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Sustainable Concrete Plant Guidelines

Version 1.1

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Introduction

Concrete is the most widely used building product worldwide, with annual consumption exceeding 13.5 billion cubic yards (10.3 billion m^3).[1] Construction depends on concrete, and small changes in how concrete is produced can have significant impacts on a global scale. These Guidelines for sustainable ready mixed concrete plant operations will help the concrete industry establish itself as an environmental leader in the construction sector.

These Guidelines provide quantitative, performance-based metrics and a prioritized point system that allow ready mixed concrete producers to demonstrate excellence in sustainable development. This document provides ready mixed concrete plant personnel with specific guidance to assess energy and resource consumption throughout the concrete life cycle and to organize a path towards high-performance and sustainability for concrete production.

Sustainability is a strategy that supports and encourages development without compromising future generations. Often, sustainability is described as having three pillars: environmental, social, and economic. These Guidelines are primarily focused on the environmental aspect of sustainability, with secondary focus on social and economic issues. As interest in sustainable development grows, the ready mixed concrete industry must be able to support sustainable development, balancing economic prosperity, social equity, and environmental responsibility. Moving towards a sustainable, environmentally conscious production model not only reduces environmental burdens, but also increases efficiency and places ready mixed concrete plants in a position of industry leadership in the growing green movement. When effectively communicated to consumers, a progressive stance on sustainability will allow the industry and its constituents to remain responsibly competitive.

Purpose of Guidelines

The purpose of the Sustainable Concrete Plant Guidelines is twofold: first, the Guidelines provide detailed guidance on how ready mixed concrete plants can meet the performance goals outlined in the National Ready Mixed Concrete Association's (NRMCA) Sustainability Initiatives; [2] and second, the Guidelines provide the ready mixed concrete industry with a methodology for defining what constitutes sustainable plant operations. The Guidelines therefore give ready mixed concrete plant personnel the ability to quantify, assess, and improve the sustainability of their operations over time.

The Guidelines build on existing NRMCA programs, systems, and publications. The NRMCA currently has a quality-oriented Plant and Truck Certification,[3] as well as the Green-Star Certification Program,[4] which requires establishing an Environmental Management System (EMS). These Guidelines build upon these two programs, as well as the NRMCA Sustainability Initiatives.

NRMCA's *Environmental Management in the Ready Mixed Concrete Industry (*Publication Number 2PEMRM) is referenced throughout the Guidelines.[5] This publication is a comprehensive resource detailing the ready mixed concrete environmental issues related to manufacturing, and is referenced as *Environmental Management* throughout the Guidelines as supplementary reading. While the Guidelines in-

[1] Van Oss, Walter, "U.S. Geological Survey, Mineral Commodity Summaries: Cement", January 2009. http://minerals.usgs.gov/minerals/pubs/commodity/cement/mcs-2009-cemen.pdf.
[2] NRMCA Sustainability Initiatives, http://www.nrmca.org/sustainability/NRMCA%20Sustainability%20Initiatives%205-8-09%208.5x11.pdf.
[3] NRMCA Plant and Truck Certification, http://www.nrmca.org/Research_Engineering/Plant_Certification/Main.htm.
[4] NRMCA Green-Star Certification, http://www.nrmca.org/operations/environment/certifications_greenstar.htm.
[5] Environmental Management for the Ready Mixed Concrete Industry, NRMCA, 2010, http://my.nrmca.org/scriptcontent/BeWeb/Orders/ProductDetail.cfm?pc=2PEMRM.

clude information pertinent to developing practices to enhance environmental performance, *Environmental Management* provides detailed background information and production-level details.

The Guidelines form the criteria for NRMCA's Sustainable Concrete Plant Certification program.[6] Companies use the Guidelines to rate their level of sustainability and submit documentation to NRMCA for review. Plants that meet the certification criteria are issued a Sustainable Concrete Plant Certification based on the number of points achieved. See Using the Guidelines section for more detail.

Organization of Guidelines

The Sustainable Concrete Plant Guidelines are organized according to the five life cycle phases of concrete construction as established in the NRMCA Sustainability Initiatives: material acquisition, production, construction, product use, and recycling. Each of the life cycle phases is further broken down into individual credits which are achieved by meeting the requirements or metrics established in the Guidelines.

