CLEANCORE TECHNOLOGIES

LIFE CYCLE ASSESSMENT OF CLEANCORE CADDY

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This analysis and report was prepared for CleanCore Technologies (CleanCore) by Ecoform, an environmental consulting firm specializing in the design, evaluation, and adoption of clean products and materials through technical and policy research.

Results and conclusions of this report are based on data provided to Ecoform for the CleanCore Caddy by CleanCore and its suppliers. This analysis would not have been possible without the cooperation of individual CleanCore employees and its clients who voluntarily provided data and confidential business information in support of this effort. Ecoform staff would like to thank the companies and their representatives for their cooperation and assistance in this analysis. Please direct any questions or enquiries about this report to the following:

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OVERVIEW OF LCA STUDY

CleanCore Technologies is a leading developer of innovative water-based cleaning systems. With the rapidly growing emphasis on green building and human health, there is a demand in the market for environmentally focused cleaning systems that provide effective cleaning while also acting to reduce or eliminate exposures to chemicals and indoor emissions. CleanCore equipment utilizes an innovative technology that infuses cold water with ozone gas to create aqueous ozone, a natural and robust cleaning solution that is created on-site and on-demand that is an alternative to traditional chemical-based cleaning solutions.

To accurately assess the benefits of this technology, CleanCore has contracted Ecoform to fully evaluate the life-cycle performance of the CleanCore Caddy (Caddy), a janitorial cart equipped with the Aqueous Ozone technology. This study evaluates the relative life-cycle benefits associated with the use of the Caddy as compared to a conventional chemical-based floor cleaning system under two separate cleaning scenarios. Potential impacts and benefits were evaluated over a range of environmental and select human health categories.

CLEAN CORE CADDY DESCRIPTION

The CleanCore™ Caddy (“CCT Caddy”) is an effective, easy to use, multipurpose cleaning system developed for janitorial professionals. The CCT Caddy system is an advanced aqueous ozone system designed specifically to promote chemical-free cleaning, focusing on environmental cleaning, floor cleaning, high-touch surface cleaning and other janitorial applications. The CCT Caddy generates an Aqueous Ozone Solution™ using cold water and the air we breathe. Simply plug the unit into an electric receptacle outlet and fill the supply water reservoir. Turn the power on and allow the system to prime.

CleanCore Sanitation Solution™ is an aqueous form of triatomic oxygen, also known as Aqueous Ozone.

The entire Caddy, including the ozone generator and delivery system is evaluated in this analysis. The CCT Caddy is calibrated by design to provide flow rates of the CleanCore™ Solution with concentration levels ranging from 1.0 - 1.5 parts per million ("ppm") of ozone in solution. All energy and water usage required under each scenario are also included in this analysis. See Appendix A for a more detailed description of the performance specifications of the CleanCore Caddy system and for a detailed list of the components evaluated in this LCA.

LIFE CYCLE ASSESSMENT SCOPE

LIFE CYCLE APPROACH

Life-cycle impacts in a variety of human health and environmental categories resulting from the cleaning of select building types were evaluated in a comparative life-cycle assessment. Evaluations of human health were restricted to select life-cycle impact categories related to respiratory effects resulting from the use or usage-stage. Two separate cleaning scenarios were evaluated, each based on data from actual building maintenance operations and practices associated with each building type. For each scenario, the impacts of the manufacturing and operation of the Caddy were directly compared to the impacts associated with the production, transportation, use and disposal of traditional cleaning solutions and their associated packaging. The resulting findings were used to then assess the environmental and human health performance of the CleanCore Caddy.

The life-cycle analysis was performed using version 6 of the GaBi Life-Cycle Software. Secondary, pre-existing data from GaBi and Ecoinvent datasets, supplemented by proprietary Ecoform data sets, comprised the entirety of the life-cycle inventory data and were based on bills of materials for both the Caddy and traditional cleaners. For a more detailed description and breakdown of the BOMs, refer to Appendix B. Specific environmental and human health impact categories evaluated are described in Appendix A.

