Maine Greenhouse Gas Action Plan Development Process

Agriculture and Forestry Greenhouse Gas Reduction Options

March 19th, 2004

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MAINE AGRICULTURE SECTOR

1. Agriculture Inventory and Baseline Follow Up From 1/29/04 TWG Meeting

Request: Check into any information to be gained from multivariate/dynamic agriculture Carbon models in farm states (CCAP/USFS). USDA economic and crop forecasts are conducted at a national level on five year and ten-year intervals, with the most recent projections to 2013. We are continuing to search for state level forecast data from dynamic modeling.

Request: DEP will take lead on sensitivity testing of Ag inventory with respect to cropland and animal unit assumptions (Mike Karagiannes/Russel Libby). Acreage assumptions may have underestimated acreage of the potato rotation system. New inventory data from the US Agricultural Census may be needed to correct this through a rerun of the EPA inventory tool. NESCAUM is in the process of providing worksheets from the original inventory runs with details on cropland and animal units that will be needed for sensitivity testing.

Request: Check into whether federal compliance with ag land management practices is reflected in Ag inventory (CCAP). The EPA inventory tool calculates CO_2, CH_4 and N_2O emissions based on inputs of the number of animal units, pounds of fertilizer or pounds of crop type, with a series of conversion factors. There are no additional policy assumptions involved in these calculations. We do not know how many farms, acres or other units are practicing best management practices with detail in Maine so far, although USDA/NRCS is exploring methods for obtaining these estimates. The EPA inventory tool allows us to test the sensitivity of increasing or decreasing numeric inputs for each of the emissions categories. We could, therefore, conduct baseline sensitivity analysis, and potentially combine this with better BMP compliance data for policy scenario development.

Request: Look into net per acre GHG benefits of organic farming in scoring option. Russ Libby and Tom Peterson will report on progress at the meeting. The primary emissions benefits of organic farming are reduced N_2O emissions from reduced fertilizer application, and possibly reduced CO_2 from equipment use and transportation, depending on farming practices and location relative to markets. See also the background under organic farming and local grown food options.

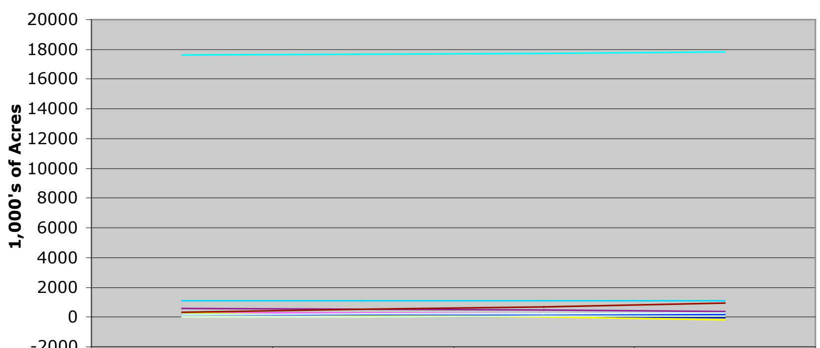
2. Baseline Updates

The graphs below show simple, linear extrapolation of 1990-2000 land and agriculture emissions trends in Maine. Alternative forecasting methods would involve some arbitrary but expert adjustment (such as zero or fixed percentage growth), or more complex modeling could be used if available.

The Natural Resource Inventory (NRI) by USDA provides data from 1982-1997 by land use type in Figure 1 below. Extrapolation of agricultural data shows a complete loss in some categories, and is probably not accurate. Other categories, such as urban land growth, may be more realistic. Wetlands are not included as a separate category and are embedded partially in the forest and agriculture categories. New figures with 2002 data will be available shortly, along with subcategory breakdowns for forestry, cropland, and urban land (Ray Voyer, USDA/NRCS, 2004).

Figure 1.

Maine Land Use Change NRI 1982-97



	1982	1997	2010	2020
Cropland, cultivated	233	155	87	-17
Cropland, noncultivated	288	258	232	192
Pastureland	265	123	1	-187
Forest Land	17640	17691	17736	17804
Minor Land Cover/uses	610	537	474	376
Urban Land	332	528	697	956
Rural Roads & Rails	177	184	191	200
Water - small streams	164	164	164	164
Water - census-streams	1090	1090	1090	1090
Federal Land (cover/use not	168	207	241	293

Years

Figure 2 below shows estimated agricultural emissions for Maine from 1990-2020 using NESCAUM results of the EPA inventory tool with simple linear extrapolation from 2000-2020. Figure 3 below was developed with the same methodology and shows estimated N2O emissions (expressed in pounds of N) for subcategories of land that is exposed to fertilizer. Linear extrapolation may or may not be the best forecasting method for these trends. Figure 4 below shows mass based trends for CH4 and N2O for Maine agriculture based on manure, enteric fermentation and fertilizer. Again, simple linear extrapolation was used but may not be the best baseline method.

Figure 2.

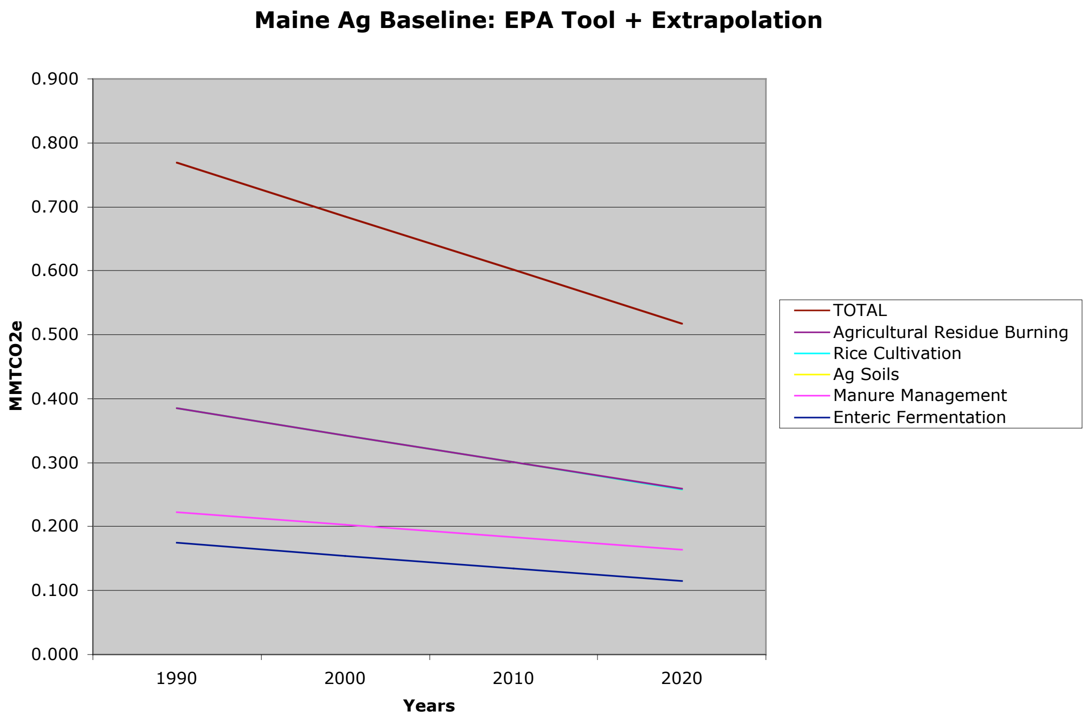


Figure 3.

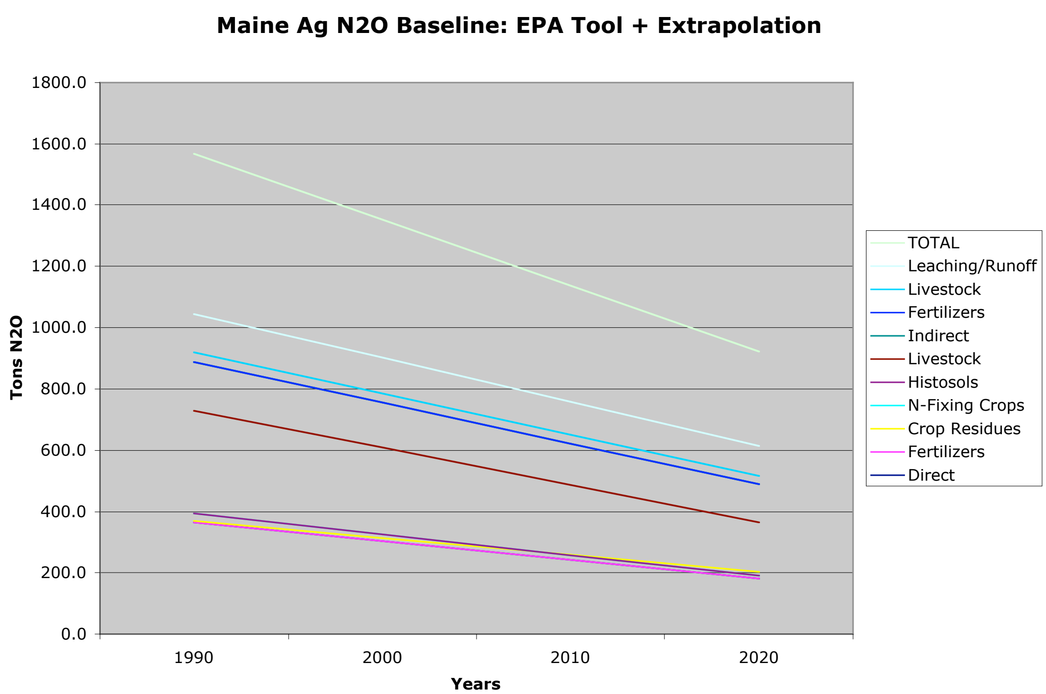
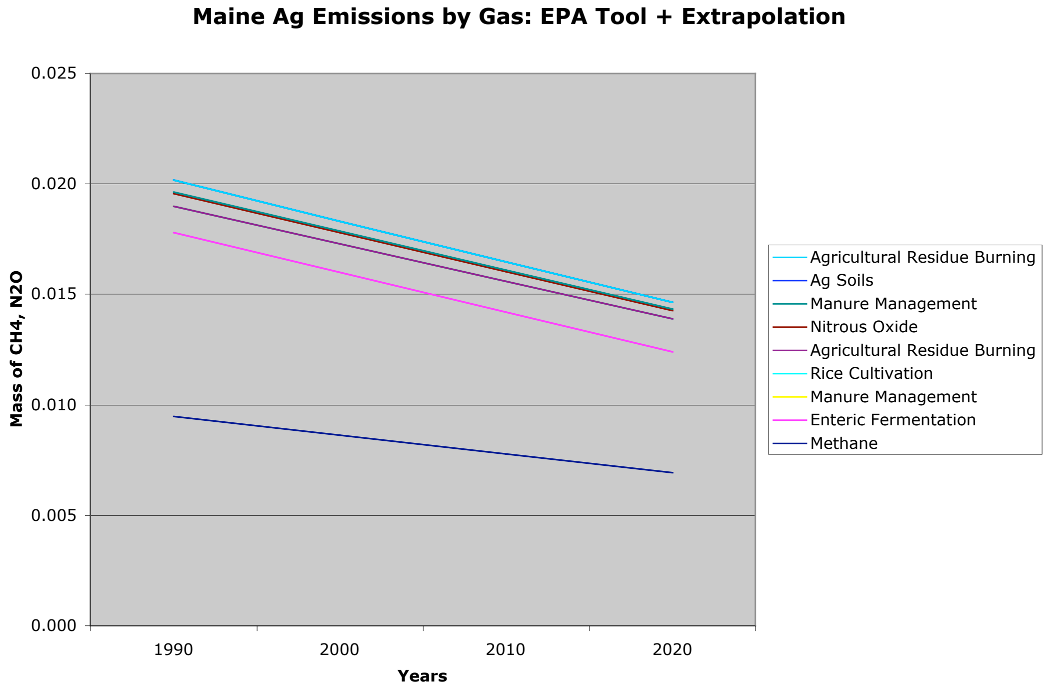


Figure 4.



The work group will need to develop a recommended method for extrapolating inventory data to years 2010 and 2020 for agricultural emissions.

