MEMORANDUM

To: Robert Griffiths, Multi-Sector Working Group Project Director

From: Michael Grant, Erika Myers, Lauren Pederson, Bill Prindle, Parker Crowe, ICF International

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Date: May 1, 2015

Re: Task 3: Tech Memo on Combined Sector List of Strategies to be Analyzed

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The purpose of this memorandum is to present ICF's recommended list of greenhouse gas (GHG) reduction strategies proposed for analysis, along with a description of methodologies to be used to analyze these strategies. The list was developed based on discussions with the Energy and Built Environment Subgroup and the Transportation and Land Use Subgroups of the Multi-Sector Working group (MSWG), and informed by feedback from public input. This memorandum serves as one of ICF's deliverables under Task 3 of this project.

The strategy and measures were developed through brainstorming by the three subgroups. Initial lists were developed, then refined at subgroup meetings. The draft list of strategies and measures were then provided for public comment through the Transportation Planning Board Citizens Advisory Committee, COG's Air and Climate Public Advisory Committee, and COG's web site. ICF reviewed the input from the subgroups and public input, and has developed this consolidated listing of strategies and implementation measures. Subgroup documents and public comments are posted on the Council of Governments website at http://www.mwcog.org/committee/committee/default.asp?COMMITTEE_ID=285.

This listing identifies strategies and implementation measures. Strategies are high-level actions that can be taken to reduce greenhouse gas emissions. They are drafted at a high level to provide for scenario level analysis. The scenarios may include near-term viable actions and stretch actions requiring new policy implementation across the region, states and nation. Implementation measures include actions that could be put in place to support achievement of the strategy level scenarios. These differ from policies, goals and targets that do not directly result in reductions in greenhouse gas emissions. These policies, goals and targets will be separately considered in the next phase of this project.

Energy and Built Environment

First we present the Energy and Built Environment Strategies in Table 1 by strategy groupings (e.g. existing buildings, new buildings), individual strategies (e.g. EBE-1, EBE-2) and potential implementation actions for each strategy (shown in the right-hand column). This list is a modified version of ICF's April 9, 2015 draft list, and incorporates edits discussed at that COG/ICF team meeting, as well as the Energy and Built Environment Working Group meeting that took place on April 13, 2015, and public comment. Following the list of strategies is Table 2, presenting ICF's analysis approach to each of the strategies.

Table 1. Energy and Built Environment GHG Reduction Strategies

Strategy	Measure Description (including possible Implementation Actions)
I. Existing Buildings	
EBE-1: Achieve annual and cumulative reductions in energy and water consumption in existing buildings Scenario: • 2% annual reduction, 30% cumulative by 2030	Leverage utility ratepayer-funded programs to drive energy performance improvements via incentives and technical assistance • Implement continuous commissioning and monitoring, leveraging utility advanced metering data and related utility service offerings. Adopt Architecture 2030 goal, adapted for existing buildings. Extend enforcement of building energy code provisions to better address existing building stock • Adopt new building code-related requirements for energy improvements during renovations, additions, major alterations. Reduce water usage via planning/zoning policies, water utility partnerships • Reduce site water loss via rainwater harvesting and other re-use technologies, stormwater runoff reduction, low maintenance natural landscaping. • Improve water conservation in buildings via fixture efficiencies. Drive private building energy and water performance via mandatory benchmarking, and voluntary challenge initiatives • Adopt benchmarking and disclosure requirements. • Adopt green leasing requirements for public agencies, guidelines for private entities. • Implement occupant sustainability programs, such as upcoming EPA Tenant Star Expand low-income housing energy and water savings by leveraging federal, state, utility resources. • Implement programs to serve low-income residents and support affordability. Expand financing options for energy and water efficiency and renewable energy. • Enable PACE financing via property tax systems. • Develop Green Bank facilities (New York State, Virginia examples). • Provide credit enhancement mechanism such as loan loss reserves. • Support loan aggregation/secondary market development (e.g. WHEEL) • Drive public/institutional energy and water savings via performance contracting, especially for public and institutional buildings.