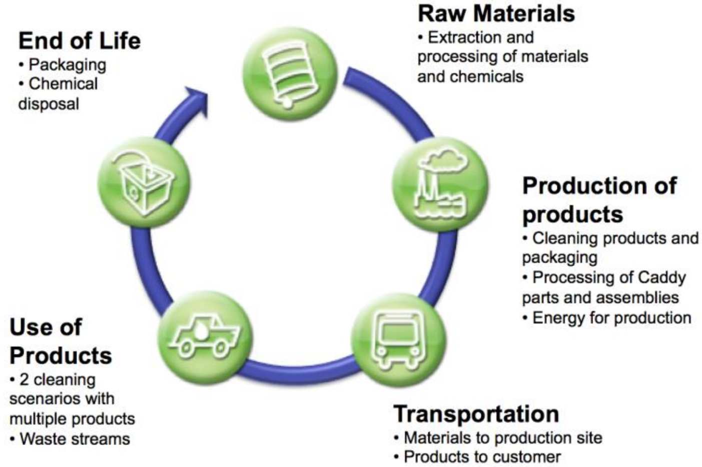

FIGURE 2: SCOPE OF LCA ANALYSIS

Overall, data quality is considered medium for this analysis, taking into account the lack of primary manufacturing data for either alternative and the average quality of a few of the secondary data sets. Overall, 92% of the total mass of the CleanCore Caddy was characterized in this assessment. Sensitivity analyses were conducted around these potential data gaps, with minimal effect on the overall disparity of the impacts. As such, the overall confidence in the study is evaluated to be good.

LIFE CYCLE SCENARIOS

Individual life-cycle scenarios were constructed to assess the life-cycle performance of the CleanCore Caddy relative to cleaning using conventional daily-use chemicals. In this study, scenarios characterizing the cleaning performed in both an Office Building and a K-12 Education environment were evaluated. Scenarios characterize the critical parameters associated with building maintenance operations and are used to define a functional unit for the study. Specific parameters for each of the scenarios evaluated in this study are presented in the Table 1. Each scenario was based on actual data collected from in field use of the Caddy and is thus representative of expected performance under similar conditions.

TABLE 1. LIFECYCLE SCENARIOS – BUILDING TYPES

Parameter	Life-Cycle Evaluation Scenarios	
	Office Building	**Education K-12**
Total Facility Size (sq ft)	75,000	154,000
Flooring Type	55k Carpet 20k VCT/Terrazo	15k Carpet 120k VCT
Restrooms	8	19
Fixtures	80	170
Cleaning Staff (# full time workers)	3	4 + manager
Cleaning Frequency	Carpet – 1/yr Hard Floor – 4/yr Restroom – 260/yr	Carpet – 1/yr Hard Floor – 4/yr Restroom – 260/yr
Equipment	1 CCT Caddy	3 Caddy's

The **functional unit** for each scenario of the LCA is defined as the production and transportation of solutions sufficient in volume to effectively clean the indoor building space as defined in each scenario over a period of 5 years. For the purposes of this study, cleaning operations were considered to include the need for floor, glass, all-purpose, toilet bowl and carpet pre-spray cleaners, and their associated cleaning operations. The 5-year period was selected to coincide with the minimum expected product life of a CleanCore Caddy in the considered market applications. The functional unit establishes a fair basis of comparison between the Caddy and the chemical-based cleaning operations based on the performance of a like amount of cleaning performed. Bills of materials (BOM) for both the Caddy and for the chemical-based cleaning operations, as well as chemical usage rates and other relevant data are presented in Appendix B.

LIFE CYCLE INVENTORY SCOPE

The Life Cycle Inventory Analysis covers the life-cycle stages as shown in Figure 3.

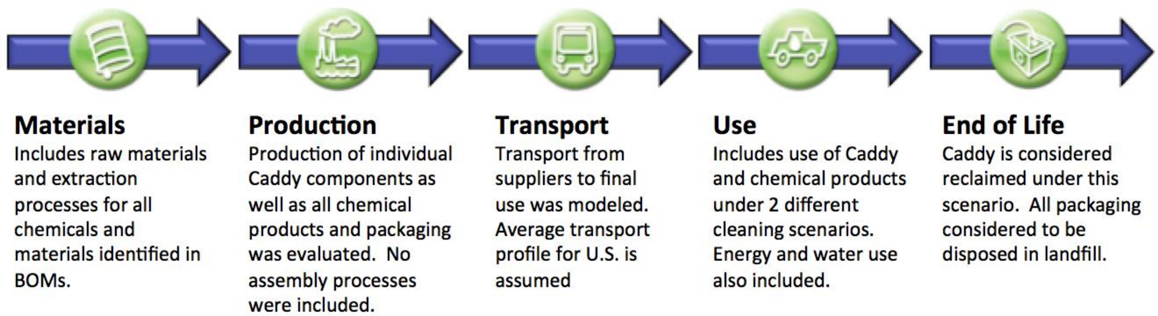

FIGURE 3: LIFECYLE INVENTORY SCOPE

LIFE CYCLE IMPACT ASSESSMENT

Impacts to a variety of key environmental and resource categories for the two cleaning systems are presented for both the education and office building scenarios. Results reflect impacts associated with the life-cycle product chain, including those resulting from the production of raw materials, energy, and resources consistent with the scope of the inventory data, depicted in Figure 4. Detailed descriptions of individual impact categories are described in the Appendix A. Bills of materials and other additional data for each scenario are given in Appendix B.

