# Appendix F

# ICE Tool Worksheets

# Project Inputs

Mitigation Inputs | Results Summary | Impacts on Vehicle Operation

**Instructions:**

1. Using information from the project or plan you want to analyze, complete the inputs on this page and on the Mitigation Inputs page by entering information in the cells that are shaded orange. Gray cells display results; do not change the information in these cells. (The tool uses the term "project" not just to refer to individual projects, but also to long-range transportation plans or other plans that consist of a suite of projects.)

2. Click on the gray buttons at the top of the page to navigate between input pages, the results page, and the impacts on vehicle operation page.

3. For further instructions, refer to the accompanying user guide for detailed descriptions of factors and assumptions used in this tool.

| Key to Cell Colors |
|---|
| User Input |
| Results Automatically Calculated |

## General Information

| | |
|---|---|
| Infrastructure location (state) | SC |
| Analysis timeframe (years) | 60 |
| Average daily traffic per lane mile - for facilities that will be reconstructed or resurfaced | 5,971 |

### Roadway System

| | |
|---|---|
| Total existing centerline miles | 43.45 |
| Total existing lane miles | 173.8 |
| Total newly-constructed centerline miles | 43.45 |
| Total newly-constructed lane miles | 173.8 |

### Rail, Bus, and Bicycle Infrastructure

| | |
|---|---|
| Total existing track miles of light rail | 0 |
| Total existing track miles of heavy rail | 0 |
| Total newly-constructed track miles of rail | 0 |
| Total existing lane miles of bus rapid transit | 0 |
| Total newly-constructed lane miles of bus rapid transit | 0 |
| Total existing lane miles of bicycle lanes | 0 |
| Total newly-constructed lane miles of bicycle lanes | 0 |

## Roadways

### Roadway Projects

| Facility type | Roadway Construction | | | | | Roadway Rehabilitation | |
|---|---|---|---|---|---|---|---|
| | New Roadway (lane miles) | Construct Additional Lane (lane miles) | Re-Alignment (lane miles) | Lane Widening (lane miles) | Shoulder Improvement (centerline miles) | Re-construct Pavement (lane miles) | Resurface Pavement (lane miles) |
| Rural Interstates | 173.8 | 0 | 0 | 0 | 0 | 430.45 | 430.45 |
| Rural Principal Arterials | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural Minor Arterials | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural Collectors | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Urban Interstates / Expressways | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Urban Principal Arterials | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Urban Minor Arterials / Collectors | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Accounting for the Full Roadway Lifespan**

The estimator tool accounts for construction, rehabilitation, routine maintenance, and preventive maintenance in different ways:

- **New Construction (user provided):** The user enters lane miles of construction projects.
- **Rehabilitation (user provided):** The user enters expected reconstruction and resurfacing projects on all existing and new roadways for the length of the analysis period. As a general rule of thumb, new roadways require resurfacing after 15 years and reconstruction after 30 years.
- **Routine Maintenance (automatically estimated):** The tool automatically estimates routine maintenance activity, such as sweeping, striping, bridge deck repair, litter pickup, and maintenance of appurtenances, per lane mile of existing and new roadway.
- **Preventive Maintenance (user provided):** The user has the option to specify a preventive maintenance program as a mitigation strategy (in the Mitigation Inputs tab). Preventive maintenance techniques include crack sealing, patching, chip seals, and micro-surfacing.

**Example:** The user enters new construction of 10 lane miles of new freeway, with an analysis period of 40 years. Assuming that all construction takes place in year 1, the user enters 10 lane miles of freeway resurfacing (assumed to take place in year 15) and 10 lane miles of freeway reconstruction (assumed to take place in year 30). The tool automatically includes routine maintenance of the 10 newly constructed lane miles. The user has the option of specifying a preventive maintenance strategy, which will increase the longevity of the pavement surface and therefore reduce the amount of energy and emissions associated with resurfacing and rehabilitation.

### Parking

| | |
|---|---|
| Surface Parking (spaces) | 0 |
| Structured Parking (spaces) | 0 |

### Options

| | |
|---|---|
| % roadway construction on rocky / mountainous terrain | 0% |

## Bridge Structures

| Bridge Structure | Construct New Bridge | | | | Reconstruct Bridge | | | | Add Lane to Bridge | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of bridges | Average number of spans per bridge | Average number of lanes per bridge | Total number of lane-spans | Number of bridges | Average number of spans per bridge | Average number of lanes per bridge | Total number of lane-spans | Number of bridges | Average number of spans per bridge | Average number of new lanes per bridge | Total number of lane-spans |
| Single-Span | 15 | 1 | 2 | 30 | 15 | 1 | 2 | 30 | 14 | 1 | 3 | 42 |
| Two-Span | 26 | 2 | 2 | 104 | 26 | 2 | 2 | 104 | 6 | 2 | 3 | 36 |
| Multi-Span (over land) | 9 | 5 | 2 | 90 | 9 | 5 | 2 | 90 | 5 | 5 | 3 | 75 |
| Multi-Span (over water) | 22 | 5 | 2 | 220 | 22 | 5 | 2 | 220 | 20 | 5 | 3 | 300 |

**How Many Bridge Spans?**

Approximately half of short bridges in the U.S. (less than 1000 feet long) are single-span or double-span. If information about number of spans is not available, it is reasonable to assume a mix of single-span and two-span bridges. Note that the number of spans is an important factor in energy use and GHG emissions. You may want to test a few different assumptions to see the effects. Longer bridges (more than 1000 feet) can't be reliably estimated in the tool.

