San Joaquin Valley Air Pollution Control District
AB 617 Community Emission Reduction Program

Vegetative Barriers and Urban Greening
Emission Reduction Program Plan

PROJECT IDENTIFICATION

This is a Community Identified Project included and prioritized in the California Air Resources Board (CARB) and District adopted Community Emission Reduction Programs (CERP). Vegetative Barriers and Urban Greening Emission Reduction Program is part of California Climate Investments, a statewide initiative that puts billions of Cap-and-Trade dollars to work reducing greenhouse gas emissions, strengthening the economy, and improving public health and the environment — particularly in disadvantaged communities.

Vegetative Barrier and Urban Greening projects use natural solutions to mitigate air quality impacts. Projects may include planting trees or vegetative barriers in the community in order to reduce emissions and provide several key co-benefits. Under strategies *UG.1 Increased Urban Greening and Forestry to Improve Air Quality* and *VB.1 Incentive Program for the Installation of Vegetative Barriers Around/Near Sources of Concern*, the CERP proposes to identify areas where these projects could be implemented and fund Vegetative Barrier/Urban Greening projects throughout the Shafter community.

While the main benefit of Urban Greening projects is greenhouse gas (GHG) reductions, Vegetative Barrier and Urban Greening projects can also reduce criteria air pollutant (CAP) emissions. Particulate matter (PM) and oxides of nitrogen (NOx) emissions are expected to decrease as a result of Vegetative Barrier/Urban Greening. According to the U.S. EPA, when properly designed, Vegetative Barriers are beneficial in reducing near-road air pollution, either alone or in combination with solid noise barriers. Factors to be considered when designing Vegetative Barriers include, but are not limited to, vegetation height, thickness, porosity, seasonal effects, air emissions of plant species, pollution and stress resistance, maintenance, and roadway safety. A full list of design considerations can be found in EPA's *Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality* attached as Exhibit A.

COMMUNITY SUPPORT

This measure received support from the Shafter Community Steering Committee (CSC) and was included in the respective adopted Community Emission Reduction Programs. This plan was developed and modeled after existing plans and resources for similar

projects within the state of California and includes feedback received from the CSC to create a plan to address the unique needs of the community. Information about the Steering Committees is included below:

(1) **Name(s) of the community group(s):**
Shafter Steering Committee Map
(2) Purpose of community group(s)
AB617 Community Engagement and Public Input
(3) Total number of members in the community group(s)
Shafter – 27 members
(4) Date(s) of formation/establishment
Shafter – December 2018
(5) A description of the decision-making process must be included.
Shafter Steering Committee Charter
(6) Community Support Demonstration
Shafter CERP

MECHANISM FOR INFORMING COMMUNITY

This measure has been discussed at Community Steering Committee meetings in addition to the outreach activities conducted to inform residents of the program and requirements for participation. The outreach conducted has and will continue to be the following:

- Social media
- Mailers
- Print ads
- Press releases and press events
- Events, town halls, webinars, etc.
- Other ideas as brought up by committee

Additionally, the District and CSC have jointly developed a tool to track progress of each measure adopted within the CERP. This tracker is updated monthly and includes updates such as number and types of projects contracted, funding allocated, project-associated benefits to the community, and other information specific to each measure. The tracker is shared directly with CSC members ahead of each regularly scheduled CSC meeting and is available on the community webpage in both English and Spanish.

PARTICIPANT REQUIREMENTS

(A) Program Eligibility:

(1) Participant Eligibility - Participants must meet the following criteria:

a) A city, county, special district, non-profit, tribal government, or public agency or entity for projects to be implemented within the selected AB 617 communities with this measure adopted within the CERP.
b) Be the owner of the land or have authority from the owner of the land where the Vegetative Barrier/Urban Greening project will be planted;
c) Maintain the green space during the entire contract period, which will be ten (10) years. This includes tree maintenance, up to and including removal and replacement of dead trees;
d) Make the project available for inspection if requested by SJVAPCD and/or CARB staff during the entire contract period, which will be ten (10) years;
e) Contact the local County Agricultural Commissioner's Office before obtaining any plant material originating from outside the respective county to ensure all the requirements for movement of plant material into the respective county are met;
f) Ensure that trees must be purchased, planted, and maintained to the specifications provided in Appendix H of CAL Fire's Urban and Community Forestry Grant Guidelines[1].
g) Where feasible, projects shall provide public access
h) Obtain any required permits;
i) Ensure that all work performed is in conformance with the California Environmental Quality Act and all other applicable statutes, rules, and regulations;
j) Have financial capacity to complete, operate, and maintain the project;
k) All property taxes where the Vegetative Barrier/Urban Greening project will be located must be current at the time of application;
l) Any funds required from other sources must reasonably be expected to be available in the time frame needed to carry out the project.

(B) Project Eligibility Criteria

(1) All Projects:

a) Species selection - required
- Non-Invasive
- Non-Poisonous
- Roadway safety conformity (where applicable)
- Maximize GHG reductions
- Low-biogenic volatile organic compound (BVOC) emitting
- Minimize allergenic pollen

b) Species selection - to be considered in selection
- Native Species
- Perennial, annual or mix

[1] Appendix H, CAL FIRE Urban and Community Forestry Grant Guidelines. Available: https://www.fire.ca.gov/media/9653/cal-fire-ucf-cci-2019-20_grant-guidelines_final.pdf#page=54 Accessed: March 2021.

- Drought resistance
- Adaptive to local site conditions (i.e., soil and climate factors)
- Erect growth habit with stiff stems
- Resistance to lodging and strong leaf retention
- Tolerance to soil deposition

c) Vegetation Characteristics – The following plant characteristics should be considered when making species selection. A full detailed description of vegetation characteristics can be found in Exhibit A.
   - Seasonal Effects
   - Leaf Surface
   - Air Emissions
   - Pollution and Stress Resistance

Applicants are encouraged to review the resources provided in Exhibit D as they prepare their proposals.

(2) Vegetative Barrier Projects:
   - Vegetative Barrier projects should be designed utilizing the design elements and concepts contained in USEPA's *Recommendations for Constructing Roadside Barriers to Improve Near-Road Air Quality* (Exhibit A), including barrier height, thickness, porosity and length.

(C) Application Process

The Program application is attached to this program plan as Exhibit B. Applications must be submitted to the District during the Request for Proposals (RFP) period. The RFP will include scoring criteria as developed with the CSC. To initiate the RFP period, the District will issue a public notification to advertise the availability of grant funds for this project type, provide instructions to access and submit the application, and include a due date by which applications must be submitted.

Entities will submit applications that include the required information as described in this Project Plan. A certification section is included in the application and details participant requirements. Participation occurs in several phases:

(1) Participants will be required to submit a completed application along with the Certifications Form signed by the applicant, a completed IRS Form W-9, Assessor's parcel map, and emission reduction estimates during the RFP period.

(2) Once the RFP period has ended, the District will review applications received and contact applicants as necessary to gather additional information. The District will aim to respond to prospective applicants

with 90 days following the end of the RFP period to alert them if their projects have been selected to receive funding. However, this timeline may be extended at the discretion of the District (e.g. to reach consensus from the CSC).

(3) Upon CSC consensus, applications selected for funding will be processed by District Staff and a contract will be offered to the participant. Once both parties have agreed to sign the contract, the participant will be notified of the contract execution, at which point participants may then commence work on the project. Project expenses cannot be incurred prior to contract execution.

(4) Once a participant has completed the Vegetative Barrier/Urban Greening project, they may submit a Claim for Payment packet for reimbursement. A complete Claim for Payment packet is required as part of the reimbursement process and must include, but is not limited to, the invoice(s) and receipts for the services performed and materials purchased, proof of payment for all expenses. During this time, District inspectors will inspect and take photos of the project site. District staff will review submitted claim packets and reimburse for eligible costs, up to the approved contract amount.

FUNDING AMOUNTS

The funding for each community will be based on the adopted community CERP.

The following costs are eligible for funding as part of this CERP strategy:

- Initial study
- Supplies and materials
- Labor and construction
- Contracted services
- Signs and interpretive aids communicating information about the project
- Up to 25% of the grant request may be budgeted for non-construction costs, including but not limited to design, permitting, outreach, direct project administration and management.
- Up to 10% may be budgeted for contingency costs.
- The grant amount will cover 100% of eligible costs.
- Ongoing project maintenance

The following costs are ineligible to receive funding as part of this CERP strategy:

- Overhead (i.e., rent, utilities, office equipment/supplies)

Projects eligible for funding must be located within the Shafter community boundary and meet eligibility requirements described in this plan.

Payments will be made on a reimbursement basis. The Grantee pays for services, products, and supplies, submits invoices and proof of payment, and is then reimbursed. If the applicant is unable to carry the financial responsibility of a reimbursement program on their own, they may partner with a local public agency or 501(c)(3) non-profit.

PROJECT SELECTION AND REPORTING

Applications received by the District will be reviewed by and distributed to District staff and the CSC. Projects will be scored by the CSC with the assistance of District staff in accordance with the criteria presented in the RFP. The scores are meant to inform the decision-making process but will not be the determining factor for project selection. A meeting with the CSC will be scheduled after the conclusion of the RFP period to present and rank the submitted proposals.

The District will report program information in accordance with Community Air Protection program guidelines found at: https://ww3.arb.ca.gov/msprog/cap/docs/cap_incentives_2019_guidelines.pdf.

All projects that receive funding under this program must comply with the requirements described in Section H of the CAP Incentives 2019 Guidelines.[2] This will involve the preparation of Mid-Cycle and Yearly reports, which the District will prepare based on information collected from project participants.

Participants must ensure that project-related information is complete, correct, supported by documentation, and supplied to the District upon request for the preparation of reports.

EMISSION REDUCTIONS

A) Emission Reductions

Various California state and institutional bodies have developed tools to help estimate the GHG reductions and co-benefits associated with Vegetative Barrier/Urban Greening projects. The methodology and referenced tools below are consistent with the Quantification Methodology developed for the California Natural Resources Agency (CNRA) Urban Greening Grant Program under the California Climate Investments Program.

[2] CARB. 2020. *Community Air Protection Incentives 2019 Guidelines*. October 14. Available at: https://ww2.arb.ca.gov/sites/default/files/2020-10/cap_incentives_2019_guidelines_final_rev_10_14_2020_0.pdf. Accessed: April 2021.

All Vegetative Barrier and Urban Greening project calculations can be performed in a workbook that has been developed by CARB for the CNRA[3]. Project applicants need to fill out data within two tabs in this workbook in order to quantify emissions and co-benefits. Applicants must fill out tabs "Project Info," and "Tree Planting – ITP." The tab "Tree Planting – ITS" should not be filled out (The "Tree Planting – ITS" tab is designed for an alternative input tab for use with alternative software that is no longer supported). Tab "New Bike-Ped Infrastructure" should not be completed, as new bicycle/pedestrian infrastructure is not included in the Vegetative Barrier/Urban Greening Program Plan.

In order to fill out all the information as prompted in the spreadsheet, project applicants will also need to use three external tools, as follows:

- University of California Agriculture and Natural Resources (UCANR) Water Use Classification of Landscape Species (WUCOLS IV) tool7[4]
- California Department of Water Resources (DWR) Water Budget Workbook8[5]
- i-Tree Planting Tool9[6]

A guide detailing how to use each of these tools can be found in Exhibit C.

(B) Qualitative Benefits

In addition to reducing GHG and CAP emissions, Vegetative Barrier and Urban Greening projects will qualitatively benefit the surrounding communities. Urban Greening projects can provide shade to sidewalks and streets, which can encourage active transportation by making it more comfortable to walk or bike in those areas. This can improve the health and well-being of the community. Similarly, Vegetative Barrier and Urban Greening projects can shade buildings and reduce energy consumption by lessening the load on air conditioning systems. When native and/or drought-resistant vegetation is planted and maintained using water efficient irrigation methods, Vegetative Barrier and Urban Greening projects can reduce water usage. In addition, planting more trees in certain areas, such as near freeways, may also help reduce noise pollution.

[3] CARB Urban Greening Calculator Tool (Version 3). Available at: https://ww2.arb.ca.gov/resources/documents/cci-quantification-benefits-and-reporting-materials?corr Accessed: February 2021.
[4] WUCOLS IV Database. Available at https://ucanr.edu/sites/WUCOLS/ Accessed: February 2021.
[5] DWR Water Budget Workbook. Available at: https://cadwr.app.box.com/s/5k39tv10u42rp5bn2uebd7fodkxzgve7 Accessed: February 2021
[6] i-Tree Planting Calculator v2.1.2. Available at: https://planting.itreetools.org/ Accessed: February 2021.

EXHIBIT A

EPA 600/R-16/072 | July 2016 | www.epa.gov/research

United States
Environmental Protection
Agency

Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality

Office of Research and Development
National Risk Management Research Laboratory, Air Pollution Prevention and Control Division

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Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality

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1.0 Introduction

Public health concerns related to near-road air quality is an important environmental issue because there are an increasing number of health studies linking adverse health effects to populations spending significant amounts of time near high-traffic roads (HEI, 2010). These effects may be attributed to increased exposure to particulate matter, gaseous criteria pollutants, and air toxics emitted by vehicle activity on the road. The significant impact of traffic emissions on urban populations all over the world has motivated research on methods to reduce exposure to these pollutants. While vehicle emission control techniques and programs to directly reduce air pollutants emitted to the air from transportation sources are vital components of air quality management, these programs often take a long time to fully implement. Thus, other mitigation options, including the preservation and planting of roadside vegetation and the construction of roadside structures such as noise barriers, are some of the few near-term mitigation strategies available for urban developers and facilities already subject to high pollution levels near roads. These mitigation methods, if successful, can complement existing pollution control programs and regulations, as well as provide measures to reduce impacts from sources that are difficult to control such as brake and tire wear and re-entrained road dust.

Several studies have investigated the role of vegetation on pollutant concentrations in urban areas employing modeling, wind tunnel, and field measurements (Baldauf et al., 2008; Brode et al., 2008; Hagler et al., 2012; Nowak, 2005; Nowak et al., 2000; Stone and Norman, 2006; Tong et al., 2015). Roadside vegetation has been shown to reduce a population's exposure to air pollution through the interception of airborne particles or through the uptake of gaseous air pollution via leaf stomata on the plant surface (Petroff et al., 2009) in addition to affecting pollutant transport and dispersion. Noise barriers combined with mature vegetation have also been found to result in lower ultrafine particle concentrations along a highway transect compared to an open field or a noise barrier alone (Baldauf et al., 2008; Bowker et al., 2007). Pollution removal (O_3, PM_{10}, NO_2, SO_2, CO) by urban trees in the United States (US) has been estimated across the continental United States using the U.S. Forest Service's i-Tree model (Nowak et al., 2014).

Removal of gaseous pollutants by trees can be permanent, while trees typically serve as a temporary retention site for particles. The removed particles can be re-suspended to the atmosphere during turbulent winds, washed off by precipitation, or dropped to the ground with leaf and twig fall (Nowak et al., 2000). These removal mechanisms can impact local air, water and soil pollution; thus, careful consideration of the land uses that surround roadside vegetation are needed when choosing species.