Options include:

1. Simple linear extrapolation of trends
2. No change assumption
3. Fixed percentage assumption based on technical work group judgment
4. Advanced modeling (not currently available)

3. Summary Of Options from 1/29/04 AF TWG Meeting

A number of suggested changes to the list of agriculture options were made at the 1/29/04 work group meeting, as follows:

Install Manure Digesters: Russ Libby pointed out that there are at most four or five Maine farms scaled large enough to actually use manure digesters anytime before 2010 or even after. Electricity rates would have to double to make this option feasible he argued. The WG did not view this option as of much potential. This option has been deleted.

Ag Biomass Feed stocks for Electricity: Although concern was expressed that there could be scale limitations here as well, it was also noted that biomass is part of a total energy package to be tested. Tom Peterson will check with Jim Brooks of DEP about the status of analyzing biomass potential. A recent CONEG study estimates no measurable potential for ag biomass electricity feed stocks in Maine. USDA/NRCS concurs. This option is recommended for deletion.

Nutrient Management: There was interest in whether existing programs can be expanded or targeted and it was noted that ancillary benefits of this option might be as big or bigger than the GHG benefits. Presently we do not have breakdowns of fertilizer use by cropping system or data on the levels of adoption of best management practices. As these are developed (with assistance of the work group, NESCAUM and USDA/NRCS) new policy scenarios can be tested for reductions of N_2O and improved carbon storage in soil. The work group will need to formulate new assumptions to support this process (see later discussion under mitigation options).

Conservation Tillage/No-Till: There was discussion about the impact of off-road vehicle emissions, which it was explained would be accounted in the Transportation sector. Currently there are no off road agriculture calculations in the Transport Work Group. We will check on the feasibility of this data. Current estimates by USDA/NRCS (Chris Jones, 2004) are that these practices are already fully adopted where they are feasible in Maine. This option is a candidate for deletion.

Increase Cover Crops: This option was viewed as having significant potential on at least 35,000 crop acres and it was noted that the second crop aspect is of economic interest to the potato industry in the state. Cover crops and longer rotation of high organic crops can potentially increase carbon storage in soils and reduce nitrogen emissions by incorporation of fertilizer. Longer rotations may have significant potential. USDA/NRCS is exploring estimates of the adoption of best management practices and the potential for expansion. As new data is available the EPA inventory tool can be rerun to provide estimates of new policy scenarios (see later discussion under mitigation options).

Agricultural Land Preservation: There was much discussion of this option in terms of how the benefits will accrue off-sector (in the Transportation accounts for example); the difficulties of measuring land use change and the need for the analysis to recognize that there are different sub state land use change processes in Maine in the north, central Maine/western mountains, and urbanizing southern Maine. The NRI data in Figure 1 shows substantial increase in urban acreage and conversion from forest and farmlands from 1982-1997 (this data is being updated). Extrapolation of this data suggests significant conversion in the future. Open space protection and smart growth scenarios are being evaluated in the transport work group and we will continue to coordinate assumptions of development patterns trends and alternative policy scenarios. In addition to transport emissions savings, preserved agricultural lands retain carbon storage ability that will be calculated under new policy scenarios. Coordination and research is ongoing (see later discussion under mitigation options).

Biodiesel and/or Ethanol for Farm Equipment: There is a 100,000-acre potential for biodiesel. A n umber of technical questions were discussed including where baseline data comes from for off-road vehicles, how the EPA State Inventory Tool handles this, and needs to coordinate data with the Transportation sector. This option is under further review (see later discussion on mitigation).

Nutrient Reduction: This option will be affected by action on AF 1.3-Nutrient Management. This option was merged into a single nutrient management category.

Organic Farming: It was noted that 20,000 of 600,000 farm acres were in organic production in 2003. There was discussion of how the $45 million/week in state payments for out-of-state food purchases represents off-sector transportation costs (this is addressed by AF 1.10). An estimate is needed of what the per acre net GHG benefits are expected from organic production. It was also noted that the ancillary benefits of this option are significant. Further research on the per acre net benefits of organic farming versus traditional farming are in progress (see later discussion under mitigation options). The work group will need to formulate policy scenarios for testing in the future.

Support Local Farming/Buy Local: See above. Further research on the transportation savings and economic development benefits of local farming versus farm imports are in progress (see later discussion under mitigation options). The work group will need to formulate policy scenarios for testing in the future.

4. Priorities For Analysis From 1/29/04 AF TWG Meeting

AGRICULTURE MITIGATION OPTION	PRIORITY FOR ANALYSIS
1. Ag Biomass Feed Stocks For Electricity	**High**
2. Biodiesel And/Or Ethanol For Farm Equipment	**High**
3. Nutrient Management – Organic And Synthetic	**High**
4. Conservation Tillage/No-Till	**High**
5. Increase Cover Crops And/Or Rotations Of High Organic Matter Crops	**High**
6. Agricultural Land Preservation	**High**
7. Organic Farming	**High**
8. Support Local Farming/Buy Local	**High**

5. Preliminary GHG Savings & Cost Estimates for Priority Measures

Policy Action	GHG savings 2010	GHG savings 2010	Cost Effectiveness
Ag Biomass Feed Stocks for Electricity	Very low	Very low	NA
Biodiesel and/or Ethanol for Farm Equipment	Very low	Very low	NA
Nutrient Management – Organic And Synthetic	Low	Low	TBD
Increase Cover Crops And/Or Rotations Of High Organic Matter Crops	Low	Low	TBD
Increase Cover Crops	Low	Low	TBD
Agricultural Land Preservation	Potentially High	Potentially High	TBD
Organic Farming	Low	Low	TBD
Support Local Farming/Buy Local	Low	Low	TBD

6. AGRICULTURE SECTOR – Mitigation Options

A-1 Agriculture Biomass Feed Stocks for Electricity

Policy Description: Incentives to grow crops or use crop waste for use as a fuel or for co-firing with fossil fuels.

BAU Policy/Program: Very little farm biomass is used for power generation in Maine currently. Crop residue is generally retained on site for soil management. Energy crops are not currently grown in Maine at a significant level.

Preliminary GHG Savings and Cost Estimates:

CONEG estimates no measurable supply potential for biomass feed stocks from agricultural residues in Maine. See "Securing a Place for Biomass in the Northeast United States: A Review of Renewable Energy and Related Policies." CONEG Policy Research Center, Inc. Northeast Regional Biomass Program 400 North Capitol Street, N.W., Suite 382 Washington, DC 20001 Prepared by: XENERGY Three Burlington Woods Burlington, MA 01803 Tel: (781) 273-5700 Web: www.xenergy.com Contact: Chris Clark**.** Biomass generation potential available at http://www.eere.energy.gov/state_energy/tech_biomass.cfm?state=ME

A-2 Biodiesel or Ethanol Fuel for Farm Equipment

Policy Description: Tax credit or other incentive to expand qualification and use of lower carbon fuels with biomass additives.

BAU Policy/Program: Two pilot programs exist for biodiesel in Maine: 1) the Chewonki Foundation has a small-scale demonstration pilot underway; and 2) a cooperative exists in Hancock County to promote use of biodiesel through existing equipment. Neither program has a significant rate of market penetration at present. L.L. Bean Company recently began testing of B20 in its fleet with purchases of biodiesel from a plant owned by Frontier Energy in South China, Maine. A graduate program at USM is exploring establishment of a biodiesel fund to support fuel needs of campus VIP fleets. The Alternative Fuels Data Center (http://www.afdc.doe.gov/refuel/state_tot.shtml) lists three biodiesel fueling locations in Maine.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

This option is under development. Key analytical questions are listed below:

<u>Supply curve questions:</u>

- What is the potential (above baseline) for sources of grain ethanol (i.e., soybeans, corn) to be grown in Maine in total acres? <u>Early indications are that supply potential is low. One gallon of biodiesel requires 1.4 bushels of soybeans, or 7.3 pounds of soybean oil. Soybeans are a minor crop in Maine, with only a few thousand acres in production.</u> What are the price inducements required and sensitivities of these supply responses?
- What is the potential (above baseline) for sources of cellulosic ethanol (switch grass, shrubs, poplars, etc) to be grown in Maine? What are the price inducements required and sensitivities of these supply responses? <u>TBD</u>
- What is the delivered price of these supplies to conversion facilities? What is the status and potential availability of conversion facilities in the future? <u>TBD</u>
- What is the conversion cost and delivered price of fuel (per gallon)? Are there any key sensitivities to be tested? <u>TBD</u>
- What is the CO_2 offset factor per unit (gallon) compared to gasoline or diesel fuel? <u>See notes below.</u>

<u>Demand curve questions:</u>

- How many current vehicles (farm equipment) can use biodiesel or ethanol, and what is the price of inducing a fuel switch? <u>Current diesel equipment can use biodiesel, however increased maintenance of valve seals may be required.</u>

- How many new biofuel vehicles can be brought into the equipment fleet, and over what time period? Is there an additional price of inducement to use biofuel vs. diesel or gasoline for these vehicles? TBD
- Will equipment use rates (per vehicle) change in the by 2010 and 2020 and, if so, by what percent on an annual basis? TBD
- What is the net offset of biofuel gallons versus baseline use of diesel fuel or gasoline? See notes below.
- What are the offset emissions factors per gallon, and in aggregate? See notes below.

Notes:

- Potential GHG lifecycle impacts from renewable fuels vary widely due to farming practices and crop choice:
  - **Recent biodiesel data shown a range of +18% to - 221% net GHG impacts.** Biodiesel is potential high in terms of GHG emissions due to the nitrogen fixation ability of soybeans, which causes N_20 releases during harvest. An alternative crop (rapeseed), improved farming practices (low till) or shifting current soybean crops (from feed to fuel) would mitigate this GHG impact.[1]
  - **Ethanol's GHG impact ranges from +20% to -20%.** Corn ethanol may increase GHG emissions if it replaces pastureland or low intensity agriculture. As with soybeans, this depends on if new cropland is dedicated to ethanol or if current corn cropland is converted from feed to ethanol. Farming practices and ethanol production processes are increasing the potential for corn-based ethanol.[2]
  - **Cellulosic-based ethanol reduces GHG emissions by up to 80% vs. gasoline.** Current research at NREL as elsewhere indicates the potential for converting a variety of feed stocks, including corn stalk or stover (as well as those plants listed above), into low-GHG renewable fuels.[3]

References:

L.L. Bean Biodiesel announcement:
http://www.afdc.doe.gov/documents/altfuelnews/7_1states.html

USM Biodiesel Initiative: http://www.megreencampus.com/USMbiodisel.html

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[1] Source: National Renewable Energy Laboratory (NREL) and Delucci et al.
[2] Source: Ibid NREL and Delucci et al.
[3] Source: Argonne National Laboratory's GREET model

A-3 Nutrient Management

Policy Description: Improve efficiency of fertilizer application. A portion of nitrogen applied to the soil is subsequently emitted as N_2O (a GHG); therefore, a reduction in the quantity of fertilizer applied or measures that improve uptake can reduce N_2O emissions. This can be accomplished by substituting organic fertilizer (primarily manure) for synthetic fertilizer, by altering the timing of applications, by altering cover crops and rotational schemes, or by increasing soil testing to improve efficiency (and reduce unnecessary applications).

BAU Policy/Program: Maine passed a Nutrient Management Law in 1998 (7 M.R.S.A. Chapter 747, Nutrient Management Act) that prevents winter manure spreading and requires a nutrient management plan. Maine also has an Agriculture Compliance program that requires plans and implementation of certain best management practices in order to quality for certain support payments. The Environmental Quality Incentives Program (EQIP) was reauthorized in the US Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. The Conservation of Private Grazing Land (CPGL) initiative ensures that technical, educational, and related assistance is provided to those who own private grazing lands. The USDA Conservation Security Program provides security payments to farmers in exchange for adoption of environmentally beneficial best management practices. The Agricultural Management Assistance Program provides cost share payments for land and water conservation to 15 states where federal crop insurance levels have been historically low, including Maine.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for new farm acreage to be placed into nutrient management practices in Maine in total acres with breakdowns by location, and practice? Estimates are under development with work group assistance and data from NESCAUM and NRCS.
- What are the price inducements required and sensitivities of these supply responses? What are the per acre costs by practice and location? Estimates are under development with work group assistance and data from NESCAUM and NRCS.
- What are the per acre GHG savings for each practice and location in Maine? What are the sensitivities for analysis? The EPA inventory guidance is not site specific and can be used for state averages. However, site variation can have a substantial difference on performance. For online calculation of potential nitrogen savings for a real (or hypothetical) site, try: www.nutrientnet.org/prototype/html/index.html.

