |
|               | Hotel                             |                         | Small Hotel   |   |
|               | Restaurant                        |                         | Small Restaurant  |   |
|               | Supermarket                       |                         | Medium Retail (revised)   | Applied grocery sales occupancy   |
|               | Retail                            |                         | Small Retail  |   |
|               | Entertainment                     |                         | Small Retail (revised)  | Applied a mix of gym, theater, and locker room occupancy  |
|               | Institutional/religious           | Medium Office (revised) | Applied a mix of conference, worship area, and civic meeting place occupancy to 1 <sup>st</sup> floor, leave floors 2-5 as office |   |
| S             | K-8 school                        | Primary School          |   |   |
|               | High school                       | Secondary School        |   |   |
|               | Community college                 | Secondary School        |   |   |

<sup>1</sup>Red highlights indicate where changes were made to the CEC prototype or a different prototype was applied.