The NRMCA Sustainability Initiatives document establishes quantitative long-term performance goals for the ready mixed concrete industry in terms of five Key Performance Indicators (KPI). Because one of the primary purposes of the Guidelines is to assist ready mixed concrete plants in achieving the long-term goals set forth in the Sustainability Initiatives, most of the credits relate to one or more KPI.

Key Performance Indicators*	**Indicator Description**
Embodied energy: down 20% by 2020 down 30% by 2030	Embodied energy is the total amount of energy used in the production of concrete.
Carbon footprint: down 20% by 2020 down 30% by 2030	Concrete's carbon footprint is the total amount of CO2 emitted due to production, encompassing raw material extraction, production method, delivery to job sites, and eventual disposal or reuse.
Potable (fresh) water use: down 10% by 2020 down 20% by 2030	Potable or fresh water is water from a municipal source (tap), surface water or on-site wells that can be consumed as drinking water.
Waste created: down 30% by 2020 down 50% by 2030	Waste is defined as materials disposed of in an unproductive manner, for example being landfilled or discarded in a quarry or back lot.
Recycled content: up 200% by 2020 up 400% by 2030	Recycled materials are materials that have been diverted from the waste stream during the manufacturing process, reclaimed from other processes, or reclaimed after consumer use, for reuse.
** all increase/decrease percentages are per unit of concrete produced from 2007 levels.*	

To make it easily apparent to the user how each credit is related to a KPI, a series of graphical impact categories were developed. These impact categories are based on the five KPI with the addition of a Social Concerns and Human Health category. Each credit has one or more impact categories associated with it. The impact categories are meant to clearly identify the critical issues at stake in each credit and to serve as a quick reference system to allow users to identify all of the credits that will help a plant work towards achieving a given KPI.

Each credit category in the Guidelines contains an introduction to the topic addressed in the credits. Each credit provides strategies that can be used to achieve the points within the credit, the metrics and associated baselines that should be used to measure performance, and details of the required documentation to demonstrate achievement of points. The strategies given are recommended paths towards credit

[6] NRMCA Sustainable Concrete Plant Certification, http://www.nrmca.org/sustainability/certification.

achievement, and often represent best industry practices gleaned from research or NRMCA sustainable concrete plant survey responses.

The performance thresholds given were determined using industry data and NRMCA survey responses from the past several years, and they are designed to award more points to plants that have adopted sustainable practices. A plant will most likely not be able to earn every available point; however, as a plant improves performance these practices will translate to higher scores.

Impact Categories	
	Embodied Energy
	Carbon Footprint
	Water Use
	Waste Reduction
	Recycled Content
	Social Concerns and Human Health

Baseline Metrics

In preparation for formulating baseline metrics for the Guidelines, a survey was distributed to NRMCA member plants to gather information on current practices. The survey gathered information on a per plant basis in the following areas of operation: general familiarity with sustainability practices and terminology, materials usage, materials sourcing, emission controls, water and site management, spill prevention plans, plant energy and fuel management, delivery methods, reuse and recycling of materials, specialty products, and site layout.

Compiled survey results were used to develop baseline thresholds for credit metrics. Where data from this survey was incomplete or judged inadequate, it was replaced by or supplemented with data from other industry surveys and literature.

Alternate Metrics

This document was developed for the U.S. market, and as such, the baseline metrics for several credits are best applied in the U.S. That said, the Guidelines could also be applied in other parts of the world. However, to offer flexibility, any organization comprising of a group of ready mixed concrete producers may develop a baseline for a country or region and report the proposed baseline back to NRMCA for review and approval. The methodology for developing a new baseline for the country or region should be developed using sound statistical methods.

Using the Guidelines

The metrics for each credit serve as a way to measure credit achievement – meeting metric thresholds awards points to the participating plant. Point assignments for each credit are based on relative importance to overall sustainability in a ready mixed concrete plant, with the greatest impacts assigned the most points. The maximum number of points is 100. To achieve a sustainability level, the plant must first meet the prerequisites in addition to achieving points for Guidelines credits. Sustainability levels are defined as:

- Bronze: 30-49 points
- Silver: 50-69 points
- Gold: 70-89 points
- Platinum: 90-100 points

Documentation required to demonstrate the achievement of points is provided in each credit narrative. Unless otherwise specified, all metrics will require documented information from a 12-month period starting no earlier than 15 months from date of documentation submittal to NRMCA. Some credits require a letter from the company's accountant or corporate officer verifying a certain quantity of material purchased or strategy implemented. Letters can be in electronic format, including e-mail.

