Solid Waste Management in Maine: Past, Present and Future

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Executive Summary

The Senator George J. Mitchell Center for Sustainability Solutions at the University of Maine has organized an interdisciplinary team of researchers with a wide array of expertise related to solid waste. Together we seek to engage with stakeholders throughout the state to identify and alleviate information gaps, provide opportunities for dialogue and to participate in the process of designing and building support for sustainable solid waste (materials management) solutions in Maine. This paper draws upon the team's collective expertise in order to: 1) provide a brief overview of the history of solid waste in Maine; 2) outline contemporary challenges; and 3) to identify opportunities for the future. While many readers will likely have more complete knowledge of solid waste management in Maine, our hope is that this document can serve as a starting point, a place where stakeholders – citizens, municipal managers, legislators, regulators, landfill operators, waste-to-energy operators, haulers, recyclers, composters, and other vital partners – can provide feedback, help to clarify and assist in reviewing the current state of our system. Our goal is to utilize collective input to identify areas of strength and to create proposals to achieve more success in a sustainable materials management system.

We invite readers to review and comment on the full report. A summary of highlights include:

- Waste generation, management and disposal is an extremely complex issue, in part because it is intricately linked to a wide variety of economic, social and environmental issues affecting our state including public service provision, municipal and state budgets, private industry, ecological and human health, land use, and resident satisfaction with service, facility siting and operations.

- There have been vast improvements in waste management services and programs since World War II, but as a result solid waste issues have been removed from public consciousness and suffered a lack of public investment in and engagement with waste issues - except in times of crisis.

- The history of waste management in Maine can be characterized as a series of periodic crises. While we have made some significant advancement, the need to respond quickly has often pre-empted or precluded long term planning for more efficient and sustainable waste management systems.

- Well-designed materials management programs (solid waste processing and disposal, recycling, organics, source reduction, reuse, etc.), citizen conscientiousness, capital investments, and innovative institutions can all contribute to the achievement of the waste hierarchy and reducing the amount of waste generated and disposed of.

- Every day, over 5000 tons of municipal solid waste are generated, collected, and managed (reuse, recycled, composted, disposed) in Maine; involving a network of varying public and private operations and services.

- Today we find ourselves closer to another “crisis” as we need to expand existing and find new homes for our waste. Meanwhile pressure is mounting to send in more waste from other states that are imposing landfill bans that limit their options.

- The future of Waste-to-Energy in Maine is unclear with one facility closed (MERC) and one with an uncertain future (PERC). WTE facilities reduce waste volume, produce electricity, and are supported by the State’s waste hierarchy.

- All management strategies have trades offs – processes have different costs, environmental impacts, and lifetimes. How the state and public should evaluate these trade-offs is not clear.

- Landfill space is a precious resource due to limited acceptable sites and public resistance to landfills. Increased public engagement in waste issues, due to current debates about landfill capacity and continued reliance upon WTE facilities, presents a significant opportunity to proactively design and invest in more sustainable materials management system in our state.

- All communities are different and there are reasons to have some variability across the state. However, modern waste management technologies (recycling facilities, landfills, waste-to-energy plants) favor large facilities. To achieve reasonable per ton costs, more regionals solutions are likely favorable. Further, inclusive and integrated planning could reduce costs, ensure more equitable investment and improve the state economy.

- Maine can look within the state as well as to other states for programs, policies, and information that successfully diverted waste and captured valuable materials.

- Maine has taken a leadership role in waste management issues in the past and can draw upon our deep culture of “waste not” ingenuity once again to design an exemplary and sustainable system.

- Finding areas to improve on current solid waste management practices will require engaging the many groups of stakeholders and looking inside and outside the state for solutions.

I. Introduction: An Opportunity to Rethink "Waste"

Waste is a curious thing. We all generate it - paper, tissues, product packaging, demolition debris and carrot tops. Indeed, in today's consumer society many of our most basic necessities are wrapped, boxed or bagged. As our population has grown, so has the volume of waste produced. To accommodate this growth our disposal approach has changed from 'dilute and disperse' to 'concentrate and contain.' This system has clear sanitary and aesthetic advantages but it also has the negative effect of removing the compounding costs of waste and the complicated issues associated with its management from the public eye and consciousness.

We acknowledge that while citizens do not want landfills near their homes, as a general rule people are happy to go on living their daily routines and don't often prioritize public investment in waste management. Yet a growing number of citizens, waste managers and policy makers recognize that our contemporary systems allow valuable resources to be wasted and thus are not optimally efficient. In today's system, natural resources are harvested, cut, mined, manufactured, distributed, sold, consumed and wasted. Even goods with significant value come to the end of a one-way, linear system of production, consumption and waste. This problem is particularly pronounced in the US where approximately 5% of the global population consumes 25% of the world's resources (Figure 1) and sends many of those resources to landfills.