LIFE CYCLE IMPACTS – K-12 EDUCATION SCENARIO

Life-cycle impacts assessed for both the CleanCore Caddy and chemical-based traditional cleaning operations are presented in Table 2. Results are based on the K-12 Education scenario and functional unit, which specifies that enough Aqueous Ozone cleaning solution be produced to clean a 154,000 square foot educational facility for a period of 5 years. Three Caddy's were evaluated, a configuration recommended by CleanCore for this scenario. Results are limited to cleaning tasks performed with floor, glass, all-purpose, toilet bowl and carpet pre-spray cleaners. Results have been normalized, and the percent differences have been presented in Table 2. and visually depicted in Figure 4. A breakdown of impacts by each life-cycle stage is presented in Appendix C.

TABLE 2. LIFECYCLE IMPACTS – EDUCATION K-12

LCA Categories		Traditional Cleaners	CCT Caddy	Benefit (%)
Ecotox	(Ton TEQ)	23,605	8,262	**65**
CO_2 Emissions	(kg CO_2)	11,882	1,663	**86**
Ozone	(g CFCs)	0.00203	0.000061	**97**
Smog	(kg NOx)	0.0269	0.00457	**83**
Acid	(kg SO_2)	33.42	9.02	**73**
Eutrophication	(kg PO4)	0.70	0.0419	**94**
Particulate	(kg PM2.5)	7.48	1.12	**85**

Results have also been depicted in Figure 4, below. In simple terms, the chart visually depicts the relative footprints of the scenario alternatives being compared. The larger colored area represents the footprint associated with cleaning operations performed using traditional cleaners, while the smaller white area represents impacts resulting from the use of the Caddy.

The cleaning operations performed in the maintenance of the educational facility consumed a significant volume of chemicals, totaling 2,810 gallons of traditional daily-use chemical product concentrates at various dilution levels. A breakdown of chemical product use is presented in Table B1 of Appendix B. Results indicate that the on-demand generation of the Aqueous Ozone cleaning solution generated by the Caddy is clearly preferential to the distribution and use of traditional daily-use cleaning chemicals. **Environmental and human health impacts ranged from 65-97 percent better than those for conventional chemicals, depending on the category**. This difference is directly related to the large volumes of all types of chemicals used in this cleaning scenario, as well as to a chemical product profile with an overall high average dilution rate of 3.9 ounces per gallon of water.

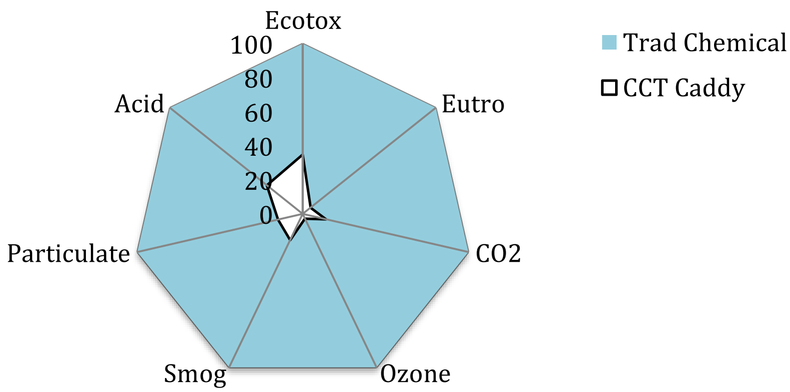

FIGURE 4. CHART OF RELATIVE LIFECYCLE IMPACTS – EDUCATION K-12

Calculation of a series of equivalent offsets (e.g. car emissions offset) for specific categories such as CO_2 emissions provide additional context for the relative results of the lifecycle comparison. Offsets are calculated by comparing the net improvement in a particular category (e.g. energy consumption) to established factors such as the energy content of coal, or emissions from an airplane to express environmental savings in a more easily understood context. The accumulated benefits of the CleanCore Caddy expressed in common equivalent offsets are presented in the Table 3. Offsets are individual expressions of potential savings and are not cumulative.

TABLE 3. EQUIVALENT OFFSETS PER CADDY – EDUCATION K-12

Category	Savings 1 Year	Savings 5 year	Equivalent Offsets per Building (3 units per building)
Energy (MegaJoule)	17,507	87,537	Barrels of Oil Offset (5 yr) – 14.16 Months of Household Energy Offset (5 yr) – 25.7 Number of Households Offset (5 yr) – 2.14 Gallons of Gasoline Offset (5 yr) – 668
Global Warming (kgCO2)	2,044	10,219	Months of Car Travel (5 yr) – 26.5 Number of Cars Offset (5 yr) – 2.2

Education buildings are the fifth most prevalent commercial building type in the U.S., with approximately 309,000 buildings which include preschools, elementary schools, middle or junior high schools, high schools, vocational schools, and college or university classrooms. They are, on average, the largest commercial buildings, with 25,100 square feet per building, and they account for 11 percent of all commercial floor space.[1] Were 10 percent of the school buildings in the U.S. to use the CleanCore Caddy system, collectively they would save enough energy annually to power more than 13,200 homes a year and offset the CO_2 emissions of more than 13,700 cars annually.

