MAJOR ISSUES AND BEST MANAGEMENT PRACTICES

CLIMATE CHANGE

Weather refers to local atmospheric conditions including rain, snow, clouds, wind or thunderstorms that occur over short periods of time such as minutes, hours or days. Climate on the other hand refers to long-term regional or global averages of temperature, humidity and rainfall patterns over seasons, years or decades. Global warming refers to the long-term heating of earth's climate system observed since the pre-industrial period due to human activities, primarily from burning fossil fuels, which increases heat-trapping greenhouse gas (GHG) levels in Earth's atmosphere G1. The terms global warming and climate change are often used interchangeably, however the latter refers to both human and naturally produced warming and the effects it has on the planet. Global warming is specific to the rapid temperature increases that are being caused by human actions.

*** graphic of earth and atmosphere illustrating how GHG's function ***

Global warming occurs when CO2 and other GHG in the atmosphere collect and absorb sunlight and solar radiation that have bounced off the earth's surface. Normally, much of this radiation would escape back into space but these pollutants trap the heat in the earth's atmosphere and cause the planet to get hotter. As the concentration of GHGs in the atmosphere increases so does the global average temperature. This is what is referred to as the greenhouse effect. Aside from water vapor, the four principal GHGs are carbon dioxide, methane, nitrous oxide, and fluorinated gases. For each GHG, a Global Warming Potential (GWP) value has been calculated to reflect how long it remains in the atmosphere, on average, and how strongly it absorbs energy. Gases with a higher GWP absorb more energy, per pound, than gases with a lower GWP, and thus contribute more to warming the Earth G2. The potential sources, time of concentration in the atmosphere, and GWP for each greenhouse gas is provided below:

- Carbon Dioxide (CO2): Sources include burning fossil fuels (coal, natural gas, oil), solid waste, trees, and wood products, as well as some chemical reactions. Although some CO2 will be absorbed from the atmosphere in the order of years to decades, much of it will persist in the atmosphere for hundreds to thousands of years. GWP (100-year):1.
- Methane (CH4): Sources include the production and transport of fossil fuels; livestock and agricultural practices; and the decay of organic waste in landfills. CH4 persists in the atmosphere for an average of 12 years. GWP (100-year): 25[1].
- Nitrous Oxide (N2O): Sources include agricultural and industrial activities, the combustion of fossil fuels, biomass and solid waste, and during the treatment of wastewater. N2O persists in the atmosphere an average of 114 years. GWP (100-year): 298[1].
- Fluorinated gases (F-Gases): Sources include industrial processes. F-gases are powerful man-made gases with global warming potential many times that of natural GHGs such as CO2. These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as High Global Warming Potential Gases. F-gases can persist in the atmosphere for various time periods with some forms lasting hundreds of years and others lasting up to 50,000 years. GWP (100-year): from 7,390 to 22,800[1].

All of these GHGs remain in the atmosphere long enough to become well mixed, meaning that the amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions G2. CO2 is the primary driver of the greenhouse effect because it is the most abundant gas being released and can remain in the atmosphere for long periods of time (months to millennia) and therefore accumulates and persists in large volumes.

*** Provide EPA 2014 or Meinhausen et al 2017 graphic of 3 Greenhouse Gas Emissions ***

Although water vapor is the most abundant GHG in the atmosphere and plays a dominant role in global temperatures, it is not a driver of global warming like the other GHGs. Changes in the concentration of atmospheric water vapor result as a reaction to changes in global temperature, not as a driver of temperature changes. As temperature rises, evaporation of water increases and more water vapor is formed. However, since water vapor is quickly removed by natural processes it only remains in the atmosphere in the order of hours to days and does not accumulate like the other GHGs G3. Instead of driving climate change, water vapor amplifies the warming that is being caused by the other GHGs. For instance, water vapor nearly doubles the amount of warming caused by CO2, thereby increasing water vapor further. This type of positive feedback loop makes changes caused by the other GHGs even greater. Water vapor can also serve as a negative feedback loop when it forms cloud cover that reflects radiation back to space before it can reach the earth, thereby having a cooling effect and reducing water vapor.

*** Photo of clouds and water tower or just cloud photo ***

In the United States, the burning of fossil fuels to make electricity is the largest source of heat-trapping carbon pollution, adding about two billion tons of CO2 to the atmosphere every year. Coal-burning power plants are the biggest contributor of GHGs in the energy sector. The country's second-largest source of carbon pollution is the transportation sector, which adds about 1.7 billion tons of CO2 emissions to the atmosphere each year G4. Over the period of time humans have existed on earth (approximately 200,000 years) a relatively stable carbon budget had been maintained. When fossil fuels are mined and burned, carbon that accumulated over millions of years is immediately released to the atmosphere, thereby upsetting the stable carbon budget. Over the past 800,000 years until industrialization, CO2 levels fluctuated between about 180 parts per million (PPM) during ice ages and 280 ppm during interglacial warm periods G5. Since around 1900, the level of CO2 quickly rose above historical fluctuations and is now 412 PPM G6. The rate of this increase is more than 100 times faster than the increase that occurred when the last ice age ended G5.