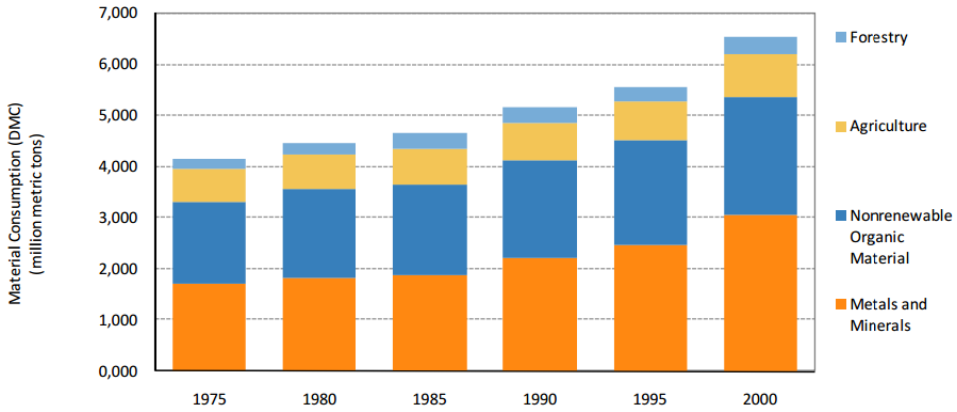

Figure 1: Materials Consumption in the US by Sector of Origin, 1975-2000 *Source: WRI Materials Flows Database 2005*

Our municipal governments are legally responsible for managing solid waste (M.R.S. Title 38 Chapter 13 §1305), but it is an expensive burden. Waste experts estimate that waste management expenditures in Maine typically rank between the third and fifth highest category on municipal budgets. Programs designed to reduce waste and capture a higher percentage of valuable resources before sending them to disposal could significantly supplement municipal budgets if alternatives can be utilized at lower costs than disposal. At the same time tight municipal budgets may translate into a strong local preference to allocate as little money as is possible to waste management. This cost aversion certainly makes sense and recent municipal surveys suggest that the overwhelming majority of municipalities are satisfied with their current waste management system and prefer not to allocate additional funding. But periodically crises arise that threaten the status quo (e.g. leaking or full landfills, expiring electrical sale rate agreements to waste-energy facilities; public resistance toward landfill expansion). Deferring decisions and investment may make economic sense in the short term, but less sense in the long term considering the implications of our current system for long-term environmental and public health, the inefficiency of wasting valuable resources and the costs that compound when long -term planning is neglected.

History repeats itself when it comes to the management of municipal solid waste (MSW), both in Maine and beyond. Most big changes to how we manage our waste have come when the status quo is no longer tenable, through progressive regulatory changes and groundswells of public reaction. For example, ocean dumping was once prevalent but was banned after debris began fouling the shore, and in some cases became a navigational hazard. Ocean dumping of sludge was also abandoned after studies showed that the sludge was negatively

altering our coastal ecosystems, one of Maine's greatest resources. At least with respect to MSW management in the US, change often proceeds as follows: 1) status quo; 2) one or more problems cannot be denied and citizens become engaged; 3) regulators create a deadline for change; 4) the deadline arrives and a crisis is declared; 5) there is a scramble for solutions but the short time frame means they are often incomplete; 6) a solution is put in place that works for the short term.

Today in Maine we're confronted with yet another moment in history when the symptoms of an unsustainable system have risen to a more prominent place in public consciousness. It is a moment when we must decide whether to continue to "manage waste" or to draw upon our strong history of environmental leadership, "waste-not" culture and unique version of entrepreneurialism to design solutions that eliminate waste, capitalize on valuable materials, and spur economic development. This is an opportunity for us all to educate and engage each other to create a more sustainable system.

II. A History of Waste Management in Maine

We begin with a brief history of waste management in Maine. The saying "history repeats itself" rings true in relation to solid waste. Indeed our history is characterized by a cycle of intermittent crises, partial solutions and periods of complacency.

After World War II, many municipalities began covering their open dumps with soil (daily cover). This practice put an end to the nuisance factor of town dumps (reduced fires, and animal issues such as seagulls and rats) (Daniel 1993). For decades there were several waste crises and concerns about garbage volume, water pollution and toxicity as environmental awareness increased. During the 1960s and 1970s various recycling programs were started including the first bottle deposit legislation in the US. During the 1980s, concern mounted over the continued use of unlined landfills in many municipalities. Due to changes in the composition of waste, landfills were becoming increasingly complex and toxic. Traditional dumps did not have engineering features to prevent groundwater contamination. In response, the US EPA enacted the Resource Conservation and Recovery Act in 1976. The Act set a deadline for the closure of inadequate and unsanitary landfills and put in place strict engineering requirements for all new facilities. While a significant step forward to prevent pollution and including a focus on source reduction and resource recovery, the act created a crisis of sorts at state and local levels as municipalities began searching for new homes for their MSW.

The resulting wave of activity in Maine included construction of sanitary landfills designed to meet EPA engineering requirements, the construction of several of waste-to-energy (WTE) facilities and the start of recycling programs. The Mid-Maine Waste Action Corporation (MMWAC) was formed in 1986 and completed refurbishing their facility in Auburn in 1992, the Maine Energy Recovery Company (MERC) built a WTE plant in Biddeford in 1987, ecomaine, originally Regional Waste Systems, built a WTE plant in Portland in 1988, and the Penobscot Energy Recovery Company (PERC) built one in Orrington of the same year. In 1989 Maine created the Maine Waste Management Agency and charged it with creating a solid waste management plan, assisting municipalities and businesses in waste reduction and recycling efforts, and developing criteria for the selection of new landfills. Perhaps most importantly, the state established a recycling goal of 50 percent, developed various assistance programs including an infrastructure grant program and educational efforts, and adopted a waste management hierarchy (38 MRSA §2101) which prioritized efforts to ensure waste reduction before recycling, waste-to-energy and landfilling (in that order).

