SAND2014-16246R

SANDIA REPORT

SAND2014-xxxxx
Unlimited Release
Printed July 2014

The Value of Recycling on Water Conservation 2nd Edition

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Abstract

Sandia National Laboratories (SNL) is working to conserve water through recycling. This report will focus on the water conservation that has been accumulated through the recycling of paper, aluminum, copper, plastic, compost, and ceiling tiles. It will discuss the use of water in the process of harvesting, manufacturing, and recycling these materials. The way that water is conserved will be reviewed. From the stand point of SNL, it will discuss the amount of material that has been accumulated from 2012 through 2013 and how much water has been saved by recycling.

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NOMENCLATURE

ABCWUA	Albuquerque/Bernalillo County Water Utility Authority
Alcoa	Aluminum Company of America
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EPA	Environmental Protection Agency
EPS	Expanded Polystyrene
HDPE	High Density Polyethylene
NOx	Nitrogen Oxide
PM10	Particulate Matter under 10 microns diameter
PM2.5	Particulate Matter under 2.5 microns diameter
SCA	Svenska Cellulosa Aktiebolaget
SNL	Sandia National Laboratories
SNL/NM	Sandia National Laboratories New Mexico
THC	Total Hydrocarbons
USGS	United States Geological Survey
VOC	Volatile Organic Compounds

1. INTRODUCTION

Recycling is the process of gathering used material and treating it to be reused into the same or different material. The concept of recovering materials became popular in previous decades and is important to the protection of Earth. This allows protection to the scarce resources on Earth like precious metals and elements. Greenhouse gases are also a large portion of manufacturing. If less processing or fewer hours of manufacturing are needed, this will limit the release of these harmful gases. Water conservation is the act of saving water through consuming less water and being aware of how and where it is used. Conserving water will permit the Earth's present water supply to last longer than if used irresponsibly. Recycling promotes water conservation because, by restoring and reprocessing goods, less water is needed in the manufacturing of various materials.

Sandia National Laboratories (SNL) is doing its share to be on the path of becoming a zero waste facility. SNL does many different things to help the community become aware of and participate in recycling. They encourage recycling in offices and buildings as well as in departments where other materials can be recycled such as concrete. SNL has recycled around 180 different types of material and about 16,146 metric tons (35,595,952 pounds) during the years of 2012 through 2013. Categories of materials that are recycled at SNL that this report will focus on are paper, aluminum, copper, plastic, compost, and ceiling tiles.

2. PAPER

Paper is used in everyday life: for school, in the media, at work, and at home. All of these uses of paper totaled 78,954,000 tons in 2013 in the United States and of that only 50,128,000 tons (or 64%) were recovered for recycling [14]. The benefits of recycling paper are enormous. By recycling paper landfill space is reduced, fewer trees need to be harvested, and water is conserved. Paper equates to 28 percent [4] of the total tonnage in landfills in the United States. The space saved in landfills in 2013, based on the number of tons recycled, was approximately 165,422 cubic yards [2] [14]. Depending on the type of paper made, it takes an average of 18 trees to make one ton of paper [56]. The pulping of wood and other processes for getting the fibers to make paper can use anywhere from 6,000 to 13,000 gallons of water per ton [28] [58]. One ton of 30% postconsumer content paper saves 7.2 trees [56] and 2,100 gallons of water [57]. The trees that are conserved can then continue to consume carbon dioxide from the atmosphere and produce more oxygen. These trees are also beneficiaries of the extra water that is saved when paper is recycled. This water is saved because less water is needed to pulp paper than to pulp wood.

SNL separates paper for recycle into three categories; mixed paper, cardboard, and white paper. Pulverized paper, white paper shredded very finely, is sent for composting. Except for cardboard, mixed paper is composed of all other paper discards that are not considered high grade paper (white paper). Mixed paper includes items such as newspapers, magazines, colored paper, and chipboard. These items will then be used to make products such as paperboard and tissue [27]. SNL/NM collected

227,581 pounds of mixed paper during the years of 2012-2013 and sells their mixed paper to local vendors for recycling.