Trees can also act as barriers between sources and populations, although vegetation is inherently more complex to study than solid structures and the effectiveness of vegetative barriers at reducing ultrafine particle (UFP) concentration has been shown to be variable (Hagler et al., 2012). This variability is likely due to a number of confounding factors. The complex and porous structure of trees and bushes can modify near-road concentrations via pollutant capture or through altering air flow, which can result in either reduced dispersion through the reduction of wind speed and boundary layer heights (Nowak et al., 2000; Wania et al., 2012) or in enhanced dispersion due to increased air turbulence and mixing. Recirculation zones have also been observed immediately downwind of forested areas with a flow structure consistent with an intermittent recirculation pattern (Detto et al., 2008; Frank and Ruck, 2008). Vegetation type, height, and thickness can all influence the extent of mixing and pollutant deposition experienced at the site. The built environment also matters greatly – air flow and impacts of trees are substantially different for a street canyon

environment than an open highway environment (Buccolieri et al., 2009; Buccolieri et al., 2011; Gromke et al., 2008).

In addition to air quality benefits, roadside vegetation can improve aesthetics, increase property values, reduce heat, control surface water runoff, and reduce noise pollution (with dense, thick and tall stands). However, vegetation can also affect driver sight lines, protrude into clear zones along highway right-of-ways, contribute to debris on roads, present fire hazards, and be pathways for pests and invasive species; thus, the benefits and potential unintended consequences of roadside vegetation need to be considered for any application.

This guidance provides insight into roadside vegetation design characteristics that have been shown to most effectively reduce near-road air pollutant levels downwind of major highways in order to implement this feature as an air pollution mitigation strategy. This guidance is written for general considerations applicable to multiple scenarios, so does not address specific siting or permitting requirements that might be required in certain circumstances, such as planting in a highway right-of-way or within a city park.

2.0
Physical Design Recommendations

Barrier Physical Characteristics

Generally, a higher and thicker vegetation barrier will result in greater reductions in downwind pollutant concentrations. While studies evaluating varying heights of vegetation barriers have been minimal, several studies have investigated the effect of height on pollutant reductions for solid noise barriers. Figure 1 shows results of Computational Fluid Dynamic (CFD) modeling of solid noise barriers of varying heights, indicating that higher barriers require additional plume transport and dispersion above the structure, resulting in greater downwind pollutant reductions.

While the porosity of vegetation will allow some air movement through the barrier, the height of the structure will still force some air flow up and over the vegetation, increasing dispersion. The porosity and thickness of the vegetation will affect the amount of air flow allowed through the structure compared with flow forced up and over. Generally, the lower the porosity and thicker the barrier, the more air flow forced over the structure. At extremely low porosities, the vegetation will affect pollutant transport and dispersion in a similar manner as a solid noise barrier. However, vegetation barrier design should allow some air flow through the vegetation in order to enhance particulate removal. Previous studies suggest porosities between 0.5 and 0.9 to be most effective (see Tong et al., 2016 for summary).

The integrity of the vegetation barrier must be maintained in order to allow for pollutant reductions downwind. Studies have shown that gaps in vegetation barriers can lead to increased pollutant concentrations downwind, sometimes higher than concentrations would be if no barrier were present. These increases can occur because pollutant emissions from the road funnel through the gaps; in addition, the highly porous vegetation can cause winds to stagnate also leading to higher downwind concentrations. Figure 2 provides examples of a) effective barriers that have full coverage from ground to top of canopy and b) ineffective vegetation barriers due to gaps that may result in higher pollutant concentrations.

In order to achieve sufficient physical characteristics of a vegetation barrier, multiple rows and types of vegetation may be most feasible. For example, a barrier could consist of a row of bushy plants and shrubs followed by a row of trees to enable a barrier with full coverage from the ground to top of canopy at the initial planting, yet achieve higher canopy heights than feasible by bushy plants alone. In addition, rows of multiple vegetation types may allow for sufficient downwind pollutant removal while the vegetation grows over time after first planting. This approach will ensure sufficient density for pollutant removal at the initial planting, while allowing for increased pollutant removal as the vegetation matures. This process will also limit concerns of promoting plant monocultures.

In addition to passing through gaps, pollutants can also meander around the edges of a roadside vegetative barrier. Thus, if a vegetative barrier will be constructed for a specific facility (e.g. school, daycare, elderly care facility) or neighborhood, it should extend sufficiently beyond the area of concern. Research on solid noise barriers suggests that the barrier should extend at least 50 meters laterally beyond the area of concern in order to maximize reductions in downwind concentrations (Baldauf et al., 2016). If extending the barrier laterally is not feasible, extending the barrier perpendicular to the road, wrapping around the area of interest, has been shown to be effective as well (Brantley et al., 2014).

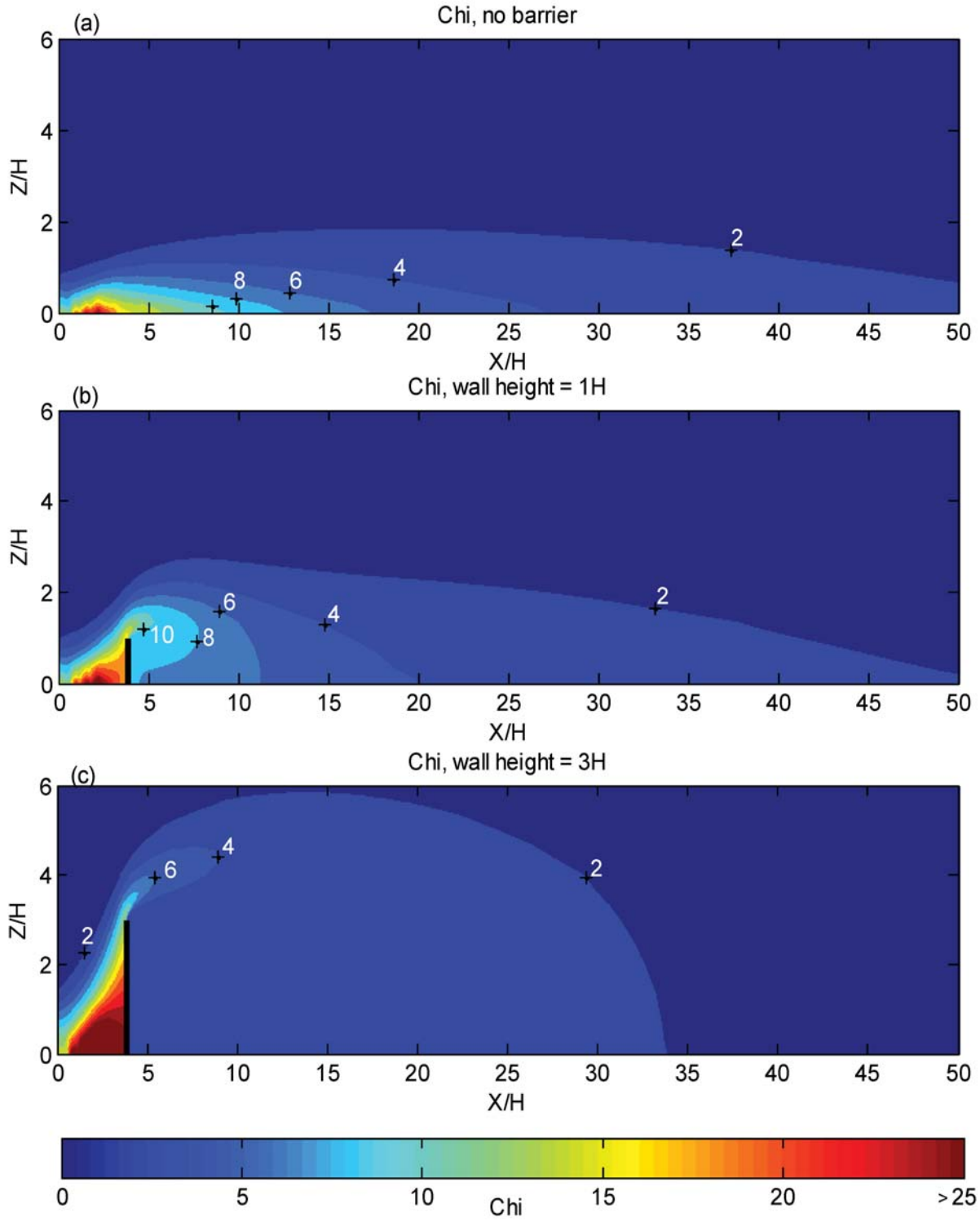

Figure 1. CFD modeling analysis of varying solid noise barrier heights. For the figure above, the top panel shows no barrier, the middle panel a barrier of height, H, and the bottom panel a barrier of height 3H. The distances downwind are also relative to the barrier height. As an example, for H=6 meters, the middle panel would represent a 6 meter tall barrier and the bottom panel an 18 meter tall barrier, and the x-axis distance values would also be multiplied by 6 meters. For this figure, Z represents the vertical height above ground and X the distance from the nearest travel lane on the road (Hagler et al, 2012).

Figure 2. Examples of effective (a) and ineffective (b) roadside barriers.

Vegetation Characteristics

Certain types and species of vegetation will provide more air quality benefits compared to other types of vegetation. When considering the design and construction of a vegetation barrier, optimal physical characteristics should be favored to the extent feasible. However, given the vast number of vegetation species, and the regional differences in the feasibility and effectiveness of specific species for a roadside barrier, specific recommendations cannot be made. The U.S. Forest Service's i-Tree model (https://www.itreetools.org) can provide a list of potential species that best meet the factors listed below, although users need to identify whether particular vegetation types can survive and prosper in a particular area of interest.

Seasonal Effects:

The vegetation chosen for a barrier should not be subject to significant changes in characteristics and integrity during changing seasons. Therefore, deciduous trees that lose leaves during the cold season should not be considered for a barrier to mitigate air quality impacts. Instead, trees that are not subject to significant seasonal changes, such as coniferous plants, should be considered. Other shrubs and bushes that are not subject to seasonal changes can also be considered as part of a roadside barrier.

Leaf Surface Characteristics:

Leaf surfaces can also enhance particulate removal through diffusion and interception. Trees and bushes with waxy and/or hairy surfaces have been shown to preferentially remove particulates compared to smooth leaf surfaces. In addition, vegetation with leaf and branch structures that provide increased surface area for particle diffusion are preferred (Tong et al., 2016). Figure 3 provides some example leaf surfaces.

Vegetation Air Emissions:

When selecting vegetation for a roadside barrier, especially at locations where sensitive populations may be spending significant amounts of time, care must be taken to choose species that do not emit compounds which can increase air pollution or allergic responses. Compounds that can be emitted by vegetation include volatile organic compounds (VOCs), which can enhance the formation of ozone, and high-allergy pollens. Both can exacerbate respiratory effects and should be avoided for roadside barriers.

Resistant to Air Pollution and Other Environmental Stressors:

Vegetation implemented in a roadside barrier must also be resistant to air pollution and other traffic stressors since concentration levels will be high. If the vegetation is not resistant and cannot maintain its integrity, gaps will form in the barrier, potentially leading to increased pollutant concentrations downwind as discussed previously. Air pollutants emitted by traffic can include the typical tailpipe emissions like CO, NOx, and particulates; materials from brake and tire wear; re-entrained road dust; and salt and sand used for road surface treatment during winter weather conditions.

(a)  (b) 

Figure 3. Example leaf characteristics including a) waxy pine needles and b) hairy leaf surfaces.

Other Considerations:

In addition to air quality considerations, other potentially beneficial and adverse aspects of vegetation need to be considered in the construction and use of a roadside barrier. These considerations include general physical and species-specific factors. While location-specific factors will need to be addressed on an individual basis, some general considerations include:

Vegetation Maintenance – The roadside vegetation will need to be maintained in order to provide a protective barrier from air pollution exposures yet not lead to safety concerns from reduced visibility or falling debris. Maintenance requirements will depend on vegetation type and species, so a plan should be in place when selecting and constructing the barrier for optimal long-term performance. These requirements include watering and fertilization needs, trimming and other pruning requirements, and overall plant care. Maintenance should also include vegetation replacement due to die-off, disease, or damage from accidents.

Water runoff control – An additional benefit of a roadside vegetation barrier can be the control and containment of surface water runoff from the impervious road and supporting infrastructure. Roadside barriers constructed to provide water runoff control can prevent localized flooding as well as improve water quality in the area. For certain regions of the country, drought resistant vegetation that can also resist high-water events may be most appropriate.

Native species – Whenever feasible, native species should be considered for implementing the roadside barrier. Native species may more likely be robust and resistant to local climatic conditions.

Non-invasive species – Vegetation barriers should not be constructed from invasive species that may not be contained within the project area of interest, and may create problems at other locations or at the roadside.

Non-poisonous species – For roadside vegetation barriers located near sensitive populations, the vegetation should not be poisonous or have the potential to cause harm in other ways. However, when the barrier can be isolated, this factor may not be a concern.

Roadway Safety – Planting on or near a highway right-of-way (ROW) requires consideration of potential safety issues. In most cases, the applicable highway department will require approvals for planting near roads due to these issues. Concerns may include creating undesirable wildlife habitat near roadways (e.g. deer and other animals that can exacerbate auto accidents), preserving safe lines-of-sight and viewshed standards for drivers on the road, maintaining compatibility of the chosen vegetation species with existing species, and not obstructing outdoor advertising.

3.0
Vegetation with Noise Barriers

Although limited, some research suggests that combining vegetation with a solid noise barrier can lead to further downwind pollutant reductions than either vegetation or a solid noise barrier alone (see Baldauf et al., 2008). For vegetation planted with a solid noise barrier, the overall considerations should be the same as for vegetation alone. However, for the vegetation to have an additive effect for pollutant reductions, the vegetation should exceed the top of the noise barrier by a sufficient height in order to allow air flow through and over the plants to enhance pollutant removal and air mixing.

Solid barriers can vary in height; research on air pollution reductions from these structures has been conducted for heights between 4.5 and 6 meters. A vegetation barrier should extend at least 1 meter above the barrier, although the higher and thicker the plants, the greater the downwind reduction. For shorter solid barriers, vegetation should extend above the barrier to a height of at least 6 meters to maximize the potential for downwind pollutant reductions. Figure 4 provides examples of combinations of vegetation with solid noise barriers that could lead to increased reductions in downwind air pollutant concentrations.

Previous research is based on vegetation planted behind the noise barrier (opposite side from the road), although bushes or plants in front could provide an added reduction if sufficiently away from the solid barrier to allow air to flow through. Some modeling studies suggest that “green walls” such as ivy or other climbing vegetation on solid noise barriers may improve local air quality; however, no air quality measurement studies have been conducted to confirm or negate these model results.

No research has been done on whether gaps or spaces in vegetation along solid walls can lead to increased downwind concentrations. Since solid noise barriers alone can reduce downwind pollutant concentrations, gaps in accompanying vegetation would likely not have the same detrimental effects as with vegetation alone, although no empirical evidence exists to confirm this assumption.

(a)

(b)

Figure 4. Examples of effective combinations of vegetation with solid noise barriers. Panel (a) shows vegetation behind the barrier (as studied in Baldauf et al., 2008) while panel (b) shows bushy vegetation in front of the barrier (no empirical evidence available).