In an effort to support the hierarchy, Maine emerged as a national leader in product stewardship programs and was among the first to implement stewardship requirements for mercury and batteries. The state also provided assistance to municipalities to improve recycling and materials recovery rates. Combined with waste to energy programs, these efforts contributed to reductions in waste production and landfilling rates. Disposal of waste to a landfill has decreased from 89 percent of total waste in 1980 to less than 54 percent of MSW in 2012. Solid waste generation per person per day peaked in 2000 in the US and the recycling rate has increased–from less than 10 percent of MSW generated in 1980 to over 34 percent in 2012 (Figures 2,3,4, & 5).

Today, most Maine communities do have more organized household collection with increases in the amount of curbside collection of waste and recycling, but recycling rates have stagnated and little additional progress has been made in meeting Maine's recycling goal of 50% (Figure 2). Indeed, Maine has struggled to find new ways to improve solid waste management practices since the mid-1990s and many argue that the waste hierarchy is not being adequately supported with policy or investment. Seeing slow progress towards the 50% recycling goal, stakeholders have increasingly questioned whether or not it is the right goal, or if significant changes must be made to overcome the barriers that are preventing its accomplishment. This is in contrast to national trends showing stabilized waste production rates per capita. This can be seen as a plateau of total waste generation along with increasing recycling rates at the national level (Figure 4, 5).

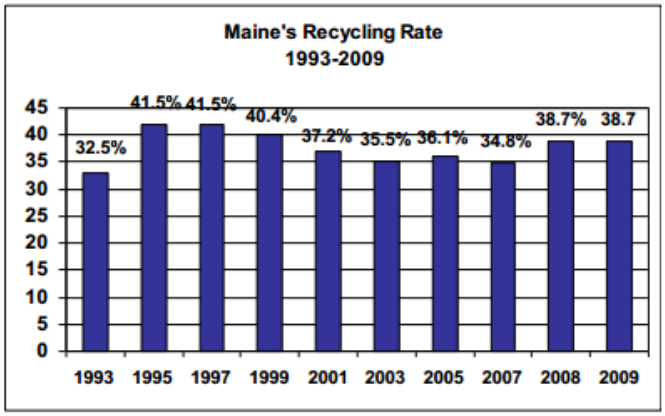

Figure 2: Maine's Recycling Rate 1993-2009

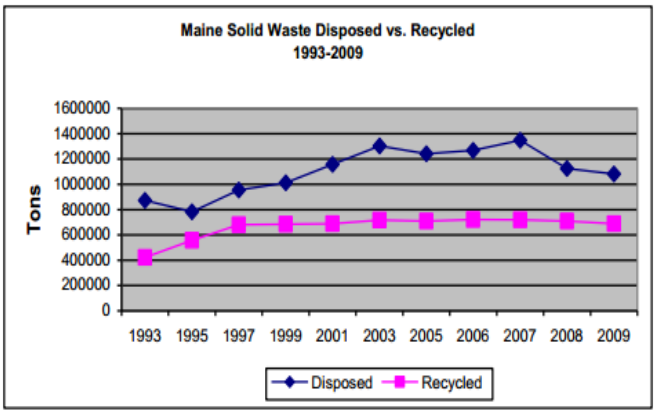

Figure 3: Maine's Solid Waste Disposed of VS. Recycling 1993-2009

Source: State Planning Office Solid Waste Generation & Disposal Capacity Report for Calendar Year 2009