LIFE CYCLE IMPACTS – OFFICE BUILDING SCENARIO

Life-cycle impacts assessed for both the CleanCore Caddy and chemical-based traditional cleaning operations are presented in Table 4. Results are based on the office building scenario and functional unit, which specifies enough ozonated cleaning solution be produced by the Caddy to clean a 75,000 square foot office building over a period of five years. A single Caddy was evaluated in this scenario, a configuration recommended by CleanCore. Results have been normalized, and the percent differences have been presented in Table 4 and visually depicted in Figure 5. A breakdown of impacts by life-cycle stage is presented in Appendix C.

TABLE 4. LIFECYCLE IMPACTS – OFFICE BUILDING

LCA Categories		Traditional Cleaners	CCT Caddy	Benefit (%)
Ecotox	(Ton TEQ)	11,212	2,578	**77**
CO_2 Emissions	(kg CO_2)	4,990	648	**87**
Ozone	(g CFCs)	0.000678	0.0000203	**97**
Smog	(kg NOx)	0.0121	0.0017	**86**
Acid	(kg SO_2)	10.66	2.34	**78**
Eutrophication	(kg PO4)	0.415	0.0165	**96**
Particulate	(kg PM2.5)	1.87	0.205	**89**

[1] http://www.apep.uci.edu/der/buildingintegration/2/BuildingTemplates/School.aspx

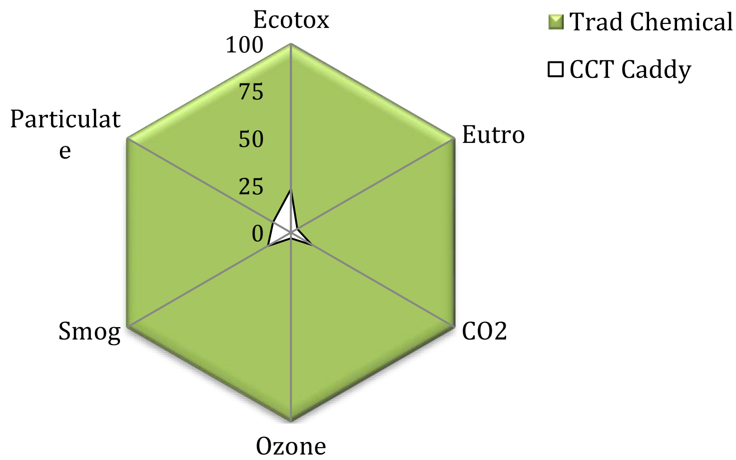

FIGURE 5. CHART OF RELATIVE LIFECYCLE IMPACTS – OFFICE BUILDING

The cleaning operations performed in the maintenance of the office building consumed a smaller but still significant volume of chemicals, totaling 900 gallons of traditional daily-use chemical product concentrates at various dilution levels. Unlike the previous education scenario, the office building scenario did not require the use of a floor neutralizer, or carpet spray cleaner. A breakdown of chemical product use is presented in Table B1 of Appendix B. Again, the results indicate that the on-demand generation of the Aqueous Ozone cleaning solution generated by the Caddy is clearly preferential to the production, distribution and use of conventional daily-use cleaning chemicals. **Environmental and human health impacts ranged from 77-97 percent better than those for conventional chemicals, depending on the category**. This is directly related to the volume traditional cleaning chemicals used in this cleaning scenario, as well as to a chemical product profile with an even higher overall average dilution rate of 4.5 ounces per gallon.