Demand curve questions:

- What is the price of inducing a switch to new management practices? Estimates are under development with work group assistance and data from NRCS.
- What is the level of government or market support for expansion of practices to new acreages? Estimates are under development with work group assistance and data from NRCS.
- What is the appropriate offset emissions factor for new practices in Maine? Calculations of GHG savings can be conducted with the EPA inventory tool by comparison of poundage of fertilizer required by acre compared to baseline numbers (forthcoming through NESCAUM).
- What is the aggregate offset for new practices? Aggregate impacts are a simple sum of per acre savings calculated by the EPA inventory tool.

Sample Calculation:

Potatoes BMP: Alter nitrogen application by applying 40 pounds initially, then waiting six to eight weeks for second application of 80 pounds as opposed to applying 120 pounds at the outset. Assume that 50 percent of current acreage of 65,000 acres uses traditional methods, and that 25 percent of the total acreage could be brought into the new application practice (16,500 acres) at a savings of 40 pounds per acre of fertilizer that will be fully incorporated by crops and not applied in excess (650,000 pounds nitrogen saved).

Using the EPA Inventory Tool:

Maine Potato growers could potentially reduce losses of 294,835 kg N as synthetic fertilizer during the calendar year 2005.

294,835 kg N x (1 – 0.1) = 265,351 kg unvolatilized N/yr

Convert emissions to N_2O-N using the 0.0125 emission factor, and then to units of N_2O using the molecular weight ratio, 44/28.

265,351 kg N/yr x 0.0125 N_2O-N/N x 44/28 = **5212.26 kg N_2O per year**

5212.26 kg N_2O = 5.74 tons N_2O x 310 Global Warming Potential (GWP) = **1779.4 tons CO2e per year**

A-4 Conservation Tillage/No-Till

Policy Description: Practices that result in less disruption of the soil can increase the carbon content (stock) of soil or reduce its rate of loss (flow) to the atmosphere.

BAU Policy/Program: Maine has an Agriculture Compliance program that requires plans and implementation of certain best management practices in order to quality for certain support payments. The Environmental Quality Incentives Program (EQIP) was reauthorized in the US Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. The Conservation of Private Grazing Land (CPGL) initiative ensures that technical, educational, and related assistance is provided to those who own private grazing lands. The USDA Conservation Security Program provides security payments to farmers in exchange for adoption of environmentally beneficial best management practices. The Agricultural Management Assistance Program provides cost share payments for land and water conservation to 15 states where federal crop insurance levels have been historically low, including Maine.

Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for new farm acreage to be placed into nutrient management practices in Maine in total acres with breakdowns by location, and practice? NRCS estimates that this practice is already adopted to the maximum extent possible and not likely to provide opportunities above baseline (Chris Jones, 2004).
- What are the price inducements required and sensitivities of these supply responses? What are the per acre costs by practice and location? Not applicable.
- What are the per acre GHG savings for each practice and location in Maine? What are the sensitivities for analysis? Not applicable.

Demand curve questions:

- What is the price of inducing a switch to new management practices? Not applicable.
- What is the level of government or market support for expansion of practices to new acreages? Not applicable.
- What is the appropriate offset emissions factor for new practices in Maine? Not applicable.
- What is the aggregate offset for new practices? Not applicable.

A-5 Increase Cover Crops

Policy Description: Increasing the use of cover crops can potentially increase soil carbon content and increase the nitrogen content of soil and reduce fertilizer need. Increased use and length of high organic rotation crops can also increase incorporation of nitrogen and storage of carbon.

BAU Policy/Program: Maine has an Agriculture Compliance program that requires plans and implementation of certain best management practices, including tillage practices, in order to quality for certain support payments. The Environmental Quality Incentives Program (EQIP) was reauthorized in the US Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. The Conservation of Private Grazing Land (CPGL) initiative ensures that technical, educational, and related assistance is provided to those who own private grazing lands. The USDA Conservation Security Program provides security payments to farmers in exchange for adoption of environmentally beneficial best management practices. The Agricultural Management Assistance Program provides cost share payments for land and water conservation to 15 states where federal crop insurance levels have been historically low, including Maine.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for new farm acreage to be placed into cover crop management practices in Maine in total acres with breakdowns by location, and practice? Estimates are under development with work group assistance and data from NESCAUM and NRCS.
- What are the price inducements required and sensitivities of these supply responses? What are the per acre costs by practice and location? Estimates are under development with work group assistance and data from NESCAUM and NRCS.
- What are the per acre GHG savings for each practice and location in Maine? What are the sensitivities for analysis? The EPA inventory guidance is not site specific and can be used for state averages. However, site variation can have a substantial difference on performance. For online calculation of potential nitrogen savings for a real (or hypothetical) site, try: www.nutrientnet.org/prototype/html/index.html.

Demand curve questions:

- What is the price of inducing a switch to new management practices? TBD

- What is the level of government or market support for expansion of practices to new acreages? TBD
- What is the appropriate offset emissions factor for new practices in Maine? TBD
- What is the aggregate offset for new practices?

A-6 Agricultural Land Conservation

Policy Description: Preservation of agricultural land can retain ability of land to sequester carbon from the atmosphere and direct growth (and related transportation emissions) to more efficient locations.

BAU Policy/Program: The Land for Maine's Future Program (LMFP) was developed in 1987 to protect natural and working lands through financing of easements or fee title; 50 percent of funds must be matched. The USDA Farm and Ranchland Protection Program (FRPP) also provides limited cost sharing for land protection. Maine's Farm and Open Space Tax Law was developed in 1975 to provide tax relief to farm and forestland owners. The Maine Tree Growth Tax Law was enacted to provide property tax relief to owners of woodlots and forestlands. The USDA Farm and Ranch Land Protection Program (FRPP) provides matching funds to help purchase development rights to keep productive farm and ranchland in agricultural uses. The USDA Wetlands Reserve Program is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Growth management policies and programs also significantly affect farmland protection, including zoning, property taxation, and infrastructure funding (particularly transportation) as well as private preservation actions by land trust organizations.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

<u>Supply curve questions:</u>

- What is the potential (above baseline) for farm acreage to be placed into permanent protection in Maine in total acres, with breakdowns by location, and type of farm? <u>At current rates NRI projects that Maine will lose 47,500 acres of farmland to urban development by 2020 (measured as land cover and not lot size: NRI figures only track acreage in lawn or within 50 feet of a dwelling, and only for lots under 10 acres in size). Growth management programs can reduce acreage conversion, and increase proximity and density of growth to reduce travel demand. Policy scenarios must be developed that estimate acreage conversion of farmland protection programs.</u>
- What are the price inducements required to landowners and sensitivities of these supply responses? What are the per acre costs by farm type and location? <u>TBD</u>
- What are the per acre GHG savings for preservation vs. alternative uses of farmland in Maine by farming type and location? <u>Benefits of land protection potentially include soil carbon, nitrogen loading, and reduced transportation emissions. Development that is not location efficient leads to higher transportation demand and CO2 emissions (each gallon of gasoline emits 19.6</u>

pounds of CO_2). Travel demand reductions can vary from relatively small to over 50 percent from growth location policies.

Demand curve questions:

- What is the market or institutional price needed to inducing land protection vs. alternative uses (development)? TBD with Transport work group.
- What is the level of government or market support for land protection? TBD with Transport work group.
- What are the appropriate offset emissions factor per acre for farmland protection in Maine? TBD with Transport work group.
- What is the aggregate GHG savings for farmland protection in Maine for each GHG account (including the farmland account and transportation account)? TBD with Transport work group.

Sample Calculation:

Assume that 50,000 new homes are located on the acreage converted from farmland in the next 20 years. (The American Housing Survey estimates the average lot size of a new single-family home at about two acres – not to be confused with the NRI measurement of lawn or dwelling area. Under NRI definitions the cover change associated with conversion of farmlands will be about half the lot size or more. A one home per acre average under the NRI definition is probably ballpark.) Assume that a combined open space protection and location efficient growth program could cut the rate of farmland conversion in half, and increase the density and proximity averages of the 50,000 new homes proportionately. Assume that travel demand per household is 5,000 miles per year less than before as a result, and that the average mileage per household per year was originally 20,000 miles. Assume the average household vehicle gets 20 miles per gallon fuel economy.

5,000 miles per household automobile travel reduction/20 miles per gallon = 250 gallons gasoline savings per year per household, or $375 per household fuel savings at $1.50 per gallon.

250 gallons of gasoline x 19.6 pounds CO_2 per gallon of gasoline = 4,900 pounds of CO_2 saved per household per year x 50,000 households = 245,000,000 pounds CO_2 saved by households per year. Due to a gradual transition of household implementation, assume half of this amount is saved during the 15-year period, or 12,250,000 pounds CO_2 per year.

12,250,000 pounds CO_2 per year = 6125 tons CO_2 per year, or .006125 MMTCO2e per year.

Over 15 years this would total .092 MMTCO2e.

Carbon sequestration savings are not included.

References:

USDA Natural Resource Inventory, USDA, NRCS office in Bangor Maine. Ray Voyer.

The American Housing Survey: US Bureau of the Census, US Department of Housing and Urban Development

A-7 Organic Farming

Policy Description: Organic farming techniques can reduce the on-farm energy uses (e.g., reduced tractor use) by reduced tillage (see 3.1) and off-farm energy (e.g., reduced transportation of fertilizer and pesticides).

BAU Policy/Program: About 20,000 acres of farmland in Maine are presently in organic farming out of 155,000 acres of total cultivated cropland. The purpose of the USDA Resource Conservation and Development (RC&D) program is to accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in designated RC&D areas. USDA has recently promulgated organic food standards.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for farm acreage to be placed into organic farming in Maine in total acres, with breakdowns by location, and type of farm? About 20,000 acres of farmland in Maine is presently in organic farming out of 155,000 acres of total cultivated cropland. The potential for expansion of this level is unknown, but could be explored through sensitivity analysis.
- What are the price inducements required to landowners and sensitivities of these supply responses? What are the per acre costs by farm type and location? TBD
- What are the per acre GHG savings for organic farming vs. alternative uses of farmland in Maine by farming type and location? These potentially include soil carbon, nitrogen loading, and reduced transportation emissions. What are the sensitivities for analysis? TBD

Demand curve questions:

- What is the market or institutional price needed to induce organic farming vs. alternative uses (development)? TBD
- What is the level of government or market support for organic farming? TBD
- What is the appropriate offset emissions factor per acre for organic farming in Maine? TBD; this will primarily be N_2O savings.
- What is the aggregate GHG savings for farmland protection in Maine for each GHG account (including the farmland account and transportation account)? TBD

References:

Maine organic farmers and gardener's association: http://www.mofga.org/

A-8 Support Local Farming/Buy Local

Policy Description: Increased purchase of locally grown produce can potentially reduce emissions associated with the transport of agricultural products.