*** Photo smokestack at sunset ***

This unprecedented rise in CO2 and other GHGs is rapidly increasing global temperatures and causing dramatic changes to the earth's climate, oceans, and ecosystems. Already, global temperatures have risen 1.9° F since 1880 G6, glaciers are rapidly melting, sea levels are rising, oceans are becoming more acidic, plant and animal ranges have shifted, precipitation has increased in some areas while drought has increased in others, and the intensity of storms has become more powerful. These trends are expected to accelerate if greenhouse gas emissions are not reduced.

*** Insert Illinois State Climatologist graph depicting temperature increase ***

In the past, the Chicago region's climate has typically consisted of cold winters, warm summers, and frequent short fluctuations in temperature, humidity, cloudiness, and wind direction. As a result of global warming, the region is expected to experience highly variable climatic changes over the coming decades that will impact its natural and built environment, economies, ecosystems, and people. The extent of these changes will be influenced, in large part, by the human behavior and the amount of GHGs released to the atmosphere over the next decade. Projected changes for the Chicago region, Illinois, and the midwest include G2, G8, G9:

- Increased precipitation, primarily in winter and spring
- Increased intensity of storms
- Increased flooding
- Increased water pollution and erosion
- Longer dry periods between rain events
- More frequent and intense drought in summers
- Higher number of very hot (equal to or over 90°)and extremely hot (equal to or over 100°) days
- Increased average high temperature of the hottest day of year from 99° up to 117°
- Increased health risks and degraded air quality from higher temperatures
- Increased water demand due to drought and high temperatures, particularly for irrigation
- Warmer winters
- Greater number of freeze thaw events
- Increased number of pests, diseases, invasive species
- Longer growing seasons and increased CO2 levels may provide the ability to increase agricultural yields, but gains will likely be offset by extreme weather (precipitation, heat, drought) and pests
- More rapid damage to property, roads and other infrastructure from increased precipitation, higher temperatures, and greater number of freeze thaw events

Many of the projected changes will have direct impacts to water resources. For instance, since air can hold four percent more water vapor with each degree Fahrenheit of temperature increase, a warming climate also means more precipitation in areas that are prone to moisture G7. The increase in storm intensity and precipitation rates will lead to increases in water pollution and erosion. Although there will be increased precipitation in the winter and spring, the midwest is also projected to experience more consecutive dry days between storm events, leading to prolonged periods of drought. The combination of increased rainfall and drought means the midwest faces greater risks of flash flooding due to heavier rains per storm and extended dry periods that impede infiltration G8. The decrease of groundwater infiltration, when combined with projected droughts, could decrease recharge rates in the shallow sand and gravel aquifers ultimately lowering long term supply. Additionally, the hotter temperatures and periods of drought will likely increase residential and agricultural demands on existing water supplies. The higher air temperatures will raise temperatures in surface waters that could lead to increased pollutant concentrations, lower dissolved oxygen levels, and increased probability of toxic blue-green algal blooms. These climate change impacts can be devastating on the region's ecosystems, making them inhospitable for wildlife and degrading or eliminating critical habitat for species that cannot otherwise relocate. G10

*** Photo collage of McHenry 2019 flooding, 2012 drought/cracked earth, and algal bloom ***

The two main forms of action commonly discussed to combat global warming and climate change are mitigation and adaptation:

1. Mitigation - Climate change mitigation refers to taking actions to reduce the magnitude of future warming by reducing greenhouse gas emissions or to increase the net uptake of atmospheric carbon through practices such as reforestation or prairie restoration since these habitats are capable of absorbing and storing large quantities of carbon. By reducing atmospheric GHGs, the worst impacts from global warming can be avoided or minimized.

2. Adaptation - Climate change adaptation is about developing ways to protect people and places by reducing their vulnerability to climate impacts. Some degree of climatic impacts are now unavoidable because of excess GHGs that have already been released and will persist in the atmosphere for many years to come. By preparing for changes such as increased flooding, greater temperature extremes, and more frequent and powerful storms, communities can be more resilient and better prepared to handle negative impacts from a more volatile climate.

