Coastal Conservancy

Appendix V.2
Methodology for Calculating GHG Emissions and Reductions

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Introduction

This Appendix provides more detailed guidance to grantees for calculating GHG emissions from projects. Specifically, this Appendix includes additional guidance for addressing elements of Step 3, "Estimating Project GHG Emissions" of the "*Suggested Steps and Actions to Address GHGs Emissions in Projects*" presented in Section I of the Guidance. In particular, the following sections will assist you with:

Step 3A: *Determining the operational emissions boundaries of the project,*

Step 3B: *Determining the scope of various emission types,*

Step 3C: *Estimating emissions from the project,*

Step 3D*: Determining baseline, project, and future emissions scenarios, and*

Step 3E: *Estimating reductions from BMPs.*

Steps 3A and 3B: Emissions Boundaries and Scopes

As described in the *Guidance for Addressing Climate Change*, the first step in estimating GHG emissions from a project is to determine the operational boundaries of the project. This approach is based on the California Climate Action Registry (CCAR) General Reporting Protocol (GRP) and the California Air Resources Board (ARB) Local Government Operations Protocol (LGOP).[1] The LGOP is the standard for estimating emissions resulting from municipal actions in California. Given the similarities between municipal emissions sources and project emissions, this protocol is also referenced in the *Guidance for Addressing Climate Change* and in this Appendix as a standard for project-level emissions inventory protocol.

These protocols also define the convention of categorizing emission sources as Scope 1 (direct), Scope 2 (indirect), and Scope 3. These scope categories provide a framework identifying which project-related emissions sources should be quantified and reduced. For example, a project involving the improvement of public access for a state park including a new visitor center would produce emissions from both its construction and

[1] The LGOP is the standard for estimating emissions resulting from municipal actions, and is referenced in this guidance as the standard project-level emissions inventory protocol. Where applicable, differences between municipal operations and project-level issues are identified.

operations. These emissions sources could include:

- construction equipment used to build any infrastructure (i.e. walkways, parking lots, roads, buildings etc. [direct, Scope 1]),
- lifecycle emissions from building materials (i.e. energy used during the production of building materials [indirect, Scope 3]),
- building operation (i.e. electricity consumption [indirect, Scope 2]),
- maintenance of new infrastructure (i.e. fuel combustion for worker trucks [direct, Scope 1]),
- increased traffic (i.e. gasoline and diesel fuel combustion for visitors' vehicles [indirect, Scope 2]), and
- changes in sequestration rates through land use type conversion (direct, Scope 1).

All Scope 1 and 2 emissions should typically be estimated for this project; Scope 3 emissions should typically be estimated when feasible. Reduction measures should focus on Scope 1 and 2 emissions; measures targeted on Scope 3 emissions should be identified if applicable and feasible.

Step 3C: Estimating GHG Emissions from Projects

Overview of Methodologies

Estimating emissions for each source generally requires a different methodology because of the typical data availability and protocols associated with each emissions source.[2] The following widely accepted protocols provide the majority of methodologies required for calculating emissions from Conservancy projects:

- California Air Resources Board (ARB) Local Governments Operations Protocol (LGOP) (2008). This protocol is the standard for estimating emissions resulting from government buildings and facilities, government fleet vehicles, wastewater treatment and potable water treatment facilities, landfill and composting facilities, and other operations.
- California Climate Action Registry (CCAR) General Reporting Protocol (GRP) (2009). This protocol provides guidance for preparing GHG inventories in California.
- ARB California Greenhouse Gas Inventory Data 1990–2006 (2009a, 2009b, 2009c). ARB's documentation provides background methodology, activity data, protocols, and calculations used for California's statewide inventory.

[2] In the GHG inventory context, *methodology* and *protocol* are defined as follows. A *methodology* is a specific technique for calculating or estimating GHG emissions from a given source. A *protocol* is a collection of principles, approaches, methodologies, and procedures for estimating and reporting GHG emissions from many sources.

- California Energy Commission (CEC) Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004 (2006). This inventory provides useful methodology and emission factors for statewide GHG emissions inventorying.
- U.S. Environmental Protection Agency (USEPA) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007 (2009). This inventory provides useful methodology and emission factors for nationwide GHG emissions inventorying.
- Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (2006). This document is the international standard for inventories and provides much of the baseline methodology used in the national and statewide emission inventories.

Detailed Emission Quantification Guidance

Refer to Table 1 in the *Guidelines for Addressing Climate Change* for each relevant emissions source for Conservancy projects and the recommended model, methodology, or protocol for quantifying the emissions. Methods for calculating emissions from each major source are discussed below.