The next category is cardboard. Cardboard requires less water than white paper because it is unbleached. Recycled cardboard gets made into items such as shipping boxes, cereal boxes, and shoeboxes [27]. During the same period of time, from 2012-2013, SNL/NM has recycled 712,148 pounds of cardboard. Cardboard is often sent to a mill located in Pruitt, New Mexico or to Mexico. The location that it is sent to is determined by demand and the amount collected by the vendors.

White paper uses the most water due to the bleaching process it is put through. The virgin wood fibers are first bleached with chemicals such as chlorine dioxide, oxygen, or hydrogen peroxide then the pulp is put through a water wash [26]. Recycled white paper has a higher value than other recovered paper due to its long fibers that can be remade into a larger variety of paper products [26]. In 2012-2013 SNL/NM recycled 247,405 pounds of white paper. SNL currently sends white paper to a mill located in Michigan where it is pulped and made into 100% recycled content fiber sheet. Since Sandia's recycled white paper carts have been found to contain sensitive documents, an internal decision was made many years ago to witness its destruction (by recycling) at a pulp mill. The Michigan mill was found to be amenable to allowing witnessed destruction. The mill's output is then sent to a paper mill in Ashdown, Arkansas where it is turned into 30% recycled content copy paper. This mill, owned by Domtar, is the principal supplier of 30% recycled content copy paper to SNL/NM, which helps Sandia complete the recycling loop.

By recycling, SNL/NM keeps paper out of landfills and in useful circulation thus saving space and conserving water. Between the years of 2012 and 2013 SNL collected approximately 593.6 tons of paper equating to as much as 4,155,200 [2] gallons of water preserved. This can be compared to the 4,748,800 gallons of water [28] on average this paper would have taken to produce from raw materials. Paper can only be recycled five to seven times [26] due to the shortening of the fibers and each time it does not have to be (and most often is not) made into the same type of paper or even paper at all. For example: masking tape, bandages, dust masks, and hospital gowns can all be made from recycled paper.

Michigan vs. Arizona:

Since a trip was planned for a witnessed destruction at the Michigan mill in early July, an analysis was requested on the carbon footprint and cost of sending the paper so far away to be recycled. From an environmental impact point of view, is it better to send the paper and witness to Michigan to recycle the paper back into high grade copy paper or to send them a much shorter distance to Arizona to downcycle the white paper into tissue products (toilet paper, paper towels, etc.)?

Michigan: The distance between Albuquerque, New Mexico where the paper originates to the mill in Menominee, Michigan is 1,486 miles. The person sent to Michigan to witness travels approximately 1,174 flight miles [44] on a commercial flight from Albuquerque, NM to Green Bay, Wisconsin. On average a plane produces about 244 pounds of carbon dioxide every mile it flies [51]. Assuming it is continuous, a roundtrip flight from Albuquerque, NM to Green Bay, WI and back would then produce

about 572,912 pounds of carbon dioxide. The witness must then drive from Green Bay, WI to Menominee, MI which is roughly 56 miles away. Once the paper is processed it is then sent to Ashdown, Arkansas which is 1,056 miles away from the Michigan mill. The total mileage (including roundtrip and the mileage of three semi-trucks) to get the paper and witness to Michigan and back is 6,918 miles. If the mileage of the three semi-trucks taking the paper to Ashdown, AR is included the total is brought up to 10,086 miles.

Arizona: If SNL/NM sent their paper to the SCA (Svenska Cellulosa Aktiebolaget) North America plant in Flagstaff, Arizona the distance would be 324 miles. Once the paper is processed at the Flagstaff mill it is taken to a SCA conversion plant in Bellemont, Arizona [45] which is approximately 15 miles away. SCA is a Swedish company which is headquartered in Stockholm, Sweden and whose American headquarters are in Philadelphia, Pennsylvania. The Flagstaff/Bellemont plants are tissue plants for SCA North America [46] and make Tork brand products. According to the Arizona Daily News, "Flagstaff can lay claim to one of this country's most sustainable paper mills-it uses no virgin fiber and only one-fourth as much water as the industry standard" [45]. According to the same article, the industry standard is between 6,000-8,000 gallons per ton of paper produced while the SCA Flagstaff plant uses only about 1,800 gallons a ton [45]. The SCA North America plant in Flagstaff doesn't use bleach in their products so the recycled material must be predominately white [45]. They primarily supply toilet paper to hotels and restaurants in Arizona, California, and parts of Colorado although the Bellemont converting center also makes paper towels. As of 2010 the SCA plant in Flagstaff, Arizona was processing 90,000 tons of recycled fiber