BAU Policy/Program: The purpose of the USDA Resource Conservation and Development (RC&D) program is to accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in designated RC&D areas.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for production of indigenous farm products vs. imports in total product volume, with breakdowns by product type and location? TBD
- What are the price inducements required to growers and sensitivities of these supply responses? What are the differential costs per product type to growers? TBD
- What is the emissions factor of a locally produced farm product vs. an imported product? What are the relevant product categories and related emissions factors? TBD

Demand curve questions:

- What is the market or institutional price needed to induce wholesalers and consumers to switch to locally grown products? TBD
- What is the level of government or market demand for new locally grown product purchases at different price levels? How sensitive are purchases to price? TBD What is the aggregate GHG savings for farm product switching in Maine for each GHG account (including the farmland account and transportation account)? TBD

References:

Food, Fuel, and Freeways: An Iowa perspective on how far food travels, fuel usage, and greenhouse gas emissions. Leopold Center for Sustainable Agriculture 209 Curtis Hall Iowa State University Ames, Iowa 50011-1050 Website: http://www.leopold.iastate.edu/

MAINE FORESTRY SECTOR

1. Forestry Inventory and Baseline Follow Up From 1/29/04 TWG Meeting

Request: Look at biomass equations in MFS 1999 report "Estimating Biomass …" for refinement of FORCARB biomass account (MFS/USFS/CCAP). **(See 2.1.a below)**

Request: Bring FHM (Phase 3) data into FORCARB inventory (USFS/MFS/CCAP). **(See 2.1.b below)**

Request: Check on how wetlands handled in FORCARB accounts (CCAP/MFS/USFS). **(See 2.1.g below)**

Request: Look into use of Skog & Nicholson (1998) data to refine wood products account in FORCARB (CCAP/USFS). **(See 2.1.d below)**

Request: Check on how methane from landfills handled in FORCARB accounts (CCAP/USFS). **(See 2.1.d below)**

2. Inventory and Baseline Updates From March 4, 2004 Forest Experts Meeting

1. **Next steps on FORCARB inventory measurements for Maine for the year 1990 and beyond, including adjustments on biomass, forest floor/woody debris, soil carbon and wood products accounts.** The goal of these tasks is the creation of consensus estimates for 1990 and 2000 GHG forest emissions and sinks in a framework that can be used for meaningful baseline projections and mitigation option analysis.

    a. Tree biomass: Maine Forest Service will provide Jim Smith copies of Maine tree biomass equations for near term incorporation into FORCARB. New runs may be available in the next two weeks. The results may significantly change earlier FORCARB2 estimates. Jim will report on progress.

    b. Forest floor: Jim Smith will begin incorporation of Forest Health Monitoring (FHM) data for Maine into FORCARB. Time series data may be limited to recent years and require back casting to 1990. It is not known how significantly this may change earlier FORCARB2 estimates or how long this will take. Jim will report on progress.

c. Soils: After extended discussion the group recommended altering the current soil methodology by creating transition functions that ramp up or down during shifts in forest types (species). The group did not recommend using the present FORCARB methodology, or using a simple "no change" assumption. Current methods assign a carbon estimate to soils based on species type regardless of stand age or elapsed time since the forest was in another species designation (they also do not consider harvest method impacts). The result of this assumption is that soil carbon levels can jump significantly when species shift due to regeneration following harvest or natural damage. Realistically these are slow ecological processes and soil carbon changes evolve slowly over time rather than making quick quantum leaps. The group also decided that a simple "no change" assumption that would hold soil carbon levels steady over time regardless of shifts to new species categories could lead to significant error. Jim Smith will create some technically realistic (from literature review) and pragmatic methods for recalculation of soil carbon that provide a gradual shift between forest types. Jim will begin this process immediately but is not sure how long it will take. The results may significantly change earlier FORCARB2 estimates. Jim will report on progress.

d. Wood products: After extended discussion the group recommended that import and export data be provided for all wood categories to address GHG accounting issues. Typically state GHG accounting debits or credits emissions depending on the location of the activity that changes emissions levels. Wood products life cycles, for instance, involve several steps from: growing stocks of carbon, extracting raw materials, processing raw materials to product, use of product (energy, structural materials, paper) and disposal of waste materials. These steps can vary in location and alter state GHG inventories and crediting. Interstate issues can be important. For instance, Maine is a net importer of wood biomass residue for energy production. A number of accounting issues will need to be addressed to calculate Maine GHG reductions from options to expand biomass flow from Maine forests into either energy or product production and use. To assist, the Maine Forest Service provided inventory data with imports and exports reaching back to 1990, and will assist in creating a spreadsheet for 1990 and 2000 estimates. Recent data may be significantly better than 1990 data and require some back casting. The group did not feel it was important to alter the basic HARVCARB coefficients for the carbon lifecycle of wood products. Tom Peterson will work with Maine Forest Service (Don Mansius) and US Forest Service (Jim Smith) on a spreadsheet that links with FORCARB.

e. Land use change: FORCARB does not attribute any carbon stocks to nonforested lands, so as forest stocks are converted form forest land use to other land uses (agriculture and residential, primarily) the model zeroes out the carbon stocks on these lands. Realistically many residential lots and farms have significant forest stocks. The group agreed that some transition function needs to be created for this land use conversion process. The group also expressed concern that non-rural land uses (residential, commercial, municipal and institutional land uses) are not captured either in the forest or agriculture inventory. Tom Peterson will look at potential data sources for these lands and report back to the group for further action on carbon stock estimates on these lands. Jim Smith will look at potential data and methods for ramping carbon stocks up or down during land use change from forested to nonforested land uses. Jim was not able to estimate the time needed to do this but will report back.

f. <u>Time series:</u> Presently FORCARB2 uses Forest Inventory Assessment (FIA) carbon stock data from 1982, 1995 and post 2000 to derive 1990 and 2000 GHG estimates. The Maine Forest Service expressed concerns about the accuracy of 1995 data (it may have understated stocks significantly) and the group noted that these numbers are being recalibrated over the next ten months. Because 1995 data is suspect and will not be corrected during the Maine SAG process (which ends June 30, 2004) the group recommended using 1982 and post 2000 data for calculation of a slope and intercept for 1990 and 2000 GHG estimates. Jim Smith will recalculate the FORCARB inventory for Maine based on this adjustment.

g. <u>Wetlands:</u> Ivan Fernandez raised a concern that wetlands may not be covered adequately under FORCARB inventories. Jim Smith reported that forested wetlands are covered under FORCARB but nonforested wetlands are not. The group expressed an interest in seeing wetlands inventory data for Maine and suggested coordination with several land protection organizations. Tom Peterson will contact these groups and identify available wetlands inventory data.

2. **Methods and options for FORCARB baseline formulation to 2020 (and beyond, if applicable).** The goal of these tasks is the creation of consensus estimates for 2010 and 2020 GHG forest emissions and sinks in a framework that can be used for meaningful mitigation option analysis.

   a. After extended discussion the group decided to recommend a simple extrapolation of trends from 1990-2000 data (excluding 1995) for forest carbon stocks. The group decided to use the most recent wood products figures as a percentage of forest stocks as a basis for baseline projection lacking any better forecast data for wood products. They also recommended checking with some industry representatives for better data. Tom Peterson will make these contacts and report back to the group on data and options. The group noted that wood products forecasts are likely to involve significant economic uncertainties.

3. Summary Of Options from 1/29/04 AF TWG Meeting

Afforestation and Reforestation: Overall, it was argued that reforestation is not as applicable to Maine's situation as afforestation, but there are questions about the amount of potential gains from stand and genetic improvements. In terms of program design, there are a number of existing technical assistance programs that are not fully funded and have additional potential. Again, the role of land use conversion was noted as important but needing analysis. <u>New data from NRI have been developed on forest conversion – see later discussion on mitigation actions.</u>

Forest Management: This option has very important potential and connects with the wood products and soils accounts and the question of alternative use of standing biomass and impacts on the Electricity sector. The option needs to be fleshed out into Maine-specific program (may be several specific options) that focus on practices which increases Carbon storage and reduce erosion. Possible option categories are Commercial Thinning, Extended Rotation, Forest Protection, Intensive Management or Carbon Management Practices. Some of these options (some practices under intensive management) can also have disbenefits it was noted. <u>Mitigation options were revised on recommendation of the forest experts group – see later discussion.</u>

Urban Forestry: The potential of this option was uncertain. It was felt the cooling benefit is the major potential GHG benefit, but that there are also ancillary benefits, perhaps the public education benefit of giving the household sector a GHG action that is relevant to them. There was a about whether this could include commercial building cooling, where the GHG benefit might be greater. The option should be kept on the table but Tom Peterson will see if the BFM Working Group can estimate potential cooling benefits. <u>New data has been developed on the role of windbreaks – see later discussion.</u>

Forest Preservation: This option should be kept on the table but redefined as <u>Conservation</u> to better fit Maine's context, practices and values. <u>Completed.</u>

No Net Loss of Forests: It was noted that the bill introduced by Sen. Collins could create a significant pool of funds for suburban-context land conservation. It was felt that this option should be combined with AF 2.4 as a sub-part. <u>Consolidated with the above option.</u>

Promote Use of Wood Products: There was a discussion of the potential for advanced wood products development/marketing (such as composites) to have GHG benefits in Maine from greater utilization of biomass in products that would otherwise not be used in production. There are complex issues here that need further investigation: what kinds of displacement of GHG-impacts take place across sectors? (e.g., energy used in production); how does the wood products account currently handle import and export of products? Tom Peterson will investigate further with MFS help, particularly how HARVCARB handles displacement issues. It was also asked whether there is a Carbon credit for building design such as use of new materials. Tom will see if this is an item the BFM Working Group can address. See results of Maine forest experts meeting.

State Procurement of Locally Grown Wood Products: In terms of program design there is an Executive Order that relates to this option that needs to be looked at. The way in which the option includes both locally produced products and locally grown wood needs to be looked at. See later discussion on mitigation options and results of forest experts meeting.

Forestry Biomass Feed stocks for Electricity: This option received a big thumbs up for potential. It was noted that forest-based Carbon savings beyond storage depend on actual conversion of energy captured by photosynthesis back into energy that displaces other energy sources less desirable for GHG-reduction purposes—hence the important potential of biomass feed stocks. Several factors needing analysis were discussed including transportation costs (and how accounted); the time limit on this option to have beneficial effects; and displacement of clean fuels. It was suggested that the air permits for existing co-generation facilities might have valuable information about costs if they are analyzed. It was felt these were big questions about a major option. See later discussion on mitigation options and results of forest experts meeting.

Carbon Offsets from Agriculture/Forestry Activities (in-state and out-of-state): Tom Peterson noted that Carbon offsets are a potentially a big issue for Maine and the region; that the New England Governors have shown some interest in a regional registry; and that baseline accounting will be a prerequisite to any program and to establishing what market for offsets is possible. There were no specific suggestions about this option's analysis/design at this time. See later discussion on mitigation options and results of forest experts meeting.

4. FORESTRY: Priorities for Analysis from 1/29/04 AF TWG

1. Afforestation
2. Forest Management: Commercial Thinning, Extended Rotation, Forest Protection, Intensive Management or Carbon Management Practices
3. Urban Forestry
4. Forest Conservation
5. Promote Use of Wood Products
6. State Procurement of Locally-Grown Wood Products
7. Forestry Biomass Feed stocks for Electricity
8. Carbon Offsets from Agriculture/Forestry Activities (in-state and out-of-state)

5. Forestry Mitigation Follow Up From 1/29/04 TWG Meeting

Request: Check with Jim Brooks/DEP about analysis of biomass potential**. In progress.**

Request: Consider changes discussed for Forestry options list: Focus AF 2.1 on afforestation, rather than reforestation; Identify Maine-specific programs that make up Forest Management (AF 2.2); Change Forest Preservation (AF 2.4) to Forest Conservation, keep option. **Completed, see item 7 below.**

Request: Check with BFM Working Group on estimation of urban tree cooling benefits for commercial use (CCAP). **In progress, see mitigation option discussion.**

Request: Check how HARVCARB handles displacement issues under wood products subsector and whether BFM Working Group can address (CCAP with MFS). **In progress.**

6. Updated Mitigation Options From March 4, 2004 Forest Experts Meeting

1. **Review of data and FORCARB modeling needs for evaluation of mitigation options, including: afforestation (urban and rural), forest management (several potential options), forest conservation, expanded wood products use, expanded local wood products use, expanded biomass feed stocks, and carbon offsets.** The goal of this task was clarification on the list and definition of potential forestry mitigation options, identification of best available data, and ranking of priorities for analysis.

   b. Tom Peterson reviewed the list of options identified at the last technical work group meeting, including:

      1. Afforestation (urban and rural)
      2. Forest management (including sub categories of increased rotation length, precommercial thins, intensive management practices, and carbon management practices)
      3. Potential options)
      4. Forest conservation
      5. Expanded wood products use
      6. Expanded local wood products use
      7. Expanded biomass feed stocks
      8. Carbon offsets

   c. Tom requested clarification on the list and definition of all options to assist with the quantification of measures, particularly for the forest management and wood products categories. Ivan Fernandez offered a list of potential new options for consideration in forest management including: wetlands protection and restoration, fire management, silviculture options, species control, and plantation forestry. The group brainstormed and developed the following new list of recommended forestry mitigation options with rankings indicating priority for analysis and GHG reduction potential:

7. Updated Priorities for Analysis from March 4, 2004 Forest Experts Meeting

FORESTRY MITIGATION OPTION	PRIORITY FOR ANALYSIS
1. **Carbon offsets policy development** (or credits) to provide market-based value for forestry mitigation options.	**High**
2. **Expanded use of biomass electricity feed stocks** to displace more carbon intensive power production from coal and gas, and to increase carbon sequestration rates in thinned stands in the forest, and to reduce carbon emissions from decomposition caused by disease and storm damage.	**High**
3. **Expanded wood products use** to displace more energy intensive building materials (steel and concrete) and increase carbon storage in structural materials.	**High**
4. **Reduce conversion of forestland to other land uses** to maintain carbon sequestration and long tem biomass flow to energy and or wood products use.	**High**
5. **Reduce conversion of wetlands to other land uses** to maintain carbon sequestration and long tem biomass flow to energy and or wood products use.	**High**
6. **Restore longer-lived softwood to sites that have reverted to hardwoods** by precommercial thin and hardwood harvest to increase carbon sequestration, and increase biomass flow to energy or wood products use.	**High**
7. **Shorten spruce harvest rotation and reduce fir component** through thinning to reduce budworm risk and decomposition emissions, increase carbon sequestration, and increase biomass flow to energy or wood products use.	**High**
8. **Expanded *local* wood products use** to reduce transportation emissions associated with delivery of raw materials and or products.	**Medium**
9. **Afforestation (rural)** to increase carbon sequestration and long tem biomass flow to energy and or wood products use.	**Low**

10. **Afforestation (urban)** to increase carbon sequestration and provide wind breaks to reduce building heat demands in the winter.	**Low**
11. **Application of bio solids to forest lands** to fertilize carbon stocks and increase carbon sequestration rates and wood biomass for energy or products use.	**Low**
12. **Maintain fire suppression programs** and biomass flow from protected stands to energy and or wood products use.	**Low**
13. **Fertilization of forests** to increase carbon sequestration rates and wood biomass for energy or products use.	**Low/Uncertain**
14. **Restore wetlands** to maintain carbon sequestration and long tem biomass flow to energy and or wood products use.	**Low/Uncertain**

8. Preliminary GHG Savings & Cost Estimates for Updated Priority Measures

FORESTRY MITIGATION OPTION	Potential GHG Savings 2010	Potential GHG Savings 2020	Potential Cost Effectiveness
Carbon Offsets Policy Development	Potentially High	Potentially High	TBD
Expanded Use Of Biomass Electricity Feed Stocks	Potentially High	Potentially High	TBD
Expanded Wood Products Use	TBD	TBD	TBD
Reduce Conversion Of Forestland To Other Land Uses	Potentially High	Potentially High	TBD
Reduce Conversion Of Wetlands To Other Land Uses	Potentially High	Potentially High	TBD
Restore Longer-Lived Softwood To Sites That Have Reverted To Hardwoods	Potentially High	Potentially High	TBD
Shorten Spruce Harvest Rotation And Reduce Fir Component	Potentially High	Potentially High	TBD
Expanded *Local* Wood Products Use	TBD	TBD	TBD
Afforestation (rural)	Very Low	Very Low	TBD
Afforestation (urban)	TBD	TBD	TBD
Application of bio solids to forest lands	Very Low	Very Low	TBD
Maintain fire suppression programs	TBD	TBD	TBD
Fertilization of forests	Very Low	Very Low	TBD
Restore wetlands	TBD	TBD	TBD

9. FORESTRY – Mitigation Options

F-1 Carbon Offsets from Agriculture/Forestry Activities (in-state and out-of-state)

Policy Description: Where caps or standards are created for emitting sectors these programs may also include options for emissions offsets from other activities, including agriculture and forest conservation and management.

BAU Policy/Program: To be developed; the regional greenhouse gas initiative (RGGI), the New England Governor's Agreement, and emerging state policies (the MA offsets rule) may create offsets markets in the region.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the commercial potential (above baseline) in MMTCO2e for production of ag and forest offsets, with breakdowns by offset type? TBD
- What are the price inducements required to growers to provide offset options on a per MMTCO2e basis, and sensitivities of these supply responses? What are the differential costs per offset type? TBD

Demand curve questions:

- Does an offset or credit market exist – inside and outside Maine? When will a market be available? What is the demand for offsets in total volume and price in 2010 and 2020? TBD
- What are the transaction costs of the market (monitoring, reporting, verification, brokerage)? TBD
- What is the market or institutional price needed to induce offset purchaser to buy offsets? TBD
- How much of the offset market can be supplied by Maine ag and forestry in total MMTCO2e and economic value? TBD

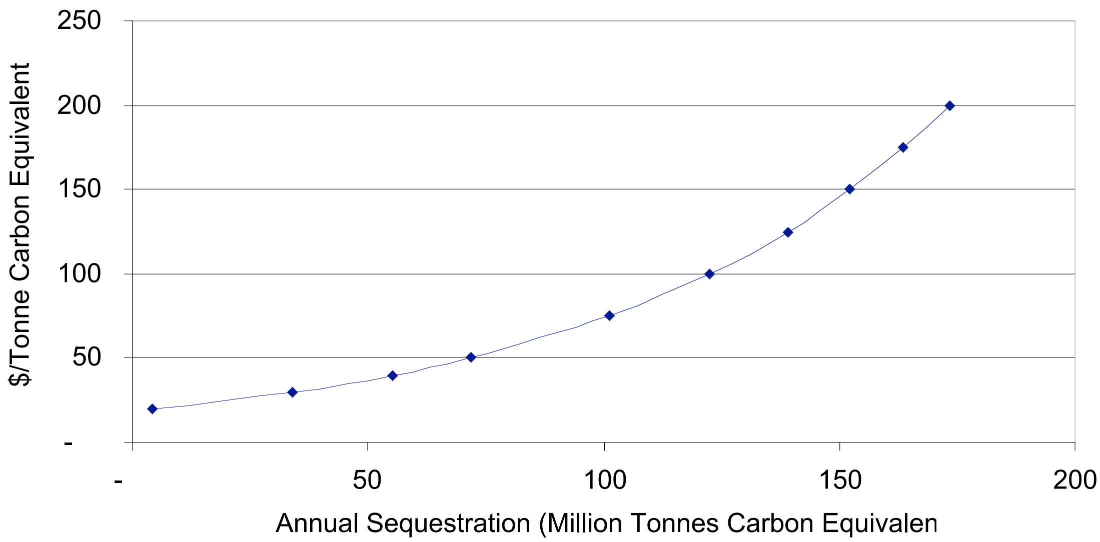
References:

Estimating The Cost Of GHG Emissions Reductions In A Future Us Emissions Trading System. Prepared For NETL By Trexler And Associates, Inc. climateservices.com, April 2003.

Figure 1 below (courtesy of ICF consulting). Estimating Costs of Carbon Sequestration

for a United States Greenhouse Gas Policy, Prepared by Kenneth R. Richards for CRA, Inc., Figure 7, November 1997. Data points were estimated from this report because specific data was not available.

Figure 1.



F-2 Forestry Biomass Feed Stocks for Electricity

Policy Description: Incentives to make greater use forest products or forest waste as a fuel (in solid or gas form) or for co-firing with fossil fuels may reduce net emissions from power supply if it replaces higher emissions supply sources. In addition, removals of overstocked trees may improve forest health and reduce emissions from dead and dying trees.

BAU Policy/Program: Presently biomass is used to a limited extent for co- firing and gas conversion, and heavily used for home heating with wood stoves. (Reference Energy Supply and Waste Working Group for Updated Heat and Electric Power Demand for Biomass.)

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

The potential benefits of expanded tree biomass use for heat and power are twofold:

- Electricity generated by biomass can displace fossil power generation with higher emission rates, thereby providing a GHG savings from electric power generation. The GHG savings for power displacement would be captured in the accounts for power generation, or for power consumption in the buildings, manufacturing and facilities sectors. Baselines are needed for these sectors and power sector modeling is needed to assess the effects of increased biomass power supplies.
- Removals of biomass can, under certain conditions, reduce emissions from dead and dying trees and improve the health of the forest. The GHG savings for this action would be captured in the FORCARB forest carbon account for biomass. Baselines are needed for the biomass account in the forestry sector and simple and spreadsheet or model analysis can be used to assess potential GHG savings. Key variables include the dry tonnage of biomass available for extraction (this will vary by delivered cost and purchase price, and in turn these vary by distance to delivery and species); emissions factors for the conversion of biomass to heat or power; and the cost of delivered energy (for heat or power).

Supply curve questions:

- What is the potential (above baseline) for sources of forest biomass to be grown and harvested in Maine in total acres with breakdowns by species, location, and harvest method, including carbon replacement? What are the price inducements required and sensitivities of these supply responses? See CONEG and NREL estimates below.
- What are the carbon life cycle assumptions for different harvest methods and biomass volume classes? See NREL estimates below; further examination of life cycle carbon accounting is needed for specific harvest methods and species in Maine.

- What are the different biomass conversion technology options? Direct co-firing, gasification; see Tellus data below.
- What is the delivered price of these supplies to conversion facilities by technology and end use? What is the status and potential availability of conversion facilities in the future? TBD - see Tellus data below.
- What is the delivered price of electricity per Mwh to Maine power purchasers by technology and biomass source? A significant price premium exists at current technology and demand levels.
- What is the CO_2 offset factor per Mwh by technology and biomass source? Biomass is assumed to be 95 percent carbon neutral (NREL) so the offset is 95 percent of the avoided regional emissions rate noted below.

Demand curve questions:

- What is the price of inducing a fuel switch to biomass generation for existing facilities? TBD
- What is the commercial potential for installation of new capacity for biomass generation in the future? TBD see Tellus data below.
- How will increased biomass power supplies affect Maine's electricity purchases in the future? TBD see Tellus data below.
- What is the appropriate offset emissions factor for new biomass power in Maine? Biomass is assumed to be 95 percent carbon neutral (NREL) so the offset is 95 percent of the avoided regional emissions rate noted below.
- What is the net offset in market application of biomass power vs. baseline projections? TBD

Current Supply Estimates For Maine:

Sample Estimate 1:

CONEG. Securing a Place for Biomass in the Northeast United States: A Review of Renewable Energy and Related Policies March 31, 2003. Prepared for: CONEG Policy Research Center, Inc. Northeast Regional Biomass Program 400 North Capitol Streets, N.W., Suite 382 Washington, DC 20001. Prepared by: XENERGY Three Burlington Woods Burlington, MA 01803 Tel: (781) 273-5700 Web: www.xenergy.com Contact: Chris Clark

Wood Biomass Gen	Mwh	Percent Of State Gen
Baseline*	2,568,527	19.7
Potential New*	1,502,887	31.2
Potential GHG savings**	.4268 MMTCO2e in 2010	
	.4211 MMTCO2e in 2020	

* U.S. Department of Energy/Energy Information Agency Renewable Energy Annual, 2003

Assumes full displacement of existing nonrenewable power generation and 95 percent closed loop carbon (NREL).

**1,502,887 Mwh x 598 lbs CO2/Mwh (average regional emissions rate in 2010 from IPM) = 898,726426 lbs CO2 / (2000 lbs per ton * 1,000,000) = .4493 MMTCO2e in 2010 * .95 (NREL closed loop assumption) = .4268 MMTCO2e

**1,502,887 Mwh x 590 lbs CO2/Mwh (average regional emissions rate in 2010 from IPM) = 898,726426 lbs CO2 / (2000 lbs per ton * 1,000,000) = .4433 MMTCO2e in 2010 * .95 (NREL closed loop assumption) = .4211 MMTCO2e

Sample Estimate 2:

DOE Oak Ridge Lab: Marie E. Walsha, Robert L. Perlacka, Anthony Turhollowa, Daniel de la Torre Ugarteb, Denny A. Beckerc, Robin L. Grahama, Stephen E. Slinskyb, and Daryll E. Rayb, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6205, University of Tennessee, Knoxville, TN 37901-1071, Science Applications International Corporation, Oak Ridge, TN 37830, April 30, 1999, Updated January, 2000.

Estimated Annual Cumulative Forest Residues Quantities (dry tons), by Delivered Price for Maine

Delivered price	Dry tons
< $30/dry ton delivered	80,6000
< $40/dry ton delivered	1,182,000
< $50/dry ton delivered	1,529,100

1. Logging residues are the unused portions of the growing of stock trees (i.e., commercial species with a diameter breast height (dbh) greater than 5 inches, excluding cull trees) that are cut or killed by logging and left behind. Rough trees are those that do not contain a saw log (i.e., 50 percent or more of live cull volume) or are not a currently merchantable species. Rotten trees are trees that do not contain a saw log because of rot (i.e., 50 percent or more of the live cull volume). Salvable dead wood includes downed or standing trees that are considered currently or potentially merchantable. Excess saplings are live trees having a dbh of between 1.0 and 4.9 inches. Small pole trees are trees with a dbh greater than 5 inches, but smaller than saw timber trees.