4.0
Summary

Research shows that roadside vegetation affects nearby air quality. If properly designed, vegetation barriers can be used to reduce near-road air pollution, either alone or in combination with solid noise barriers. The important factors to consider for effective roadside vegetative barriers are included in the summary table at the end of this document.

Additional Resources

Many resources exist which can aid in the siting, design and maintenance of roadside vegetation barriers to provide air quality and other benefits to local communities. Just a few examples include:

- USDA Forest Service i-Tree program (**www.iTreetools.org**)
- State and local extension services
- EPA Stormwater Calculator (**https://www.epa.gov/water-research/national-stormwater-calculator**)
- EPA EnviroAtlas (**https://www.epa.gov/enviroatlas**)

Acknowledgements

Special thanks go to the many experts who provided advice and comments for the development of these recommendations.

These experts include David Nowak (U.S. Forest Service), Greg McPherson (U.S. Forest Service), Kevin Jefferson (Urban Releaf), David Ralston (Bay Area Air Quality Management District), Tom Hanf (Michigan DOT), Drew Buckner (Michigan DOT), Gorette Yung (Michigan DOT), Kevin Sayers (Michigan DEQ), Sheila Batka (U.S. EPA), Ken Davidson (U.S. EPA), Bob Newport (U.S. EPA), Laura Jackson (U.S. EPA), Sue Kimbrough (U.S. EPA) and Vlad Isakov (U.S. EPA).

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Summary Table

Barrier Characteristic	Recommendation	Description
Physical Characteristics		
Height	5 meters or higher (or extend 1+ meter above an existing solid barrier)	The higher the vegetative barrier, the greater the pollutant reductions. A minimum of 5 meters should provide enough height to be above typical emission elevations for vehicles on the road. However, heights of 10 meters or more would likely provide additional pollutant reductions.
Thickness	10 meters or more	The thicker the vegetative barrier, the greater the pollutant reductions. A minimum thickness of 10 meters should provide enough of a barrier to remove particulate and enhance dispersion. However, gaps in the barrier should be avoided. Multiple rows of different types of vegetation (e.g. bushes, shrubs, trees) should be considered for maximum coverage and pollutant removal during all stages of the barrier.
Porosity	0.5 to 0.9	Porosity should not be too high to allow pollutants to easily pass through the barrier or cause wind stagnation. As the porosity gets lower, the vegetation barrier will perform similarly to a solid barrier, which may limit the amount of particulate removal since air is forced up and around the plants.
Length	50 meters or more beyond area of concern	Extending the barrier beyond the area of concern protects against pollutant meandering around edges. May also consider constructing the barrier perpendicular from the road depending on land availability.
Vegetation Characteristics		
Seasonal Effects	Vegetation not subject to change by season	Vegetative barrier characteristics must be consistent throughout all seasons and climatic conditions in order to ensure effective pollutant reductions.
Leaf Surface	Complex waxy and/or hairy surfaces with high surface area	Leaf surfaces with complex and large surface areas will capture and contain more particulate pollutants as air passes through the structure.
Air Emissions	Vegetation with low or no air emissions	Vegetation used for roadside barriers should not be sources of air pollution, either at the local or regional scale.
Pollution and Stress Resistant	Resistant to effects of air pollution and other stressors	Vegetation must be able to survive and maintain its integrity under the high pollution levels and stress that can occur near roads in order to provide effective pollution reductions from traffic emissions. In addition to air pollution, other stressors can include salt and sand for winter road conditioning and noise impacts

Summary Table

Barrier Characteristic	Recommendation	Description
Other Considerations		
Maintenance	Plan must be in place to properly maintain vegetative barrier	Proper vegetation maintenance must be provided in order for the barrier to survive and maintain its integrity to provide effective pollution reductions from traffic emissions.
Water Runoff	Contain surface water runoff and improve water quality	Roadside vegetative barriers constructed appropriately can provide an added benefit of controlling and containing surface water runoff from the road, which can also improve local water quality.
Drought Resistant	Choose species resistant to drought and flooding	Many regions face climatic conditions of extended drought followed by localized flooding. Vegetative barrier must maintain its integrity under these conditions in order to provide effective pollution reductions.
Native Species	Choose native species	Native species will be more robust and resistant to climatic conditions in the area of interest; thus, maintaining its integrity under these conditions in order to provide effective pollution reductions.
Non-invasive	Choose non-invasive species	The use of non-invasive species will ensure effective pollutant reductions without potential unintended consequences from invasive species adversely effecting nearby land uses.
Non-poisonous	Choose non-poisonous species if sensitive populations will be nearby	Non-poisonous species are strongly encouraged and should be used if the barrier will be at a location with sensitive populations, such as elementary schools, parks, and recreation fields where small children may be active and in close contact.
Roadway Safety	Maintains safety for drivers on the road; conforms to local safety and permit requirements	Prior to planting, ensure vegetation plan will meet all safety and other local permit requirements (e.g. local highway department, city planning department) to preserve sight-lines and vegetation compatibility while avoiding potential wildlife/auto accidents and obstruction of outdoor advertising.

United States
Environmental Protection
Agency

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San Joaquin Valley AIR POLLUTION CONTROL DISTRICT

EXHIBIT B

VEGETATIVE BARRIERS/URBAN GREENING

APPLICATION

Vegetative Barriers and Urban Greening Emission Reduction Program is part of California Climate Investments, a statewide initiative that puts billions of Cap-and-Trade dollars to work reducing greenhouse gas emissions, strengthening the economy, and improving public health and the environment — particularly in disadvantaged communities.

SECTION 1 - APPLICANT INFORMATION (PLEASE PRINT OR TYPE)

ORGANIZATION INFORMATION		
1. Organization, Company, or Proprietor's Name (as it appears on Form W-9):		
2. Address:		
3. City:	4. State:	5. Zip Code:
6. Mailing Address (if different from above):		
7. City:	8. State:	9. Zip Code:

SECTION 2- CONTACT INFORMATION (PLEASE PRINT OR TYPE)

PRIMARY CONTACT INFORMATION	
1. First and Last Name:	2. Title:
3. Phone Number:	4. Fax Number:
5. Alternate Contact Number:	6. Email:
SIGNING AUTHORITY INFORMATION (IF DIFFERENT FROM ABOVE)	
7. First and Last Name:	8. Title:
9. Phone Number:	10. Fax Number:

11. Alternate Contact Number:	12. Email:

SECTION 3 – PROJECT INFORMATION (PLEASE PRINT OR TYPE)

1. Select Project Type: ☐ Vegetative Barrier ☐ Urban Greening
2. Project Summary Briefly describe your project including how the project will meet environmental goals or have a benefit on the environment.

3. Location of Project

Provide address or cross-streets and describe surrounding area. Please attach photographs of the project site and a representation of the project plan area (i.e., site plan). For projects with vegetative barriers, please provide planned barrier height, thickness, porosity, and length.

4. Legal Owner of Each Parcel within Project Footprint

5. Describe Proposed Greenery

Include quantity of each plant or tree to be planted. Also note environmental benefits of the selected species (e.g., if the species is native, drought resistant, non-allergenic, or low-BVOC emitting), if possible.

6. Area of Green Space to be created or Enhanced (acres or square footage)

7. Proposed Irrigation Systems
Describe the type of irrigation systems (e.g., drip, overhead spray)

8. Project Limitations
Describe any possible project limits such as parking, hours of operation, available staffing, user fees, seasonal restrictions, or other ecological considerations.

9. Sensitive Receptors
Provide a list of sensitive receptors (e.g., schools, day cares, residences) within 1,000 feet of the project

Name of Location	Distance from Project

10. Estimated Timeline for Project Implementation

Provide an estimated timeline for project implementation assuming project is notified of grant approval within 60 working days of submittal of application.

Include preliminary design, environmental documentation, permitting, long-term operations and maintenance commitments, and any other relevant actions as steps in this timeline.

Date	Action

Describe the measures that will be utilized to assure completion of the project within the indicated time.

11. Project Implementation

Identify the key individuals responsible for project implementation and their roles.

Name	Title/Position	Project Role

12. Project Costs

Describe the estimated costs of the project.

Description	Cost
Supplies and Materials	
Labor and Construction	
Contracted Services	
Signs and Interpretive Aids	
Non-Construction Costs	
Contingency Costs	
Other (describe)	
Total Project Cost	

Provide quotes of project costs identified above (submit with application).

13. Funding amount requested:

14. Additional Funding Secured for this Project:

Include source of funding.

CERTIFICATIONS FORM

I have read the Eligibility Criteria and Program Guidelines and I agree to **ALL** the following terms and conditions by **signing below**:

- **I have not purchased, made any payments toward, or began any work, nor will I, until I have an executed contract from the District.**
- I understand that submission of this application does not guarantee incentive funding for the project.
- I am the owner of the land or I have authority from the owner of the land to construct and maintain the Vegetative Barrier/Urban Greening project as described in the project application.
- I agree to maintain the green space for a minimum of 10 years.
- I will make the project site available for inspection if requested by SJVAPCD and/or CARB staff during the ten (10) year contract period.
- I will provide photo documentation upon completion of the project.
- I will provide annual or bi-annual status updates in the form of a photo update or a tree condition report to ensure project maintenance is occurring throughout the grant term.
- I understand it is my responsibility to contact the local County Agricultural Commissioner's Office before obtaining any plant material originating from outside respective county to ensure all the requirements for movement of plant material into respective county are met.
- I understand, where feasible, projects shall provide public access.
- Plant species selected to maximize GHG reductions and minimize ROG (BVOC) and allergenic pollen.
- Project plan incorporates recommendations in the anti-displacement resources provided.
- All property taxes are current at the time of application.
- I understand that I am responsible for obtaining any permits required.
- I have financial capacity to complete, operate, and maintain the project.
- I understand that any funds required from other sources must reasonably be expected to be available in the time frame needed to carry out the project.
- I understand that the final funding amount reimbursed may be less than the maximum incentive amount if the final invoice amount for the eligible costs of the project is less than the maximum incentive amount.
- I understand that the selection of a third party contractor to perform any or all of the project is completely my choice and the District does not endorse, or is not in partnership with any such contractors and shall not be responsible for any disputes arising from the work performed between the applicant and the contractor. The District will not be held liable for any disputes, circumstances or events that occur between the applicant and contractor. Contractors are independent contractors; they are not officers, representatives, agents, servants, employees, partners, associates, or joint ventures of the District.
- Projects funded by District will not be used as marketable emission reduction credits, to offset any emission reduction obligation, or for credit under any federal or state emission averaging, banking

and trading program. In addition, projects funded through this program may not be used to generate a compliance extension or extra credit for determining regulatory compliance.

- Any current financial incentive that directly reduces the project cost, including tax credits or deductions, grants, or other public financial assistance for the same project, must be disclosed to the District.

I hereby certify that all information provided in this application and any attachments are true and correct to the best of my knowledge.

Owner's Signature:	Date:
Print Name:	Title:

APPLICATION PACKET CHECKLIST

When submitting a project for consideration, submit a **complete** application packet. An incomplete application packet will lengthen the application processing time and delay possible incentive funding. A complete application packet includes the following items:

- ❑ Completed **Application**, no fields left blank.
- ❑ Completed **Certifications Form** section, signed by **Applicant.**
- ❑ First page of IRS **Form W-9.**
- ❑ Completed **California Natural Resources Agency (CNRA) Draft Urban Greening Benefits Calculator Tool**
- ❑ Dated and itemized **Quote(s)** for the project costs.

Please return all completed applications to:

1990 East Gettysburg Avenue Fresno, CA 93726-0244

Phone: (559) 230-5800 ■ Fax: (559) 230-6112 ■ Email: grants@valleyair.org

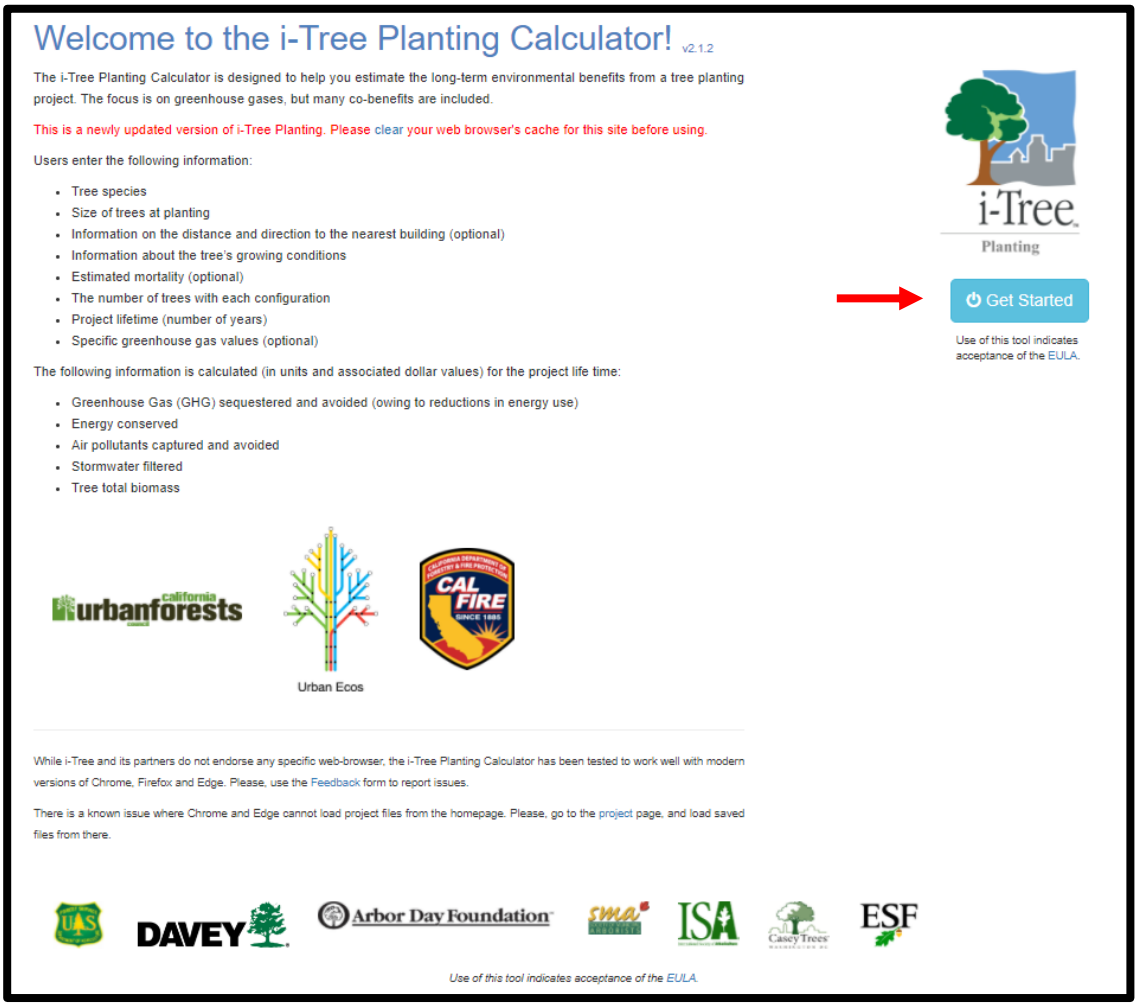
Don't forget to retain a full copy of the completed application for your own records.