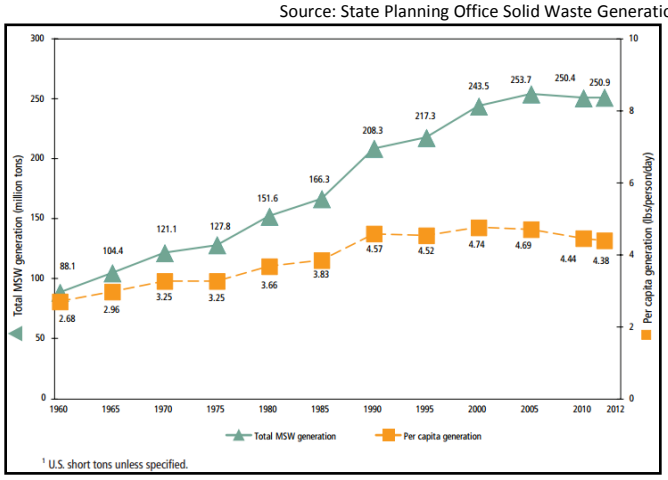

Figure 4: MSW generation rates, 1960 to 2012

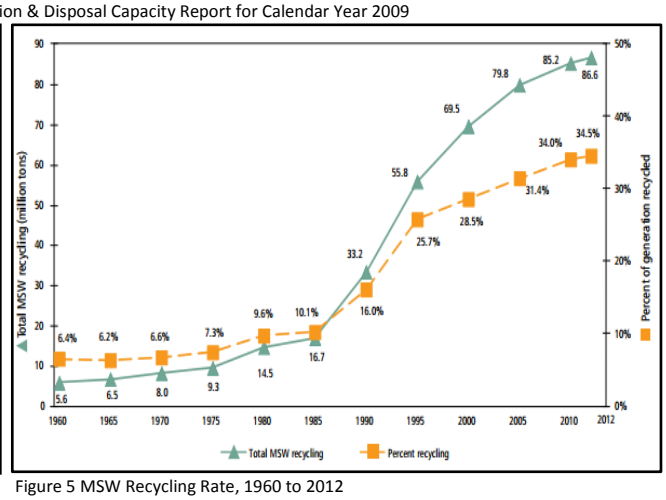

Figure 5 MSW Recycling Rate, 1960 to 2012

Source: USEPA Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012

Complicating planning for the waste hierarchy at the state level, the two state agencies which have helped to set goals for solid waste management have both been eliminated. The Maine Waste Management Agency Act was repealed in 1995, and the State Planning Office closed in July of 2012. These changes in Maine's policy and departmental priorities have added considerable uncertainty to the direction of solid waste regulation and planning for the state. The Department of Environmental Protection is now tasked with Solid Waste data collection and reporting, but their role as regulators could impact their ability to direct solid waste planning for the state.

The current era may be coming to an end as history repeats itself and public interest in MSW policy is once again rising, due to an impending crisis and deadline. Maine Energy Recovery Company's (MERC) WTE facility in Biddeford closed at the end of 2012, taking with it more than one third of the state's waste WTE capacity. In 2018 the waste-to-energy plant, Penobscot Energy Recovery Company (PERC), will lose favorable electrical rates for the energy they produce. Together MERC and PERC represented 72% of the state's waste-to-energy capacity prior to 2012. If PERC were to close, a significant increase in landfilling may be necessary in the absence of

alternative technologies or aggressive waste reduction programs. Yet increased landfilling is inconsistent with Maine's waste hierarchy that places waste processing to reduce volume (i.e. WTE and potentially new technologies) at a higher priority level than landfilling.

One of the PERC owners is the Municipal Review Committee (MRC), a nonprofit organization composed of the 187 eastern Maine municipalities that generate much of the waste PERC receives. As part of the MRC effort to identify alternatives for disposal of their MSW post-2018, the organization proposed siting a new landfill at one of two sites in Argyle or Greenbush, Maine. While the State of Maine, through the Maine DEP, would deny both MRC landfill location requests, the proposals sparked significant public protest and brought waste management back into the public consciousness. Meanwhile other municipalities, struggling to find adequate room in their budgets to manage waste, find proposals to subsidize waste-to-energy unfair given that WTE may not be accessible to all municipalities.

The history of MSW management leads us to look at both the challenges and opportunities associated with our current system of waste management and the potentially historical moment in which we find ourselves.

III. Defining Challenges and Opportunities

Meeting the goals of Maine's waste hierarchy may be difficult without new technologies, renewed support for waste-to-energy, and significant declines in waste generation or policy to restructure landfill incentives. In this section we outline our understanding of the challenges associated with Maine's current MSW system, including our continued reliance on landfills

Waste management and the economy

The state of Maine currently owns three landfill sites: Juniper Ridge in Old Town (operated by Casella); Dolby Landfill in East Millinocket; and undeveloped Carpenter Ridge in Lincoln. Maine also has five municipally-owned landfills (Hatch-Hill in Augusta, Bath, Brunswick, Presque Isle, and Tri-Community in Fort-Fairfield), two ash landfills for WTE residue (ecomaine's and Lewiston), one commercially owned and operated landfill (Crossroads in Norridgewock owned by Waste Management), and two larger waste remediation and Construction and Demolition Debris (CDD) disposal sites (Mid Coast Solid Waste in Rockport and Rockland). As of 2013, the remaining landfill capacity for MSW was 9.4 million cubic yards (Maine DEP 2015). That number could potentially increase if landfill expansion proposals expected in the summer of 2015 are approved and with the legislative rules regarding commercial landfills being changed. If approved and at current disposal rates, these expansions would increase the states capacity beyond 20 years, though some landfills would fill sooner. This time frame would be further compressed with the closure of PERC if no agreeable alternatives to direct landfilling are identified.

The siting of new landfills and the expansion of existing sites are difficult due, most obviously, to local opposition to perceived environmental and operational issues, but also to a host of other reasons including geography and economics. For example, large landfills benefit from economies of scale as large amounts of waste can offset the high costs associated with siting and development, construction and operations. It would be prohibitively expensive for all but Maine's largest municipalities to have individual landfills. But large landfills must be regional in order to obtain sufficient MSW. This is a problem for our largely rural state, however, since geography and infrastructure can make transportation cost-prohibitive for many municipalities if the landfills are far from population centers.