EBE-2. Support existing building-level renewable energy development Scenario: • Included in EBE-6 level	Support cooperative/aggregated renewable energy purchasing for public, residential and commercial sectors Provide incentives for building-level renewable technologies (e.g. property tax abatements, density allowances). Adopt solar access ordinances and similar regulations to support renewable development.
II. Location Efficiency	
EBE-3: Encourage development in activity centers Scenario: • increase in the proportion of new development built in Activity Centers by 2030. (Cross-referenced with Land Use strategies (L-2); primary assessment to be conducted by Land Use subgroup)	Update comprehensive plans to include energy and transportation efficiencies as a factor in public facility siting decisions. Update zoning policies and permitting guidelines to encourage low-impact site development, e.g. “rain garden” runoff landscaping, xeriscaping. Locate development at sites and in densities that can be served by efficient and renewable district energy systems. Encourage activity-center residential density to reduce average housing unit size and energy demand. Tie development review to GHG performance; e.g. locating new development in activity centers could be linked to a GHG credit or bonus.
III. New Buildings	
EBE-4: Improve new building energy and water efficiency performance Scenario: • 100% compliance with most stringent ICC (including IGCC) or ASHRAE building code/energy performance standards by 2020 • 100% of new buildings designed to meet ENERGY STAR Target Finder performance levels by 2030 • 100% of new buildings use WaterSense fixtures by 2030 to reduce energy needs of water and wastewater) • 50% of new buildings designed to be net zero energy by 2040 • 100% new buildings designed to be net zero energy by 2050. *Targets may need to be adjusted by building type; green power/other offset mechanisms likely to be needed*)	Adopt and enforce updated building codes and energy performance standards Develop building code compliance efforts, including utility programs. Create electric vehicle “charging-ready” infrastructure code provisions. Adopt Architecture 2030 goals in public policies. • Express preference for zero-energy performance levels via planning/zoning/permitting policies and practices (typically non-binding but encourage developers to bring such projects forward). Provide Net Zero building incentives, such as property tax abatements (e.g. Green Building tax credits) or permitting prioritization policies. Integrate green power purchasing into new building policies to offset any remaining site energy use. • Support development of long-term utility “green tariff” policies tied to meter address or other actions. Require new building sites to meet low-impact site development requirements, e.g. “rain garden” runoff landscaping, xeriscaping.

	Adapt planning/zoning policies and work with water utilities to increase rainwater harvesting and other re-use technologies, manage storm water, and encourage low-maintenance natural landscaping. Update planning/zoning policies and work with water utilities to improve water conservation in buildings to reduce water consumption. Create building code-related policies to mandate WaterSense or comparable performance levels in applicable fixtures.
IV. Public and Private Infrastructure	
EBE-5: Achieve annual and cumulative reductions in fossil energy use by improving Infrastructure efficiency and increasing renewable energy use Scenario: • 1% annual reduction in fossil energy use, 35% cumulative by 2050	Reduce energy use by water and wastewater systems by reducing leaks, increasing onsite generation, increasing system efficiency, and fostering process improvements, by working through institutional and utility programs. Implement outdoor lighting and other end-use efficiency technologies, working through institutional and utility programs. Install on-site renewable power systems at facility and transit sites by working through institutional and utility programs.
V. Energy Source and Supply	
EBE-6: Achieve targeted reductions in power sector emissions Scenario: • 30% reduction in emissions from energy generation by 2030 (on a total emissions (mass) basis rather than an emission-rate basis)	Support state plans to achieve a 30% mass-based reduction in electrical generation emissions. • Allow District of Columbia GHG successes to be leveraged in Maryland's Clean Power Plan. • Phase out coal use in regional coal plants by 2030. • Explore the possibility of installing additional units at existing regional nuclear plants. • Increase efficiency of thermal power plants. Support increases in state Renewable Portfolio Standards (RPS) to 40% by 2030. • Increase Solar PV capacity via RPS carve outs or other policies. Increase electric-grid energy storage capacity by supporting utility investments in grid storage technology. Reduce energy waste from transmission and distribution of energy by supporting utility efforts to upgrade grid efficiencies via efficient transformers, smart grid technologies, etc. Expand natural gas supply infrastructure to existing and new power plant sites. Sustain and expand federal, state and local grid-scale renewable energy incentives, e.g. federal PTC