## Rail, bus, bicycle, and pedestrian facilities

### Rail construction

| Project Type | Light rail | Heavy rail |
|---|---|---|
| New construction (underground - hard rock) - track miles | 0 | 0 |
| New construction (underground - soft soil) - track miles | 0 | 0 |
| New construction (elevated) - track miles | 0 | 0 |
| New construction (at grade) - track miles | 0 | 0 |
| Converted or upgraded existing facility - track miles | 0 | N/A |
| New rail station (underground) - stations | 0 | 0 |
| New rail station (elevated) - stations | 0 | 0 |
| New rail station (at grade) - stations | 0 | 0 |

### Bus rapid transit construction

| | |
|---|---|
| New lane or right-of-way - lane miles | 0 |
| Converted or upgraded lane/facility - lane miles | 0 |
| New BRT Stations | 0 |

### Bicycle and Pedestrian Facilities

| Project Type | New Construction | Resurfacing | Restriping |
|---|---|---|---|
| Off-Street Bicycle or Pedestrian Path - miles | 0 | 0 | N/A |
| On-Street Bicycle Lane - lane miles | 0 | 0 | 0 |
| On-Street Sidewalk - miles | 0 | N/A | N/A |

## Construction - Delay

| | |
|---|---|
| Total project-days of lane closure | 0 |
| Average daily traffic per directional segment for facilities requiring lane closure | 0 |
| Percentage of facility lanes closed during construction | |

**Estimating Project-Days of Lane Closure**

Estimates of project-days of lane closure may be available from project documents. The tool assumes that lane closures occur in one-mile increments. Average values for construction schedules (e.g., daytime versus overnight) are incorporated in the calculations. Estimates of emissions from construction delay are meant to provide a rough sense of the scale of emissions relative to the construction processes themselves, and are not meant to replace estimates derived from traffic modeling software. Planned construction projects that will result in significant lane closures on high volume roads should be evaluated using traffic modeling software.

Impacts on Vehicle Operation

# Mitigation Inputs

Project Inputs | Results Summary | Impacts on Vehicle Operation

**Instructions:** Follow the steps below to calculate the impact of energy and GHG mitigation strategies:

1. Enter the baseline deployment (i.e., the extent to which the strategy is currently deployed) in Column B.

2. Enter the planned deployment (i.e., the extent to which the strategy will be deployed in the project that you are examining) in Column C.

Column D displays the maximum potential deployment of the strategy, based on research. If you enter a value in Column B or C that is greater than the value shown in Column D, the cell will appear highlighted in light red with dark red text as a warning. The calculations in the sheet will continue to function.

Some reduction strategies (i.e., biodiesel/hybrid maintenance vehicles and equipment; biodiesel/hybrid construction vehicles and equipment; and in-place roadway recycling for BRT conversions) apply to the same activities. Care must be taken to make sure you do not input a total deployment greater than 100% for overlapping strategies. For example, the tool does **not** prevent you from applying a combined deployment of B20 and B100 maintenance vehicles exceeding 100% of the maintenance fleet.

3. Compare the mitigated and unmitigated results on the *Results* page to assess the impact of mitigation strategies. Energy/GHG reductions are calculated based on the difference between planned and baseline deployment and the energy/GHG reduction potential of each strategy. If the planned deployment of a strategy is less than the baseline deployment, energy/GHG reductions will