Construction Emissions

The physical work of the Conservancy's projects can often be broadly classified as construction, as it includes the following: the building or maintenance of trails; the building or improvement of structures such as learning centers; the building or improvement of public access areas such as parking areas and access roads, the removal of dams or other fish barriers in streams; the removal of invasive species; and the restoration of habitat which can include the moving of rock and soil to/from the project area.

Project grantees will usually need to quantify construction emissions only for projects that involve major construction activity. Major construction activity involves processes that are very energy-intensive, such as dredging, grading, extended construction periods (i.e. more than one year), and a large construction equipment fleet (i.e. greater than 10 pieces of construction equipment). For example, a wetland restoration project which requires dredging, grading, soil hauling, and levee demolition over a two-year period would likely need to quantify construction emissions. Most projects with major construction activity will likely be required to quantify emissions as part of the development of an EIR. However, some air districts (such as the BAAQMD), require quantification of construction emissions for all projects that require air permits. Conservancy Staff will work with you to quantify construction emissions as appropriate.

In order to calculate project-specific construction emissions, an inventory of construction equipment and vehicle activity must be developed that identifies the type of equipment used and the equipment hours of operation and vehicle miles traveled. With this detail, the GHG emissions can be calculated using EMFAC (an ARB spreadsheet model that provides on-road emission factors), OFFROAD (an ARB spreadsheet model that provides off-road emission factors), or URBEMIS (if default parameters are changed to reflect project specific conditions). Construction activities may include the use of marine vehicles (i.e. tug boats, dredgers, harbor craft, etc.). GHG emissions from marine vehicles can be quantified using ICF's Port Emissions report, ARB's commercial marine vessels reports, EPA's Commercial Marine Vessels Emissions Data, or EPA's AP-42 emission factor data. If electricity is used for construction, then factors from the CCAR's GRP can be used to determined indirect electricity emissions. This approach is labor intensive and requires that detailed information be provided by the project proponent. In many cases, due to various factors, this detailed data is not always available at the time of analysis.

If project-specific construction equipment, vehicle activity, and other information are not available, GHG emissions can be calculated for the project using models such as URBEMIS or EMFAC and by utilizing each model's default parameters for general construction activity. For example, if the date and duration of construction activity is known, along with the size of the construction site and the general types of construction anticipated to occur (i.e. grading, paving, building construction), URBEMIS will calculate CO_2 emissions based on default equipment fleets. Emissions from other GHGs such as CH_4 and N_2O can be scaled from CO_2 emissions using conversion and emission factors from the CCAR GRP.

Lifecycle Emissions

Lifecycle emissions associated with water supply and conveyance and building materials are described in detail below.

Water Supply and Conveyance
Depending on how water is conveyed to the project, delivery of water can result in indirect emissions that are not included in the electricity demand of the project. The emissions of water delivery include electricity and fuel used for water transportation (such as via pipeline and pumps) and water treatment. Local water purveyors with a completed GHG inventory may have determined average GHG emissions per acre-foot of water delivered. However, some local water purveyors do not include the embodied emissions of water for delivery from other water retailers or state or federal projects. The California Energy Commission (CEC) also has generic factors for water embodied emissions for Northern and Southern California in a broad study of embodied emissions (see *Resources and Tools* below).

Building Materials
Building materials such as concrete, pavement, and steel have greenhouse gas emissions related to their manufacture and transport for their use in construction. There are developing tools for the quantification of the embodied emissions in building materials using life-cycle analysis. Greenhouse gas calculators often have built-in assumptions that may or may not be appropriate to a specific application; these assumptions should be disclosed in any calculations that utilize these applications. In some cases, the calculators require detailed data inputs regarding the types and quantities of the building materials.

If specific information about the project is known, there are various online calculators that can be used to estimate embodied emissions. One of the more detailed is the calculator developed by the ATHENA Institute (along with University of Minnesota and Morrison Hershfield Consulting Engineers). UC Berkeley's Consortium on Green Design and Manufacturing also has a Pavement Life-cycle Assessment Tool (PaLATE) that can analyze greenhouse gas emissions associated with the use of pavement and concrete for roadway projects and allows for comparison of the emissions associated with various building material types. The National Renewable Energy Laboratory (NREL) also maintains the U.S. Life-Cycle Inventory (LCI) database that contains data modules that quantify the material and energy flows into and out of the environment for common unit processes. This database can also be used to analyze the greenhouse gas emissions of building materials.

Operational Emissions

Some projects may involve operational activities or involve changes in land use types, which can affect the carbon stock and sequestration potential of the affected land area. Operational emissions include direct and indirect emissions related to building energy consumption, transportation emissions, waste emissions, and changes in sequestration. Grantees should work to quantify emissions from operation and land use change for all projects that are otherwise required to develop an EIR.