For additional assistance, please contact staff in the Strategies and Incentives Department at (559) 230-5800

i-Tree Planting Calculator User Guide

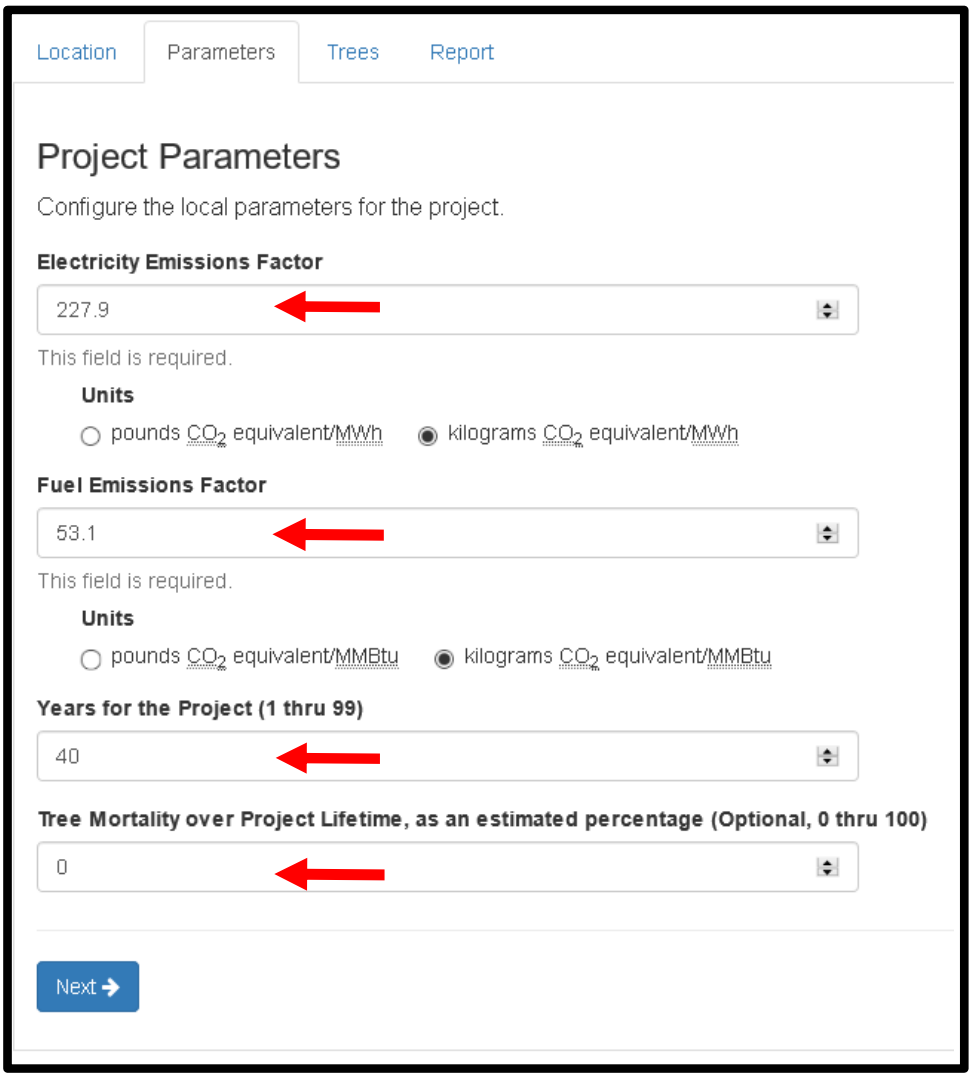
The tool **i-Tree Planting** should be used in order to help estimate the tree carbon storage, energy savings, and pollution reduction due to each group of trees to be planted. This tool can be found at https://planting.itreetools.org/

Step One – Open Tool. Once at the website, click "Get Started" on the right of the screen to access the tool, as shown below:



Step Two – Specify Project Location. Once in the tool, enter the project location (state, county, then city) as prompted from the three dropdown menus. Click next to continue.

Step Three – Specify Project Parameters. On the Project Parameters page, the Electricity Emissions Factor, Fuel Emissions Factor, Years for the Project, and Tree Mortality over Project Lifetime are all adjustable. Per CNRA guidelines, the Electricity Emissions Factor should be 227.9 kg CO2e/ MWH and the Fuel Emissions Factor should be entered as 53.1 kg CO2e/MMBtu. The Years for the Project value should represent the total years of tree growth 40 years from the project start date. For example, for trees planted in the first year of the project, enter "40." For trees planted in the second year, enter "39," and so on. The Urban Greening Benefits Calculator Tool will account for the Tree Mortality over the Project Lifetime, so please enter zero for this field. See the following screenshot for an example of what this page may look like for a project within the San Joaquin Valley:



After making this change, hit next again to progress to the next tab, "Tree Planting Configurations."

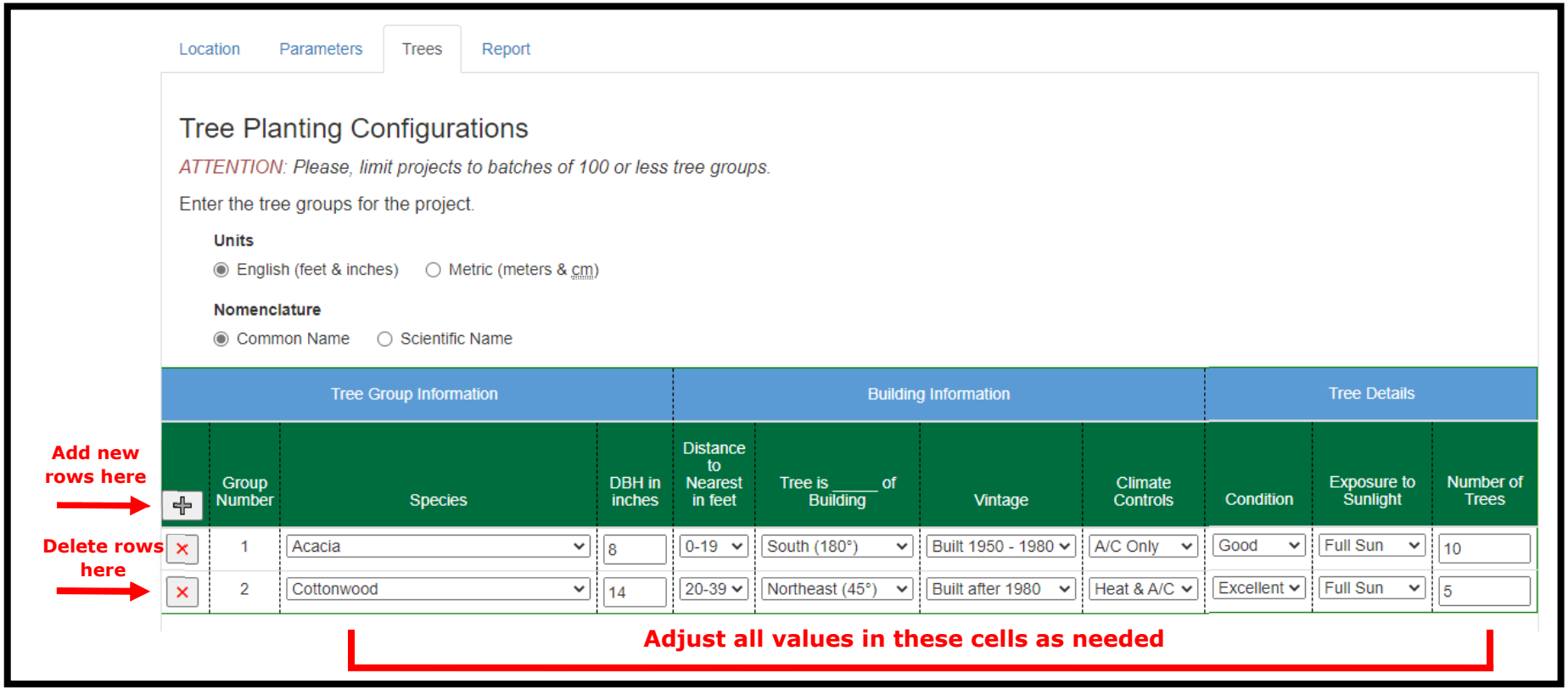
Step Four – Specify Units for Tree Planting Configurations. At the top of the Tree Planting Configurations page, the units can be adjusted between English and Metric, and it can be selected whether the tree species will be listed using their common or scientific names.

Step Five – Enter Tree Planting Configuration Information. After the units and nomenclature items are selected (under Step Four), the following must be entered:

- Tree Group Information
  - Species of tree *(select from dropdown)*
  - Diameter at breast height (DBH) at time of planting
- Building Information
  - Distance to nearest building *(select from dropdown)*
  - Direction from nearest building *(select from dropdown the cardinal direction [e.g., North South, etc.] in which the tree is located when standing at the building)*
  - Age of building *(select from dropdown)*
  - Climate controls within the nearest building *(select from dropdown)*
- Tree Details
  - Tree condition *(select from dropdown)*
  - Exposure to sunlight *(select from dropdown)*
  - Number of trees to be planted

This information must be entered for each different group of trees that will be planted. A new group is required whenever any of the above parameters are different for a set of trees. To add a new group of trees, hit the plus sign at the far left of the table. To remove a group, click the X at the left of the row that needs to be removed.

An example of this completed tab with two groups of trees is shown below:



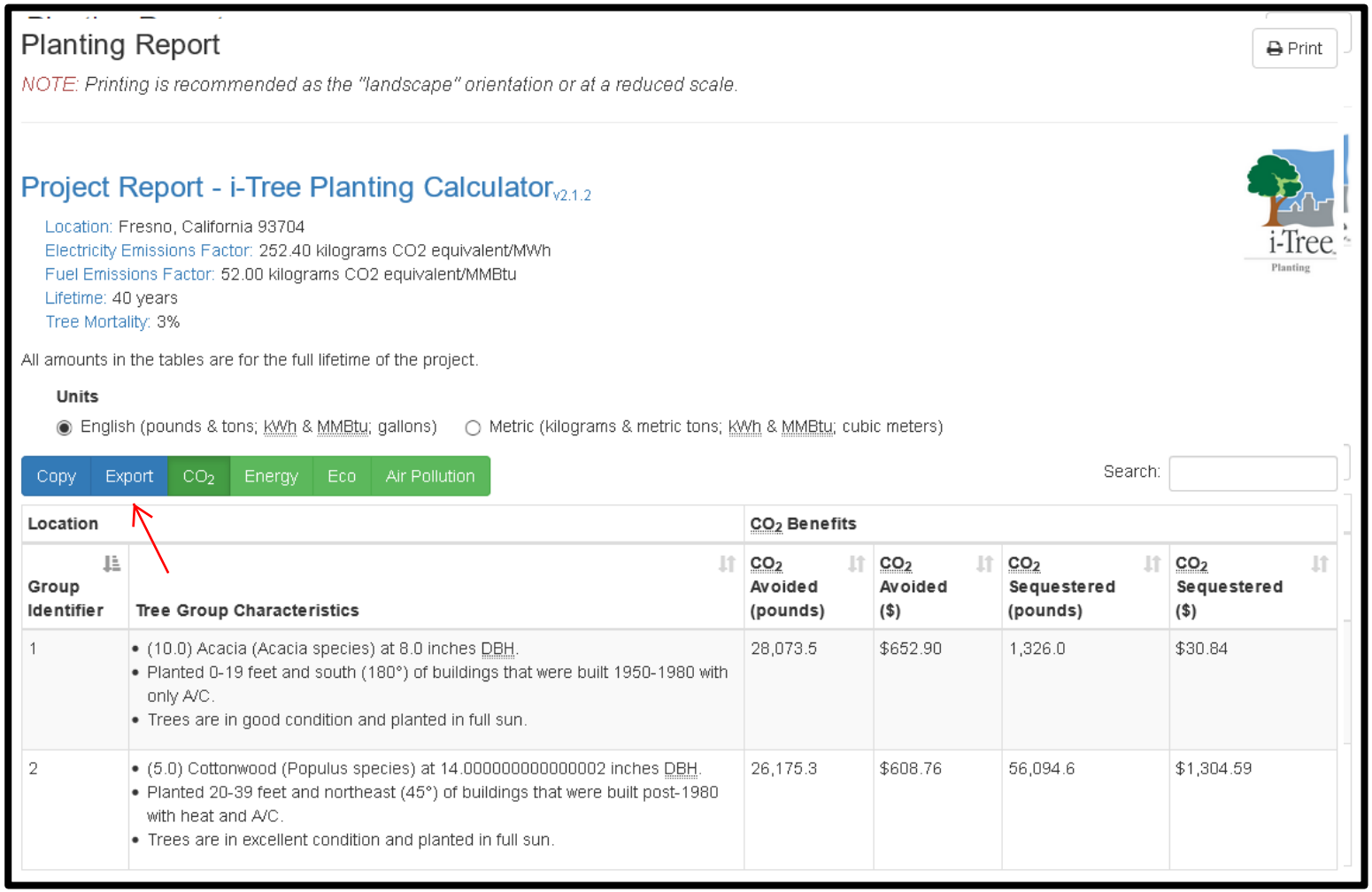
Step Six – Generate Report. After inputting this information, hit next again. This will generate the final report from i-Tree Planting.

The report has four sections within the webtool:

- "CO2" shows the pounds of CO2 avoided and sequestered and the resultant cost savings.
- "Energy" shows the electricity and other fuel savings and resultant cost savings.
- "Eco" shows the total tree biomass, rainfall interception, and the avoided runoff in gallons and resultant cost savings.
- "Air Pollution" shows the total mass of several key air pollutants that was either avoided (via deposition and dispersion) or removed (via absorption) as a result of the project.

In order to see values from all four of these tabs at once, proceed to Step Seven – Export Report.

Step Seven – Export Report.



Planting Report

Print

NOTE: Printing is recommended as the "landscape" orientation or at a reduced scale.

Project Report - i-Tree Planting Calculator v2.1.2

Location: Fresno, California 93704
Electricity Emissions Factor: 252.40 kilograms CO2 equivalent/MWh
Fuel Emissions Factor: 52.00 kilograms CO2 equivalent/MMBtu
Lifetime: 40 years
Tree Mortality: 3%

All amounts in the tables are for the full lifetime of the project.