Both approaches will be necessary because even if greenhouse gas emissions are dramatically decreased over the next decade, adaptation will still be needed to address the global changes that have already been set in motion. There is not a "one size fits all" approach to anticipate, plan and implement climate change mitigation and adaptation strategies. The emission sources and rates may vary from one county to another, or even within a county. For instance, stationary buildings will likely have a higher carbon footprint in densely populated areas that have access to public transportation, while transportation may represent a larger percentage of the carbon footprint in less densely populated rural areas.

*** NEED Oblique aerial photos of residential neighborhood and heavy traffic ***

To help plan, develop, and implement mitigation and adaptation strategies the county and municipalities should collaborate with partners throughout the region. For instance the Chicago Metropolitan Agency for Planning (CMAP) has developed many climate change resources to assist communities throughout the Chicago region, which includes the city of Chicago and the surrounding seven counties (Cook, Lake, McHenry, Kane, DuPage, Will and Kendall). The Metropolitan Mayor's Caucus (MMC) has had 125 municipalities and 3 counties adopt their Greenest Region Compact that helps provide direction for achieving strong, vibrant, and sustainable cities. Both CMAP and MMC are working to provide tools and data that will help municipalities address climate change in their communities. Chicago Wilderness is a conservation based organization that can help counties, municipalities, park districts and residents manage natural resources to be more resilient to a rapidly changing climate. By sharing resources, knowledge and experience with partners throughout the region, McHenry County can act efficiently and effectively on climate change.

<u>Climate Change Mitigation</u> - *The County, municipalities, businesses and individuals should develop and implement climate change mitigation strategies to reduce their GHG emissions and to improve the capacity of natural systems to absorb and store carbon.*

Climate change mitigation can be implemented in McHenry County on any scale including county, municipal, business or individual level. However, the greater the scale of the mitigation the greater the impact. In the absence of strong federal leadership the most effective mitigation efforts can be accomplished working on a state, regional, county, or municipal scale. The first steps are to understand

the problem, identify where changes can be made, and determine which changes can provide the greatest benefit. To help initiate this process, the CMAP completed a Regional Greenhouse Gas Emissions Inventory for the Chicago region in 2015 G11. The GHG Emissions Inventory included an estimated breakdown of GHG emissions in McHenry County by source. The table below provides an understanding of the relative contribution of each emission source in McHenry County that can be used to help identify where opportunities to reduce emissions can be found.

Table ???

2015 Emissions (MMTCO$_2$eq)

Sector	McHenry County Total	Regional Total (Chicago and 7 Counties)
Stationary Energy	**2.55**	**81.90**
Residential Buildings	1.32	31.38
Commercial and institutional buildings and facilities	0.80	28.13
Manufacturing industries	0.43	20.48
Energy industries	-	0.06
Fugitive emissions from oil and natural gas systems	0.00	1.86
Transportation	**1.54**	**34.07**
On-road	1.27	28.65
Railways	0.01	1.02
Waterborne navigation	0.00	0.08
Aviation	-	0.00
Off-road	0.25	4.32
Waste	**0.10**	**3.16**
Disposal of solid waste generated in the city	0.09	2.78
Biological treatment of waste generated in the city	0.00	0.05
Wastewater generated in the city	0.00	0.33
Total	**4.19**	**119.13**
Percent of Total Emissions in Chicago Region	4%	100%

*** Pie chart (in same format as CMAP Inventory Report) w/breakdown of McHenry County Sources ***

Based on the emissions data for McHenry County the greatest opportunity for GHG reduction in the Stationary Energy Sector appears to be by improving energy efficiency of residential buildings. This can be accomplished by weatherizing homes and reducing energy demands through the use of more efficient lighting and appliances. In the Transportation Sector the greatest opportunity appears to be reducing fossil fuel consumption from on-road travel. This can be accomplished by promoting electric vehicle use, increasing use of public transportation, providing greater opportunities for carpooling, and improving infrastructure for bike and pedestrian transportation. GHG reductions in the Waste sector could be accomplished by upgrading waste water treatment plants, expanding access to commercial compost facilities and improving recycling rates.

Examples of climate change mitigation options include:

Buildings and Community

- Collaborate with partners throughout the region to share resources, knowledge and experience to help develop and implement mitigation strategies efficiently and effectively
- Conduct GHG emissions inventory on local levels (county and/or municipalities) to identify and evaluate the most effective mitigation options for their communities
- Implement smart growth and transit-oriented-development
- Weatherize homes, commercial buildings, and manufacturing facilities
- Install energy efficient lighting, appliances, HVAC systems, etc.