For successful implementation of the Guidelines, it is recommended that a program champion or rater be designated at the plant. This person should be familiar with the Guidelines and associated tools and worksheets, and oversee the pursuit of credits by organizing information and data tracking, performance monitoring, collection of documentation, and other assessment activities. Having a program champion can help focus sustainability efforts and will maximize the ability of these Guidelines to improve environmental performance.

Note, for the purposes of these Guidelines, a concrete plant is defined as a property or plant site containing one or more batching units and associated equipment. When multiple batching units are located on the plant site, all the batching units and associated equipment must meet the requirements of the Guidelines in order to achieve points in the program.

Prerequisites

Prerequisites ensure that each plant has the basis upon which sustainable practices can be built. The following prerequisites must be obtained for the plant being evaluated prior to achievement of any Guideline credits or sustainability level:

Prerequisite 1: Compliance with Environmental Regulations

Comply with federal, state, and local environmental regulations. Please see *Environmental Management* Chapter 3, U.S. Environmental Protection Agency (EPA) and State Regulatory Agencies; Chapter 4, Inspections; and Appendix 4, State Environmental Agencies, for more in-depth discussions of these topics. These environmental regulations will function as the baseline performance level and generally include, but are not limited to:

- Air Quality Permit, or equivalent, from the appropriate jurisdiction.
- Permit coverage, or equivalent under, the National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Industrial Activity from the appropriate jurisdiction.
- Permit coverage for a point source discharge of water (NPDES), other than stormwater associated with industrial activity, if applicable.
- Water Use Permit (to take water), if applicable.
- Permit to discharge to a sanitary sewer system, if applicable.
- Compliance with applicable local or regional noise ordinances or regulations.
- Compliance with Hazardous Waste Regulations, including registration of generator status with appropriate agency, if applicable.
- Compliance with the Emergency Planning and Community Right to Know Act (EPCRA) chemical reporting requirements, if applicable. These requirements typically include Hazardous Chemical Storage reporting (section 311 and 312) as well as Toxics Release Inventory reporting (section 313), if applicable.
- A current and complete Spill Prevention Control and Countermeasures (SPCC) plan in place, if applicable.

Documentation

Submit a signed letter from an officer of the company stating that the plant has been in full compliance with all applicable federal, state, and local regulations within the 12-month period.

Prerequisite 2: Environmental Management System (EMS)

Implement and maintain an Environmental Management System (EMS) demonstrated by achieving NRMCA Green-Star certification, ISO 14001 certification, or equivalent EMS program. Please refer to *Environmental Management* Chapter 16, Environmental Management System, for further information on EMSs in the ready mixed concrete industry.

Documentation

Submit a copy of NRMCA Green-Star certificate or ISO 14001 certificate. If equivalent EMS program is being claimed, provide third party documentation to demonstrate equivalency with NRMCA Green-Star certification or ISO 14001 certification including third party on-site inspections.

Prerequisite 3: Energy Audit

If not included as part of the EMS, complete an energy audit conducted by an independent consultant or energy utility company.

Documentation

Submit a copy of the energy audit that includes energy use over the 12 month period. Include electricity and fuel use and any other form of energy used for plant operations. Do not include fuel use for concrete delivery trucks.

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Prerequisite 4: Site Plan

Provide a site plan of the plant property, which should include a visual summary of all potential environmental hazards resulting from plant operations and the measures taken by the plant to mitigate, control, or contain these hazards. Include the following elements, at a minimum:

- Location of all plant features, including batch plant, aggregate storage, cement and supplementary cementitious material (SCM) silos, storage tanks, fueling station, vehicle parking, maintenance building, and roadways.
- Location of water management structures (rinse/wash water settlement basins, retention/detention ponds, underground storm drains, discharge outfalls, etc.).
- Arrows or topographic lines indicating flow patterns.