## Energy / GHG reduction strategies

| Strategy | Baseline deployment | Planned deployment | Maximum potential deployment | Applied to |
|---|---|---|---|---|
| Alternative fuels and vehicle hybridization | | | | |
| Hybrid maintenance vehicles and equipment | 0% | 0% | 44% | Fuel use by maintenance equipment |
| Switch from diesel to B20 in maintenance vehicles and equipment | 0% | 0% | 100% | Fuel use by maintenance equipment |
| Switch from diesel to B100 in maintenance vehicles and equipment | 0% | 0% | 100% | Fuel use by maintenance equipment |
| Combined hybridization/B20 in maintenance vehicles and equipment | 0% | 0% | 44% | Fuel use by maintenance equipment |
| Hybrid construction vehicles and equipment | 0% | 0% | 44% | Fuel use by construction equipment |
| Switch from diesel to B20 in construction vehicles and equipment | 0% | 0% | 100% | Fuel use by construction equipment |
| Switch from diesel to B100 in construction vehicles and equipment | 0% | 0% | 100% | Fuel use by construction equipment |
| Combined hybridization/B20 in construction vehicles and equipment | 0% | 0% | 44% | Fuel use by construction equipment |
| Vegetation management | | | | |
| Alternative vegetation management strategies (hardscaping, alternative mowing, integrated roadway/vegetation management) | No | No | N/A | Fuel use by vegetation management equipment |
| Snow fencing and removal strategies | | | | |
| Alternative snow removal strategies (snow fencing, wing plows) | No | No | N/A | Fuel use by snow removal equipment |
| In-place roadway recycling | | | | |
| Cold In-place recycling | 0% | 0% | 99% | Asphalt and fuel use by construction equipment in roadway resurfacing and BRT conversions |
| Full depth reclamation | 0% | 0% | 99% | Base stone and fuel use by construction equipment in roadway reconstruction and BRT conversions |
| Warm-mix asphalt | | | | |
| Warm-mix asphalt | 0% | 0% | 100% | Asphalt use in all projects |
| Recycled and reclaimed materials | | | | |
| Use recycled asphalt pavement as a substitute for virgin asphalt aggregate | 0% | 0% | 25% | Asphalt use in all projects |
| Use recycled asphalt pavement as a substitute for virgin asphalt bitumen | 0% | 0% | 40% | Asphalt use in all projects |
| Use industrial byproducts as substitutes for Portland cement | 0% | 0% | 33% | Concrete use in all projects |
| Use recycled concrete aggregate as a substitute for base stone | 0% | 0% | 100% | Base stone use in all projects |
| Preventive maintenance | | | | |
| Preventive maintenance | 0% | 0% | 100% | Materials and construction fuel use in roadway resurfacing and reconstruction projects |

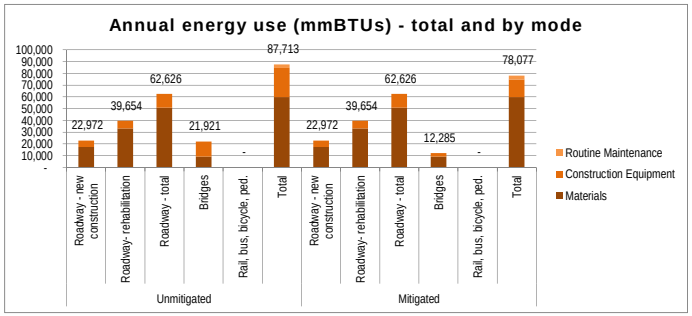
# Results Summary

Project Inputs | Mitigation Inputs | Impacts on Vehicle Operation

| Annualized energy use (mmBTUs), per year over 60 years | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unmitigated | | | | | | Mitigated | | | | | |
| | Roadway - new construction | Roadway- rehabilitation | Roadway - total | Bridges | Rail, bus, bicycle, ped. | Total | Roadway - new construction | Roadway- rehabilitation | Roadway - total | Bridges | Rail, bus, bicycle, ped. | Total |
| Upstream Energy | | | | | | | | | | | | |
| Materials | 17,456 | 33,308 | 50,764 | 9,117 | - | 59,881 | 17,456 | 33,308 | 50,764 | 9,117 | - | 59,881 |
| Direct Energy | | | | | | | | | | | | |
| Construction Equipment | 5,516 | 6,346 | 11,862 | 12,804 | - | 24,666 | 5,516 | 6,346 | 11,862 | 3,168 | - | 15,030 |
| Routine Maintenance | | | | | | 3,166 | | | | | | 3,166 |
| Total | 22,972 | 39,654 | 62,626 | 21,921 | - | 87,713 | 22,972 | 39,654 | 62,626 | 12,285 | - | 78,077 |

**Note:** To convert mmBTU to the equivalent gallons of US conventional diesel, use the conversion factor of 7.785 gallons of diesel / mmBTU. Please keep in mind that this conversion represents the equivalent amount of energy required, which can be useful for informational purposes, but it does not necessarily represent actual gallons of diesel required.

Annualized over 60 Years




| Annual GHG emissions (MT CO2e), per year over 60 years | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unmitigated | | | | | | Mitigated | | | | | |
| | Roadway - new construction | Roadway- rehabilitation | Roadway - total | Bridges | Rail, bus, bicycle, ped. | Total | Roadway - new construction | Roadway- rehabilitation | Roadway - total | Bridges | Rail, bus, bicycle, ped. | Total |
| Upstream Emissions | | | | | | | | | | | | |
| Materials | 1,074 | 1,945 | 3,019 | 809 | - | 3,828 | 1,074 | 1,945 | 3,019 | 809 | - | 3,828 |
| Direct Emissions | | | | | | | | | | | | |
| Construction Equipment | 402 | 462 | 864 | 304 | - | 1,168 | 402 | 462 | 864 | 304 | - | 1,168 |
| Routine Maintenance | | | | | | 231 | | | | | | 231 |
| Total | 1,476 | 2,407 | 3,883 | 1,113 | - | 5,227 | 1,476 | 2,407 | 3,883 | 1,113 | - | 5,227 |

Annualized over 60 Years