2. Retrieval efficiency accounts for the quantity of the inventory that can actually be recovered due to technology or equipment (assumed to be 40 percent). It is assumed that 50 percent of the resource is accessible without having to construct roads, except for logging residues for which 100 percent of the inventory is assumed accessible. Finally, inventory that lies on slopes greater than 20 percent or where conventional equipment cannot be used are eliminated for cost and environmental reasons.

Each dry ton contains 50 percent carbon that will be replaced in the forest assuming proper silviculture.

<u>Biomass energy parameters (courtesy of the Tellus Institute):</u>

Woody material content	17.0 Mbtu/dry ton (Michael Lazarus)
Ag material content	15.0 Mbtu/dry ton (Michael Lazarus)

Heat rates

Co-firing: 11	550 BTU/kWh
Biomass: GCC 8	911 BTU/kWh

EGRID indicates that in 2000 24.631% of Maine's generation was from biomass (3,460,266 MWh). EIA renewable results do not include industrial cogeneration.

Plants - Black Liquor*

Androscoggin Mill	80 MW
Eastern Paper Lincoln Mill	6.5 MW
Old Town Division	19 MW
S D Warren Co 2	71.3 MW
Woodland Pulp Paper	67.2 MW

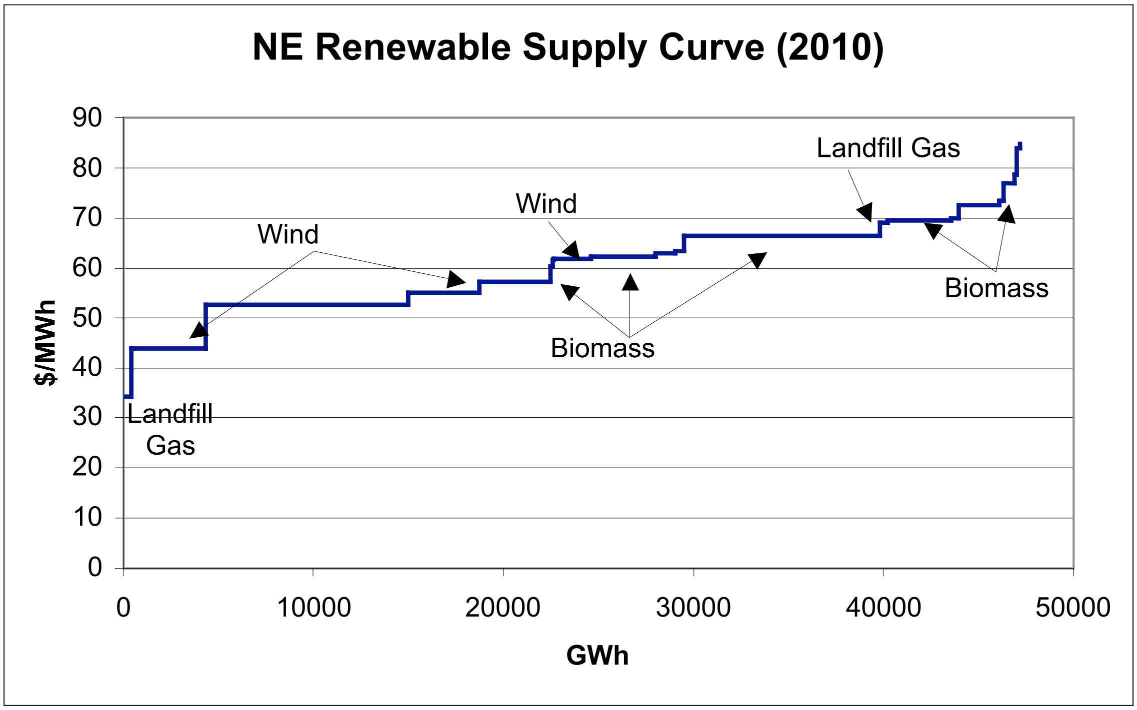
Wood And Wood Waste*

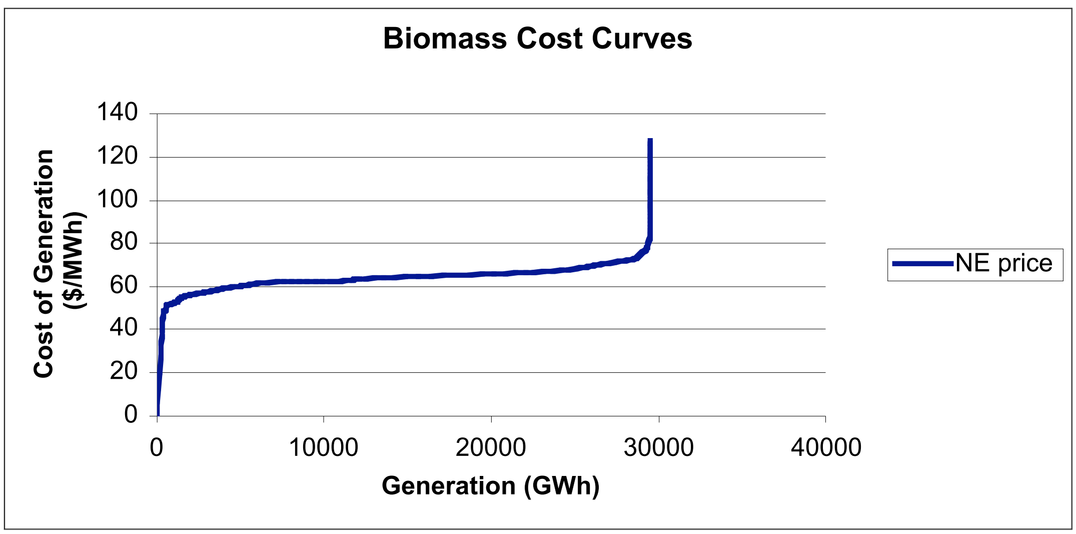
Aroostook Valley	37.5
Beaver Ashland	39.6
Beaver Livermore Falls	39.6
Beaver Wood Joint Venture	17
Boralex Athens Energy	16
Boralex Stratton Energy Inc	45.7
Forster Inc Strong Plant	1.3
Greenville Steam Co	15.6
Indeck Jonesboro Energy Center	27.5
Indeck West Enfield Energy Center	27.5
Lavalley Lumber Llc	1.5
Sherman Energy Facility	21.1

Somerset Plant	108
Worcester Energy Co Inc	18.7

*Not all capacity commercially operating

NEMS Supply Curves (Courtesy Of The Tellus Institute)





F-3 Promote Use of Wood Products

Policy Description: Durable wood products in construction of furnishings and buildings can sequester carbon for long periods of time depending on the type of harvesting practices and end use of the wood products. Wood products may be less energy-intensive in production and use than other materials.

BAU Policy/Program: To be developed

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for switching to wood vs. non-wood products in total product volume, with breakdowns by product type and location? TBD
- What are the price inducements required to suppliers and sensitivities of these supply responses? What are the differential costs per product type to suppliers? TBD
- What is the emissions factor of a wood product vs. a non-wood product? What are the relevant product categories and related emissions factors? TBD – see note below:

  The "embodied energy," or the amount of energy used to produce a given material, varies from product to product. Following are estimates of embodied energy for typical building materials (data available at www.ctclimatechange.com, forestry recommendations):

  - Simple sawed wood product: 3 GJ Mg^{-1}
  - Plywood: 14 GJ Mg^{-1}
  - Steel: 20–25 GJ Mg^{-1}
  - Plastic: 60–80 GJ Mg^{-1}
  - Aluminum: 190 GJ Mg^{-1}

Demand curve questions:

- What is the market or institutional price needed to induce consumers to switch to wood products? TBD
- What is the level of government or market demand for wood products at different price levels? How sensitive are purchases to price? TBD
- What is the aggregate GHG savings for wood product switching in Maine for each GHG account (including the forestry, buildings/manufacturing/facilities, and transportation accounts)? TBD

F-4 Reduce Conversion Of Forestland To Other Land Uses

Policy Description: Preservation of forestland may reduce or avoid the loss of carbon sequestered in forestlands. It may also have the effect of directing growth to more efficient locations and reduce transportation emissions.

BAU Policy/Program: The Forest Legacy Program of USDA is an incentive-based and strictly voluntary program that conserves working forests through financial support of land acquisition. The Land for Maine's Future Program (LMFP) was developed in 1987 to protect natural and working lands through financing of easements or fee title; 50 percent of funds must be matched. The USDA Farm and Ranchland Protection Program (FRPP) also provides limited cost sharing for land protection. Maine's Farm and Open Space Tax Law was developed in 1975 to provide tax relief to farm and forestland owners. The Maine Tree Growth Tax Law was enacted to provide property tax relief to owners of woodlots and forestlands. The Wetlands Reserve Program is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their wetland restoration efforts. Forestland protection is also significantly affected by growth management policies and programs, including zoning, property taxation, and infrastructure funding (particularly transportation) as well as private preservation actions by land trust organizations. The USDA Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat.

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

<u>Supply curve questions:</u>

- What is the potential (above baseline) for forest acreage to be placed into permanent protection in Maine in total acres, with breakdowns by location, and type of forest? <u>At present rates Maine will lose 141,300 acres of forestland to urbanization between 2005 and 2020.</u>
- What are the price inducements required to landowners and sensitivities of these supply responses? What are the per acre costs by forest type and location?
- What are the per acre GHG savings for preservation vs. alternative uses of forestland in Maine by farming type and location? These potentially include forest carbon and reduced transportation emissions. What are the sensitivities for analysis? <u>Benefits of land protection potentially include forest carbon, wood products production, and reduced transportation emissions. Development that is not location efficient leads to higher transportation demand and CO2 emissions</u>

(each gallon of gasoline emits 19.6 pounds of CO_2). Travel demand reductions can vary from relatively small to over 50 percent from growth location policies.

Demand curve questions:

- What is the market or institutional price needed to inducing land protection vs. alternative uses (development)?
- What is the level of government or market support for forestland protection?
- What is the appropriate offset emissions factor per acre for forest land protection in Maine?
- What is the aggregate GHG savings for forestland protection in Maine for each GHG account (including the forestry account and transportation account)?

Sample Calculation:

Assume that 150,000 new homes are located on the acreage converted from farmland in the next 20 years. (The American Housing Survey estimates the average lot size of a new single-family home at about two acres – not to be confused with the NRI measurement of lawn or dwelling area. Under NRI definitions the cover change associated with conversion of farmlands will be about half the lot size or more. A one home per acre average under the NRI definition is probably ballpark.) Assume that a combined open space protection and location efficient growth program could cut the rate of farmland conversion in half, and increase the density and proximity averages of the 150,000 new homes proportionately. Assume that travel demand per household is 5,000 miles per year less than before as a result, and that the average mileage per household per year was originally 20,000 miles. Assume the average household vehicle gets 20 miles per gallon fuel economy.

5,000 miles per household automobile travel reduction/20 miles per gallon = 250 gallons gasoline savings per year per household, or $375 per household fuel savings at $1.50 per gallon.

250 gallons of gasoline x 19.6 pounds CO_2 per gallon of gasoline = 4,900 pounds of CO_2 saved per household per year x 150,000 households = 735,000,000 pounds CO_2 saved by households per year. Due to a gradual transition of household implementation, assume half of this amount is saved during the 15-year period, or 36,750,000 pounds CO_2 per year.

36,750,000 pounds CO_2 per year = 18,375 tons CO_2 per year, or .018375 MMTCO2e per year.

Over 15 years this would total .275 MMTCO2e in CO_2 savings from transportation.

Carbon sequestration and wood products savings are not included.

References:

USDA Natural Resource Inventory, USDA, NRCS office in Bangor Maine. Ray Voyer.

The American Housing Survey: US Bureau of the Census, US Department of Housing and Urban Development

F-5 Reduce Conversion Of Wetlands To Other Land Uses

TBD

F-6 Restore Longer-Lived Softwood To Sites That Have Reverted To Hardwoods

Policy Description: Significant percentages of Maine's original softwood forests have shifted to hardwoods as a result of forest practices. With long-term forest succession they are likely to return to softwoods in the very long term, but this process can be accelerated with practices that remove hardwood stocks by thinning or harvest and replace them with longer-lived softwoods. In the process significant biomass could be generated for wood products and energy use, carbon sequestration rates may be improved by stimulating biomass growth response in the forest, and spruce budworm risks may be reduced along with emissions associated with decomposition of dead or dying wood.