each year [45]. Again including roundtrip, the mileage of the three semi-trucks, and witnessing the trip to Arizona is 1,665 miles total.

Pollutants: According to the Environmental Protection Agency (EPA) certain amounts of pollutants are released depending on the vehicle. Both of these trips require the use of at least three semi-trucks to carry the paper to its destination.

Pollutants released from three semi-trucks* in grams based on distance driven. [47]

Pollutants	Albuquerque, NM to Menominee, MI (1,486 miles)	Menominee, MI to Ashdown, AR (1,056 miles)	Michigan total (2,542 miles)	Albuquerque, NM to Flagstaff, AZ (324 miles)	Flagstaff, AZ to Bellemont, AZ (15 miles)	Arizona total (338 miles)
Volatile Organic Compounds (VOC)	2,028 grams	1,441 grams	3,470 grams	442 grams	20 grams	463 grams
Carbon Monoxide (CO)	10,677 grams	7,587 grams	18,264 grams	2,328 grams	108 grams	2,436 grams
Particulate Matter 2.5 (PM2.5)	958 grams	681 grams	1,640 grams	209 grams	10 grams	219 grams
Particulate Matter 10 (PM10)	1,039 grams	738 grams	1,777 grams	226 grams	11 grams	237 grams
Nitrogen Oxide (NOx)	40,974 grams	29,117 grams	70,091 grams	8,934 grams	414 grams	9,347 grams
Carbon Dioxide (CO_2) [66]	7,552,641 grams	5,359,939 grams	12,912,581 grams	1,644,527 grams	60,908 grams	1,705,435 grams

*Ultra-low sulfur diesel taken into account. EPA assumed diesel fuel content of 11ppm. [47]

Pollutants released from average passenger car based on distance driven [50]

Pollutants	From Green Bay, WI to Menominee, MI (112 miles)*	From Albuquerque, NM to Flagstaff, AZ (648 miles)*
Volatile Organic Compounds (VOC)	116 grams	670 grams
Total Hydrocarbons (THC)	121 grams	698 grams
Carbon Monoxide (CO)	1,053 grams	6,091 grams
Nitrogen Oxide (NOx)	78 grams	449 grams
Particulate Matter 2.5 (PM2.5)	0.5 grams	3 grams
Particulate Matter 10 (PM10)	0.5 grams	3 grams
Carbon Dioxide (CO_2)	27,356 grams [54]	158,133 grams [54]

*Total miles roundtrip.

Fuel Consumption: The average semi-truck gets about 6 miles per gallon [48] and holds between 200-300 gallons of diesel. A compact car, on average, gets about 26 miles per gallon [52] and holds 12-15 gallons of gasoline.

Approximate Fuel Consumption in Gallons of Three Semi-Trucks.

Fuel Type	Albuquerque, NM to Menominee, MI (1,486 miles)	Menominee, MI to Ashdown, AR (1,056 miles)	Michigan total (2,542 miles)	Albuquerque, NM to Flagstaff, AZ (324 miles)	Flagstaff, AZ to Bellemont, AZ (15 miles)	Arizona total (338 miles)
Diesel	744 gallons	528 gallons	1,272 gallons	162 gallons	6 gallons	168 gallons

Approximate Fuel Consumption in Gallons of a Compact Car.