One tool called BGM (BAAQMD GHG Model) was created by the Bay Area Air Quality Management District to estimate GHG emissions from land uses such as from transportation, electricity use, water use, waste disposal, and refrigerants. Using imported land use data from URBEMIS, BGM estimates a project's carbon dioxide equivalent emissions from direct and indirect emission sources. BGM adjusts for state GHG regulations, specifically California's low carbon fuel rules and Pavley regulations, and contains a range of GHG reduction strategies for projects to apply.

Building Energy

Building energy emissions include both direct and indirect greenhouse gas emissions. To calculate direct emissions, determine the estimated on-site combustion of natural gas and other fossil fuels and use emission factors from the CCAR General Reporting Protocol for combustion of each type of fuel. An alternative approach is to use URBEMIS, which calculates natural gas building emissions from land use projects and area sources (such as emissions from lawn care and maintenance).

To calculate indirect emissions, determine the on-site electricity consumption and use emission factors from the CCAR GRP for electricity consumption for the region. The GRP provides average factors for USEPA's Emissions & Generation Resource Integrated Database (eGRID) subregions. An alternative and more precise method is to obtain the average emissions factors from the provider of electricity to the project (i.e., public utility, on-site generation, or other source such as local cogeneration) and then to apply these factors to the on-site electricity consumption. Many electricity providers report an electricity delivery metric under the California Registry's Power/Utility Protocol available on the California Registry website. At present, URBEMIS does not calculate electricity emissions, but the model is being updated to provide this calculation in the next version.

Transportation

URBEMIS can be used to calculate carbon dioxide emissions associated with the project's transportation activities. URBEMIS uses default trip generation factors from the Institute of Transportation Engineers, but these factors can be adjusted to reflect site-specific details. URBEMIS also uses default trip lengths, though these may or may not be adequate to capture the full length of project-related trips. Important steps for running URBEMIS are as follows:

1. Without a traffic study prepared for the project, the user should consult with the local air district for direction on which default options should be used in the modeling exercise. Some air districts have recommendations in their CEQA guidelines.[3]
2. If a traffic study was prepared specifically for the project, the following information must be provided:
    a. Total number of average daily vehicle trips or trip-generation rates by land use type per number of units; and,
    b. Average VMT per residential and nonresidential trip.
    c. The user overwrites the "Trip Rate (per day)" fields for each land use in URBEMIS such that the resultant "Total Trips" and the "Total VMT" match the number of total trips and total VMT contained in the traffic study.
    d. Overwrite "Trip Length" fields for residential and nonresidential trips in URBEMIS with the project-specific lengths obtained from the traffic study.
3. Calculate results and obtain the CO_2 emissions from the URBEMIS output file.

Changes in Land Cover/Vegetation

Changes in Sequestration Rates
The U.S Forest Service has a Tree Carbon Calculator that is approved by the Climate Action Reserve's Urban Forest Project Reporting Protocol for quantifying carbon dioxide sequestration from GHG tree planting projects. The model is programmed in an Excel spreadsheet and provides carbon-related information for a single tree located in one of six California climate zones. The State of the Carbon Cycle Report (SOCCR) is funded by the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF) and includes literature-based summaries of the sequestration values of different types of land covers.

If the project removes trees (or plants trees) or removes or restores natural land covers (like woodland or grassland), use the tools and research sources discussed above (along

[3] Air districts post these recommendations on their websites. For coastal areas, there are no adopted air district guidelines with thresholds for GHGs. The Bay Area AQMD has adopted a land use project GHG threshold. The South Coast AQMD has adopted a threshold for stationary sources that is unlikely to apply to Conservancy projects. SCAQMD is considering a project GHG threshold for residential, commercial, and mixed use projects but has not proposed anything yet that might be relevant to coastal projects in the SCAQMD area.

with other research sources as applicable) to approximate the value of lost or gained carbon sequestration. The Conservancy is assisting in developing a separate protocol for quantifying sequestration from wetland restoration projects. Once completed, this protocol should be consulted when estimating sequestration.

Changes in Land-Use Practices
Projects which impact the sequestration rates of land may also affect other emissions already occurring (the baseline scenario). For example, to determine emissions from a project which involves restoration of land currently being used for agriculture, perform the following tasks: 1) calculate emissions from current agricultural practices (such as fuel combustion for machinery, methane from animal digestion and manure, or nitrogen from fertilizer application)[4]; 2) calculate emissions from project operation; and 3) subtract emissions determined in step 1 from emissions determined in step 2. The difference may be negative if the emissions resulting from project operation are less than the emissions resulting from current operations (in the absence of the project).