BAU Policy/Program: A number of existing programs potentially support intensified management of private non-industrial forests in Maine. The Stewardship Incentive Program (SIP) of the USDA Forest Service provides technical and financial assistance to encourage non-industrial private forest landowners to keep their lands and natural resources productive and healthy. Qualifying land includes rural lands with existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Indian tribe, or other legal private entity. Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land. Authorizations may be obtained for exceptions of up to 5,000 acres. The purpose of the USDA Resource Conservation and Development (RC&D) program is to accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in designated RC&D areas

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for softwood restoration options in Maine in total acres, with breakdowns by location, practice, and type of forest? TBD
- What are the price inducements required to growers, and sensitivities of these supply responses? What are the per acre costs by forest type, practice and location? TBD
- What are the per acre GHG savings for forest management options by forest type and location? These potentially include all FORCARB accounts (biomass, soil carbon, forest floor, wood products). What are the sensitivities for analysis? TBD

Demand curve questions:

- What is the level of government or market support for forest management options? TBD

- What is the appropriate offset emissions factor per acre for forest management options acres vs. acres not to in these options in Maine? TBD
- What is the aggregate GHG savings for forest management options in Maine for each GHG account? TBD

F-7 Shorten Spruce Harvest Rotation And Reduce Fir Component

Policy Description: Significant percentages of Maine's spruce/fir forests have suffered spruce budworm outbreaks in the last two decades. By reducing the fir component of this forest type and shortening rotations, budworm risks can be reduced. In the process significant biomass could be generated for wood products and energy use, carbon sequestration rates may be improved by stimulating biomass growth response in the forest, and spruce budworm risks may be reduced along with emissions associated with decomposition of dead or dying wood.

BAU Policy/Program: A number of existing programs potentially support intensified management of private non-industrial forests in Maine. The Stewardship Incentive Program (SIP) of the USDA Forest Service provides technical and financial assistance to encourage non-industrial private forest landowners to keep their lands and natural resources productive and healthy. Qualifying land includes rural lands with existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Indian tribe, or other legal private entity. Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land. Authorizations may be obtained for exceptions of up to 5,000 acres. The purpose of the USDA Resource Conservation and Development (RC&D) program is to accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in designated RC&D areas

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for spruce fir management options in Maine in total acres, with breakdowns by location, practice, and type of forest? TBD
- What are the price inducements required to growers, and sensitivities of these supply responses? What are the per acre costs by forest type, practice and location? TBD
- What are the per acre GHG savings for forest management options by forest type and location? These potentially include all FORCARB accounts (biomass, soil carbon, forest floor, wood products). What are the sensitivities for analysis? TBD

Demand curve questions:

- What is the level of government or market support for forest management options? TBD
- What is the appropriate offset emissions factor per acre for forest management options acres vs. acres not to in these options in Maine? TBD

- What is the aggregate GHG savings for forest management options in Maine for each GHG account? TBD

F-8 Expanded *Local* Wood Products Use

Policy Description: Incentives or requirements for state government procurement of locally grown wood products may reduce transportation emissions associated with imported wood products and result in greater use of wood versus more energy intensive building materials depending on the management of the forests and end use of the wood products

BAU Policy/Program: To be developed

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for production of indigenous forest products vs. imports in total product volume, with breakdowns by product type and location? TBD
- What are the price inducements required to growers and sensitivities of these supply responses? What are the differential costs per product type to suppliers? TBD
- What is the emissions factor of a locally produced forest product vs. an imported product? What are the relevant product categories and related emissions factors? TBD

Demand curve questions:

- What is the market or institutional price needed to induce consumers to switch to locally grown products? TBD
- What is the level of government or market demand for new locally grown product purchases at different price levels? How sensitive are purchases to price? TBD
- What is the aggregate GHG savings for forest product switching in Maine for each GHG account (including the forestry, buildings/manufacturing/facilities, transportation accounts)? TBD

F-9 Afforestation (Rural)

Policy Description: Establishing forests on sites not previously in forest cover (afforestation) or replanting previously forested area following harvest (reforestation) can increase carbon stocks and reduce carbon flows. (Deforestation is the process of converting forested land to permanent non-forest use).

BAU Policy/Program: The Stewardship Incentive Program (SIP) of the USDA Forest Service provides technical and financial assistance to encourage non-industrial private forest landowners to keep their lands and natural resources productive and healthy. Qualifying land includes rural lands with existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Indian tribe, or other legal private entity. Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land. Authorizations may be obtained for exceptions of up to 5,000 acres. The purpose of the USDA Resource Conservation and Development (RC&D) program is to accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in designated RC&D areas

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for afforestation in Maine in total acres, with breakdowns by location, and type of forest? TBD
- What are the price inducements required to growers, and sensitivities of these supply responses? What are the per acre costs by forest type, afforestation practice, and location? TBD
- What are the per acre GHG savings for afforestation by forest type, practice and location? These potentially include all FORCARB accounts (biomass, soil carbon, forest floor, wood products). What are the sensitivities for analysis? TBD

Demand curve questions:

- What is the level of government or market support for afforestation? TBD
- What is the appropriate offset emissions factor per acre for afforestation acres vs. acres not to be afforested in Maine? TBD
- What is the aggregate GHG savings for afforestation in Maine for each GHG account? TBD

F-10 Afforestation (Urban)

Policy Description: Planting urban trees may, if properly done, reduce the consumption of energy for heating by reducing wind effects on buildings, and thereby avoid fossil fuel emissions in the energy sector. Urban forests may also increase the carbon stock of previously non-forested land (afforestation).

BAU Policy/Program: To be developed

Data Needs, Sources & Assumptions for Preliminary GHG Savings and Cost Estimates:

Supply curve questions:

- What is the potential (above baseline) for establishing urban tree planting or protection programs in Maine in total acres, with breakdowns by location, and type of forest? TBD
- What are the price inducements required to growers, and sensitivities of these supply responses? What are the per acre costs by forest type, afforestation practice, and urban location? TBD
- What are the per acre GHG savings for afforestation by forest type, practice and urban location? These potentially include all FORCARB accounts (biomass, soil carbon, forest floor, wood products) as well as the building/manufacturing/facilities accounts. What are the sensitivities for analysis? TBD

Demand curve questions:

- What is the level of government or market support for urban afforestation? TBD
- What is the appropriate offset emissions factor per acre for urban afforestation acres vs. acres not to be afforested in Maine? TBD
- What is the aggregate GHG savings for urban afforestation in Maine for each GHG account? TBD

F-11 Application Of Bio Solids To Forest Lands

TBD

F-12 Maintain Fire Suppression Programs

TBD

F-13 Fertilization Of Forests

TBD

F-14 Restore Wetlands

TBD

APPENDIX 1

NESCAUM inventory table from 12/17 meeting

Emissions (MMTCO2E)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Agriculture	0.483	0.491	0.488	0.496	0.492	0.478	0.512	0.534	0.540	0.536	0.437
Enteric Fermentation	0.174	0.177	0.174	0.173	0.174	0.164	0.166	0.164	0.159	0.158	0.154
Manure Management	0.048	0.048	0.048	0.052	0.051	0.050	0.052	0.052	0.053	0.053	0.048
Agricultural Soil Management	0.261	0.266	0.266	0.271	0.268	0.264	0.293	0.318	0.328	0.325	0.234
Burning of Agricultural Crop Waste	-	-	-	-	-	-	-	-	-	-	0.000
Forest Management and Land-Use Change	5.236	5.234	5.232	5.809	5.819	5.822	5.831	5.834	5.834	5.836	5.835

APPENDIX 2

**MW Capacity and MWhs Generated
by Electric Generating Facilities in Maine
Developed by the MPUC December 2003**

Plant	MW Capacity (rounded)	Annual MWhs (2002)	Location - Town	Source, Whs
Biomass				
Boralex Stratton	46		Stratton	
Boralex Livermore	40		Livermore	
Indeck Jonesboro	27	691	Jonesboro	GIS
Indeck West Enfield	27	128,882	W. Enfield	GIS
Greenville Steam	16	65,530	Greenville	GIS
Boralex Ashland	34		Ashland	
Boralex Athens	16		Athens	
Boralex Ft. Fairfield	32		Ft. Fairfield	
Wheelabrator Sherman	18		Sherman	
Robbins Lumber	1.3		**Searsmont**	
Forster Strong	0.1		Strong	
Dirigo Dowels	0.3	223		GIS
Total MW capacity	**258**			
(in addition, 4 large cogen plants use biomass)				
Municipal Solid Waste				
PERC	25	153,885	Orrington	GIS
MERC	22	161,347	Biddeford	GIS
Regional Waste System	11	78,979	Portland	GIS
MMWAC	4	15,717	Auburn	GIS
Total MW capacity	**62**			
Efficient Cogeneration				
Scott Somerset	107	173,391		GIS
Champion Bucksport	78	204,362	Bucksport	GIS
S.D. Warren Westbrook	40		Westbrook	
Mead Rumford	103		Rumford	
Total MW capacity	**328**			
(in addition, 3 small cogenerators are included in biomass)				
Behind-the-Meter Self-Generators				
IP Jay	28		Jay	
Total MW capacity	**28**			
Peat				
Worcester Energy	22.8		Dublois	
Total MW capacity	**22.8**			
Natural Gas				
Westbrook - Calpine Energ	528	3,937,077	Westbrook	GIS
ME Independence	540	3,742,267		GIS
Rumford Power	271	1,835,698	Rumford	GIS
Bucksport Energy	193	1,135,614	Bucksport	GIS
Androscogin Energy	193	824,046	Jay	GIS
Total MW capacity	**1,725**	11,474,702		

Oil				
Cape 5	21	165		GIS
Cape 4	17	182		GIS
Yarmouth 1	54	9,400	Yarmouth	GIS
Yarmouth 2	54	8,812		GIS
Yarmouth 3	119	79,306		GIS
Yarmouth 4	620	332,315		GIS
Mason 3	32	977		GIS
Mason 4	33	952		GIS
Mason 5	33	936		GIS
Medway Diesels (BHE)	8	345	Chester	GIS
Bar Harbor Diesels (BHE)	8	436	Ellsworth	GIS
Eastport Diesels (BHE)	4	85	Washington	GIS
Total MW capacity	**1003**	**433911**		

Wind	
Allen's Blueberry	0.05
Net billed customers	0.25
Total MW capacity	**0.30**

Hydro Electric (Capacity > 5 MW)				
Sebasticook Composite	6	13,840	Winslow??	GIS
Milford	6		Milford	
Deer Rips	7			
West Buxton	7		Buxton	
Aziscohos Hydro	8	22,757		GIS
Cataract East	8	35,702	Biddeford/Saco	GIS
Veazie	8		Veazie	
Ellsworth Hydro	9	24,160	Ellsworth	GIS
Howland	9		Howland	
Shawmut	10	41,855	Fairfield/Benton	GIS
Bonny Eagle w/ W. Buxton	10	63,778	Buxton/Hollis/Standish	GIS
Hiram	12	43,237	Hiram/Baldwin	GIS
West Enfield	13	75,915	W. Enfield	GIS
Weston	13	65,388	Skowhegan	GIS
Pejepscot	14	57,869	Topsham	GIS
Williams	15	71,284	Embden/Solon	GIS
UAH	15		Winslow	
Miller Hydro	19	71,898	Topsham	GIS
Skelton	20	81,031		GIS
Great Northern	20		Millinocket	
Brunswick	20	80,131	Brunswick/Topsham	GIS
Madison composite	22			
Graham	22	138,100		GIS
Gulf Island	23			
Monty	28	108,079	Auburn/Lewiston	GIS
Tinker	34			
Great Lakes	67	22,765	Millinocket	GIS
Wyman	83	238,151	Moscow	GIS
Harris	87	134,122	Indian Stream Township	GIS
Total MW Capacity	**613**			

Hydro Electric (Capacity < 5 MW)