Documentation

Submit a copy of the site plan indicating items listed above.

1. Material Acquisition

Environmental impacts of the material acquisition life cycle phase are primarily the result of resource extraction, processing, and transportation. Raw materials must be mined or extracted, and processed for use in concrete. The impacts of these processes differ from material to material. For example, the manufacture of portland cement is much more energy intensive than fly ash, a by-product of the coal combustion process at electric power plants. The environmental impact of transportation will also vary depending on the distance between the plant and the source location as well as the mode of transportation.

Over half of the embodied energy of concrete production is from raw materials extraction, processing, and transport to the plant.[7] Plants have the opportunity to improve environmental performance by making material purchasing decisions based on a number of factors, including recycled content, fuel and process used during material manufacturing, supplier environmental policies and practices, mode of material transportation, and source location of materials. The credits in this section address these choices, and provide guidance for reducing the environmental burdens in this life cycle phase. Please see *Environmental Management* Chapter 7, Solid Materials Management, for further information.

Recycled Content

Credit 1.1: Recycled Aggregate
Credit 1.2: Optimized Portland Cement Use

Use of recycled materials reduces the use of virgin materials, which in turn reduces environmental burdens from quarrying and manufacturing. Where recycled material is reclaimed from plant processes or incorporated in component material manufacturing, environmental impacts of associated transportation are also avoided. Rather than purchasing only virgin aggregate, which must be quarried, consider the use of reclaimed concrete, construction and demolition debris, and other recycled materials to supplement virgin aggregate in concrete batching. Rather than only using portland cement, which requires an especially energy-intensive manufacturing process, use supplementary cementitious materials (SCMs) as portland cement replacements as often as possible. The use of waste fuels or recycled material in the manufacture or processing of component materials for concrete can also impact material choice decisions.

Materials Transportation

Credit 1.3: Materials Transportation Analysis

While transportation represents a relatively small percentage of the CO2 emissions related to concrete production, there are ways in which the ready mix plant can reduce these emissions. The distance traveled to deliver ingredient materials, the type of transportation used and the weight of the material will all affect transportation impacts. By preferring locally quarried or manufactured materials, and low emission transport such as rail or barge, the embodied energy and carbon footprint of concrete can be reduced.

Greening the Supply Chain

Credit 1.4: Sustainable Purchasing Plan

Preferring green suppliers and encouraging suppliers to improve their environmental practices will support an industry-wide shift in priorities, eventually enabling an even higher level of environmental performance at the plant level.

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[7] *Cement and Structural Concrete Products: Life Cycle Inventory Update*, Athena Sustainable Materials Institute, Ottawa, Canada, 2005, p51.

Credit 1.1: Recycled Aggregate *4 points*

By increasing the use of recycled aggregate, the burden of resource extraction (i.e. quarrying virgin aggregate) is reduced. Because aggregate (coarse and fine) typically comprises 60-70% of concrete, use of recycled aggregate can significantly reduce environmental impacts during the material acquisition phase.

Crushed returned concrete aggregate (CCA) is the most commonly used recycled aggregate, and when used as coarse aggregate it performs similarly to natural stone.[8] It is estimated that approximately 60% of returned concrete can be used as CCA, resulting in possible industry-wide savings of up to $300 million annually.[9] Recycled aggregate can be reclaimed from plant processes by windrowing returned concrete, toploading, or discharging returned concrete into a mechanical reclaiming system. Please refer to Section 5, Material Reuse and Recycling, for a more detailed discussion on methods of reclaiming returned concrete for reuse.

An excellent resource investigating the use of CCA is "Crushed Returned Concrete as Aggregates for New Concrete", available on the NRMCA and RMC Research & Education Foundation websites.[10] This resource provides guidance for the ready mixed concrete producer and engineer on CCA utilization, calculates average savings per ton as a result of CCA, and discusses CCA in the context of ASTM specifications (ASTM C 33 permits the use of crushed hydraulic-cement concrete as coarse and fine aggregate).[11] The use of recycled materials in ready mixed concrete must always meet specification requirements.

Crushed concrete from demolition, foundry sands and glass can also be used to replace virgin aggregate in structural concrete. An even larger variety of aggregate replacements are possible in non-structural concrete. Recycled aggregate can also be obtained from demolition work on the same job site, for example when replacing sections of highway.