Units

(•) English (pounds & tons; kWh & MMBtu; gallons) ( ) Metric (kilograms & metric tons; kWh & MMBtu; cubic meters)

Copy | Export | CO_2 | Energy | Eco | Air Pollution

Search:

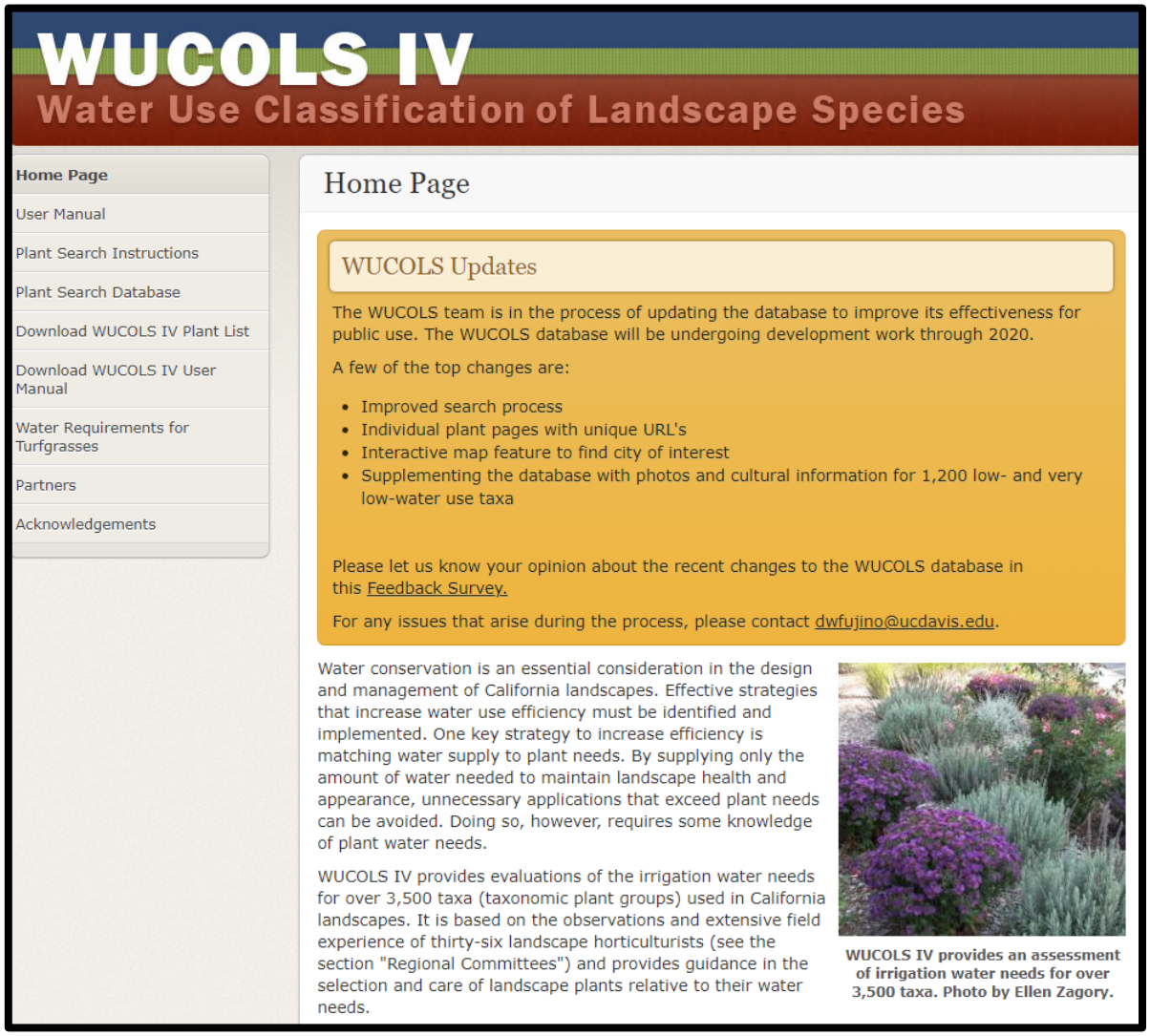
Location		CO_2 Benefits			
Group Identifier	Tree Group Characteristics	CO_2 Avoided (pounds)	CO_2 Avoided ($)	CO_2 Sequestered (pounds)	CO_2 Sequestered ($)
1	• (10.0) Acacia (Acacia species) at 8.0 inches DBH. • Planted 0-19 feet and south (180°) of buildings that were built 1950-1980 with only A/C. • Trees are in good condition and planted in full sun.	28,073.5	$652.90	1,326.0	$30.84
2	• (5.0) Cottonwood (Populus species) at 14.000000000000002 inches DBH. • Planted 20-39 feet and northeast (45°) of buildings that were built post-1980 with heat and A/C. • Trees are in excellent condition and planted in full sun.	26,175.3	$608.76	56,094.6	$1,304.59

Hitting export will generate an Excel spreadsheet with all relevant values included. These values will need to be imported into tab "Tree Planting – ITP" in the CNRA Calculator Tool.

Water Use Classification of Landscape Species (WUCOLS IV) Tool User Guide

The University of California Agriculture and Natural Resources (UC ANR) **WUCOLS** tool should be used in conjunction with the DWR Water Budget Workbook in order to estimate the amount of water and type of irrigation that this project will require. This tool is available here: https://ucanr.edu/sites/WUCOLS.

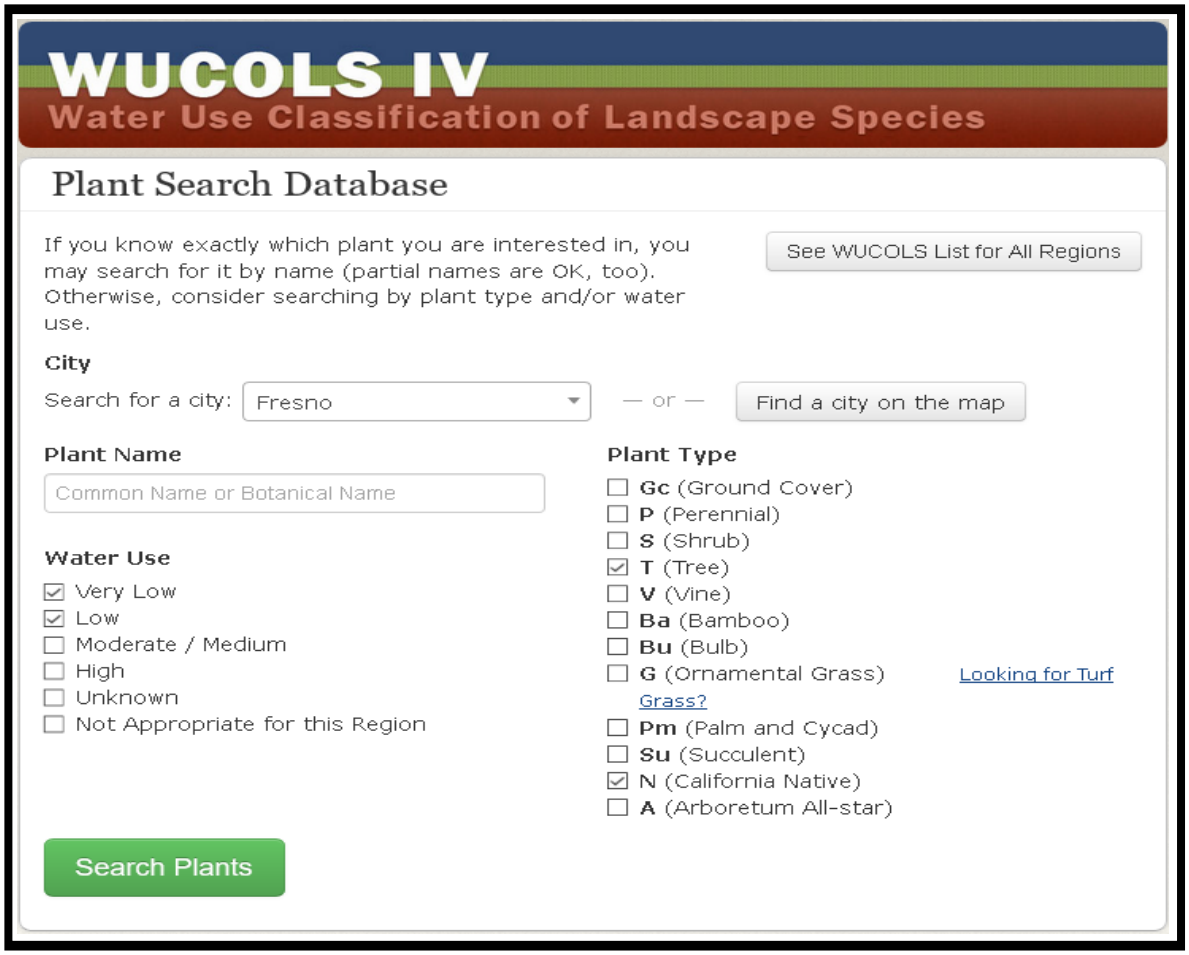
Step One – Open Plant Search Database. From the tool home page, click "Plant Search Database" to enter the tool itself, as shown below:



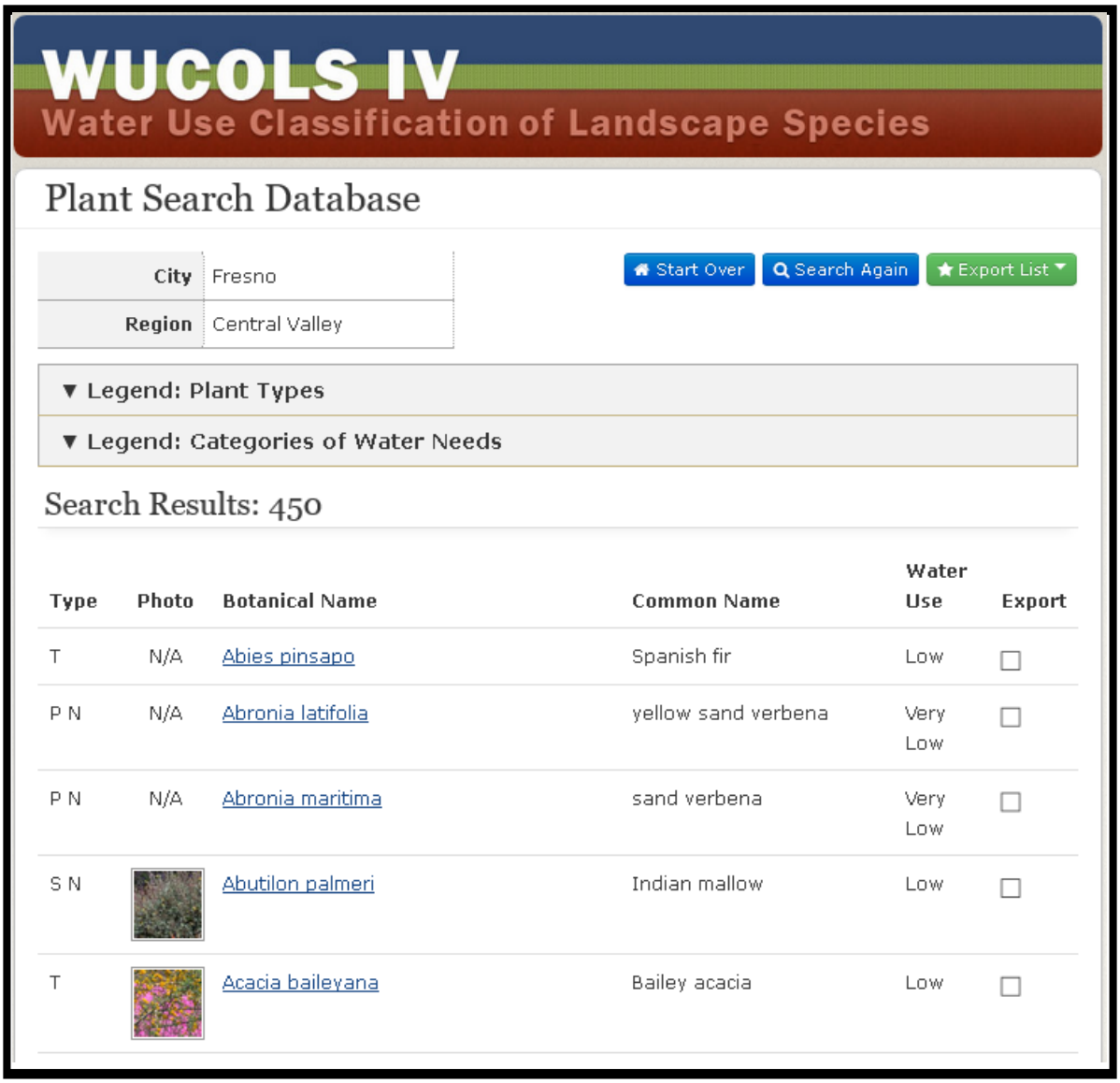
Clicking that link will open the Plant Search Database.

Step Two – Enter City Name. Enter the city in which the proposed project will be located using the drop-down menu or "Find a city on the map" option.

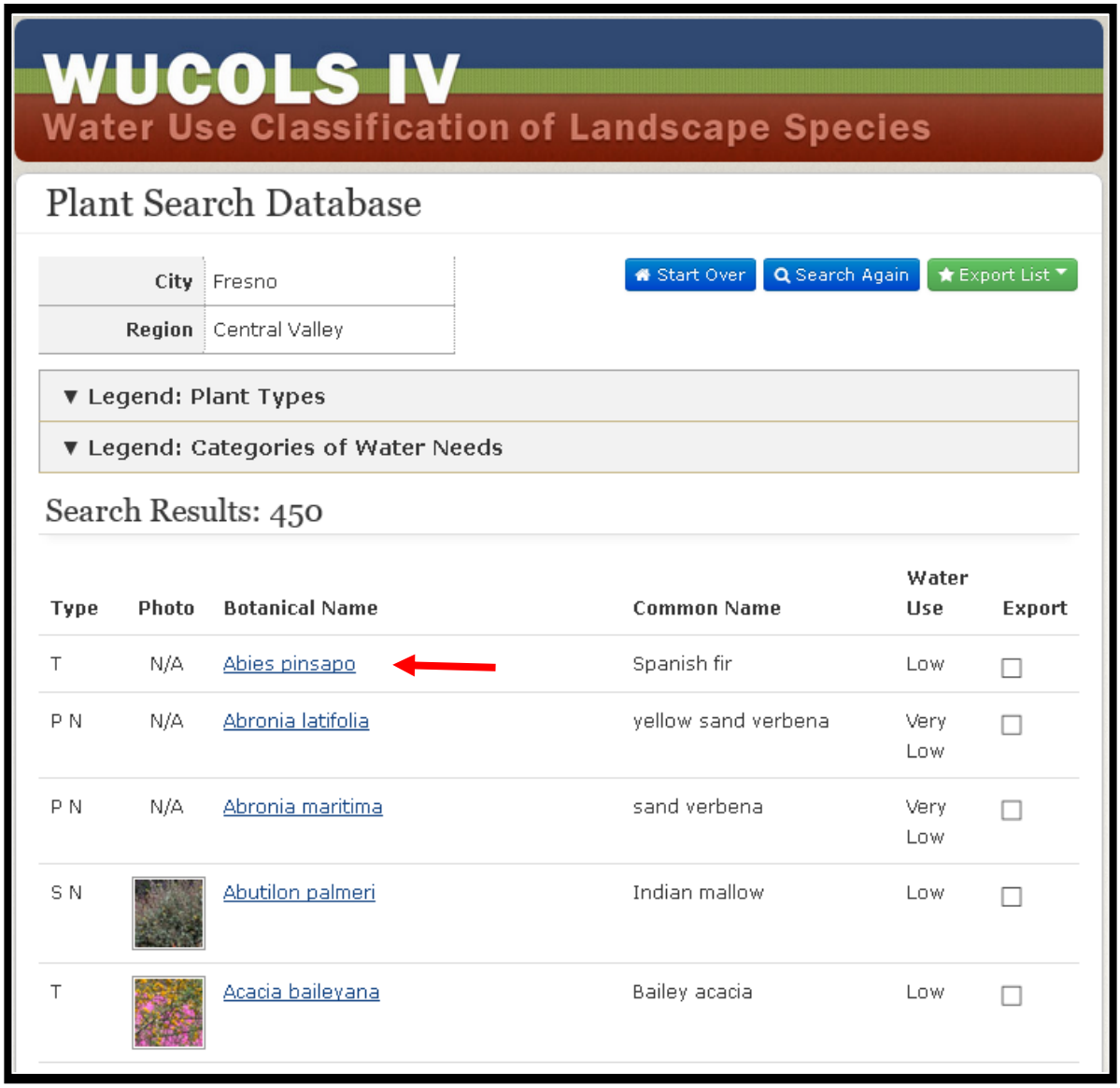
Step Three – Choose Plant Type. Once the city name is entered, there are two options. If the types of plant and greenery for the project have already been determined, use the "Plant Name" search box to choose the specific plants and greenery. If not, then the general Plant Type can be chosen from the list on the right, and the water usage can be chosen from the checklist on the left. In the example below, the user selected California native trees that require very low or low water usage within Calexico:



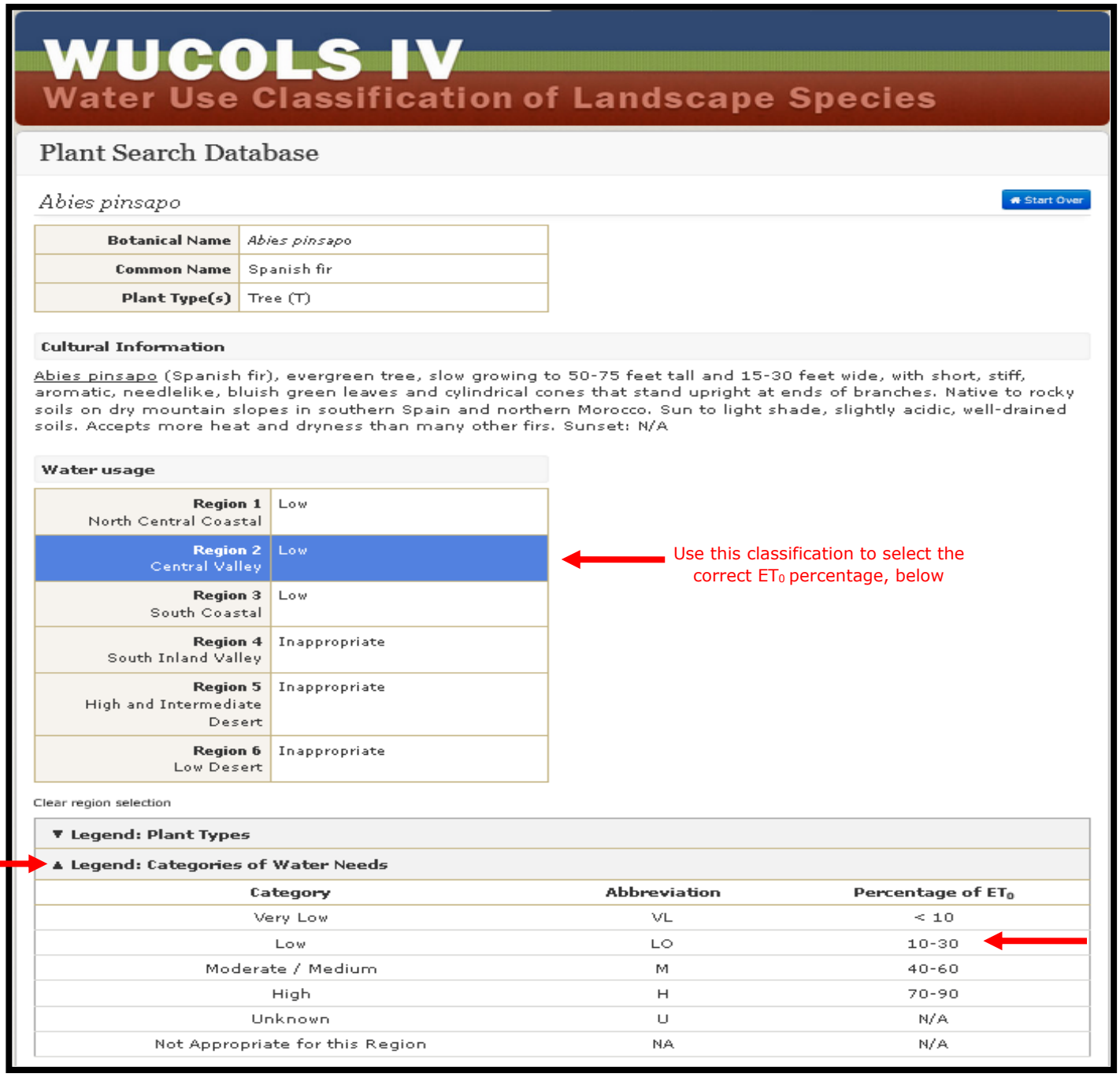
Step Four – Search Plants. After the options have been set, click "Search Plants" on the bottom left of the screen in order to view the results. The top results of the plant type selected in Step Three appear alphabetically as shown on the following page:


WUCOLS IV
Water Use Classification of Landscape Species
Plant Search Database
City Fresno
Region Central Valley
Start Over
Search Again
Export List
▼ Legend: Plant Types
▼ Legend: Categories of Water Needs
Search Results: 450
Type Photo Botanical Name Common Name Water Use Export
T N/A Abies pinsapo Spanish fir Low
P N N/A Abronia latifolia yellow sand verbena Very Low
P N N/A Abronia maritima sand verbena Very Low
S N Abutilon palmeri Indian mallow Low
T Acacia baileyana Bailey acacia Low

Step Five – Choose Plant Type. Once an appropriate plant has been identified, or once the type of plant that has already been chosen for this project is found, click on its name. An example for the first search result, *Abies pinsapo*, is shown below:



Step Six – Obtain Evapotranspiration Rate. On the next page, click on the text "Legend: Categories of Water Needs" in order to display the evapotranspiration rates for the chosen plant. Look for the value that matches the water usage classification for that plant, which should be highlighted in blue. An example for the first search result, *Abies pinsapo*, is shown on the following page:



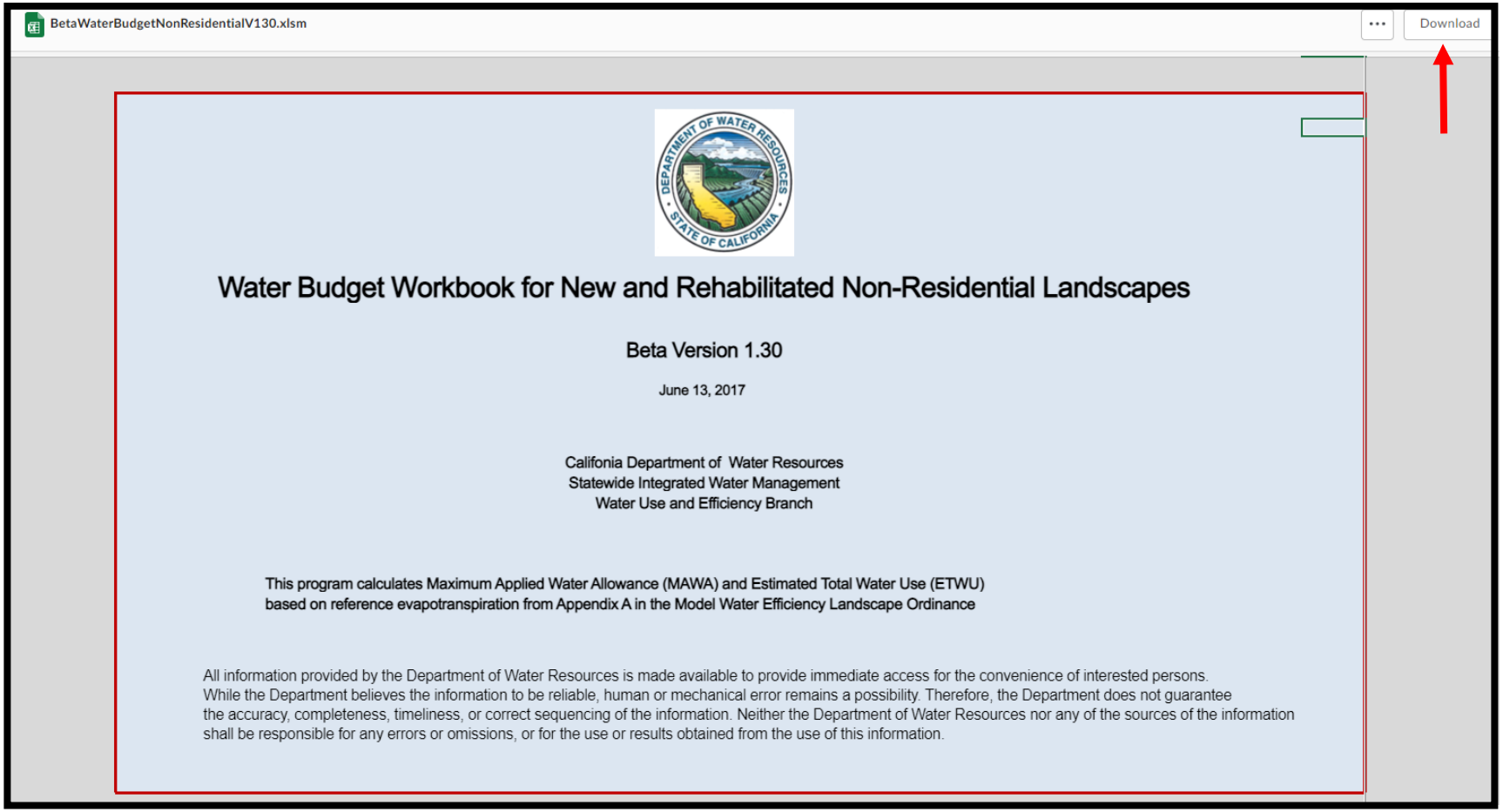
The Evapotranspiration Rate, ET_0, is shown in the "Percentage of ET_0" column. Take note of the average value from the column "Percentage of ET_0," shown above. In this case, the average would be 20%.

The ET_0 value needs to be obtained for all plants that are currently at the proposed project site, as well as all of the species that would be planted as part of the project itself. Once these values have been collected, they can be entered into the next tool, the DWR Water Budget Workbook.

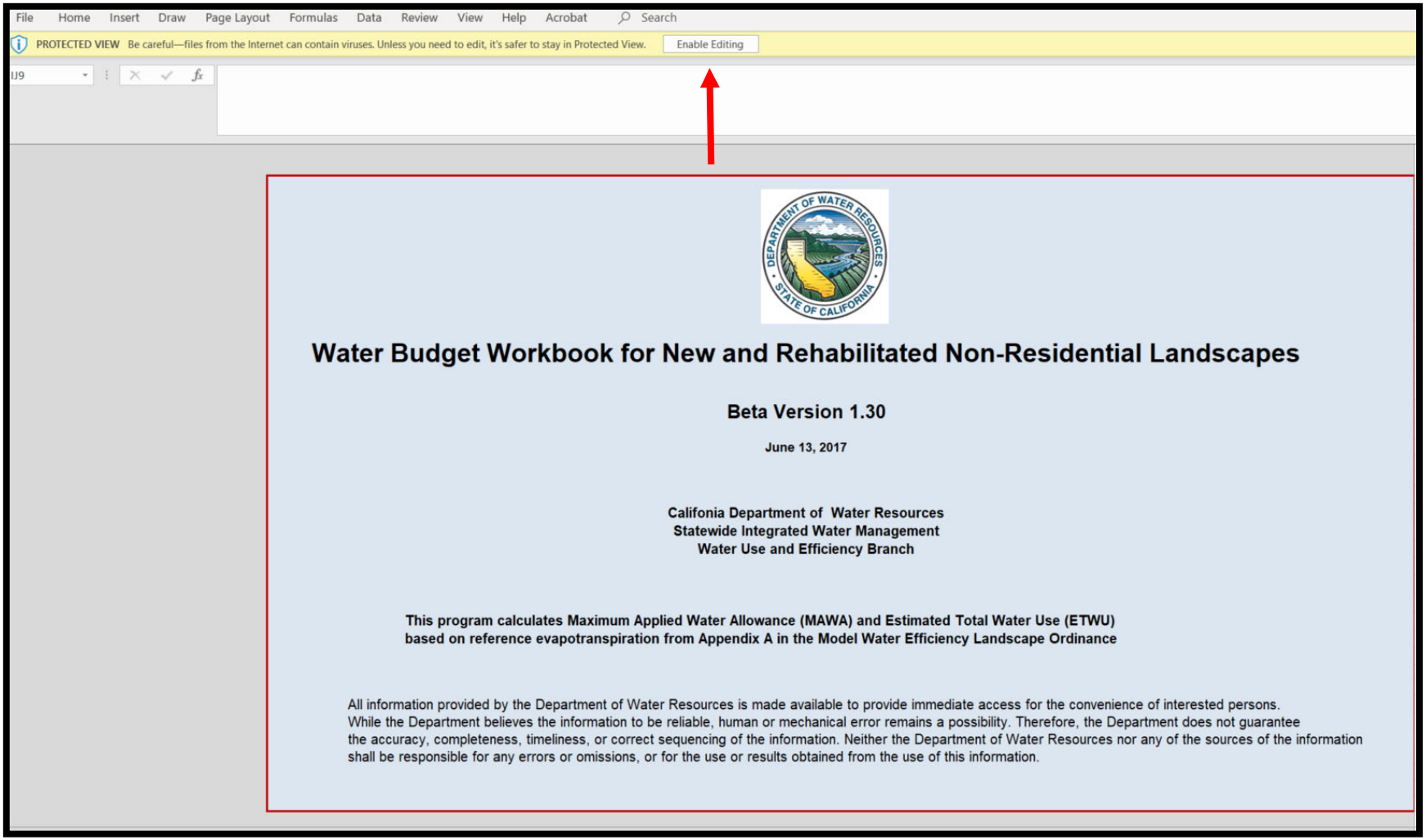
DWR Water Budget Workbook User Guide

After the WUCOLS tool is run, the California Department of Water Resources' Water Budget Workbook for New and Rehabilitated Non-Residential Landscapes **("DWR Water Budget Workbook")** should be used in order to estimate the amount of water and type of irrigation that the proposed project will require. This tool is available for download here: https://cadwr.app.box.com/s/5k39tv10u42rp5bn2uebd7fodkxzgve7.

Step One – Download Tool. Clicking the link above opens an embedded workbook. In order to access the tool in Excel, click "Download" in the top right, as shown below.