Fuel Type	Green Bay, WI to Menominee, MI (112 miles*)	Albuquerque, NM to Flagstaff, AZ (648 miles*)
Gasoline	4 gallons	25 gallons

*Roundtrip

Michigan (Costs): Using a shipping calculator, the estimated cost for shipping paper to Michigan is about $3,450 a truck. This makes for a total of $10,350 for 3 full trucks [55]. The cost of a roundtrip flight with Delta Airlines from Albuquerque, NM to Green Bay, WI and back is about $560. The average cost of renting a compact/intermediate car from Avis for two days is about $110 [53]. As of June 23, 2014 the national average for gasoline was $3.70 per gallon [49]. By using approximately 4 gallons of gas on the roundtrip between Green Bay, WI and Menominee, MI the cost would be approximately $15. This makes for an approximate total cost of $11,040.

Arizona (Costs): The estimated cost for shipping the paper to Flagstaff, AZ is $850 a truck which would be $2,550 for three [55]. The cost of renting a car from SNL/NM Fleet Services is $40 a day. Having the car for three days (including travel time) the total cost would be $120. For the roundtrip from Albuquerque, NM to Flagstaff, AZ and back a total of about 25 gallons of gas would be used costing about $93. The total cost for this trip would then be about $2,760.

	Michigan	Arizona
Total Cost	$11,040	$2,760
Gas Usage	4 gallons	25 gallons
Diesel Usage (of 3 Semi-trucks)	1,272 gallons	168 gallons
CO_2 Production	12,939,937 grams	1,863,568 grams
NO_x Production	70,169 grams	9,796 grams
Total Miles	10,086 miles	1,665 miles
Plant water Consumption	6,000 gallons/ton*	1,800 gallons/ton

*Industry Standard

Based on the information above it would be significantly more cost effective and environmentally friendly to send SNL/NM's white paper to the SCA North America plant in Flagstaff, Arizona. This analysis is now available to help make the decision on whether SNL/NM should forego the closed loop recycling in favor of a shorter trip to downcycle the recycled paper.

3. ALUMINUM

Lots of things are made from aluminum; cans, foil, and even the new 2015 Ford F-150 truck. Aluminum, like glass, is a great thing to recycle because it is 100% recyclable and can be recycled over and over without losing its quality. By recycling one ton of aluminum ten cubic yards of landfill space can be saved [36]. In 2012, the United States generated a total of 3.6 million tons of aluminum of which 1.9 million tons were in the form of cans and packaging [35]. Of that 55% of aluminum cans were recycled equating about 0.7 million tons [35].

A lot of resources are needed to make aluminum. To produce one pound of aluminum it takes 5 pounds of raw materials: 4 pounds of bauxite [37][38], 0.5 pounds of petroleum coke, 0.25 pounds of pitch, and 0.2 pounds of lime and soda ash [38]. In 2013, Alcoa (Aluminum Company of America) used roughly 1,083 gallons of water per a metric ton of aluminum produced [39]. This amount can be compared to numbers from 1956 in which some companies were using roughly 1,198 gallons on the refining process called the Bayer Process and another 26,526 gallons [38] on the smelting process known as the Hall-Heroult Process. The Bayer Process is a refining process for obtaining alumina (aluminum oxide) from bauxite. It was invented in 1887 by Austrian scientist Karl Josef Bayer [40]. It consists of several steps for extracting the alumina. Once the alumina has been refined it is then smelted. According to the EPA, "Aluminum is produced in much the same way it has been produced for the last century, using the Hall-Heroult process" [41]. The Hall-Heroult process is still used in the aluminum industry by companies such as Alcoa, although it has been made more efficient and less water consuming. In this process alumina is melted in bath of cryolite

and is then put through electrolysis. This separates the aluminum from the oxygen leaving pure aluminum. The water used in aluminum production is used first during the Bayer stage where it is used to wash the aluminum oxide crystals after precipitation. In the Hall-Heroult process, water is reused as part of a cooling process once the aluminum is extracted and molded into ingots.

In 2013, the world generated a total of 50,602,000 metric tons of aluminum, averaging about 138.6 tons a day [42]. This amount of aluminum required 54,801,966,000 gallons of fresh water for production. Recycling one metric ton of aluminum can save close to 6,000 gallons of water [43] because it eliminates the need for mining and refining bauxite into alumina (aluminum oxide). SNL/NM recycled 5,559 pounds of aluminum cans and 25,416 pounds of other forms of aluminum during the years of 2012-2013. The recycling of a total 30,975 pounds (14 metric tons) of aluminum by SNL saved roughly 84,300 gallons of water [43]. This can be compared to the 104,897 gallons [43] of water it would have taken to make that amount of aluminum from new materials.