Another economic complication concerns contemporary incentives for landfill operators. To ensure adequate cash flow for operations, landfill operators may have an incentive to secure more volume and to fill at a rapid rate. When analyzing landfill closure timelines, such as with Mid-Coast Solid Waste and the City of Bath's landfill, the least-cost alternative found was to fill the landfill expediently and close it, but that would not be the appropriate option given the needs of the region they serve. These models were based on many social and economic assumptions. There are other factors such as the ability to have a controllable local landfill that isn't quantifiable. Landfills also settle over time as methane, carbon-dioxide, and water are released and allow for a

cubic yard of waste today to not occupy that same space in the future. In terms of general finance it is also known that a dollar today is worth more than future dollars. These factors increase the complexity of landfill planning and operation.

Waste to energy facilities are, as we all know, another option but these too can only exist if they can compete economically with other means of disposing of waste. Being tied to a volatile energy markets leads to a great deal of uncertainty. Materials recovery facilities have the same risks due to extreme fluctuations in the prices of materials. Corrugated cardboard, for example, reached prices of over $200 a ton in recent history, but has historically averaged closer to $70 a ton.

Recycling and capturing materials are important strategies for waste diversion; they also come with a price. Transporting two streams can be costly in rural areas where there are lower volumes. Composting facilities have perceptions of odor that make it difficult to gain community support. Larger facilities could be more cost efficient, but guaranteeing adequate materials inflow prior to construction would prove difficult. That type of price fluctuation makes planning difficult for facilities and brokers that sell recovered materials. There are also concerns about the distances materials (waste, recycling, and other) must travel. Many bailed recyclable materials end up in places far away, sometimes across the globe. The local transfer station or recycling center was a hub for the consolidation of materials, but with the number of communities that have curbside recycling and some form of single stream recycling increasing, the road miles of these collected materials has increased. Diversion technologies also require large capital investments that individual communities or regions often cannot afford by themselves. Private companies have an important role to play in this form of regionalization; allowing for coordination between communities and markets at lower costs.

Alternative incentive structures could potentially be created to address these economic challenges, but waste disposal also presents longer term ecological and public health risks.

Waste management and environmental health

Landfills have been a key part of the waste disposal system, but result in several long-term ecological challenges ranging from land allocation and potential engineering failures to leachate treatment and the production of greenhouse gasses. Policy makers have recognized the scarcity of suitable landfill sites, writing “The Legislature finds that environmentally suitable sites for waste disposal are in limited supply and represent a critical natural resource.” (M.R.S. Title 38 Chapter 13 §1302)

Ideal sites for landfills in Maine are limited given the state’s surficial geology and landscape. Some of the better locations, far away from vulnerable water resources, are also far away from population centers making transportation costs an issue of concern. Once landfills are approved, with today’s requirements that moisture and air be excluded, waste materials in a landfill slowly decay, producing gasses and leachate that may be released into our air and water. Air emissions from landfills primarily consist of Carbon dioxide (CO2), methane, malodorous compounds, and other organic compounds (US EPA 1995) which contribute to air quality problems. Impacts of landfill leachate include the pollution of ground and surface waters and the energy and chemicals associated with treating collected leachate.

These risks are present even for new landfills constructed to modern standards using best engineering practices. Landfills present legacy problems for the state and its citizenry. Already approximately 12% of the closed municipal landfills in Maine have been identified as environment risks as defined by the Maine DEP. Even modern engineered landfills must be monitored over the long-term to safeguard human health and the environment. The US EPA requires that the care period for Municipal Solid Waste Landfills for non-hazardous wastes be 30 years post-closure (US EPA 2014) but Dr. G. Fred Lee and associates, a landfill engineering and environmental consulting group, states that a 30 year post-closure period “has essentially no relationship to the period during which the wastes in the landfill will pose a threat to public health/welfare or environmental quality.” (Jones-Lee & Lee 2014).

Waste-to-energy also has environmental impacts. While many mechanisms and technologies have been put in place to ensure emissions meet regulated air quality levels and to detoxify ash, particularly since the Clean Air Act of 1970, there are still emissions. Many communities object to the odors associated with some WTE facilities and the extra layer of processing also requires significant transportation and ash disposal.

Challenges and Opportunities at (and in) the Home

Landfill and WTE operators provide an essential service for the benefit of a citizenry that produces significant waste (approximately 3 pounds per-person-per-day in Maine). While it is true that both absolute and per capita waste generation has declined in Maine over the last decade, it is also clear that even these reduced levels of waste generation will require new solutions (Maine DEP 2013). While the best solutions will include a mix of these elements and a strong systemic approach, research suggests that the most economic and resource efficient solutions (the low-hanging fruit, so to speak) are found not at the end of the lifecycle, but rather up the supply chain in design modifications or in consumer behavioral modifications (West Coast Forum on Materials Management).