EBE-7: Achieve targeted reductions in reduce natural gas pipeline leaks Scenario: • 20% reduction in methane leaks from natural gas pipelines by 2030)	Support utility investments by encouraging utility commission action on cost recovery.
VI. Resource Recovery, Conservation and Management	
EBE-8: Achieve targeted reduction in municipal solid waste Scenario: • Net Zero Waste by 2050	Increase the recycling rate of the region to 75%, via waste collection fees and other policies. Increase reuse of construction /demolition waste by 15% by 2020 and 100% by 2050 via tipping fees, builder incentives, and similar measures. Divert 100% of organic waste by 2040 via tipping fees, waste collection fees and other measures. Implement green purchasing and procurement programs via government agency and private sector commitments. Increase use of waste to energy plants, including landfill gas projects.
VII. Non-road Engines	
EBE-9: Reduce emissions from non-road engines Scenario: • 2% annual, 30% cumulative reduction in greenhouse gas emissions from non-road sources by 2030	Increase market penetration of energy efficient alternatives for non-road engines including back-up generators, construction equipment, agriculture, lawn and garden equipment, construction equipment, commercial and industrial equipment, and recreational equipment, as listed in the MWCOG Gold Book.
VIII. Awareness and Education	
EBE-10: Educate and motivate public through community engagement Move education to action - Create measurable results through community energy engagement.	Educate on benefits and costs of clean energy technologies and behaviors, via school curricula and public information campaigns. Increase motivation through incentives and other measures, linked to utility customer education and information services. • Use utility advanced metering data to monitor and influence behavior. Create a culture of responsibility via school curricula and public information campaigns. Encourage employee behavior change to increase teleworking and commuting by public transportation through actions such as the “Commuter Connections” program.

Table 2 below provides the analysis approach for each of the Energy and Built Environment Strategies and the proposed scenarios for evaluation.

Table 2. Analysis Methodology for Energy and Built Environment GHG Reduction Strategies

Strategy	Affected Resource Type		Analytic Methodology	Scenarios
	Energy Efficiency	Energy Supply		
EBE-1. Existing Buildings - Energy and water performance	x		Apply savings estimates from existing energy efficiency (EE) potential studies (e.g. Pepco, Montgomery County), augmented by individual policy and program impact data (e.g. DC benchmarking EUI results)	2% annual reductions, 30% cumulative reductions by 2030
EBE-2. Building-level renewables		x	Apply per-building renewable energy (RE) production estimates based on regional experience to market penetration assumptions.	
EBE-3. Encourage development in activity centers	x		Apply housing size reduction estimates and expected number of units	Increase in % of new development in Activity Centers by 2030
EBE-4. New Buildings - Energy and water performance	x		Reduce energy use and emissions impacts of new residential and commercial building stock using three scenarios Calculate water usage reductions based on difference between NAECA standards and WaterSense performance levels for affected fixtures. Use existing EECC building codes calculator tool	100% of new buildings reach ENERGY STAR levels by 2030 50% of new buildings NZE by 2040 100% of new buildings NZE by 2050 100% of new buildings use WaterSense fixtures by 2030 100% compliance with most stringent model codes by 2020
EBE-5. Infrastructure – Energy and water performance and increase renewable energy use	x	x	Apply scenario savings goals to current and project infrastructure usage estimates	1% annual reduction, 35% cumulative reduction by 2050

Strategy	Affected Resource Type		Analytic Methodology	Scenarios
	Energy Efficiency	Energy Supply		
EBE-6. Reduction in power sector emissions	x	x	Project emission reductions on a regional mass basis, applying impact estimates of defined actions	30% reduction in total mass emissions by 2030
EBE-7. Reduction in gas pipeline leaks		x	Estimate reduced methane emissions (converted to CO2e) from WGL system based on available data	20% reduction in methane leakage by 2030
EBE-8. Reduction in municipal solid waste	x	x	Estimate energy and emissions impacts of increased recycling/waste prevention, and increased utilization of waste to energy projects	Net zero waste by 2050
EBE-9. Reduction in emissions from non-road engines	x	x	See transportation analysis	2% annual, 30% cumulative reductions in NRE GHGs by 2030
EBE-10. Educate and motivate public	x	x	Use impact estimates from previous public campaigns and educational efforts	

Transportation and Land Use

Based on the discussions during the combined Transportation and Land Use Work Group meeting on April 17, 2015, and feedback from the public comment process, ICF is recommending the 12 bundled Transportation and Land Use GHG Reduction Strategies shown in Table 3 for further analysis. Also, based on the feedback received at the April 17th meeting and from the public comment process, ICF is recommending the elimination of a few of the previously identified draft transportation strategies from further analysis due to limited GHG reduction potential, controversial nature, or overlap with other proposed strategies. The strategies to be dropped from further analysis are shown in Table 5 and are described further in a later section of this memo. Table 5 also shows how ICF is recommending the other previously identified Transportation and Land Use strategies be grouped into a set of strategy bundles for analysis. Other edits to strategies were generally minor (for instance, rather than "Reduce speed limits", this strategy was edited to say "Increase speed limit enforcement").