Emissions Calculation Resources and Tools

The following resources and tools can be used to estimate GHG emissions from Conservancy projects. This list includes the models, tools, and calculators described above, as well as other government and agency resources such as guidance documents for estimating emissions.

ATHENA Institute in association with the University of Minnesota and Morrison Hershfield Consulting Engineers. ATHENA® EcoCalculator for Assemblies. Lifecycle tool for building materials. http://www.athenasmi.org/tools/ecoCalculator/

Bay Area Air Quality Management District. Greenhouse Gas Model. http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx

California Air Resources Board, California Climate Action Registry, ICLEI – Local Governments for Sustainability and The Climate Registry. Local Government Operations Protocol for the quantification and reporting of greenhouse gas emissions inventories. http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

California Air Resources Board. Commercial Marine Vessels. http://www.arb.ca.gov/ports/marinevess/marinevess.htm

California Climate Action Registry. General Reporting Protocol. Public Reports for Reporting Entities.

[4] ARB's California GHG Inventory (ARB 2009a, 2009b, 2009c) and IPCC's Guidelines for National Greenhouse Gas Inventories (IPCC 2006) provide methodology and protocols for estimating agricultural-related emissions.

http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Energy Commission. Refining Estimates of Water-Related Energy use in California.
http://www.energy.ca.gov/pier/project_reports/CEC-500-2006-118.html

Cool California. Local Government and Small Business Toolkits. Carbon Calculators. Case Studies
http://www.coolcalifornia.org/

EMFAC. Model for onroad mobile emissions sources from the California Air Resources Board.
http://www.arb.ca.gov/msei/onroad/latest_version.htm

Greenpoint Rated Calculator. Calculator for determining reductions in emissions for green point rated buildings compared to average buildings.
http://www.stopwaste.org/docs/calculator_report-spring_09_update.pdf

ICF International. Prepared for U.S. Environmental Protection Agency. Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories.
http://www.epa.gov/sectors/sectorinfo/sectorprofiles/ports/ports-emission-inv-april09.pdf

Intergovernmental Panel on Climate Change. Guidelines for National Greenhouse Gas Inventories.
http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

OFFROAD. Model for factors for offroad equipment from the California Air Resources Board.
http://www.arb.ca.gov/msei/offroad/offroad.htm

National Renewable Energy Laboratory. Life cycle inventory database.
http://www.nrel.gov/lci/database/default.asp

State of the Carbon Cycle Report. Research summary of sequestration values of different landcovers.
http://cdiac.ornl.gov/SOCCR

U.S. Environmental Protection Agency. Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data.
http://www.epa.gov/oms/models/nonrdmdl/c-marine/r00002.pdf

U.S. Environmental Protection Agency. Emissions Factors & AP 42.
http://www.epa.gov/ttn/chief/ap42/index.html

U.S. Forest Service. The Center for Urban Forest Research Tree Carbon Calculator (CTCC) – calculator for determining carbon sequestration in trees.
http://www.fs.fed.us/ccrc/topics/urban-forests/

URBEMIS. Spreadsheet based public domain software for calculation criteria pollutant and carbon dioxide emissions from land use projects. http://www.urbemis.com

UC Berkeley Consortium on Green Design and Manufacturing. Pavement Life-cycle Assessment Tool for Environmental and Economic Effects**.** http://www.ce.berkeley.edu/~horvath/palate.html

Step 3D: Baseline, Project, and Future Emissions Scenarios

Determining baseline and project emissions scenarios for each project is required under CEQA. It is also useful to identify the future emissions scenario for each project, as this scenario can serve as a "business-as-usual" (BAU)[5] scenario, against which reduction measures can be evaluated.

The *baseline scenario* is normally defined as the "existing conditions" at project approval. Existing conditions represent the GHG emissions associated with the existing, on-the-ground conditions within the project area. The baseline is a reference point from which to measure GHG emissions increases or decreases over time as a result of project implementation. While it can be similar, the baseline is different than the no-project scenario in that it doesn't evolve with time. The no-project scenario illustrates "business-as-usual" conditions into the future, in which the project's implementation would not occur.[6]

The *project scenario* represents all GHG emissions associated with "full-buildout" of the project, once construction is complete. For Conservancy projects, the project scenario may include construction and operational emissions, as applicable.[7] Project scenarios are generally categorized by year; however, since construction will often occur over multiple years at varying intensities, it is recommended that the project scenario include the total construction emissions over the lifetime of the project's construction (for projects quantifying construction emissions).