A 2011 study by the University of Maine and State Planning Office (Criner & Blackmer 2011) found that 20% of baggable household waste (after recycling) gathered from 17 municipalities in Maine was recyclable, and more notably, that 40% was compostable. This raises significant questions about waste that might be avoided through the encouragement of changes in household behaviors (meal planning, re-evaluation of "best by" dates, food sharing, household composting etc.). The elimination of food waste and composting keeps valuable nutrients circulating and reduces waste tonnages and landfill-associated emissions. According to several studies, waste prevention and food waste composting offer the greatest potential for waste reduction (West Coast Forum 2014, Cox et al. 2010).

Information and (dis)incentives can often times be effective, but researchers have long noted a gap between environmental awareness, attitudes and behaviors (Thorgeson and Olander 2003). In order to increase household participation in waste reduction these practices must also be convenient (Mueller 2013, Wilk 2009). Municipalities have also recognized the need for convenience, leading to a vast increase in communities using curbside recycling and either single-stream or zero-sort™ for recycling. While single stream can have significant benefits, it can also increase the distances that materials are transported and can break down local community and regional efforts. The significant investment required for single stream materials recovery facilities mean that they are often centralized in urban centers.

Another alternative designed to reduce household waste is Pay-As-You-Throw (PAYT). These programs have also grown in popularity in recent years. In 2006, the EPA reported that there are over 7,000 communities in the US with PAYT (Skumatz 2006). PAYT programs may be perceived as controversial and often fought by citizens. The research on PAYT is mixed, with some reporting significant waste reduction near 50% (EPA 2010, individual municipalities; Brewer, Sanford). Other researchers finding that while there are substantial impacts, they are not only due to PAYT, but also are due to other important factors such as: demographics; available programs; current economic conditions; etc. (Blackmer & Criner 2014; Allers 2010, Ferrera 2005). Finally some studies suggest that reductions in waste from PAYT may be small and heavily undermined by illegal dumping, waste "shifting", "leakage" or "tourism" since those who wish to avoid paying also have an incentive to take their waste to other municipalities (Fullerton 1996).

While economic (dis)incentives like PAYT often shift behaviors in the short term, critics argue that they often fail to produce long term change if the incentive is removed. These findings suggest that while one-dimensional change models like awareness campaigns and financial incentives have enjoyed significant popularity, their effects have been limited if our goal is to affect long-term and comprehensive behavioral change. Strategies to promote household waste reduction need to create strong multi-dimensional programs that ensure awareness, convenience, and incentives but that also help to build strong social environments, shared values and structural support through complimentary programs such as extended producer responsibility, strong prevention targets

and community-based collaborations between the public and private sectors (Cox et al. 2010). Certainly the optimal package of programs utilized is likely to be a product of the specific traits of the community.

IV. Moving Toward Sustainable Materials Management in Maine

The creation of a waste hierarchy in Maine marked an important shift toward sustainable materials management and an attempt to create a more efficient, sustainable and resourceful state economy. But we are still wasting materials and nutrients of significant value. While systems that can capture this value require significant investment, they can reduce long term costs and boost local, regional and state economies in the long term.

Waste-to-energy proved an important step toward reducing the volume of waste generated prior to end disposal. The benefit is that it both generates revenue from the creation of electricity while reducing the volume of the waste to be landfilled by approximately 90%. WTE remains an important part of waste management in our state. The current technological landscape for WTE facilities in Maine is between mass-burn systems and refuse-derived fuel systems (RDF). While ecomaine and (MMWAC) both use mass burn technology, PERC is an RDF. Mass burn technologies have proven to be more cost effective over time as capital costs per ton of capacity are higher and there are additional processing costs for RDF facilities according to the United Nations Environmental Programme.

New and emerging waste stream management technologies have the potential to create a great deal of improvement in the future of managing waste. These technologies have the capability of treating the waste as a resource and not a burden. However, these technologies are still subject to the same issues surrounding transportation, economies of scale, and Maine's low population density outside of the Portland area. Their place in Maine's waste hierarchy is also uncertain as they have complex processes. The most pressing concern in the DEP 5 year plan is removing organics from the waste stream. The use of Anaerobic Digestion, dry fermentation, or larger scale composting facilities to remove organics from the waste stream would accomplish the organics diversion objective from the 5 year plan, but significant capital and transportation barriers exist. Maine has one fully operation digester in Exeter with a couple in the preliminary planning phase with the future uncertain.

The Municipal Review Committee's proposed waste processing facility is an emerging technology that has interesting implications and potential. A report by Pendse et al., has a review of the proposed technologies. Fiberight is still in its infancy, but offers promising chemical and biological processes to produce various types of fuels from the waste. Whether or not the Fiberight plant gets built and what levels products and residuals it creates is still uncertain. On existing landfills, the capture of methane for combustion has become more common. There also exist several places where solar fields are being set up on top of closed landfills to utilize the space to create renewable energy. One example of this is Casella's landfill in Coventry, Vermont which is projected to produce over 3,000 mega-watt hours of electricity per year (Gerlat 2014).

The development and implementation of waste technologies that are efficient, cost-effective and allow us to reduce the amount landfilled, capture valuable materials and nutrients and contribute to new economic activity are certainly desirable on multiple levels. Our discussions with stakeholders from various areas of waste management in Maine suggest this is the case. But the incentive structures, processes, capital investments, public pressure and responsive leadership required to usher in such significant investments and transitions are not currently in place.