Energy

- Expand the production and use of renewable energy sources (solar and wind)

Transportation

- Shift to more fuel efficient vehicles including hybrid, biofuel and electric vehicles
- Purchase electric or fuel efficient fleet vehicles
- Improve and expand more sustainable forms of transportation such as trains and public transit
- Provide more parking areas and promotion for rideshare opportunities
- Promote the installation of electric vehicle charging stations
- Improve and expand opportunities for bicycle and pedestrian transportation
- Adopt an anti-idling ordinance

Waste

- Expand composting of organic waste
- Improve waste water treatment facilities ability to optimize CH4 oxidation or recovery of other gas byproducts
- Improve recycling rates and waste minimization

Natural Resources and Environment

- Expand and restore areas of natural habitats such as prairie, savanna and forest on public and private properties to enhance the regions ability to absorb atmospheric CO2

Agriculture

- Improve crop and grazing land management to increase soil carbon storage
- Improve cultivation techniques and livestock and manure management to reduce CH4 emissions
- Improve nitrogen fertilizer application techniques to reduce N2O emissions
- Improve energy efficiency

Climate Change Adaptation - *The County, municipalities, businesses and individuals should develop and implement climate change adaptation strategies that improve resilience to unavoidable, rapid changes in climate.*

Midwestern cities, suburbs and rural areas are projected to be more vulnerable to negative impacts of climate change including heavy rainfalls, flooding, drought, and extreme heat. Flooding can lead to property damage, mold growth in homes or businesses, groundwater well contamination, and disruption of agricultural practices. Excessive heat can increase pollutant concentrations in water, degrade air quality, endanger people's health and safety, damage roads or other infrastructure, and lead to crop failure.

To better manage risk and improve resilience, communities will need to modify behavior and their built environment. For instance, most of the existing roads, bridges, and stormwater infrastructure in the county were designed and sized based on historical climate data and may not be capable to handle the hotter and wetter conditions that are predicted. To better provide long-term performance, infrastructure should be built or retrofitted for the climatic conditions that are expected over their intended lifespans. The use of green infrastructure can provide multiple benefits including flood storage and water quality treatment while also providing opportunity for greater flexibility for maintenance and modification over time. Planting and managing street trees can help intercept and absorb stormwater, improve comfort from the heat, and reduce air conditioning costs and reduce loading on the power grid. Strategies such as these will help communities adapt to changing conditions and protect public safety. Other adaptation strategies include:

*** NEED photos of green infrastructure during storm and construction of adaptation BMPs ***

Buildings and Community

- Collaborate with partners throughout the region to share resources, knowledge and experience to help develop and implement adaptation strategies efficiently and effectively
- Municipalities should conduct a local vulnerability assessment to help identify specific challenges, prioritize impacts to address, and develop an adaptation strategy.
- Develop stormwater master plans to identify needed drainage improvements
- Expand the implementation and maintenance of green infrastructure
- Increase flood protection elevations
- Adapt drinking water planning to prepare for increased frequency and severity of droughts and other emergencies
- Implement water conservation measures
- Develop extreme heat plans and assign a staff lead
- Require measures to improve building material durability for resistance to moisture, mold, pests, and decay
- Encourage or require passive solar design features such as orientation, south-facing windows and overhangs, and strategic locations for shade trees

Energy

- Convert electric lines to run underground to improve reliability, reduce conflicts with trees or other resources, and minimize disruptions during extreme weather events
- Permit and encourage distributed renewable energy generation
- Support energy efficiency efforts

Transportation

- Utilize a formal pavement management system
- Protect and re-establish overland flow paths for stormwater to accomodate future rainfall patterns
- Implement site-scale green infrastructure during construction
- Reduce contribution of local roads to the urban heat island effect through use of street trees or high albedo pavements
- Consider pavement designs suited to an altered climate

Waste

- Request climate-resilient designs for new or upgraded wastewater treatment plants
- Consider additional flood protection for existing wastewater treatment plants

Natural Resources and Environment

- Plant more trees in public rights-of-way and provide for their long-term management to manage stormwater, reduce flooding, and promote evaporative cooling
- Update tree-planting requirements in ordinances and promote tree planting on private property to manage stormwater, reduce flooding, and promote evaporative cooling
- Update comprehensive planning and site design to protect and expand green infrastructure and greenway networks
- Utilize native vegetation in landscaping to reduce irrigation needs, improve infiltration
- Convert areas of turfgrass to native vegetation on public and private properties to reduce needs for irrigation, manage stormwater, promote infiltration, and reduce flooding
- Expand, restore or enhance habitat in existing naturals areas to improve the health and resilience of ecosystems
- Provide additional natural buffers adjacent to natural areas, greenways, water bodies to expand habitat and improve resilience of ecosystems