Calculation of a series of equivalent offsets (e.g. car emissions offset) for specific categories such as CO_2 emissions provide additional context for the relative results of the life-cycle comparison. Offsets are calculated by comparing the net improvement in a particular category (e.g. energy consumption) to established factors such as the energy content of coal, or emissions from an airplane to express environmental savings in a more easily understood context. The accumulated benefits of the CleanCore Caddy expressed in common equivalent offsets are presented in the Table 5. Offsets are individual expressions of potential savings and are not cumulative

TABLE 5. EQUIVALENT OFFSETS PER CADDY – OFFICE BUILDING

Category	Savings 1 Year	Savings 5 year	Equivalent Offsets per Building (per unit)
Energy (MegaJoule)	2,083	10,414	Barrels of Oil Offset (5 yr) – 1.7 Months of Household Energy Offset (5 yr) – 3.06 Number of Households Offset (5 yr) – 0.25 Gallons of Gasoline Offset (5 yr) – 79
Global Warming ($kgCO_2$)	868	4,342	Months of Car Travel (5 yr) – 11.3 Number of Cars Offset (5 yr) – 0.95

There are an estimated 3,000 office building locations worldwide for Fortune 500 corporations. Assuming that 40 percent of these buildings were to use the on demand generated ozonated cleaning agent produced by the CleanCore Caddy to perform the required maintenance operations, they would collectively save enough energy annually to power 38 homes annually and offset the global warming emissions from more than 140 cars annually.

ANALYSIS OF RESULTS

Results of the life-cycle impact assessment demonstrate clearly the significant environmental benefits associated with the use of the CCT Caddy. In every category evaluated, the Caddy resulted in a fraction of the overall environmental impacts associated with cleaning using traditional cleaners. Net benefits ranged from 65-97 percent depending on the category, and on the scenario evaluated.

To fully understand the disparity, a critical analysis of the life-cycle material and resource consumption of the two alternatives is useful. Key consumption data for each scenario are presented in Table 6 below.

Data for the Office building scenario demonstrate the large initial disparity in the materials required to manufacture the two cleaning alternatives. The nearly 36 kilogram mass of Caddy is significantly less than the 714 kilogram mass of the various chemicals and packaging associated with the traditional cleaner-based system leaving a margin of more than 678 kilograms in only the first year. The disparity grows to over 3,500 kilograms in following years, as the Caddy operates a minimum of five years, while traditional cleaners are consumables requiring continuous replacement as they are depleted. The accumulated life-cycle impacts associated with the production of this additional mass of chemicals clearly dominates this analysis, and becomes even greater in the K-12 education scenario.

TABLE 6. KEY CONSUMPTION PARAMETERS – BY SCENARIO

Parameter	K-12 Education		Office Building	
	Traditional Cleaners	CCT Caddy	Traditional Cleaners	CCT Caddy
Manufacturing				
Total Mass – Year 1	2,230 kg	107.4 kg	714 kg	35.8 kg
Total Mass – Years 2-5	8,920 kg	None	2,856 kg	None
Product Use				
Water use – per year	67,200 kg/yr	74,060 kg/yr	18,600 kg/yr	20,700 kg/yr
Energy use – per year	None	363 kWh	None	138 kWh

In addition to mass, both systems require the use of natural resources. During the use stage, both systems require a substantial amount of water to either dilute the chemical concentrates to make ready to use cleaners, or in the case of the Caddy, to generate the ozone-based cleaning agent. However, the Caddy also consumes energy to generate on-site the ozone based cleaning agent, consuming as much as 363 kWh of energy per year in the K-12 education scenario. While the differences in energy and water consumption work against the Caddy in the analysis, they are more than surpassed by the environmental and human health benefits of the large disparity in mass of the two systems. Production of these additional materials and resources for traditional cleaners result in impacts and resource consumption throughout the entire product life-cycle, driving the large disparity in the overall impacts of the two systems.

Upon review of this data, it is clear that the results are supported by the underlying data and align with expectations. It is also unlikely that the system would be sensitive to small changes in many of the key parameters that were assumed for this study given the disparity in the overall material consumption profiles. For example, even if the volume of chemicals consumed yearly in the K-12 education scenario were halved, the total mass of consumables use in traditional cleaning would still be 1,780 kg, or nearly 50 times greater than that of Caddy.

Overall, the results indicate that there are significant benefits to the environment associated with the use of the CleanCore Caddy in every category as compared with cleaning with traditional cleaners.

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APPENDIX A – IMPACT CATEGORYS

The following is a brief description of each of the impact categories for which the Caddy was evaluated.

Acidification, (AP): Acidification originates from the emissions of sulfur dioxide and oxides of nitrogen. These oxides react with water vapor in the atmosphere to form acids, which subsequently fall to earth in the form of precipitation, and present a hazard to fish and forests by lowering the pH of water and soil. The most significant man-made sources of acidification are combustion processes in electricity and heating production, and transport. Acidification potentials are typically presented in g SO_2 equivalents

CO_2 Emissions, (CO2): Global warming of the atmosphere occurs when carbon dioxide, methane, or other gases contributing to global warming absorb infrared radiation from sunlight, trapping it within the atmosphere. Some of the biggest human contributors to global warming are the combustion of fossil fuels like oil, coal and natural gas. This impact category includes the contributions of all such gases, even though it is expressed as CO_2 Emissions. Global warming potential are typically presented in g CO_2 equivalents.