Table 3. Transportation and Land Use GHG Reduction Strategies

Strategy Type/Focus	Measure Description (including possible Implementation Actions)
TLU-1: Increase urban tree canopy and land stewardship Scenario: • 2020: Project effects of 2020 development increment on canopy coverage; possibly augment with tree preservation/planting programs in short term • 2040: Link tree and undeveloped land cover to base and stretch scenarios.	Measures to maintain/increase open space, tree canopy, and green infrastructure through sustainable landscaping and land management practices: • Maximize urban canopy • Tree conservation ordinances • Conservation of open space • Regional mitigation bank • Shifting more new development into activity centers with smaller environmental footprint (through measures like L-2 and L-3 below) and thus preserving existing undeveloped lands. • Commercial and residential landscaping should follow Climate, Community, and Biodiversity Standards • Reduce impervious surfaces to minimize water treatment energy needs to remove phosphorus, nitrogen, and sediment • Support soil and forest carbon sequestration
TLU-2: Sustainable Development Patterns & Urban Design (including Enhancements for Non-motorized Modes) Scenario: • 2020: Run base CLRP land use and transport networks (don't have 2020 AC growth assumptions – can't tell if meaningful shifts are available) • 2040: Run base CLRP land use and networks • 2040 stretch: Reallocate growth and balance into and among	Measures to encourage a higher share of new development in Activity Centers (ACs), together with associated sustainable urban design factors, such as: • Build near transit (transit-oriented development) and/or enhance existing transit service levels • Higher densities • Greater mix & balance of uses • Street network/walk friendly • Management of parking supply/cost • Greater mix of housing options RE size and affordability • School locations, design and access

centers, accounting for proximity to rail transit, jobs/housing ratios, holding capacity and other factors	Recommend testing as a package of the above, in three different levels: • Constrained Long-Range Plan (CLRP) activity levels and networks (with assumed growth in ACs) • Maximum shift to ACs: assume entire 2014-2040 growth increment into ACs • Augmented: increase above current planned levels, rule-based targeting to centers by place type (transit service, location in major corridors) Efforts to foster greater jobs/housing balance, particularly by targeting more residential opportunities to areas with high jobs/housing ratios. Key actions embodied in this strategy include • Housing affordability (especially in center city and inner suburban jurisdictions and areas near transit) • Live Near Your Work incentives • Balancing job opportunities between west and east region • More job opportunities in bedroom communities and exurban satellite cities • Incentivize jobs in eastern region Ensure adequate pedestrian and bicycle infrastructure and connectivity in activity centers to support walking and biking as modes, as well as access to transit. Key actions embodied in this strategy include: • Local street networks meeting block size or intersection density criteria • Complete streets concepts • Traffic calming measures. On & off-road bicycle networks and storage facilities Actions embodied in this strategy include: • Higher retail/service to households or employment ratios • Location incentives for retail • Easing/changing zoning to allow broader array of retail/service options, locations Retail must be located strategically within centers This measure seeks to locate as much of new or relocated government employment near premium transit (Metro, commuter rail, LRT/BRT), including: • Federal agencies • State agencies Regional, county and municipal agencies

	Measures designed to increase the share of bike/walk trips, such as: • Complete streets policies • Increased bike-sharing • Completion of bicycle/pedestrian enhancements • Increased connectivity of pedestrian network (especially in cul-de-sac developments), require sidewalks on all streets except freeways which should have parallel trails, connect communities to parks, and identify and complete trails with maximum potential
TLU-3: Improve Fuel Economy of Light-duty Vehicle Fleet Scenario: • 2020: Increase % of light-duty zero emission vehicles (ZEVs) to 2% of total vehicle population in study region • 2040: Increase % of light-duty ZEVs to 15% • 2040 stretch: Increase % of light-duty ZEVs to 25%	Measures to incentivize more fuel efficient passenger vehicles: • Implement a "Cash for Clunkers" program to encourage replacement of older, less fuel efficient vehicles • Offer incentives for consumer/private sector purchase of electric vehicles and charging equipment • Offer incentives for purchases of fuel-efficient vehicles (fee-bates) • Provide disincentives for purchases of fuel-inefficient vehicles (gas guzzler tax/registration fees) • Adoption of CA Low-Emission Vehicle (LEV) Phase II program
TLU-4: Increase Alternative Fuels in Public Sector Fleets Scenario: • 2020: Add X(TBD) CNG buses to public transit fleet • 2040: Increase % of ZEVs in municipal light-duty fleets to 15% of total fleet population; require B5 in all municipal fleets and school buses; require X%(TBD) of public transit fleet to be converted to CNG • 2040 stretch: Increase % of ZEVs in municipal light-duty fleets to 25% of total fleet population; require B20 in all municipal fleets and school buses; require X% (TBD) of public transit fleet to be converted to CNG	Measures to incentivize more fuel efficient passenger vehicles: • Implement a "Cash for Clunkers" program to encourage replacement of older, less fuel efficient vehicles • Offer incentives for consumer/private sector purchase of electric vehicles and charging equipment • Offer incentives for purchases of fuel-efficient vehicles (fee-bates) • Provide disincentives for purchases of fuel-inefficient vehicles (gas guzzler tax/registration fees) • Adoption of CA Low-Emission Vehicle (LEV) Phase II program