V. Learning and Leading: Drawing inspiration and Leading the Way

At the national level, federal guidance continues to advocate a roadmap, outlined in the document 'Sustainable Materials Management: The Road Ahead' (US EPA 2009). This approach focuses on creating prosperity using fewer materials. Wide arrays of policy tools are available to ensure more sustainable and efficient materials management practices and a movement toward an economy that wastes very little.

These policies are increasingly seen as an opportunity for both savings and new funding streams. The Ellen MacAurthur Foundation's report Towards the Circular Economy: Opportunities for the Consumer Goods Sector

(MacAurthur 2013) draws on analysis from McKinsey to estimate additional income of $1.5 billion annually if municipalities collected food waste from households to produce biogas or return nutrients to the soil. Drawing on analysis of the value embodied in products from multiple sectors (e.g. used clothing, appliances) the report estimates that we are currently wasting $2.6 trillion every year. The authors calculate that the full potential of a circular economy could result in material savings worth as much as $700 billion annually. Further, the development of industry to support materials collection and processing has significant job creation potential (MacAurthur 2013). The European Environment Agency (2013) writes, "If a country is to generate greater economic returns at lower costs to the environment then it must find ways to extract more value from the resources that it takes from nature, while cutting the burden of emissions and waste."

Some governments have made significant steps to ensure that materials management adheres to their waste hierarchy. In the European Union, for example, the hierarchy is integrated into the European Commission's Roadmap on a resource efficient Europe (EC 2011) and the EU's Waste Framework Directive (EU 2008). As part of the circular economy package the EU has adopted a legislative proposal that is projected to create 180,000 new jobs while making Europe more competitive and reduce demand for increasingly scarce resources. It aims to increase recycling and reuse of municipal waste to 70% by 2030 and to reduce food waste by 30% and phase out landfilling for recyclables by 2025.

Together these directives have prompted many countries such as Austria, the Netherlands and Germany to virtually eliminate landfilling. As a result the EU reduced landfilled waste by nearly 20 percent between 2001 and 2011 (Cox et al. 2013). Implemented policies in the EU, other US states and beyond range from the educational and voluntary to incentive-based soft policies and hard mandates. While Maine is certainly unique in many ways and leadership in materials management can certainly take a variety of forms, it is wise to look toward implemented programs in other locales to evaluate costs, benefits and suitability for our state.

Educational and Voluntary Programs:
A variety of programs have been put in place to encourage more sustainable behaviors through education and consumer "nudges". One interesting example is the EPA's "Food too Good to Waste" program which provides cities with a "toolkit" which includes educational materials and motivational challenges to engage households in food waste prevention. According to the program an average household in the US can save $1600 annually by reducing food waste alone. Composting can also cut down on the $750 million Americans spend each year to landfill waste and reduce the 14% of US greenhouse gas emissions associated with food waste (West Coast Forum 2014).

Incentives:
While several studies have illustrated that voluntary programs are much less effective, they are less politically contentious and not as deeply unpopular as hard restrictions on choice. Many scholars have shown that a desirable middle ground can be found in policies that provide economic incentives or disincentives for desirable actions. The European Environmental Agency has suggested, for example, that landfill fees can play an important role in incentivizing a shift up the waste hierarchy. Maine was an early leader in the development of policies designed to incentivize waste reduction and materials recovery. The "bottle bill", a container deposit program was enacted in 1976 and implemented in 1978. The system, still in place, makes a significant contribution to recycling rates.
In many municipalities PAYT programs have been put in place to give households an economic disincentive for generating waste. The requirement to purchase bags or stickers for collection provides households with the incentive to remain mindful of waste and reduce costs. Several studies suggest that these programs are largely successful though uncertainties remain about the perception to which these programs contribute to illegal dumping practices.

Mandates:
Many states and national governments have gone further than voluntary programs and incentives to restrict personal choice in the favor of the public interest. While disposal bans, purchasing requirements, mandatory recycling and composting ordinances and product stewardship requirements often meet hard political

resistance, they can be extremely effective. Not only do they result in significant improvements, but they can drive innovation.

Vermont's 2012 legislation is an example of an extremely proactive movement toward sustainable materials management. The state has required the "universal recycling of solid waste." The act bans disposal of recyclables by July 1, 2015; leaf and yard debris and clean wood by July 1, 2016; and food scraps by July 1, 2020. It also requires solid waste haulers and facilities to collect these same materials. The legislation also requires waste characterization and feasibility studies as well as the development of marketing potential for materials. Vermont is able to be aggressive with their food waste due to the high quantity of anaerobic digesters located in the state. Vermont and Maine are not identical and there are different barriers and opportunities predicated on geography, available facilities, and political environment.

Other states that also have landfill bans of recyclables include Massachusetts, Wisconsin, Minnesota, Michigan, and North Carolina. Some cities, such as Seattle, and states like Connecticut, have created mandatory recycling laws that level fines against citizens who throw away certain recyclable materials. California has also recently succeeded in passing SB 270 a plastic bag ban that prohibits grocery and convenience stores from providing free plastic bags after July 1, 2015.