The project scenario will include operational emissions during the year that best represents the standard emissions profile of the project, which is generally the first year of full operation or the "full-buildout" year (once all construction activities have ceased). For example, a project whose construction lasts from 2010 to 2011 and becomes fully operational in 2012 would choose 2012 for its project scenario. The project scenario can also be used to estimate GHG reductions from BMPs and other reduction measures.

The *future scenario* is the emissions profile of a project at some future date (such as 2020). The future scenario will depend on whether project operational emissions are anticipated to change after the full-buildout year. For example, once a wetland

[5] "Business as usual" (abbreviated BAU) is defined as current practices in construction, building materials, building energy, transportation, waste, water, and other sectors without consideration of the implementation of future regulations and requirements that may reduce GHG emissions. BAU is usually defined in terms of practices as they exist in a benchmark year. When determining reductions compared to BAU, it is important to establish a benchmark year to define "current practices."
[6] The no-project scenario is not normally considered the baseline scenario under CEQA.
[7] Lifecycle emissions may be included in one or both of these categories.

restoration project is fully implemented, the restored wetland will continue to develop and mature over time. This will affect the GHG flux from the wetland long after the project itself has been implemented. Projects such as this may actually result in net emission sinks by increasing the sequestration potential of impacted land types or by preserving existing sequestration that would otherwise be removed through development or other actions in the absence of the project.

The future emissions estimate should be selected for a specific out-date, such as 2020. The future scenario does not assume the implementation of any federal, state, or local reduction measures (if applicable), but projects the future emissions based on current energy and carbon intensity in the existing economy.[8] Not all projects will have future emissions scenarios. The following list provides examples of emission scenarios for a selection of project types.

Conservancy projects *likely* to result in future scenarios:

- protection and enhancement of coastal and ocean habitats (potential for changing natural emissions flux);
- protection and enhancement of wetlands, rivers, and watersheds (potential for changing natural emissions flux);
- education, interpretation and outreach (may involve operational emissions);
- scientific research (may involve operational emissions); and
- acquisition of open space and agricultural lands (if acquisition represents avoided land conversion[9]).

Conservancy projects *not likely* to result in future scenarios:

- public access development or improvement (where minimal operational emissions but may reduce existing emissions in cases of trail gap closure where trail use would offset existing vehicle trips);
- protection, restoration, and enhancement of biological diversity (where this will not change natural emissions flux); and
- acquisition of open space and agricultural lands (if acquisition does not represent avoided land conversion).

In general, the project and future scenarios will be the same if there is no anticipated change in project-related activity, energy consumption, or natural emissions and sequestration between the project year and the future year. If the Conservancy or project applicant expects a change in energy consumption (or other emission-generating activities) between the project year and the future year, the future scenario will be a projection of the project emissions estimate based on the anticipated change in

[8] The future and baseline scenarios should not be confused with the AB32 "business-as-usual" (BAU) scenario, which is commonly used for local, regional, or statewide GHG inventories. For Conservancy projects, the BAU scenario would often be the no-project scenario, as defined by CEQA. BAU is not applicable in the context of this appendix.

[9] In this context, avoided land conversion refers to the protection of a natural land resource that effectively *avoids* the future land-use conversion that would result in GHG emissions. In these cases the future scenario would reflect the elevated emissions level that *would* have occurred without the project, in many cases showing a net sequestration benefit to the project.

emissions. As mentioned above, the future scenario *should not* incorporate any anticipated GHG emissions reductions from federal, state, or project measures. These measures are estimated separately to demonstrate the reductions anticipated to be achieved through their implementation.

Figures V.2-1through V.2-4 below illustrate the emission scenarios for four theoretical situations.

Figure V.2-1. Visitor center: construction and operational emissions. This project involves major construction activities that cease at full-buildout of a visitor center, and operational emissions that begin once the visitor center is open (i.e., at full-buildout). The project construction and operational emissions exceed the baseline and no-project emissions.