TLU-5: Clean Freight Technologies Scenario: • 2020: Add one truck stop electrification (TSE) location with 30 bays in study region • 2040: Add five additional TSE locations with 30 bays/location • 2040 stretch: Add eight additional TSE locations with 30 bays/location	Measures to reduce emissions associated with freight: • Engine and powertrain technologies to improve fuel efficiency (e.g., hybrids, plug-in electric, and alternative fuel vehicles) • Vehicle technologies to improve fuel efficiency (e.g., aerodynamic devices, low rolling resistance tires, tire pressure systems, idle reduction technologies) • Operational strategies (e.g., routing software, engine governors, truck-stop electrification, efficient truck refrigeration units, off-peak delivery incentives) • Clean truck corridor infrastructure (e.g., overhead catenary systems, linear synchronous motors, in-road battery charging capabilities)
TLU-6: Low Carbon Fuel Standard Scenario: • 2020: N/A • 2040: Reduce fuel emissions in region by 10% • 2040 stretch: Reduce fuel emissions in region by 15%	Implement market-based program to reduce carbon intensity of on-road fuels through use of lower-carbon alternatives (e.g., natural gas, electricity, biofuels, hydrogen)
Enhancing system operations (T-7, T-8, and T-11) Scenario: • 2020: 20% of drivers adopt eco-driving practices; corridor operational improvements reduce travel time by 10% • 2040: 80% of drivers adopt eco-driving practices; corridor operational improvements reduce travel time by 20% • 2040 stretch: 100% of drivers utilize eco-driving practices; corridor operational improvements reduce travel time by 25%	Apply cost effective operational improvements to freeways and arterials/collectors, such as: • Integrated corridor management (ICM) on freeway and major arterial corridors • Implement ramp metering • Freeway operations patrols / faster incident management • Signal retiming • Roundabouts Intersection efficiency improvements Promote driving patterns to reduce rapid acceleration/deceleration and extended idling System efficiency improvements through connected vehicles, such as vehicle-to-vehicle, vehicle-to-infrastructure, and autonomous vehicles

TLU-8: Reduce Speeding on Freeways Scenario: • 2020: Average speeds on freeways (outside of congested periods) reduced to 57 mph. • 2040: Average speeds on freeways (outside of congested periods) reduced to 57 mph. • 2040 stretch: Average speeds on freeways (outside of congested periods) reduced to 55 mph. Incorporate into Operational Improvements Strategy Scenario.	Enforce speed limits on freeways and included GHG surcharge as part of enforcement
TLU-9: Travel Demand Management Scenario: • 2020: Expand employer-based incentives (subsidies of $50 per month for 40% of employers); 50% of parking in activity centers is priced at average of at least $8 per day ($1 per hour) • 2040: Expand employer-based incentives (subsidies of $50 per month for 80% of employers); 90% of parking in activity centers is priced at average of at least $8 per day ($1 per hour) • 2040 stretch: Expand employer-based incentives (subsidies of $80 per month for 100% of employers); 100% of parking in activity centers is priced at average of at least $8 per day ($1 per hour)	Measures to reduce the availability of free parking in activity centers, such as: • Parking impact fees • Parking caps Parking pricing for on and off-street parking Measures designed to incentives carpooling/ridesharing, non-motorized modes, and telecommuting, such as: • Expanding telecommuting • Carpool incentive programs • Vanpool incentive programs • Increased employer outreach Ordinances to require employers to offer parking cash out / transit benefits
TLU-10: Transit Enhancements Scenario: • 2020: Reduce transit travel times by 5% and reduce headways (wait time) by 5% on 10 major commute corridors • 2040: Reduce transit travel times by 20% and reduce headways (wait time) by 20% on 24 major commute corridors	Measures designed to increase the share of transit trips through increased/improved services, such as: • More neighborhood circulator buses • Enhanced commuter bus services • Real-time bus scheduling information • Transit signal priority improvements / bus rapid transit • Expand Metrorail / Commuter rail • Bus stop improvements (benches, shelters) • Increase schedule coordination between transit agencies