Ecotoxicity, (AEP): Living organisms that inhabit a given ecosystem may be harmed through exposure to chemicals and other toxins released into the aquatic ecosystem. Such toxins may have a particularly harmful affect on ecosystem health including biochemistry, physiology, and the behavior and interactions of living organisms inhabiting the ecosystem. Ecotoxicity potentials are typically presented in g TEQ equivalents.

Eutrophication, (EP): Nutrients from discharged wastewater and fertilized farmland act to accelerate the growth of algae and other vegetation in the water. Oxygen deficiency then results from the degradation of organic material in the water, posing a threat to fish and other life in the aquatic ecosystem. Oxides of nitrogen from combustion processes are of significance. Eutrophication potentials are typically presented in g NO_3 equivalents.

Ozone Depletion Potential, (ODP): Stratospheric ozone is broken down as a consequence of man-made emissions of halocarbons (CFC's, HCFC's, haloes, chlorine, bromine etc.). The ozone content of the stratosphere is therefore decreasing, resulting in a thinning of ozone layer, often referred to as the ozone hole. The consequences are increased frequency of skin cancer in humans and damage to plants. Ozone depletion potentials are typically presented in g CFC equivalents.

Particulates, (P): Particulates are released as a consequence of both mobile and point source operations, usually involving combustion of materials. When inhaled, particulates directly affect humans often resulting in respiratory irritation and even prolonged chronic respiratory illness. Smaller diameter particulates, such as those smaller than 2.5 microns (PM 2.5) pose the greatest threat. Particulates are typically presented in g PM 2.5 released.

Photochemical Smog, (POCP): Photochemical smog (also referred to as ground level ozone) is formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of heat and sunlight. Smog forms readily in the atmosphere, usually during hot summer weather, and contributes to respiratory illness in humans such as chronic bronchitis and emphysema. Photochemical smog formation potentials are typically presented in g ethane equivalents.

APPENDIX B – SCENARIO DETAILS/BOMS

Life-cycle analysis was conducted on the alternatives for two separate cleaning scenarios. The model for each scenario was based on a bill of materials (BOM) calculated from data collected from actual cleaning operations for identical buildings, key operating parameters, or both. A BOM is a listing of the total materials and resources that make up that alternative. This appendix presents the BOMs and other key parameters for the CleanCore Caddy as well as for the system using a conventional, chemical-based cleaning system.

CLEANCORE CADDY – BILL OF MATERIALS AND OTHER SPECIFICATIONS

Analysis of the impacts from the CleanCore Caddy were based on its design operating parameters, and measured data from customers in relevant applications and scenarios. Key performance specifications used in this analysis for the CleanCore Caddy are presented in Table B1 below.

TABLE B1. PERFORMANCE SPECIFICAITONS FOR CADDY

Category	Spec
Generation Rate of Solution	0.5 gal/min
Reservoir Capacity	3 Gals
Application method	Spray with Vacuum recovery for hard floors
Energy Usage (kWh)	Generation - 0.396 Suction - 0.72
Freq of Cleaning – cycles/yr	365 Retail/Health 200 Education

A bill of materials was constructed that includes both the material composition of the CleanCore Caddy, as well as the energy, water and other materials associated with its usage of each of the scenarios assessed. The Bill of materials for the Caddy itself is presented in Table B2 below.

TABLE B2. MATERIALS BREAKDOWN OF CLEANCORE CADDY

Metals	Kg	%
Aluminum	0.01	0.03
Brass	0.12	0.32
Copper	1.15	3.2
Stainless Steel	8.96	25
Tin	0.02	0.006

Plastics	Kg	%
ABS	0.41	1.2
Acetal	0.04	0.12
EPDM	0.76	2.1
Polycarbonate	0.1	0.29
Polyethylene-HD	22.3	62.4
Polyethylene- LLD	0.53	1.5
Polypropylene	0.1	0.29
Polyvinyl Chloride	0.34	0.94

Other Materials	Kg	%
Silicone	0.47	1.3
Glass	0.01	0.03
Nylon	0.03	0.07
Rubber	0.09	0.25
Other materials	0.33	0.92

The combined bill of materials for the Caddy-based cleaning system used for each scenario (includes energy, water, etc. is presented in Table B3.

TABLE B3. BILL OF MATERIAL OF CLEANCORE CADDY – BY SCENARIO

Chemical/Material	Life-Cycle Evaluation Scenarios	
	Office Bldg	**K-12**
CCT Caddys	1	3
Total Materials (kg)	36	107
Water (kg)	103,651	370,300
Total Materials	**103,687**	**370,414**
Non Material Resources		
Energy (kWh)	688	1,812

TRADITONAL CHEMICALS – BILL OF MATERIALS AND USAGE RATES

Analysis of the impacts from cleaning using traditional cleaning products was based on actual chemical usage rates from real life facilities. A breakdown of the product types and usage rates over 5-years for each scenario is presented in Table B4. Actual chemical formulas used for each product type are presented in Tables B6-B12.