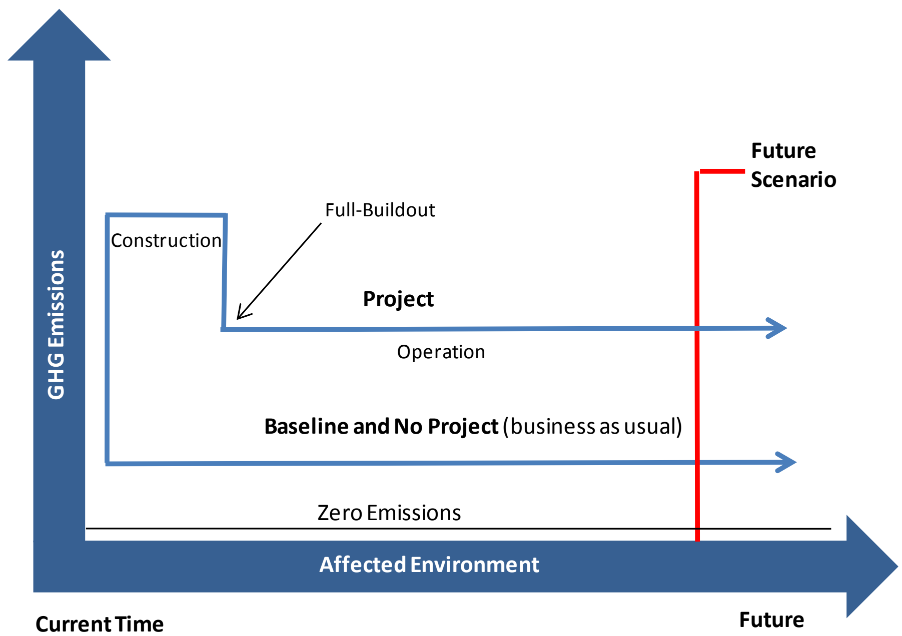


Figure V.2-2. Freshwater wetland restoration project: no construction emissions and increasing methane emissions. This project involves minimal construction activities (which are not quantified) at an existing wetland site that currently has net-positive GHG emissions. The project results in additional restored freshwater wetland that emits methane at a greater rate than before. As the wetland matures, the rate of methane emissions increases faster than the no-project scenario. The project would increase emissions compared to both the baseline and the no-project scenarios. This scenario assumes that the net GHG effect of increased methane emissions is greater than the increased sequestration of carbon dioxide (this balance is the subject of much research and can vary significantly between different types of wetlands).

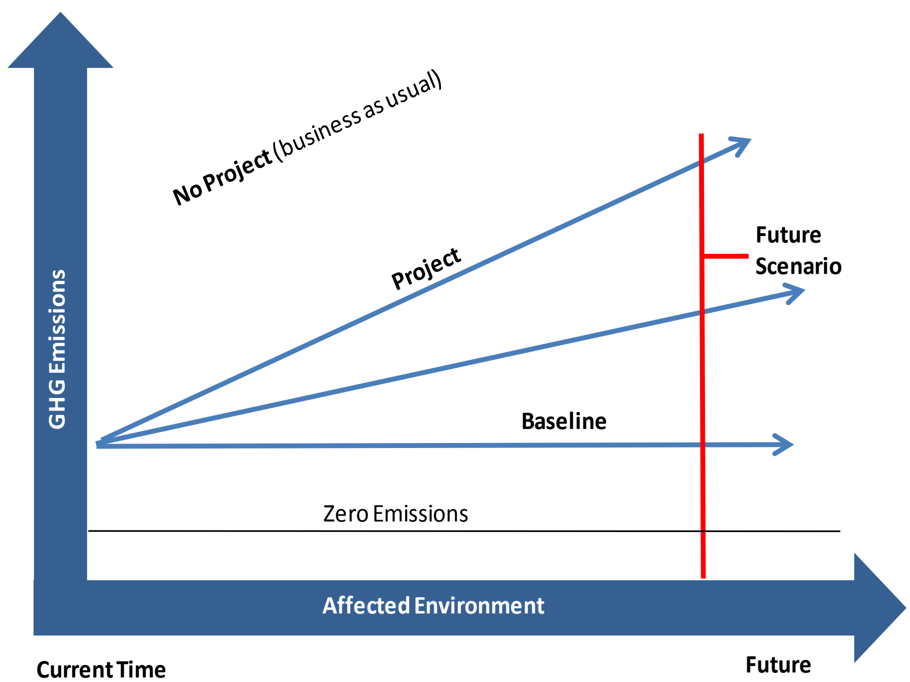


Figure V.2-3. Salt marsh restoration project: construction emissions and increasing sequestration rate. This project involves major construction activities at a wetland site that currently sequesters a moderate amount of carbon. The project results in a restored and expanded salt marsh which sequesters carbon at a greater rate than before. As the marsh matures, the rate of carbon sequestration increases faster than the no-project scenario. The project would increase emissions in the short term over the baseline (from construction), but would increase the sequestration rate over time, resulting in lower emissions compared to the baseline and no-project scenarios in the future. This scenario assumes that methane emissions from the restored wetland are more than offset by the increased carbon sequestration.