• 2040 stretch: Reduce transit travel times by 30% and reduce headways (wait time) by 30% on 24 major commute corridors; reduce wait time by 10% on all other corridors (assumed due to improved traveler information)	• Bus on Shoulder • Transit access improvements to eliminate drive access to bus • System of dedicated bus lanes • Bus infrastructure commitments
TLU-11: Transit Incentives / Fare Reductions Scenario: • 2020: Reduce transit fares during off-peak periods by 5% by offering monthly passes or providing free trips for students or free transfers • 2040: Reduce transit fares regionally by 20% • 2040 stretch: Reduce transit fares regionally by 40% partially funded through pricing strategies	Measures designed to incentivize transit use through lower fares, such as: • Reduced price monthly transit passes • Free bus-rail transfers • Free off-peak bus service
TLU-12: Road Pricing Scenario: • 2020: None – Long-term scenario only; but potentially assume 20 percent of drivers switch to Pay-As-You-Drive insurance • 2040: Full VMT-based pricing at $0.25 per mile [May consider option for pricing only all freeways, but challenging without more detailed modeling • 2040 stretch: Full VMT-based pricing on road network at $0.25 per mile peak. Cordon pricing into downtown DC at $5 [Need to determine if can forecast, and overlaps with transit service enhancements and fare reductions]	Pricing freeway travel, such as: • Electronic tolling of major bridges and connectors • Conversion to full electronic tolling VMT-based vehicle fees Adding roadway pricing for entering major activity centers across the region (e.g., downtown Washington, Tysons Corner)

Table 4 below provides the analysis approach for each of the Transportation and Land Use Strategies bundled for analysis and the proposed scenarios for evaluation.

Table 4. Transportation and Land Use Strategies Recommended for Quantitative Analysis[1]

Strategy	Affected Mobile Source Emissions Parameter			Analytic Methodology	Scenarios
	VMT	Speed/ Idling	Vehicles/ Fuels		
TLU-1: Increase Urban Tree Canopy and Land Stewardship				Estimate carbon sequestration equivalent of 1 acre of tree cover. Develop acreage-saved conversion factor for relocating a household or employee from suburban/exurban greenfield development to urban/TOD/MXD location. Assess potential increase in tree coverage from other programs.	2015: Establish base year tree canopy coverage by jurisdiction (also impervious surface, undeveloped land) 2020: Project effects of 2020 development increment on canopy coverage; possibly augment with tree preservation/planting programs in short term 2040: Link tree and undeveloped ground cover to base and stretch scenarios.
TLU-2: Sustainable Development Patterns & Urban Design (including Enhancements for Non-motorized Modes)	X			Calculate TAZ level modal accessibility scores for 2015, 2020 and 2040. Use these scores to project the effects of TR+LU on mode choice, leading to delta trips by mode and delta VMT. Create alternative land use allocations for the region & activity centers in 2040, and possibly key enhancements to the transportation network. Recalculate accessibilities and travel impacts	2015: Base year accounting for accessibility effects on mode share (effects beyond COG model) 2020: Run base CLRP land use and transport networks (don't have 2020 AC growth assumptions – can't tell if meaningful shifts are available) 2040: Run base CLRP land use and networks 2040 stretch: Reallocate growth and balance into and among centers, accounting for proximity to rail transit, jobs/housing ratios, holding capacity and other factors

[1] Explanation of bundling strategies are included in Table 5 and implementation strategies included in Table 3

Strategy	Affected Mobile Source Emissions Parameter			Analytic Methodology	Scenarios
	VMT	Speed/ Idling	Vehicles/ Fuels		
TLU-3: Improve Fuel Economy of Light-duty Vehicle Fleet			X	Use GREET Model and spreadsheet analysis to develop residual mix profile (electricity) and calculate avg. lifecycle emission reduction per ZEV	2020: Increase % of light-duty zero emission vehicles (ZEVs) to 2% of total vehicle population in study region 2040: Increase % of light-duty ZEVs to 15% 2040 stretch: Increase % of light-duty ZEVs to 25%
TLU-4: Increase Alternative Fuels in Public Sector Fleets			X	GREET Model and spreadsheet analysis to calculate lifecycle emission reductions per CNG vehicle, ZEV vehicle and from projected biodiesel consumption	2020: Add X (TBD) CNG buses to public transit fleet 2040: Increase % of ZEVs in municipal light-duty fleets to 15% of total fleet population; require B5 in all municipal fleets and school buses; % (TBD) of public transit fleet to be converted to CNG 2040 stretch: Increase % of ZEVs in municipal light-duty fleets to 25% of total fleet population; require B20 in all municipal fleets and school buses; % (TBD) of public transit fleet to be converted to CNG
TLU-5: Clean Freight Technologies			X	Spreadsheet analysis and literature review to estimate lifecycle emission reductions per truck stop electrification (TSE) bay compared to avg. GHG emission reductions from diesel trucks (GREET)	2020: Add one TSE location with 30 bays in study region 2040: Add five additional TSE locations with 30 bays/location 2040 stretch: Add eight additional TSE locations with 30 bays/location