Beyond landfill bans many governments have targeted actors further up the supply chain. British Columbia's Environmental Management Act (B.C. Reg. 449/2004 & 88/2014) has enacted a single "results-based framework that engages industry in new ways by shifting responsibility for environmentally sound product end-of-life management and recycling to producers and consumers". As such British Columbia requires producers of regulated products to submit stewardship plans before they may sell their products in the province. Currently the act includes; universals such as batteries and mercury switches but has also been expanded in recent years to include televisions, printers, smoke detectors and hand held devices.

Maine became a national leader in the establishment of product stewardship programs. It was among the first to implement stewardship requirements for mercury and batteries and now the program also includes electronic waste and cellular phones. Paint will be added as of April 1, 2015 and other products such as mattresses and carpets are under consideration. The DEP website states that, "Maine's Product Stewardship Framework law affirms product stewardship programs as an integral part of the State's solid waste management strategy…This process provides the opportunity for municipalities, manufacturers, retailers, consumers, and non-governmental organizations to provide their input into the establishment and revision of product stewardship programs in Maine," (Maine's Product Stewardship Program).

Comparative studies of landfilling and recycling rates show the importance of using multiple instruments and a systemic approach to materials management.

VI. Engaging Diverse Stakeholders in the Generation of Solutions

Finding solutions to solid waste problems requires the involvement of many people with different areas of expertise, including citizens, solid waste professionals communities, engineers, policy makers, and scientists. We cannot come up with sustainable solutions if some stakeholders are left out of the discussion. That said, it can be enormously challenging to bring people together who do not share the same goals, history, or perspectives on solid waste. We need to find ways to draw together that diverse knowledge to come up with an integrated solution.

Maine is being looked to as a model by other states because we are increasingly discovering ways to bring diverse groups together to come up with solutions on contentious topics. The University of Maine, through such activities as the Sustainability Solutions Initiative, has tested out ways that the university can be a helpful convener and partner on bringing together research and action on tough environmental issues.

The Maine Policy Review issue on environmental issues is filled with examples of how policy makers, researchers, and stakeholders are being successfully brought together to design solutions. Strategies described that we could draw on in solid waste discussions include:

- How to work at the local, county, and regional level
- How to find out if people want to work together and in what ways
- How to involve groups that haven't been able to communicate with each other in the past
- How to bring together people who have spent various amounts of time with a topic
- How to deal with a history of conflict
- How to take into account economic issues, environmental issues, and social issues
- How to deal with complex topics with a history of failed attempts to resolve them

The kinds of solutions include: product stewardship policies; public education and engagement campaigns; increased regional planning and coordination; landfill assessment fees; investments in developing markets for recyclables; investments in innovative new technologies that increase diversion or byproducts of solid waste disposal; partnerships to redesign local manufacturing capacity so that recovered materials can be utilized; and assistant programs such as grant funding for local improvements.

The right combination is certainly influenced by local context, but in general studies show that those governments using a broad range of instrument have higher levels of waste diversion than those with relatively few or no policy instruments

VII. **Conclusion**

In this paper we have offered perspectives regarding the complexities that surround managing waste. The history of solid waste management is not one of zero progress; in fact a great deal of progress has been made with managing solid waste in the past thirty years. Thirty years ago lining a landfill and having a recycling operation was ground-breaking, today it is viewed as a bare minimum. Although waste generation rates per capita have plateaued, recycling rates have remained stable. Waste management is an essential facet of society, but it is an increasingly costly endeavor. Suitable landfill space near population centers are limited and therefore a precious resource to the state. Economic and environmental factors should weigh heavily into our materials management decision making process. The challenges and opportunities that are currently present for solid waste management in Maine require thoughtful, thorough analysis and discourse before action is taken. New technologies, regionalization, economic (dis)incentives, increased convenience for households, and other influences create opportunities for towns to improve their outcomes in managing trash, recycling, and other diverted materials. Government guidelines, policies, goals, and mandates can be utilized to direct municipal actions in how to determine what the appropriate way to manage their individual waste stream is. The ability of the many and diverse stakeholders to join forces and come to level of collective action not previously achieved may yield an increase in group knowledge, help overcome long-standing divides, and inspire improved outcomes. These possibilities are a starting point to bring all parties to the table to discuss how Maine can achieve the best possible outcome for the leftover waste/resources that we accumulate throughout the course of daily life.

Maine is at a crossroads with solid waste (materials) management. We know that solid waste issues are bigger than one community or municipality, and technical and policy issues are complex. The Mitchell Center can play a unique role in bridging the traditional barriers by working in partnership with the various stakeholders. Such an approach has had considerable success in other controversial areas in Maine including forestry, agriculture, urbanization, coastal systems, alternative energy, freshwater quality, and more. The Mitchell Center envisions leading a process where the various stakeholders work in an iterative and collaborative process that combines the vast wealth of knowledge and experience of the various individuals involved (waste management professionals, municipal and regional planners and managers, private companies, state officials, citizens, environmental and advocacy groups, universities, and other interested parties).

The Mitchell Center Waste Materials Management Research Group thanks you for reading our whitepaper and solicits your opinions in the comment section at the Materials Management Research Team's website.

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