Recycled aggregate is generally less expensive than natural aggregate, dependent on size and composition, making recycled aggregate a financially beneficial alternative to virgin aggregate. Utilizing returned concrete from the plant will further reduce costs by eliminating disposal fees. Recycled concrete aggregate is approximately 10-15% lighter than comparable virgin quarry materials, and may therefore reduce energy/transportation costs.[12]

Strategies

To incorporate more recycled aggregate in concrete batching consider the following strategies:

1. Replace a portion of virgin coarse aggregate with recycled coarse aggregate, which can be reclaimed from plant processes by use of a reclaimer, windrowing and crushing returned concrete or toploading. Recycled coarse aggregate may also be available for purchase from some suppliers.
2. Replace a portion of virgin fine aggregate with recycled fine aggregate for non-structural applications, which can come in the form of CCA, crushed glass, foundry sand, limestone tailings, and other sources.

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[8] Obla, Karthik, Haejin Kim and Colin Lobo, "Crushed Returned Concrete as Aggregates for New Concrete: Final Report to the RMC Research & Education Foundation", September 2007, pp. 27-28 http://www.nrmca.org/research/cca%20study%20final%20report%209-07.pdf or http://www.rmc-foundation.org/images/CCA%20Study%20Final%20Report%209-07.pdf

[9] Ibid., p. 1

[10] Ibid.

[11] Ibid., p.26

[12] NRMCA Sustainability Initiatives, p. 17.

Metrics

Percentage of recycled aggregate by weight.

≥ 2% recycled aggregate	1 point
≥ 4% recycled aggregate	+1 point
≥ 6% recycled aggregate	+1 point
≥ 8% recycled aggregate	+1 point

[US Customary] $$recycled\ aggregate\ (\%) = \frac{recycled\ aggregate\ used\ (tons)}{total\ aggregate\ used\ (tons)} \times 100$$

[SI Units] $$recycled\ aggregate\ (\%) = \frac{recycled\ aggregate\ used\ (t)}{total\ aggregate\ used\ (t)} \times 100$$

Documentation

Submit letter from company's accountant or corporate officer stating the total quantity of recycled aggregate used and the total quantity of all aggregate used at the plant during the 12-month period. Retain records of the quantity of aggregate reclaimed from returned concrete, and recycled aggregate claimed from other sources, as well as total aggregate. Retain receipts from recycled and virgin aggregate purchases.

Credit 1.2: Optimized Portland Cement Use *6 points*

Optimizing the use of portland cement while maintaining required performance is a crucial step towards decreasing the carbon footprint of concrete. Life cycle assessment[13] reveals that cement content is the most important factor in determining a concrete mix's embodied energy and carbon footprint. The production of portland cement emits approximately 0.927 tons (.927 t) of carbon dioxide for each ton (tonne) of portland cement produced. On average, the cement used in a concrete mix represents over 85% of embodied energy and up to 96% of greenhouse gas (GHG) emissions per unit volume of concrete produced.[14]

Portland cement use can be reduced either by incorporating SCMs, or by designing mixtures requiring overall less cementitious material. In either case, it is the reduction in portland cement that achieves environmental benefits, which is why this credit is structured to measure decrease in portland cement use per cubic yard. Many NRMCA survey respondents reported using fly ash or slag whenever possible, if use of SCMs was not specifically disallowed in a mix.

Fly ash and slag cement are both industrial by-products, and therefore have a much smaller carbon footprint than portland cement. Increasing the quantity of SCM with a lower carbon footprint than portland cement, while minimizing the total cementitious materials in concrete will have a net beneficial environmental impact. Blended cement can also be purchased, in which a pre-determined blend of portland cement and SCM is sold to the ready mix producer.

Fly ash is a by-product of coal combustion. Typically, fly ash reduces the permeability of concrete, which results in greater durability and longer service life. Fly ash normally replaces 10-35% of the portland cement in a mix, but higher content may be appropriate for different purposes. Consider evaluating concrete mixture proportions to include larger amounts of fly ash (based on the performance requirements desired). Encourage architects and engineers to specify 56 day rather than 28 day strengths, as high-volume fly ash concrete mixes gain 50-80% of their ultimate strength between 28 days and 1 year.[15] Encourage the elimination of specific limitations on quantities of SCMs and minimum cement in project specifications.