Strategy	Affected Mobile Source Emissions Parameter			Analytic Methodology	Scenarios
	VMT	Speed/ Idling	Vehicles/ Fuels		
TLU-6: Low Carbon Fuel Standard			X	Will use analysis already prepared by NESCAUM and apply portion of projected reductions specific to fuel use in region	2020: N/A 2040: Reduce fuel emissions in region by 10% 2040 stretch: Reduce fuel emissions in region by 15%
TLU-7: Enhance System Operations		X		Utilize literature to estimate change in speed profile for vehicles from eco-driving; utilize TOPS-BC and literature to estimate potential reduction in delay or idling time. Apply speed-based emissions factors or idle emissions factors to estimate GHG reduction. Add V2I description as part of methodology	2020: 20% of drivers adopt eco-driving practices; corridor operational improvements reduce travel time by 10% 2040: 80% of drivers adopt eco-driving practices; corridor operational improvements reduce travel time by 20% 2040 stretch: 100% of drivers utilize eco-driving practices; corridor operational improvements reduce travel time by 25%
TLU-8: Reduce Speeding on Freeways		X		Spreadsheet analysis - Examine share of traffic on freeways at speeds above posted limits. For applicable VMT, apply emissions factors for corresponding speeds.	2020: Average speeds on freeways (outside of congested periods) reduced to 57 mph. 2040: Average speeds on freeways (outside of congested periods) reduced to 57 mph. 2040 stretch: Average speeds on freeways (outside of congested periods) reduced to 55 mph. Incorporate into Operational Improvements Strategy Scenario. *Note: This strategy overlaps with the ecodriving strategy, and potentially could be grouped.*

TLU-9: Travel Demand Management	X			Use TRIMMS sketch planning tool - Extract mode shares (by region, sub-region, or by O-D pairs) and apply elasticities from TRIMMS to estimate change in mode split.	2020: Expand employer-based incentives (subsidies of $50 per month for 40% of employers); 50% of parking in activity centers is priced at average of at least $8 per day ($1 per hour) 2040: Expand employer-based incentives (subsidies of $50 per month for 80% of employers); 90% of parking in activity centers is priced at average of at least $8 per day ($1 per hour) 2040 stretch: Expand employer-based incentives (subsidies of $80 per month for 100% of employers); 100% of parking in activity centers is priced at average of at least $8 per day ($1 per hour)
TLU-10: Transit Enhancements	X	X		Use TRIMMS sketch planning tool - Extract mode shares (by region, sub-region, or by O-D pairs) and apply elasticities from TRIMMS to estimate change in mode split.	2020: Reduce transit travel times by 5% and reduce headways (wait time) by 5% on 10 major commute corridors 2040: Reduce transit travel times by 20% and reduce headways (wait time) by 20% on 24 major commute corridors 2040 stretch: Reduce transit travel times by 30% and reduce headways (wait time) by 30% on 24 major commute corridors; reduce wait time by 10% on all other corridors (assumed due to improved traveler information)

TLU-11: Transit Incentives / Fare Reductions	X			Use TRIMMS sketch planning tool - Extract mode shares (by region, sub-region, or by O-D pairs) and apply elasticities from TRIMMS to estimate change in mode split.	2020: Reduce transit fares during off-peak periods by 5% by offering monthly passes or providing free trips for students or free transfers 2040: Reduce transit fares regionally by 20% 2040 stretch: Reduce transit fares regionally by 40% partially funded through pricing strategies
TLU-12: Road Pricing	X			Use TRIMMS sketch planning tool - Extract mode shares (by region, sub-region, or by O-D pairs) and apply elasticities from TRIMMS to estimate change in mode split.	2020: None – Long-term scenario only; but potentially assume 20 percent of drivers switch to Pay-As-You-Drive insurance 2040: Full VMT-based pricing at $0.25 per mile [May consider option for pricing only all freeways, but challenging without more detailed modeling 2040 stretch: Full VMT-based pricing on road network at $0.25 per mile peak. Cordon pricing into downtown DC at $5 [Need to determine if can forecast, and overlaps with transit service enhancements and fare reductions]

Table 5. Mapping of Proposed Transportation-Land Use Strategy Bundles for Analysis with Detailed Strategy List