Step Two – Enable Workbook. After downloading the spreadsheet, click "Enable Editing" in order to gain access to the spreadsheet.



This tool consists of three main tabs: Maximum Applied Water Allowance (MAWA), Estimated Total Water Use (ETWU), and Special Landscape Area (SLA).

For all proposed projects, this entire workbook must be filled out twice:

- Once using the current landscape characteristics of the proposed project site ("Pre-Project Scenario"), and
- Once accounting for the landscape characteristics after the proposed project is implemented ("Post-Project Scenario").

To do so, it is recommended that the applicant save two copies of the Water Budget workbook: one for the Pre-Project Scenario, and one for the Post-Project Scenario.

Workbook cells highlighted in blue are ones for which data should be entered. Cells highlighted in tan display results and should not be adjusted.

"MAWA" Tab

Steps One through Three should be performed in the blue highlighted cells in the "MAWA" tab. For reference, a screenshot of this tab is provided on the next page. Note that there is additional instruction to the left of the data entry in this tab.

Step Three – Specify Project Location. In the tab "MAWA," first select the city where the proposed project will be located.

Step Four – Specify Project Area. Next, enter square footage of the landscape area that is irrigated via overhead spray, as well as the square footage of landscape area that is irrigated by drip irrigation. Where prompted, also enter the square footage of any special landscape area on the project site. Special landscape area includes recreational area, area permanently and solely dedicated to edible plants, and area irrigated with recycled water.

Step Five – Specify Project Precipitation. If known, enter the annual precipitation at the project site in inches per year. If the annual precipitation is unknown, this cell can be left blank.

Maximum Applied Water Allowance Calculations for New and Rehabilitated Non-Residential Landscapes

Enter value in Pale Blue Cells

Tan Cells Show Results

Messages and Warnings

Click on the blue cell on right to Pick City Name	**Fresno**	**me of City**
ET_o of City from Appendix A	**51.10**	**ET_o** (inches/year)
	23000	Overhead Landscape Area (ft^2)
	27000	Drip Landscape Area (ft^2)
	43000	SLA (ft^2)
Total Landscape Area	**93,000**	
Results:		
$(ET_o) \times (0.62) \times [(0.45 \times LA) + (1.0 - 0.45) \times SLA)]$	**2,075,040**	Gallons
	277,393	Cubic Feet
	2,774	HCF
	6	Acre-feet
	2	Millions of Gallons
MAWA calculation incorporating Effective Precipitation (Optional) **Precipitation (Optional)**		
ET_o of City from Appendix A	**51**	ET_o (inches/year)
Total Landscape Area	**93,000**	LA (ft^2)
Special Landscape Area	**43,000**	SLA (ft^2)
		Total annual precipitiation (inches/year)
Enter Effective Precipitation	**0.00**	Eppt (in/yr)(25% of total annual precipitation)
Results:		
$MAWA = [(ET_o - Eppt) \times (0.62)] \times [(0.45 \times LA) + ((1.0 - 0.45) \times SLA)]$	-	Gallons
	-	Cubic Feet
	-	HCF
	-	Acre-feet
	-	Millions of Gallons

Next, move to tab "ETWU."

"ETWU" Tab

Steps Six through Nine should be performed in the blue highlighted cells in the "ETWU" tab. For reference, a screenshot of this tab is provided on the next page.

Note that after download, the tool will display example data in this sheet, with six hydrozones listed. Delete the irrigation type, plant factor, and hydrozone area columns before starting.

Step Six – Specify Irrigation Type. Fill out the irrigation type (overhead spray or drip) for each hydrozone. A hydrozone is a portion of the landscaped area having plants with similar water needs. If two different types of tree are planted as part of this project, then each type of tree qualifies as its own hydrozone. Additionally, if certain areas of the landscape are irrigated in different ways then those areas would constitute different hydrozones as well. Special Landscape Areas do not need to be entered on this tab.

Step Seven – Specify Area of Each Hydrozone. For each hydrozone, enter the area in square feet in the column labelled "Hydrozone Area Without SLA." The total area entered for all hydrozones on this page should match the total area entered on the "MAWA" tab. Special Landscape Areas do not need to be entered on this tab.

Step Eight – Enter Plant Factors. Next, input the correct plant factor for each hydrozone. This plant factor will be the average evapotranspiration rate (ET_0) that was obtained from the WUCOLS tool. Each type of plant will have its own plant factor, and thus may represent its own hydrozone. Special Landscape Areas do not need to be entered on this tab.

These three items will be input into the columns highlighted in blue, as shown below for a project with six example hydrozones:

Estimated Total Water Use

Equation: ETWU = ET_o x 0.62 x [((PF x HA)/IE) + SLA]; Considering precipitation ETWA = (ETo-Eppt) x 0.62 x [((PF x HA)/IE) +SLA]

Enter values in Pale Blue Cells

Tan Cells Show Results

Messages and Warnings

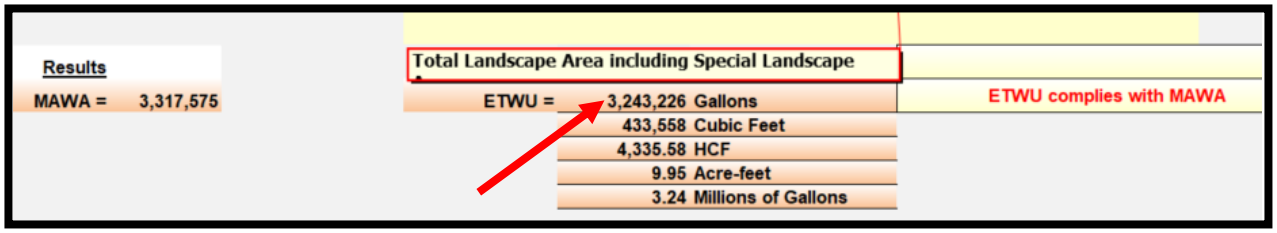
Irrigation Efficiency Default Value for overhead 0.75 and drip 0.81.

Plant Water Use Type	Plant Factor
Very Low	0 - 0.1
Low	0.2 - 0.3
Medium	0.4 - 0.6
High	0.7 - 1.0
SLA	1.0

Hydrozone	Select System From the Dropdown List click on cell below	Plant Water Use Type (s) (low, medium, high)	Plant Factor (PF)	Hydrozone Area (HA) (ft^2) Without SLA	Irrigation Efficiency (IE)	(PF x HA (ft^2))/IE
Zone 1	Overhead Spray	High	0.70	5,000	0.75	4,667
Zone 2	Overhead Spray	Medium	0.50	4,000	0.75	2,667
Zone 3	Overhead Spray	Medium	0.40	3,000	0.75	1,600
Zone 4	Drip	Low	0.30	7,000	0.81	2,593
Zone 5	Drip	Low	0.30	15,000	0.81	5,556
Zone 6	Drip	Low	0.20	16,000	0.81	3,951

Step Nine – View Results. At the bottom of this tab, the workbook will display the estimated total water usage as shown below. Note this value (in gallons) for both the pre- and post-project scenarios, as it will need to be entered into tab "Tree Planting-ITP" of the CNRA calculations workbook.

Projects must comply with MAWA, per California's updated Model Water Efficient Landscape Ordinance (MWELO).1 This workbook will show if a project complies with MAWA as shown in red font in the screenshot below.



Note that the DWR Water Budget Workbook also includes a third tab, "SLA." For purposes of these projects, the inputs on this tab do not affect the project results. Therefore, this tab can be ignored.

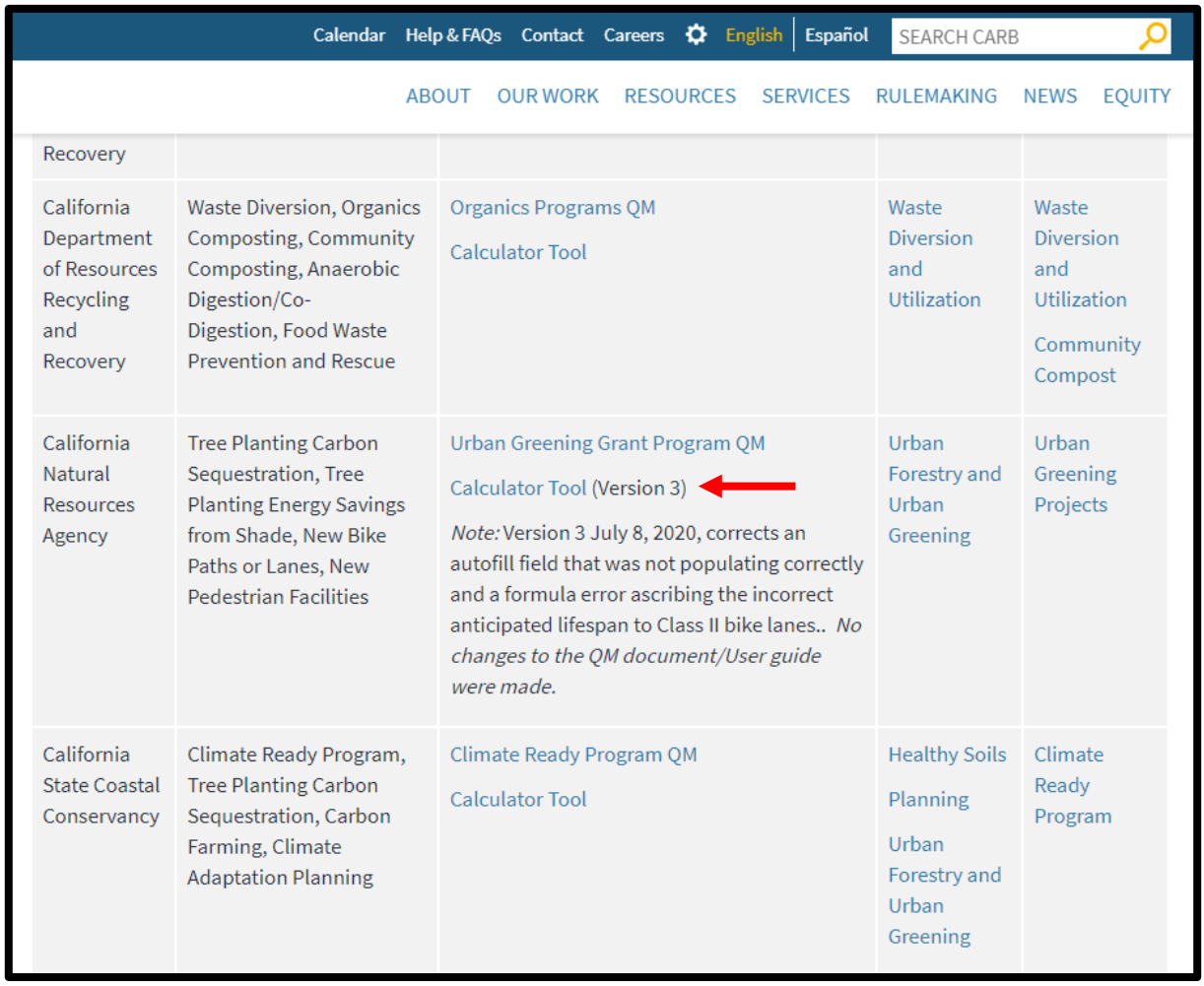
CNRA Benefits Calculator Tool User Guide

After using i-Tree Planting, WUCOLS IV, and the DWR Water Budget Workbook, the California Natural Resources Agency (CNRA) **Benefits Calculator Tool** can be completed for the proposed urban greening project.

To access the tool, visit the following site: https://www.arb.ca.gov/cci-resources.

Step One – Locate Tool. Scroll down to the section labelled "Natural Resources and Waste Diversion," then look for the California Natural Resources Agency's Urban Greening Program.

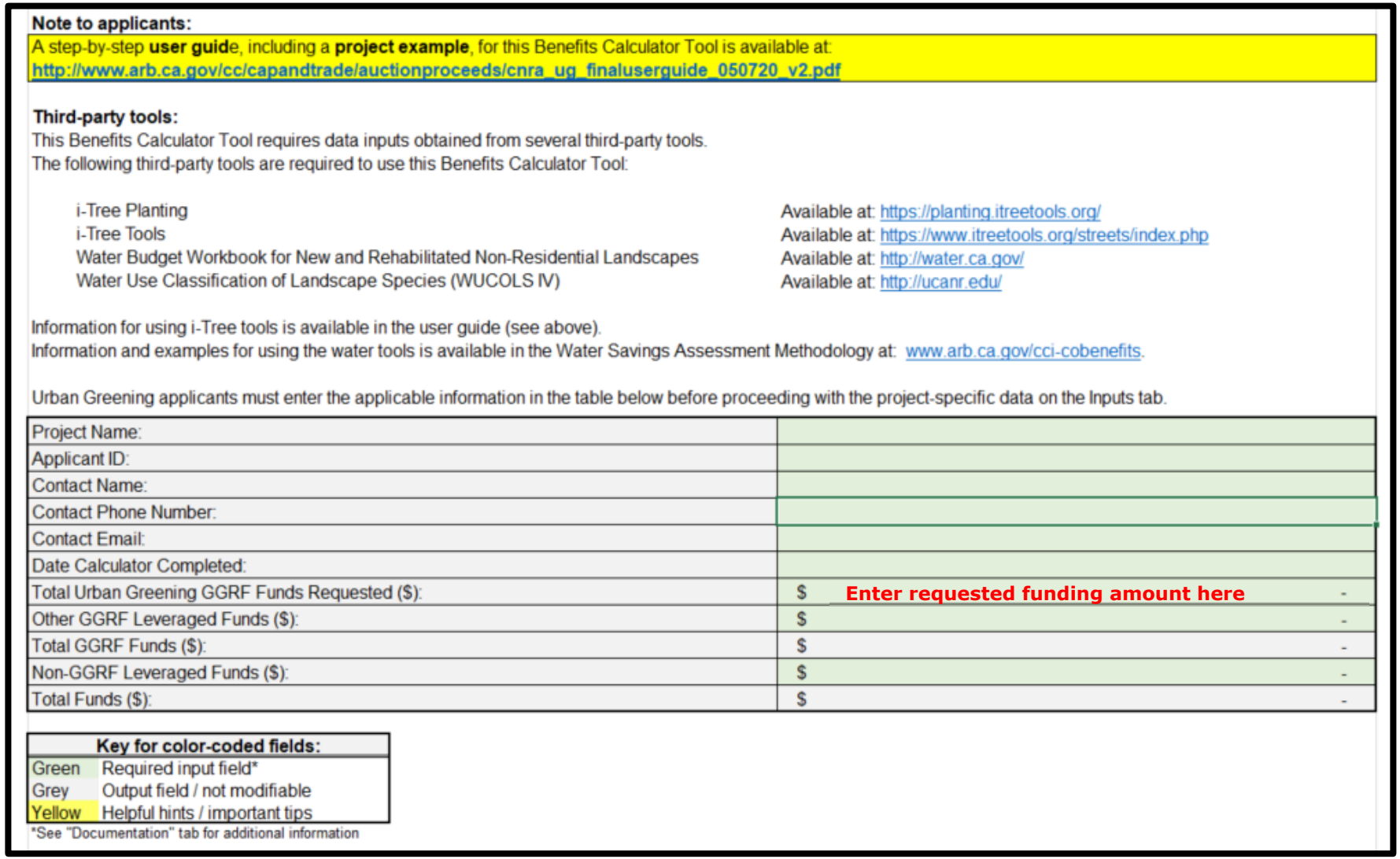
Step Two – Open Tool. Once identified, click the link for "Calculator Tool (Version 3)," as shown below, to open the tool. This will download an Excel file named "cnra_ug_finalcalculator_070820_v3.xlsx". Open the Excel file and click the prompt to "Enable Editing" if necessary.