TABLE B4. LIFE CYCLE SCENARIO – TRADITIONAL CLEANING PRODUCTS (gals Conc./5 yr)

Product	**Life-Cycle Evaluation Scenarios**	
	Office Building[a] (gal/yr)	Education K-12 (gal/yr)
Glass Cleaner RTU (No Dilution)	120	150
Daily Floor Cleaner (Diluted 1 oz to 1 gal)	60	260
All-Purpose Cleaner (Diluted 4 oz to 1 gal)	160	180
Floor Neutralizer (Diluted 1 oz to 1 gal)	--	80
General Disinfectant (Diluted 2 oz to 1 gal)	200	300
Carpet Pre-Spray (Diluted 10 oz to 1 gal)	--	40
Toilet Bowl Cleaner RTU (No Dilution)	360	1800

[a] Carpet cleaning was not performed by actual facility, which contracted the task out.

Analysis of the baseline traditional chemical-based process for each scenario was based on an accumulated Bill of Materials that included not only the chemicals, but also the packaging and any natural resources required, such as water required for dilution of concentrated chemical products. Although the mass of chemicals dominates the overall BOM mass, the packaging and corrugate volumes represent a significant and avoidable waste stream. The Bill of Materials for the Traditional cleaning products is presented in Table B5.

TABLE B5. BILL OF MATERIAL OF TRADITIONAL CLEANING PRODUCTS (kg)

Chemical/Material	Life-Cycle Evaluation Scenarios	
	Office Bldg	**K-12**
Chemicals	3,273	10,218
Packaging	122	379
Corrugate	176	548
Total Materials– Non-H20	**3,570**	**11,145**
Water (dilution)	93,100	336,000
Total Materials	**96,670**	**347,000**

Tables B6-B12 present the formulations for each of the traditional daily-use chemical cleaners assessed in this study. These formulations were developed using MSDS data from multiple brand chemical cleaners, and from other published LCA studies[2].

TABLE B6. CHEMICAL FORMULATION – GLASS CLEANER RTU

No dilution required	CAS #	Wt %
Diethylene glycol butyl ether	112-34-5	3
2-butoxyethanol	111-76-2	5
Sodium Lauryl sulfate	151-21-3	2
Ammonium hydroxide	1336-21-6	1
Water	7732-18-5	89

TABLE B7. CHEMICAL FORMULATION – ALL PURPOSE CLEANER

Diluted 4 oz cleaner to 1 gallon of water	CAS #	Wt %

[2] Life-cycle Analysis of Orbo Technologies 5000-Sc, August 2011.

Water	7732-18-5	68
Alcohol Ethoxylate	68439-46-3	12
Propylene glycol monobutyl ether	5131-66-8	10
SXS	1300-72-7	4
Veresene 100, EDTA	64-02-8	3
Sodium metasilicate $5H_20$	6834-92-0	3

TABLE B8. CHEMICAL FORMULATION – FLOOR CLEANER

Diluted 1 oz cleaner to 1 gallon of water	**CAS #**	**Wt%**
Water	7732-18-5	87.25
Alcohol Ethoxylate	68439-46-3	9.5
SXS	1300-72-7	2.5
Veresene 100, EDTA	64-02-8	0.75

TABLE B9. CHEMICAL FORMULATION – CARPET PRE-SPRAY

Diluted 6oz cleaner to 1 gallon of water	**CAS #**	**Wt %**
Tripropylene glycol methyl ether	25498-49-1	20
Naphthalene sodium sulfonate	26264-58-4	10
Diethylene glycol monobutyl ether	112-34-5	15
Linear primary alcohol ethoxylate	34398-01-1	10
Tetrasodium ethylenediamine	64-02-8	3
Water	7732-18-5	42

TABLE B10. CHEMICAL FORMULATION - DISINFECTANT

Diluted 1 oz cleaner to 2 gallon of water	**CAS #**	**Wt %**
Quat ammonium salt	7173-51-5	4.9
Quat ammonium salt	68424-85-1	3.2
Dimethyl octylamine oxide	2605-78-9	1.6
Veresene 100, EDTA	64-02-8	1.9
Ethyl alcohol	64-17-5	1.6
Water	7732-18-5	86.8