Strategy for Analysis	L-1: Maximize urban tree canopy and land stewardship	L-2: Increase proportion of new housing & jobs in activity centers	L-3: Improve regional jobs/housing balance	L-4: Maximize walkable design in activity centers	L-5: Establish adequate retail balance in activity centers	L-6: Focus Government employment near premium transit	T-1: Improve fuel economy of light-duty vehicle fleet	T-2: Increase alternative fuels in public sector fleets	T-3: Clean freight technologies	T-4: Lower emissions off-road construction vehicles	T-5: Low carbon fuel standard	T-6: Roadway bottleneck relief / targeted capacity enhancements	T-7: Corridor / regional operational improvements	T-8: Promote ecodriving	T-9: Off-peak freight deliveries	T-10: Increase speed limit enforcement	T-11: Advance adoption of connected vehicle technologies	T-12: Enhance the bicycle/pedestrian environment	T-13: Enhance transit services	T-14: Transit incentives	T-15: Park-and-ride and HOV investments	T-16: Parking management	T-17: Travel demand management	T-18: Road pricing / congestion pricing	T-19: Cordon pricing	T-20: Pay As You Drive insurance	T-21: Increasing fuel taxes / Carbon tax
TLU-1: Increase Urban Tree Canopy and Land Stewardship	■																										
TLU-2: Sustainable Development Patterns & Urban Design		■	■	■	■	■												■									
TLU-3: Improve Fuel Economy of Light-duty Vehicle Fleet							■																				
TLU-4: Increase Alternative Fuels in Public Sector Fleets								■																			
TLU-5: Clean Freight Technologies									■																		
TLU-6: Low Carbon Fuel Standard											■																
TLU-7: Enhance System Operations													■	■			■										
TLU-8: Reduce Speeding on Freeways														■		■											
TLU-9: Travel Demand Management																				■	■	■					
TLU-10: Transit Enhancements																			■								
TLU-11: Transit Incentives / Fare Reductions																				■							
TLU-12: Road Pricing																								■	■		

Strategy Elimination: The following draft transportation strategies were eliminated from consideration for the following reasons:

Roadway bottleneck relief / targeted capacity enhancements (T-6): ICF received negative feedback about this particular strategy; some of the impacts of this strategy will be addressed by the enhanced system operations bundle, and some capacity enhancements and bottleneck relief projects should be part of the baseline transportation plan.

Off-peak freight delivery (T-9): Based on our initial qualitative assessment, ICF believes that this strategy would have a nominal GHG emission reduction potential and would be difficult to analyze given limitations in data.

Pay as you drive insurance (T-20): As a voluntary measure, this incentive is likely to only attract individuals that are already in a position to use alternative modes of transportation. This strategy works in a way very similar to road pricing (providing a monetary incentive to reduce vehicle travel) and so could be encompassed as part of the road pricing strategy.

Increasing fuel tax / carbon tax (T-21): Based on feedback, this pricing strategy is controversial. It is likely that this strategy would be most effectively implemented at the federal level.

Groupings of Strategies: ICF grouped closely aligned strategies in order to recognize synergies across these strategies and because they share GHG benefits that would be best to analyze together. For analysis purposes, we are suggesting the following strategies be grouped as follows (and as shown in Table 5, and renamed "TLU" to reflect the bundled strategies):

Sustainable Development Patterns & Urban Design (TLU-2): Increase proportion of new housing and jobs in activity centers (L-2) + Improve regional jobs/housing balance (L-3) + Maximize walkable design in activity centers (L-4) + Establish adequate retail balance in activity centers (L-5) + Focus Government employment near premium transit (L-6) + Enhance the bicycle/pedestrian environment (T-12).

Enhance System Operations / Ecodriving (TLU-7): Corridor/regional operational improvements (T-7) + Promote ecodriving (T-8) + Advanced adoption of connected vehicle technologies (T-11)

Travel Demand Management (TLU-9): Park-and-ride and HOV investments (T-15) + Parking management (T-16) + Travel demand management (T-17)

Road Pricing (TLU-12): Road pricing / congestion pricing (T-18) + Cordon pricing (T-19)

Lower emissions off-road construction vehicles (T-4): Based on our initial qualitative assessment, ICF believes that this strategy would have a nominal GHG emission reduction potential. Few alternative options exist to reduce off-road construction vehicle emissions due to less stringent federal efficiency requirements for off-road engines. However, this is still being evaluated as part of Energy and Built Environment sector (EBE-9) as together, there may be more than nominal reductions from improvements to larger construction equipment and fixed generators.