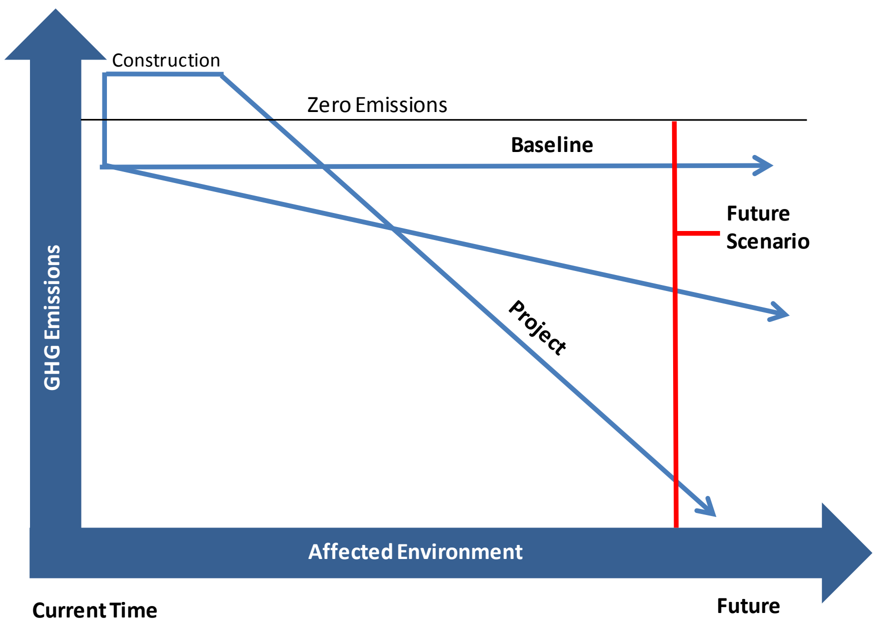
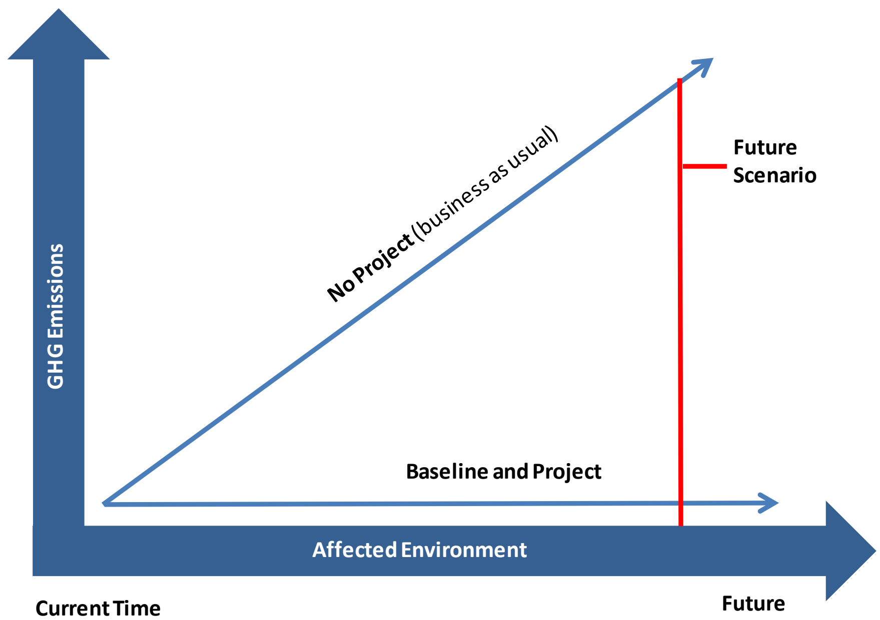


Figure V.2-4. Avoided conversion project (land conservation). This project involves no construction activities and preserves natural land from imminent development, which would normally result in both construction and operational emissions (here only operational emissions are depicted). The project would prevent emissions from land conversion occurring in the no-project scenario (i.e. preserve current conditions at the baseline level).



Step 3E: Quantify GHG reductions from BMPs

The most effective reduction strategy is to target reduction opportunities associated with the project's largest emission sources. For example, a restoration project may produce a majority of its emissions from operation of construction equipment. Opportunities for reducing these emissions may include using alternative-fueled equipment and local building materials and recycling construction and demolition waste. As another example, a public access project may produce a majority of emissions from increased visitor traffic. The opportunities for reducing these emissions may include activities to increase the potential for visitor use of alternative modes of transportation, such as incorporating public transit access, providing shuttle service, or including bicycle parking and preferred parking for alternative-fuel vehicles. The Conservancy's *Best Management Practices* document (Appendix V.1) includes specific emissions reduction opportunities for each of these categories, as applicable to Conservancy projects.