Sevey	0.01			
Abbotts Mill	0.03			
Morgans Mills	0.03			
Sysko **(Stony or Wight??**	0.03	106 or 122		
Gardiner Brook	0.05	166	Andover	GIS
Upper Spears	0.05			
Bisco Falls	0.08			
Goose River 3	0.09			
Goose River 1	0.10			
North New Portland	0.10			
Seabright	0.10			
Whispering Valley	0.10			
Swans Falls	0.13			
Sparhawk	0.18	635	Yarmouth	GIS
Andro Lower	0.20			
Eustis Hydro	0.21	120	Eustis	GIS
Pioneer	0.23	147		GIS
Upper Kezar	0.30			
Dudley	0.32	657		GIS
Norway Hydro	0.34	8	Norway	GIS
Rocky Gorge	0.36	1,738	So. Berwick	GIS
Great Works composite	0.37	1,208	Old Town/Bradley	GIS
Waverly	0.40	173		GIS
Kennebec Water	0.41	1,647		GIS
Damariscotta	0.46	313	Damariscotta	GIS
Hackett Mills	0.50	206		GIS
Old Falls	0.52			
South Berwick	0.53		So. Berwick	
Squaw Pan	0.58			
New Dam	0.58			
Greenville	0.63	440	Greenville	GIS
Lewiston U5	0.64	3,712	Lewiston??	GIS
Browns Mill	0.67	616	Dover-Foxcroft	GIS
Milo	0.75		Milo	
Kennebago Hydro	0.90	2,057		GIS
Caribou	0.90		Caribou	
Lower Kezar	1.00			
Ledgemere	1.00	4,093	Limerick/Waterboro	GIS
Continental	1.00			
York	1.10	1,260		GIS
Pittsfield	1.10	1,538	Burnham	GIS
Mechanic Falls	1.14	64	Mechanic Falls	GIS
Gardiner Hydro	1.15	1,264	Gardiner	GIS
Salmon Falls	1.20	2,400		GIS
Pumpkin Hill	1.30			
Squaw Pan	1.40			
Barker Lower Hydro	1.43	663	Auburn	GIS
Barker Upper Hydro	1.52	617	Auburn	GIS
Ft. Halifax	1.80	5,025	Winslow	GIS
Howland	1.90		Howland	
North Gorham	1.94	6,318	Windham/Gorham/Stanc	GIS
Stillwater	1.95		Stillwater	
Hill Mill	2.00			
Rice Rips	2.00			
BHE composite	2.80	8,160		GIS
Oakland	3.00		Oakland	
Bates Upper	3.00			
Medway	3.44		Medway	
Lockwood	3.75	32,103	Waterville/Winslow	GIS
Andro 3	4.00			
Bar Mills	4.00	15,103	Buxton/Hollis	GIS
Brassua	4.00	13,007	Rockwood	GIS
Benton Falls	4.33	3,772	Benton	GIS
Little Androscoggin Comp.	4.40	10,322	Lewiston/Auburn	GIS
Total MW Capacity	**74.53**			

APPENDIX 3

MAINE FORESTRY EXPERTS MEETING SUMMARY

March 4, 2004, 9 am -12 pm

Moderator: Mike Karagiannes

Attendance: Tom Peterson Penn State University, Kevin McDonald Maine DEP, Malcolm Burson Maine DEP, Jim Smith USFS, Don Mansius Maine FS, Dave Struble Maine FS, Ken Laustsen Maine FS, Ivan Fernandez, UM

AGENDA

1. Updates and next steps on FORCARB inventory measurements for Maine for the year 1990 and beyond, including adjustments on biomass, forest floor/woody debris, soil carbon and wood products accounts.
2. Methods and options for FORCARB baseline formulation to 2020 (and beyond if applicable)
3. Data and FORCARB needs for evaluation of mitigation options, including: afforestation (urban and rural), forest management (several potential options), forest conservation, expanded wood products use, expanded local wood products use, expanded biomass feed stocks, and carbon offsets.
4. Agreements on FORCARB runs for the March 19 meeting, potentially.

OUTCOMES

3. **Updates and next steps on FORCARB inventory measurements for Maine for the year 1990 and beyond, including adjustments on biomass, forest floor/woody debris, soil carbon and wood products accounts.** The goal of these tasks is the creation of consensus estimates for 1990 and 2000 GHG forest emissions and sinks in a framework that can be used for meaningful baseline projections and mitigation option analysis.

    a. Tree biomass: Maine Forest Service will provide Jim Smith copies of Maine tree biomass equations for near term incorporation into FORCARB. New runs may be available in the next two weeks. The results may significantly change earlier FORCARB2 estimates. Jim will report on progress.

    b. Forest floor: Jim Smith will begin incorporation of Forest Health Monitoring (FHM) data for Maine into FORCARB. Time series data may be limited to recent years and require back casting to 1990. It is not known how significantly this may change earlier FORCARB2 estimates or how long this will take. Jim will report on progress.

c. Soils: After extended discussion the group recommended altering the current soil methodology by creating transition functions that ramp up or down during shifts in forest types (species). The group did not recommend using the present FORCARB methodology, or using a simple “no change” assumption. Current methods assign a carbon estimate to soils based on species type regardless of stand age or elapsed time since the forest was in another species designation (they also do not consider harvest method impacts). The result of this assumption is that soil carbon levels can jump significantly when species shift due to regeneration following harvest or natural damage. Realistically these are slow ecological processes and soil carbon changes evolve slowly over time rather than making quick quantum leaps. The group also decided that a simple “no change” assumption that would hold soil carbon levels steady over time regardless of shifts to new species categories could lead to significant error. Jim Smith will create some technically realistic (from literature review) and pragmatic methods for recalculation of soil carbon that provide a gradual shift between forest types. Jim will begin this process immediately but is not sure how long it will take. The results may significantly change earlier FORCARB2 estimates. Jim will report on progress.

d. Wood products: After extended discussion the group recommended that import and export data be provided for all wood categories to address GHG accounting issues. Typically state GHG accounting debits or credits emissions depending on the location of the activity that changes emissions levels. Wood products life cycles, for instance, involve several steps from: growing stocks of carbon, extracting raw materials, processing raw materials to product, use of product (energy, structural materials, paper) and disposal of waste materials. These steps can vary in location and alter state GHG inventories and crediting. Interstate issues can be important. For instance, Maine is a net importer of wood biomass residue for energy production. A number of accounting issues will need to be addressed to calculate Maine GHG reductions from options to expand biomass flow from Maine forests into either energy or product production and use. To assist, the Maine Forest Service provided inventory data with imports and exports reaching back to 1990, and will assist in creating a spreadsheet for 1990 and 2000 estimates. Recent data may be significantly better than 1990 data and require some back casting. The group did not feel it was important to alter the basic HARVCARB coefficients for the carbon lifecycle of wood products. Tom Peterson will work with Maine Forest Service (Don Mansius) and US Forest Service (Jim Smith) on a spreadsheet that links with FORCARB.

e. Land use change: FORCARB does not attribute any carbon stocks to nonforested lands, so as forest stocks are converted form forest land use to other land uses (agriculture and residential, primarily) the model zeroes out the carbon stocks on these lands. Realistically many residential lots and farms have significant forest stocks. The group agreed that some transition function needs to be created for this land use conversion process. The group also expressed concern that non-rural land uses (residential, commercial, municipal and institutional land uses) are not captured either in the forest or agriculture inventory. Tom Peterson will look at potential data sources for these lands and report back to the group for further action on carbon stock estimates on these lands. Jim Smith will look at potential data and methods for ramping carbon stocks up or down during land use change from forested to nonforested land uses. Jim was not able to estimate the time needed to do this but will report back.

f. Time series: Presently FORCARB2 uses Forest Inventory Assessment (FIA) carbon stock data from 1982, 1995 and post 2000 to derive 1990 and 2000 GHG estimates. The Maine Forest Service expressed concerns about the accuracy of 1995 data (it may have understated stocks significantly) and the group noted that these numbers are being recalibrated over the next ten months. Because 1995 data is suspect and will not be corrected during the Maine SAG process (which ends June 30, 2004) the group recommended using 1982 and post 2000 data for calculation of a slope and intercept for 1990 and 2000 GHG estimates. Jim Smith will recalculate the FORCARB inventory for Maine based on this adjustment.

g. Wetlands: Ivan Fernandez raised a concern that wetlands may not be covered adequately under FORCARB inventories. Jim Smith reported that forested wetlands are covered under FORCARB but nonforested wetlands are not. The group expressed an interest in seeing wetlands inventory data for Maine and suggested coordination with several land protection organizations. Tom Peterson will contact these groups and identify available wetlands inventory data.

4. **Methods and options for FORCARB baseline formulation to 2020 (and beyond, if applicable).** The goal of these tasks is the creation of consensus estimates for 2010 and 2020 GHG forest emissions and sinks in a framework that can be used for meaningful mitigation option analysis.

   a. After extended discussion the group decided to recommend a simple extrapolation of trends from 1990-2000 data (excluding 1995) for forest carbon stocks. The group decided to use the most recent wood products figures as a percentage of forest stocks as a basis for baseline projection lacking any better forecast data for wood products. They also recommended checking with some industry representatives for better data. Tom Peterson will make these contacts and report back to the group on data and options. The group noted that wood products forecasts are likely to involve significant economic uncertainties.

5. **Data and FORCARB needs for evaluation of mitigation options, including: afforestation (urban and rural), forest management (several potential options), forest conservation, expanded wood products use, expanded local wood products use, expanded biomass feed stocks, and carbon offsets.** The goal of this task was clarification on the list and definition of potential forestry mitigation options, identification of best available data, and ranking of priorities for analysis.

   a. Tom Peterson reviewed the list of options identified at the last technical work group meeting, including:

      1. Afforestation (urban and rural)
      2. Forest management (including sub categories of increased rotation length, precommercial thins, intensive management practices, and carbon management practices)
      3. Potential options)
      4. Forest conservation
      5. Expanded wood products use
      6. Expanded local wood products use
      7. Expanded biomass feed stocks
      8. Carbon offsets

   b. Tom requested clarification on the list and definition of all options to assist with the quantification of measures, particularly for the forest management and wood products categories. Ivan Fernandez offered a list of potential new options for consideration in forest management including: wetlands protection and restoration, fire management, silviculture options, species control, and plantation forestry. The group brainstormed and developed the following new list of recommended forestry mitigation options with rankings indicating priority for analysis and GHG reduction potential:

FORESTRY MITIGATION OPTION	PRIORITY FOR ANALYSIS
15. **Carbon offsets policy development** (or credits) to provide market-based value for forestry mitigation options.	**High**
16. **Expanded use of biomass electricity feed stocks** to displace more carbon intensive power production from coal and gas, and to increase carbon sequestration rates in thinned stands in the forest, and to reduce carbon emissions from decomposition caused by disease and storm damage.	**High**

17. **Expanded wood products use** to displace more energy intensive building materials (steel and concrete) and increase carbon storage in structural materials.	**High**
18. **Reduce conversion of forestland to other land uses** to maintain carbon sequestration and long tem biomass flow to energy and or wood products use.	**High**
19. **Reduce conversion of wetlands to other land uses** to maintain carbon sequestration and long tem biomass flow to energy and or wood products use.	**High**
20. **Restore longer-lived softwood to sites that have reverted to hardwoods** by precommercial thin and hardwood harvest to increase carbon sequestration, and increase biomass flow to energy or wood products use.	**High**
21. **Shorten spruce harvest rotation and reduce fir component** through thinning to reduce budworm risk and decomposition emissions, increase carbon sequestration, and increase biomass flow to energy or wood products use.	**High**
22. **Expanded *local* wood products use** to reduce transportation emissions associated with delivery of raw materials and or products.	**Medium**
23. **Afforestation (rural)** to increase carbon sequestration and long tem biomass flow to energy and or wood products use.	**Low**
24. **Afforestation (urban)** to increase carbon sequestration and provide wind breaks to reduce building heat demands in the winter. **Low**	**Low**
25. **Application of bio solids to forest lands** to fertilize carbon stocks and increase carbon sequestration rates and wood biomass for energy or products use.	**Low**
26. **Maintain fire suppression programs** and biomass flow from protected stands to energy and or wood products use.	**Low**
27. **Fertilization of forests** to increase carbon sequestration rates and wood biomass for energy or products use.	**Low/Uncertain**
28. **Restore wetlands** to maintain carbon sequestration and long tem biomass flow to energy and or wood products use.	**Low/Uncertain**

6. **Agreements on FORCARB runs for the March 19 meeting, potentially.** The goal of this task is scheduling and follow up.

    a. As noted, data improvements will be made to the FORCARB inventory, wood products inventory, wetlands inventory, and non-forestland use category. Baselines will be recalculated as upgraded inventory data becomes incorporated, but is not likely to be complete by the April 8, 2004 SAG meeting. Forest management options can be redefined and data methods, sources and assumptions identified for the agriculture and forestry work group meeting scheduled for March 19, 2004.