4. COPPER

Copper is has been used to make goods for at least a 10,000 years. Copper is the most conductive, non-precious metal, and is second only to silver. It is used to make electrical wiring, piping, and a wide variety of other objects. Like aluminum, copper and its alloys are 100% recyclable and can be recycled indefinitely without losing its qualities [59]. In 2012, the United States produced a total of 1,001,000 metric tons of refined copper. The United States is completely copper sufficient with most of its copper coming from Arizona, Utah, New Mexico, Nevada, and Montana [60]. As of 1985, the United States had an average ore grade of 0.51% copper, which means that 200 metric tons of ore are needed to produce 1 metric ton of metal [61]. The ore grade has been dropping around the world as higher grade copper resources are depleted. In 1985, the world's ore grade average is around 0.79% copper [61].

There are two main types of copper bearing minerals; oxides and sulfides. The main oxide minerals are malachite, azurite, and chrysocolla and the main sulfides are bornite, chalcocite, and chalcopyrite [62]. The procedure for extracting copper from these minerals differs depending on whether it is an oxide or a sulfide. Sulfide ore refining requires about 2.4 times more water than oxide ore refining [63]. The copper coming out of the western United States is produced mostly from copper sulfide ore [61]. Sulfide ore is put through a series of grinders and crushed very finely. The crushed material is then put through the flotation process where it is combined with water and chemicals. The copper particles rise to the surface with air bubbles and are skimmed off the top. They are then dried and concentrated to be sent to a smelter. At the end of smelting the copper is 99% pure and is then sent to be refined. At the electrolytic refinery copper

anodes are immersed in a tank of sulfuric acid and copper sulfate [62]. The purer copper is then deposited and later made into items such as wiring.

. In Arizona mines the average amount of water used per a pound of copper was 28.3 gallons [64]. That means for one ton of copper mined and concentrated 56,600 gallons of water were needed. Water is used for the flotation process, for cooling, and for various other tasks. The water requirements of copper production vary depending on the process step. The water requirements for the flotation process, according to the State of Arizona Department of Mines and Mineral Resources, "which include recirculated water, vary between 800 and 400 gallons/ton of ore" [64]. According to the same report, the fresh water consumption at a concentration plant is around 500 gallons per a ton of ore [64]. In 1979 another 30,000 gallons of water per ton of copper was needed for refining [67]. This is amount of water is similar to refining water requirements found in 1961 [68]. This makes for a total water usage of roughly 86,600 gallons of water for one ton of copper. Recycling one ton of copper saves about 1,430 gallons of water [69] [70]. This is because mining and flotation are eliminated from the process. Scrap copper is washed, melted down, electro refined, and then cast into ingots.

In 2012, the world produced 20,961,000 metric tons of copper of which 3,586,000 metric tons were from secondary sources [65]. This amount of copper required about 1,658,873,000,000 [71] gallons of fresh water for production. From 2012 through 2013 SNL/NM has recycled 110,889 pounds (55.4 tons) of copper. This amount of copper saved 79,220 gallons [69] [70] of water.

5. PLASTIC

In 2012, the amount of plastic recycled nationally was only nine percent [17] of the total plastic generated. Plastic, like paper, is used in everyday life and can be found everywhere. Water is used in the manufacturing of plastic as a cooling process and as a lubricant to make the removal of plastic out of the molding easier [16]. It may seem like only a small application of water is needed, but for every metric ton of plastic made a total of 145,700 gallons of water are used [24]. Just one plastic water bottle takes 1.85

gallons of water to make [33]. By recycling one metric ton of plastic 6,000 gallons of water are saved [13] [22]. This water is saved by eliminating the need for extraction and refinement of the raw materials. Recycling plastic is important because plastic does not start breaking down for 700 years [9]. This means that plastic takes up a lot of space in landfills because every day the world uses 100 million plastic bottles [9].