TABLE B11. CHEMICAL FORMULATION – FLOOR NEUTRALIZER

Diluted 1 oz cleaner to 1 gallon of water	**CAS #**	**Wt %**
sodium carbonate	497-19-8	25
citric acid	77-92-9	75
Water	7732-18-5	0

TABLE B12. CHEMICAL FORMULATION – TOILET BOWL CLEANER RTU

No dilution required	CAS #	Wt %
alcohol ethoxylate	68439-46-3	5
Dialkyl dimethyl ammonium chloride	68424-95-3	1
Ammonium chloride	68424-85-1	1
Water	7732-18-5	93

APPENDIX C – LIFE-CYCLE IMPACTS BREAKDOWN

Life-cycle results for each cleaning scenario analyzed are presented previously in Tables 2 and 4 of this report. In this Appendix, impacts for each scenario are broken down and presented by life-cycle stage in Tables C1 –C4 below.

OFFICE BUILDING SCENARIO

TABLE C1. CCT CADDY IMPACTS BY STAGE – OFFICE BUILDING

LCA Categories		Total	Materials	Trans	Manufacture	Use	EOL
Ecotox	(Ton TEQ)	2,578	1,559	5.15	567.2	412.5	33.5
CO_2 Emissions	(kg CO_2)	648	226.8	16.8	112.7	278.6	12.9
Ozone	(g CFCs)	2.03E-05	9.15E-06	3.25E-08	3.12E-06	7.92E-06	6.09E-08
Smog	(kg NOx)	1.7E-03	6.32E-04	3.90E-05	3.22E-04	6.95E-04	6.78E-08
Acid	(kg SO_2)	2.34	0.689	0.0257	0.41	1.219	0.0012
Eutrophication	(kg PO4)	0.0165	0.011	3.13E-05	0.0023	0.0035	3.3E-05
Particulate	(kg PM2.5)	0.205	9.88E-02	2.87E-03	0.0254	0.078	8.26E-06

TABLE C2. TRADITIONAL CHEMICAL IMPACTS BY STAGE – OFFICE BUILDING

LCA Categories		Total	Materials	Trans	Manufacture	Use	EOL
Ecotox	(Ton TEQ)	11,212	10,427	44.8	616.6	-	123.3
CO_2 Emissions	(kg CO_2)	4,990	3,847	104.8	943	-	94.8
Ozone	(g CFCs)	0.000678	6.04E-04	3.52E-06	7.05E-05	-	5.43E-07
Smog	(kg NOx)	0.0121	9.93E-03	4.97E-04	1.59E-03	-	8.48E-05
Acid	(kg SO_2)	10.66	9.27	0.181	1.20	-	3.19E-03
Eutrophication	(kg PO4)	0.415	0.328	1.24E-03	0.084	-	1.65E-03
Particulate	(kg PM2.5)	1.87	1.682	0.0729	0.112	-	1.31E-04

EDUCATION K-12 SCENARIO

TABLE C3. CCT CADDY IMPACTS BY STAGE – EDUCATION K-12

LCA Categories		Total	Materials	Trans	Manufac-ture	Use	EOL
Ecotox	(Ton TEQ)	8,262	5,163	16.5	1,570	1,405	107.4
CO_2 Emissions	(kg CO_2)	1,663	560.6	36.6	289.4	745.2	31.6
Ozone	(g CFCs)	0.000061	2.51-05	9.76E-08	1.29E-05	2.26E-05	3.05E-07
Smog	(kg NOx)	0.00457	1.84E-03	9.58E-05	8.26E-04	1.79E-03	1.37E-05
Acid	(kg SO_2)	9.02	2.55	0.117	1.904	4.45	0.0045
Eutrophication	(kg PO4)	0.0419	0.025	7.95E-05	0.0068	0.0096	7.11E-06
Particulate	(kg PM2.5)	1.12	0.506	0.0157	0.157	0.443	4.49E-05

TABLE C4. TRADITIONAL CHEMICAL IMPACTS BY STAGE – EDUCATION K-12

LCA Categories		Total	Materials	Trans	Manufac-ture	Use	EOL
Ecotox	(Ton TEQ)	23,605	21,716	94.42	1,581	-	212.4
CO_2 Emissions	(kg CO_2)	11,882	9,291	249.5	2,126	-	213.8
Ozone	(g CFCs)	0.00203	1.74E-03	1.06E-06	2.84E-05	-	1.42E-06
Smog	(kg NOx)	0.0269	2.18E-02	1.11E-03	3.71E-03	-	1.88E-04
Acid	(kg SO_2)	33.42	28.1	0.568	4.74	-	1.67E-02
Eutrophication	(kg PO4)	0.70	0.552	2.09E-03	0.141	-	2.09E-03
Particulate	(kg PM2.5)	7.48	6.52	0.291	0.665	-	5.23E-04