Slag cement is produced from the non-metallic materials emerging from the blast furnace after iron has been extracted during the steel manufacturing process. The molten slag is quenched with water and ground finely for use as an SCM. Slag increases strength and durability, and decreases permeability. Portland cement replacement quantities vary from 25-80%, depending on the application.[16]

Plants are encouraged to engage in research and experimentation, and to train quality control staff in the development of performance-based concrete mixtures. Controlling the variability of concrete production, as measured by factors such as the standard deviation of strength tests, and ensuring reliable testing will help reduce "overdesign" of concrete to meet specification requirements. Keeping up-to-date with new technology and specification advances will increase benefits in this credit.

The RMC Research & Education Foundation has funded extensive research on performance-based specifications,[17] and works in conjunction with the NRMCA Prescriptive-to-Performance (P2P) initiative to encourage performance-based specifications.

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[13] Life cycle assessment, or LCA, is a holistic environmental impact assessment methodology that analyses all upstream and downstream (within predetermined system boundaries) processes related to a given product or process.

[14] Marceau, Medgar, Michael Nisbet, Martha VanGeem, *Life Cycle Inventory of Portland Cement Concrete*, Skokie IL: Portland Cement Association, 2007, pp. 15-16.

[15] Mehta, Dr. P. Kumar and Helena Meryman. "Tools for Reducing Carbon Emissions Due to Cement Consumption." STRUCTURE magazine, January 2009, p. 12.

[16] Prusinski, Jan, Medgar Marceau and Martha VanGeem. "Life Cycle Inventory of Slag Cement Concrete," presented at eighth CANMET/ACI International Conference on Fly Ash, Silica Fume, Slag and Natural Pozzolans in Concrete, p. 3.

[17] Publicly available on website: http://www.rmc-foundation.org/.

Credit paths

There are two alternative paths for this credit, and plants can choose the most appropriate path. Path A awards points for a portland cement ratio below a U.S. national average. Path B alternatively awards points for demonstrating significant improvement in portland cement ratio over the plant's 2007 portland cement ratio.

Strategies

To optimize portland cement use consider the following strategies:

1. Develop data in order to support performance-based concrete mixtures and negotiate for performance-based alternatives in specifications.
2. Include SCMs in concrete mixtures and minimize total cementitious materials whenever feasible and appropriate, keeping in mind that higher SCM content can be utilized in non-structural concrete, such as flowable fill.

Metrics

PATH A – PCR BELOW NATIONAL AVERAGE
The Portland Cement Ratio (PCR) is a measure of the average amount of portland cement used per cubic yard of concrete produced. By increasing use and ratios of SCMs, or designing mixes requiring less overall cementitious materials, the PCR will decrease. Points are awarded for the plant PCR below the U.S. national average PCR.

Plant PCR 5% or more below U.S. national average	1 point
Plant PCR 10% or more below U.S. national average	+1 point
Plant PCR 15% or more below U.S. national average	+1 point
Plant PCR 20% or more below U.S. national average	+1 point
Plant PCR 25% or more below U.S. national average	+1 point
Plant PCR 30% or more below U.S. national average	+1 point

[US Customary] $$PCR = \frac{portland\ cement\ used\ (lbs)}{concrete\ produced\ (cy)}$$

[SI Units] $$PCR = \frac{portland\ cement\ used\ (kg)}{concrete\ produced\ (m^3)}$$

PCR percentage below the U.S. national average PCR of 465 lb/cy (276 kg/m^3), based on sustainable concrete plant survey responses:

[US Customary] $$PCR\ below\ U.S.\ national\ average\ (\%) = \frac{465 - PCR}{465} \times 100$$

[SI Units] $$PCR\ below\ U.S.\ national\ average\ (\%) = \frac{276 - PCR}{276} \times 100$$

PATH B – CURRENT PCR BELOW 2007 PCR The Portland Cement Ratio (PCR) is a measure of the average amount of portland cement used per cubic yard of concrete produced. By increasing use and ratios of SCMs, or designing mixes requiring less overall cementitious materials, the PCR will decrease. Points are awarded for the plant's current PCR below the plant's PCR in 2007.