As shown above in Figure V.2-3, some projects may actually result in net emission sinks by increasing the sequestration potential of impacted land types or by preserving existing sequestration that would otherwise be removed through imminent development or other actions in the absence of the project. In these cases, there may be opportunities to maximize the sequestration benefits of the project to maximize the associated emissions sink.

Methods for estimating changes in the GHG flux of land due to natural processes, including carbon sequestration and methane emissions from wetlands, are constantly improving. Carbon cycling, CH_4 production, and nitrogen cycling vary substantially for different ecosystems and land types at different times of the year, and highly site-specific chemical and biological characteristics play a major role in these processes. Because there is currently a substantial amount of uncertainty in estimating potential changes in GHG emissions and sequestration in such dynamic environments, the best available science should be used.

Refer to Table 2 in the *Guidelines for Addressing Climate Change* for the recommended calculation methodology for estimating emissions and reductions for each emissions source applicable to the project. The California Air Pollution Control Officers Association (CAPCOA) *CEQA and Climate Change* guidance document, the San Joaquin Air Pollution Control District (SJVAPCD) *Final Staff Report Addressing Greenhouse Gas Emissions Impacts Under the California Environmental Quality Act*, the Sacramento Metropolitan Air Quality Management District (SMAQMD*) Recommended Guidance for Land Use Emission Reductions*, and the Bay Area Air Quality Management District (BAAQMD) CEQA *Air Quality Guidelines* are such resources. These documents provide brief descriptions of common measures, feasibility assessments, and emission reductions estimates. URBEMIS can also quantify reductions from various measures, including mobile-source and operational-related measures. There are also many additional resources for quantifying reduction measures.

Emission reductions can also be calculated manually by comparing expected emissions-producing activities (such as fuel or electricity consumption) and emission factors before and after implementation of a reduction measure. The following basic steps guide this calculation process:

1. Calculate project emissions for the targeted source using activity data and emission factors (in the future scenario).
2. Calculate reduced emissions for the targeted source using new activity data and emission factors based on the reduction measure.
3. Subtract reduced emissions (step 2) from project emissions (step 1) to determine emissions after inclusion of the measures.

For example, a measure could be to target building energy-related emissions through energy efficiency and the use of renewable energy sources. This measure could reduce energy consumption by 20 percent and provide half of the remaining 80 percent of the energy from renewable sources (assumed to be carbon-neutral). Assuming energy-related emissions are 100 metric tons of carbon dioxide equivalents ($MTCO_2e$),[10] emissions reductions would be 60 $MTCO_2e$.[11] Consequently, final emissions would be 40 $MTCO_2e$.

[10] This is the international unit that combines the differing impacts of all greenhouse gases into a single unit, by multiplying each emitted gas by its global warming potential (GWP). GWP is the measure of how much a given mass of greenhouse gas contributes to global warming.
[11] Calculation: (100 * 0.2) + ([100-{100 * 0.2}] * 0.5) = 60.

Once such measures are quantified, the total estimated reductions can be compared to the future project emissions scenario to demonstrate an overall percent reduction.

Cost-Effectiveness of GHG Reduction Measures

There are many resources for estimating the cost-effectiveness of BMPs and other reduction measures. The McKinsey Global Institute (MGI) analyzed GHG reduction options in their report, *The Carbon Productivity Challenge: Curbing Climate Change and Sustaining Economic Growth* (MGI 2008). In this report, MGI developed a global cost abatement curve for a variety of GHG reduction actions. The report demonstrates that there are numerous actions that have a net negative cost.

The cost-effectiveness of each reduction measure will differ by project based on availability of fuel types, building materials, project specifications, and many other factors. Some projects may incorporate energy efficient lighting, while other projects may include other types of cost effective reduction measures. Analyzing the cost effectiveness of each measure may be limited by data availability and/or information about payback period. Information and tools for estimating cost effectiveness varies by emissions source, such that for some measures, project-specific information must be used instead of proxy factors. For energy efficiency measures, for example, the California Energy Commission and California Public Utilities Commission maintains a large database (the Database for Energy Efficient Resources) that includes well-documented information on costs and savings associated with specific energy efficiency actions (CEC et al. 2009). This database can be a useful tool for estimating the cost effectiveness of a project's energy efficiency measures, in lieu of a more detailed analysis.

Printed References

California Air Resources Board (CARB). 2009a. *2000-20086 inventory by IPCC category - Full Detail*. Available: http://arb.ca.gov/cc/inventory/data/tables/ghg_inventory_ipcc_00-08_all_2010-05-12.pdf

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