Step Three – Enter Project Information. Within the Excel file, two main tabs need to be updated manually. The first is labelled "Project Info." This tab requires the applicant to enter the project name, contact information, and the requested funding amount. The items that should be filled out are highlighted in green.

While there are multiple line items set up for funding, the total amount of funding requested under the San Joaquin Valley AB 617 program should be entered in the row labelled "Total Urban Greening GGRF

Funds Requested," as shown below. Unless other funding is available, all other funding rows can be labelled as $0.



Note to applicants:

A step-by-step **user guide**, including a **project example**, for this Benefits Calculator Tool is available at:
http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/cnra_ug_finaluserguide_050720_v2.pdf

Third-party tools:

This Benefits Calculator Tool requires data inputs obtained from several third-party tools.
The following third-party tools are required to use this Benefits Calculator Tool:

i-Tree Planting	Available at: https://planting.itreetools.org/
i-Tree Tools	Available at: https://www.itreetools.org/streets/index.php
Water Budget Workbook for New and Rehabilitated Non-Residential Landscapes	Available at: http://water.ca.gov/
Water Use Classification of Landscape Species (WUCOLS IV)	Available at: http://ucanr.edu/

Information for using i-Tree tools is available in the user guide (see above).
Information and examples for using the water tools is available in the Water Savings Assessment Methodology at: www.arb.ca.gov/cci-cobenefits.

Urban Greening applicants must enter the applicable information in the table below before proceeding with the project-specific data on the Inputs tab.

Project Name:	
Applicant ID:	
Contact Name:	
Contact Phone Number:	
Contact Email:	
Date Calculator Completed:	
Total Urban Greening GGRF Funds Requested ($):	$ **Enter requested funding amount here** -
Other GGRF Leveraged Funds ($):	$ -
Total GGRF Funds ($):	$ -
Non-GGRF Leveraged Funds ($):	$ -
Total Funds ($):	$ -

Key for color-coded fields:	
Green	Required input field*
Grey	Output field / not modifiable
Yellow	Helpful hints / important tips

*See "Documentation" tab for additional information

After the "Project Info" tab has been filled out, go to tab "Tree Planting-ITP." Steps Four and Five should be entered on the "Tree Planting-ITP" tab.

Step Four – Enter Water Usages.

At the top of the "Tree Planting – ITP" tab, there are two rows to enter the estimated annual baseline on-site water use and the estimated annual on-site water use after planting. Here, enter the estimate total water usage (ETWU) from the DWR Water Budget Workbook. Enter the value from the pre-project scenario in row 16, and the value from the post-project scenario in row 17, as shown below:

Estimated Change in Water Irrigation from Planting Trees

Enter data below after using the UCANR Water Use Classification of Landscape Species (WUCOLS IV) and the DWR Water Budget Workbook for New and Rehabilitated Non-Residential Landscapes (Water Budget Workbook).

If Project Involves Additional Irrigation, Estimated Annual Baseline On-site Water Use (gal/yr)	Enter pre-project ETWU from DWR Workbook here →	
If Project Involves Additional Irrigation, Estimated Annual On-Site Water Use After Planting (gal/yr)	Enter post-project ETWU from DWR Workbook here →	
Irrigation Savings Over 40 Year Quantification Period (gal)		0

Step Five – Enter Data from i-Tree Planting. In the second table on the "Tree Plating – ITP" (shown below), enter the results from the i-Tree Planting Report as prompted. Enter the results for each individual group of trees in a separate row. Once all of the green cells below have been populated, this tool will calculate emission reductions as well as water and energy savings at the bottom of the tab.

Tree Planting Benefits

Enter data below after using i-Tree Planting to estimate tree carbon storage, electricity savings, natural gas savings, and co-pollutants removed due to the groups of trees.

Group Identifier	Tree Group Characteristics	Quantity of Trees to be Planted within this Tree Group	Carbon Stored in Tree Group Over the 40 Year Quantification Period (lb CO_2e)	Electricity Savings From Tree Group Over the 40 Year Quantification Period (kWh)	Natural Gas Savings From Tree Group Over the 40 Year Quantification Period (MMBtu)	NO_2 Removed Over the 40 Year Quantification Period (lb)	$PM_{2.5}$ Removed Over the 40 Year Quantification Period (lb)	Rainfall Interception Over the 40 Year Quantification Period (gal)	Avoided Runoff Over the 40 Year Quantification Period (gal)

The data from the i-Tree Planting output file should match the table above as shown below:

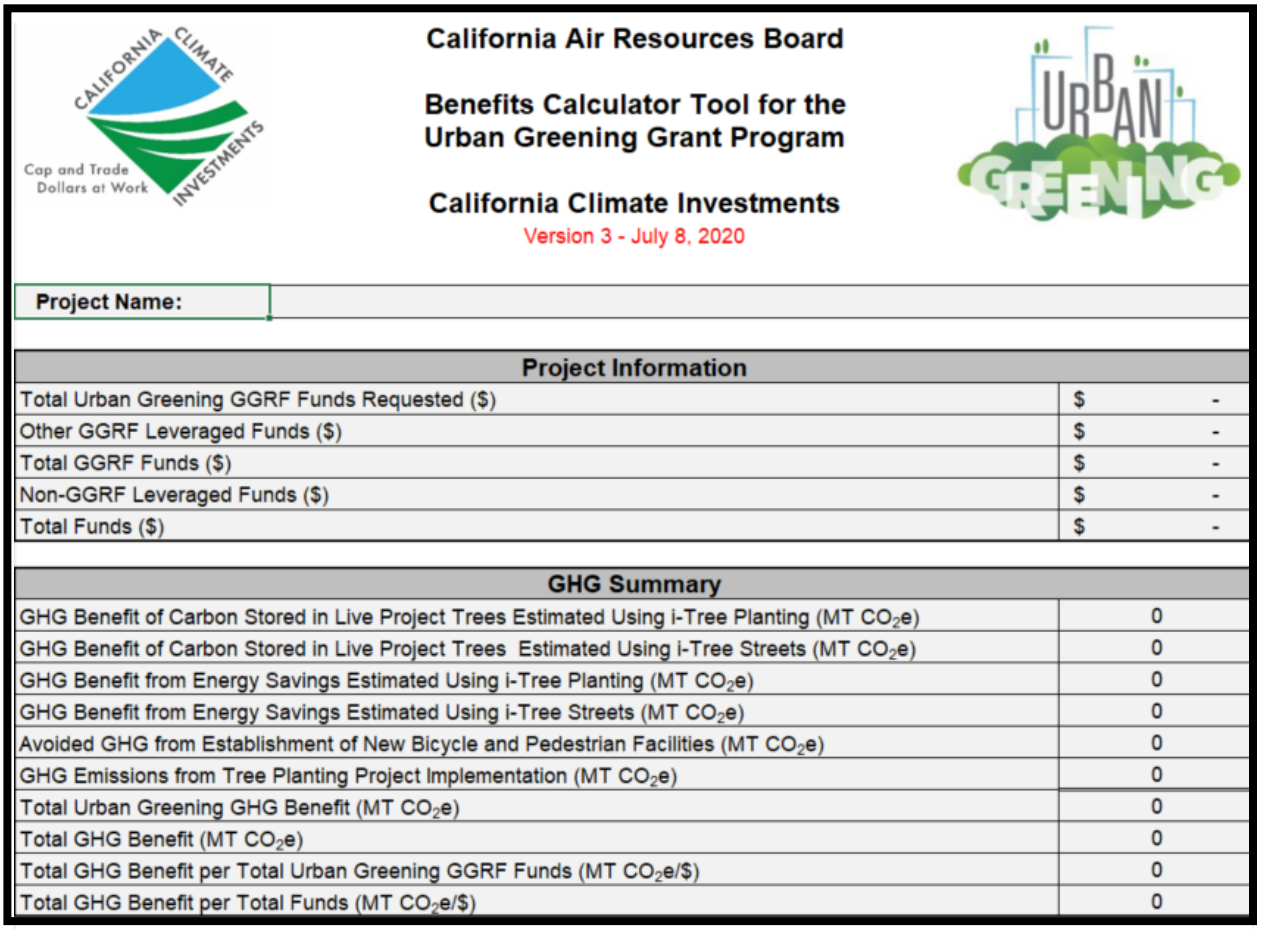
Data Label in Exported i-Tree Planting Report	**Data Label in Tab "Tree Planting – ITP"**
Group Identifier	Group Identifier
Tree Group Characteristics	Tree Group Characteristics
CO_2 Sequestered (pounds)	Carbon Stored in Tree Group over the 40 Year Quantification Period
Electricity Saved (kWh)	Electricity Savings from Tree Group over the 40 Year Quantification Period
Fuel Saved (MMBtu)	Natural Gas Savings from Tree Group over the 40 Year Quantification Period
NO_2 Removed (pounds)	NO_2 Removed Over the 40 Year Quantification Period
$PM_{2.5}$ Removed (pounds)	$PM_{2.5}$ Removed Over the 40 Year Quantification Period
Rainfall Interception (gallons)	Rainfall Interception Over the 40 Year Quantification Period
Avoided Runoff (gallons)	Avoided Runoff Over the 40 Year Quantification Period

The workbook contains two additional data entry tabs highlighted in green. The "Tree Planting-ITS" tab should not be filled out (the "Tree Planting – ITS" tab is designed as an alternative input tab for use with alternative software that is no longer supported).

The "New Bike-Ped Infrastructure" tab is used for estimating benefits from implementation of new bicycle or pedestrian infrastructure. This action was not identified as a requirement in the Vegetative Barrier/Urban Greening Program Plan, so this tab may also be skipped.

Step Six – View Results. Results are viewed on the gray-highlighted tabs, "GHG Summary" and "Co-benefit Summary". The applicant does not need to fill in any information in these tabs. However, the applicant shall attach a copy of these results to the San Joaquin Valley Vegetative Barriers/Urban Greening Project Application form as prompted. Screenshots of these two tabs are shown on the following pages:

Tab "**GHG Summary**:"



California Air Resources Board

Benefits Calculator Tool for the Urban Greening Grant Program

California Climate Investments

Version 3 - July 8, 2020

Project Name:	

Project Information		
Total Urban Greening GGRF Funds Requested ($)	$	-
Other GGRF Leveraged Funds ($)	$	-
Total GGRF Funds ($)	$	-
Non-GGRF Leveraged Funds ($)	$	-
Total Funds ($)	$	-

GHG Summary	
GHG Benefit of Carbon Stored in Live Project Trees Estimated Using i-Tree Planting (MT CO_2e)	0
GHG Benefit of Carbon Stored in Live Project Trees Estimated Using i-Tree Streets (MT CO_2e)	0
GHG Benefit from Energy Savings Estimated Using i-Tree Planting (MT CO_2e)	0
GHG Benefit from Energy Savings Estimated Using i-Tree Streets (MT CO_2e)	0
Avoided GHG from Establishment of New Bicycle and Pedestrian Facilities (MT CO_2e)	0
GHG Emissions from Tree Planting Project Implementation (MT CO_2e)	0
Total Urban Greening GHG Benefit (MT CO_2e)	0
Total GHG Benefit (MT CO_2e)	0
Total GHG Benefit per Total Urban Greening GGRF Funds (MT CO_2e/$)	0
Total GHG Benefit per Total Funds (MT CO_2e/$)	0

Tab "**Co-benefit Summary**:"

Project Name:	
Co-benefits and Key Variables Summary	
Urban Greening GGRF Funds	
Total $PM_{2.5}$ Emission Reductions (lb)	0
Total NOx Emission Reductions (lb)	0
Total ROG Emission Reductions (lb)	0
Total Diesel PM emission reductions (lb)	0
Remote PM2.5 Emission Reductions (lb)	0
Remote NOx Emission Reductions (lb)	0
Remote ROG Emission Reductions (lb)	0
Trees Planted	0
Total Water Savings (gal)	0
Annual Water Savings (acre feet/year)	0
Fossil Fuel Based Energy Use Reductions (kWh)	0
Fossil Fuel Based Energy Use Reductions (therms)	0
Energy and Fuel Cost Savings ($)	$0
Passenger VMT Reductions (miles)	0
Fossil Fuel Based Transportation Fuel Use Reductions (gal)	0
Travel Cost Savings ($)	$0
Total	
Total $PM_{2.5}$ Emission Reductions (lb)	0
Total NOx Emission Reductions (lb)	0
Total ROG Emission Reductions (lb)	0
Total Diesel PM emission reductions (lbs)	0
Remote PM2.5 Emission Reductions (lb)	0
Remote NOx Emission Reductions (lb)	0
Remote ROG Emission Reductions (lb)	0
Trees Planted	0
Total Water Savings (gal)	0
Annual Water Savings (acre feet/year)	0
Fossil Fuel Based Energy Use Reductions (kWh)	0
Fossil Fuel Based Energy Use Reductions (therms)	0
Energy and Fuel Cost Savings ($)	$0
Passenger VMT Reductions (miles)	0
Fossil Fuel Based Transportation Fuel Use Reductions (gal)	0
Travel Cost Savings ($)	$0

EXHIBIT D

Helpful Resources

Applicants are encouraged to review the following resources provided as they prepare their proposals.

Plant Selection Resources

- SelecTree: A Tree Selection Guide
  - https://selectree.calpoly.edu/
- Allergy-Free Gardening Considerations for Asthmatic and Sensitive Residents
  - http://www.allergyfree-gardening.com/
- California Native Plant Society Calscape Tool
  - https://www.calscape.org/
- SMAQMD Landscaping Guidance
  - http://www.airquality.org/LandUseTransportation/Documents/LandscapingGuidanceforImprovingAirQualityNearRoadwaysMay2020V2.pdf#page=21

Anti-Displacement Resources

- Greening without Gentrification Guide
  - https://www.ioes.ucla.edu/wp-content/uploads/Parks-Related-Anti-Displacement-Strategies-report-with-appendix.pdf

Additional Guidelines

- CAL FIRE Standards and Specifications for Purchasing, Planting, and Maintaining Trees, Appendix H
  - https://www.fire.ca.gov/media/9653/cal-fire-ucf-cci-2019-20_grant-guidelines_final.pdf#page=54
- SMAQMD Vegetative Barrier Recommendations
  - http://www.airquality.org/LandUseTransportation/Documents/LandscapingGuidanceforImprovingAirQualityNearRoadwaysMay2020V2.pdf#page=15
- USEPA Recommendations for Constructing Roadside Vegetation Barriers
  - https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NRMRL&dirEntryId=321772&simpleSearch=1&searchAll=Recommendations+for+constructing+roadside+vegetation+barriers+to+improve+near+road+air+quality