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Agriculture (adaptation tactics from USDA Adaptation Resources for Agriculture)

- Minimize soil disturbance by avoiding or reducing tillage for planting, weed control, or other purposes
- Provide nearly year-round ground cover of residue or plants to reduce soil exposure to erosive forces of water and wind
- Increase soil organic matter to improve soil water-holding capacity, soil structure, and water infiltration, and to reduce erosion (use cover crops and mixes, crop or livestock residues, compost, mulch, biochar, or other organic amendments)
- Diversify crop rotations to include plant species of different functional groups to improve soil conditions and reduce threats from disease, weed, and insect pests
- Shift planting dates to avoid field operations and soil compaction during wet conditions
- Modify pesticide and nutrient applications and ensure that use of pesticides, organic materials, fertilizers, amendments, and all sources of nutrients are matched to changing climate conditions
- Use water management practices such as diversions, terraces, waterways, grade stabilization structures, etc. to manage water to prevent ponding, running, erosion, and nutrient leaching
- For sites with animal agriculture, greenhouse, nursery and mushroom production, divert clean water from areas at risk for contamination
- Improve irrigation efficiency for water conveyance and application with latest technology such as micro, drip or sub-surface irrigation
- Maintain or restore natural ecosystems, biological diversity and landscape connectivity

The impacts of climate change are already being felt and will increasingly become a dominant factor affecting the economic, social and environmental well-being of McHenry County. The extent of the change and challenges that will need to be faced in the future are dependent on the decisions regarding GHG emissions being made today. The tools are available to help develop effective mitigation and adaptation plans. By working with others in the Chicago region to develop and implement mitigation strategies the worst possible impacts of climate change can be avoided. However, even if GHG emissions are drastically reduced, McHenry County will have to adapt to climatic changes that are already under way. The sooner mitigation and adaptation plans are prepared, the simpler, less costly and more effective they will be to implement.

*** Callout with brief description of climate change resources available for planning including: ***

National Climate Assessment
https://nca2018.globalchange.gov/

NASA Global Climate Change
https://climate.nasa.gov/

U.S. Climate Resilience Toolkit
https://toolkit.climate.gov/

CMAP Climate Action Toolkit for Municipalities in the Chicago Region
https://www.cmap.illinois.gov/documents/10180/14193/FY13-0119+Climate+Adaptation+toolkit+lowres.pdf/98b5e57c-453f-4111-bc02-6e2cdea0dabc

CMAP Climate Resilience Strategy Paper
https://www.cmap.illinois.gov/documents/10180/517388/Climate+Resilience+Strategy+Paper.pdf/dd610883-d00f-407d-808b-484f9800a3f6

CMAP 2015 Chicago Regional Greenhouse Gas Emissions Inventory
https://www.cmap.illinois.gov/documents/10180/885293/2015+Chicago+Regional+Inventory_Final+Report_June+2018.pdf/03087e10-fc65-f276-3342-7059f212b9d2

Adaptation Resources for Agriculture
https://www.climatehubs.usda.gov/sites/default/files/AdaptationResourcesForAgriculture.pdf

REFERENCES

G1 https://climate.nasa.gov/resources/global-warming-vs-climate-change/

G2 https://www.epa.gov/ghgemissions/overview-greenhouse-gases

G3 https://www.theguardian.com/environment/2012/jan/16/greenhouse-gases-remain-air

G4 NRDC, Global Warming 101 https://www.nrdc.org/stories/global-warming-101

G5 https://www.esrl.noaa.gov/gmd/news/7074.html

G6 https://climate.nasa.gov

G7 Illinois Department of Natural Resources, 2015, "Urban Flooding Awareness Act," https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

G8 CMAP Climate Resilience Strategy Paper

https://www.cmap.illinois.gov/documents/10180/517388/Climate+Resilience+Strategy+Paper.pdf/dd610883-d00f-407d-808b-484f9800a3f6

G9 CMAP Appendix A: Primary Impacts of Climate Change in the Chicago Region

https://www.cmap.illinois.gov/documents/10180/14193/Appendix+A+-+Primary+Impacts+of+Climate+Change+in+the+Chicago+Region.pdf/2a85b021-f3bd-4b98-81d1-f64890adc5a7

G10 CMAP ON TO 2050 Water Resources Strategy Paper, pg 25

G11 CMAP, 2015 Chicago Regional Greenhouse Gas Emissions Inventory
https://www.cmap.illinois.gov/documents/10180/885293/2015+Chicago+Regional+Inventory_Final+Report_June+2018.pdf/03087e10-fc65-f276-3342-7059f212b9d2

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