Not all plastic is the same. This is due to their chemical makeups which differ. For example polyethylene's chemical makeup is $(C_2H_4)_nH_2$ while polystyrene's is $(C_8H_8)_n$. Most plastics have a number that helps identify the type of plastic they are. For example number 2 plastics are made of High Density Polyethylene (HDPE) and number 6 is usually used to designate Styrofoam. The plastics are separated because each is

made of different materials and each is recycled into different materials. The major plastic categories that are recycled are #2 plastics, #6 plastics, and mixed.

As mentioned above, number 2 plastics are HDPE which is the most recycled plastic. Items made of HDPE include, but are not limited to, milk jugs, detergent bottles, and yogurt/butter tubs [32]. When HDPE plastic is recycled it is usually remade into things such as recycling containers, lumber/fencing, and detergent bottles [32]. During the years of 2012-2013 SNL/NM has recycled close to 17,218 pounds of HDPE.

Number 6 plastics include items such as DVD cases, carry out containers, and Styrofoam. At SNL Styrofoam is recycled separately from the other #6's, which are placed in the mixed category. The term Styrofoam is a trademarked name of the Dow Chemical Co. [29] and so is also known as EPS (Expanded Polystyrene) foam. Styrofoam is not biodegradable and in 500 years will still be sitting in a landfill. It also is difficult to recycle and many recycling programs will not accept it [32]. Every year roughly 25,000,000,000 Styrofoam cups are thrown away in the United States alone [30]. Styrofoam takes up an estimated 30% of landfill space world-wide [29]. One pound of Styrofoam takes roughly 20.5 gallons of water to make [31]. During the years of 2012-2013 SNL has recycled 3,463 pounds of Styrofoam. This Styrofoam is put through a grinder and turned into compact logs. These logs are then sold to a vendor. It can be remade into egg cartons, foam packing, and insulation [32].

The last category of plastic that will be discussed is the mixed plastic. This category ranges anywhere from #1- #7 plastics to the plastic off of electronics. In just two years (2012-2013) SNL/NM has recycled about 17,804 pounds of mixed plastics.

With the SNL campus having so many offices, plastic containers are common. SNL/NM offers plastic recycling bins in all occupied buildings for #1 through #7 plastic. The Pollution Prevention team will also support the recycling of abnormal plastics upon request. SNL/NM has recycled 58.4 tons (116,726 pounds) during of years of 2012-2013. This recycled material has conserved approximately 317,877 gallons of water. It would have taken about 7,719,040 gallons to make this amount of plastic from raw materials. With a total plastic savings of 58.4 tons SNL/NM has saved roughly 1,751 cubic yards of landfill space [34].

6. COMPOST

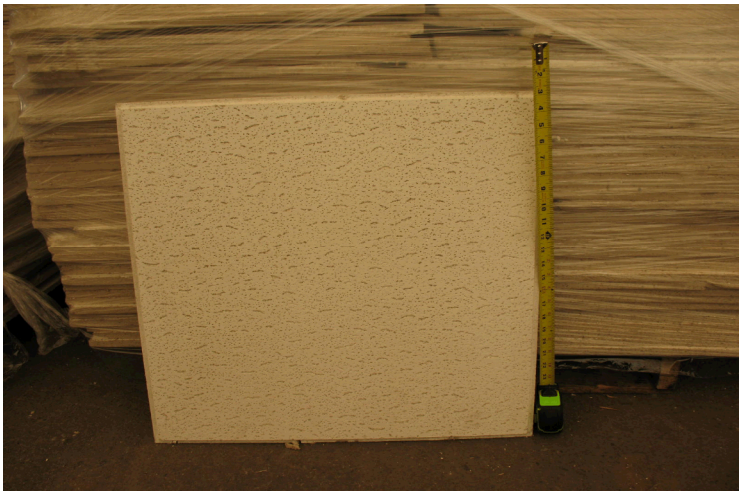
United States landfills are comprised of 30% organic material that could have been composted [7]. According to the EPA, 35 million tons of food waste ends up in landfills and incinerators every year [25]. Compost has many functions; the primary functions include improving the nutrient content of the soil and conserving water. An average residential landscape with grass, trees and bushes in the United States can go through 10,000 gallons of water a year [5]. This is a lot of water for the threatened

amount of water that there is in the country. Compost can hold more water because of increased absorbency due to the spongy texture caused by the decomposing of the organic materials. The moisture content that is recommended for compost is between forty and sixty percent by weight [6]. This moisture content allows the decomposing of the organic material to take place steadily. One metric ton of compost contains about 145 gallons of moisture [20]. The moisture that is in the compost is not pure water, but rather it comes from the moisture stored in the food or green waste that the compost is composed of. SNL/NM contracts with a local composting company in order for the food waste that is generated at the two cafeterias on the SNL campus to be picked up. Between the years of 2012 and 2013 SNL/NM contributed about 40.3 metric tons of food waste from these two locations. Besides the food or green waste contributed to compost, SNL/NM has also contributed 309,380 pounds of pulverized paper to be composted in 2012-2013. SNL/NM also collects green

waste such as landscape debris. This material goes to the Albuquerque/Bernalillo County Water Utility Authority (ABCWUA) Soils Amendment Facility for composting. This facility has received about 128.4 tons of green waste (including plywood) and pulverized paper from SNL/NM among the years of 2012 through 2013. In exchange for the feedstock material, ABCWUA Soils Amendment Facility periodically provides a load of finished compost to SNL/NM, so that we can conserve water with our landscapes. This totaled to 128.4 tons (256,851pounds) of material composted by SNL during 2012-2013. Compost's ability to retain larger amounts of water and reduce runoff can save fifty percent [21] of the water that would be used if compost was not present. SNL/NM has conserved about 21,300 gallons of water in the compostable material that they have collected. This number is for a one time use so the savings are much greater because one application of compost can last a lengthy amount of time. If compost wasn't present the water amount that would be used is approximately 42,500 gallons [23].

7. CEILING TILES

Ceiling tiles are found in the majority of office buildings. Ceiling tiles are easy to install and are used primarily to hide electrical wiring and air ducts from plain sight. They also soundproof rooms by keeping noise from traveling to other offices. In 2011, Armstrong Corporation sold almost 350 million ceiling tiles from their factories around the world [11] [19]. Ceiling tile production is like that of paper, including a pulping process to get the correct mixture to be molded and cut. Water is used to produce ceiling tiles by processing the raw material before they enter the slurry to be molded into ceiling tiles.[11] The slurry contains water. One metric ton of ceiling tiles takes approximately 5,600 gallons of water to produce [11]. Armstrong is known for using recycled material in new products. Ceiling tiles from Armstrong can contain different percentages of recycled material, which saves water. Recycling one metric ton of ceiling tiles can save 11 tons of raw materials and roughly 1,892 gallons of water [19]. Water is saved because, with recycled materials, the water that would be used to process raw materials is saved.



SNL/NM works with Armstrong to reduce the impact of ceiling tiles on landfills. This is done two ways; SNL/NM sends their used ceiling tiles to be recycled, and purchases back ceiling tiles that contain recycled material. From 2012 through 2013, SNL/NM has recycled 9.1 metric tons of ceiling tiles. The ceiling tile that SNL/NM has

recycled has saved around 17,217 gallons of water [19]. Making this amount of ceiling tiles from raw materials would have required 50,960 gallons of water. A great quality of recycling ceiling tiles is they can be recycled multiple times thus saving an abundant amount of water in the process.

8. CONCLUSION

Recycling is important to the well-being of the Earth. Goods that people use on a daily basis come from raw materials that are being depleted. The future occupancy of Earth depends on the sustainability and the conservation of these materials. By recycling today and diverting useful material from landfills, we are preventing the landfill build up or needless incineration. Water is an extremely valuable resource needed for life on this planet. Recycling conserves water and, as we have seen in this report, rapidly becomes a significant quantity. The six materials discussed from SNL/NM have helped conserve 4,675,114 gallons of water for the years of 2012 through 2013.

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