Current PCR 5% or more below 2007 PCR	1 point
Current PCR 10% or more below 2007 PCR	+1 point
Current PCR 15% or more below 2007 PCR	+1 point
Current PCR 20% or more below 2007 PCR	+1 point
Current PCR 25% or more below 2007 PCR	+1 point
Current PCR 30% or more below 2007 PCR	+1 point

[US Customary] $$2007\ PCR = \frac{portland\ cement\ used\ in\ 2007\ (lbs)}{concrete\ produced\ in\ 2007\ (cy)}$$

[SI Units] $$2007\ PCR = \frac{portland\ cement\ used\ in\ 2007\ (kg)}{concrete\ produced\ in\ 2007\ (m^3)}$$

[US Customary] $$Current\ PCR = \frac{portland\ cement\ used\ (lbs)}{concrete\ produced\ (cy)}$$

[SI Units] $$Current\ PCR = \frac{portland\ cement\ used\ (kg)}{concrete\ produced\ (m^3)}$$

Current PCR percentage below 2007 PCR:

[US Customary] $$Current\ PCR\ below\ 2007\ PCR\ (\%) = \frac{2007\ PCR - Current\ PCR}{2007\ PCR} \times 100$$

[SI Units] $$Current\ PCR\ below\ 2007\ PCR\ (\%) = \frac{2007\ PCR - Current\ PCR}{2007\ PCR} \times 100$$

Documentation

PATH A – PCR BELOW NATIONAL AVERAGE
Submit letter from company's accountant or corporate officer stating the total quantity of portland cement used and the total quantity of concrete produced at plant during the 12-month period. Retain records of all portland cement purchased and concrete produced.

PATH B – CURRENT PCR BELOW 2007 PCR
Submit letter from company's accountant or corporate officer stating the total quantity of portland cement used and the total quantity of concrete produced at plant during the 12-month period and the total quantity of portland cement used in 2007 and the total quantity of concrete produced in 2007. Retain records of all portland cement purchased and concrete produced.

Credit 1.3: Materials Transportation Analysis — *4 points*

Local materials are defined as materials originating within a specific radius of the plant. While no radius is specified in this credit, obtaining materials from closer facilities will ensure reduced transportation emissions and costs. Using local materials can also strengthen the local economy by supporting manufacturing and labor forces within the area.

The most common types of transportation for heavy construction materials are ship, barge, rail, and truck. Ship, barge and rail transport have the lowest emissions factors, while truck transport has the highest. Therefore, a ton of aggregate transported by rail results in lower energy use and fewer CO2 emissions than a ton of aggregate transported the same distance by truck. However, if transportation by rail will result in a material traveling twice as far as it would by truck, then it may not be reasonable or environmentally preferable to do so. Utilizing different means of transportation may also result in significantly different financial costs for the plant.

A transportation analysis will help determine the most environmentally preferable means of transportation. To this end, a tool called the *Materials Transportation Calculator* has been provided for use with this credit. Transportation distances, weights, and modes for different materials can be entered into the tool, and the associated CO2 emissions are then calculated. The emissions are measured in CO2e, or CO2 equivalents, which measures the output of all GHGs in a single unit. The tool can be used to assess the current environmental impacts of ingredient material transportation, and can also be used to compare the impact of different transportation scenarios. A financial assessment can be paired with the transportation analysis to help the plant make decisions concerning materials sourcing.

Strategies

To reduce CO2 emissions and costs due to materials transportation consider the following strategies:

1. Conduct an analysis of raw material transportation.
2. Some plants have rail-compatible receiving capabilities; consider installing receiving ports if not already in existence.

Metrics

Utilize the *Materials Transportation Calculator* by inputting transportation distances and modes of transportation for the targeted materials in the 12-month period to get the total associated CO2e.

U.S. baseline emissions are 76.9 lb CO2e/cy (45.6 kg CO2e/m^3), based on sustainable concrete plant survey responses.

Plant CO2e 5% or more below U.S. national baseline	1 point
Plant CO2e 10% or more below U.S. national baseline	+1 point
Plant CO2e 15% or more below U.S. national baseline	+1 point
Plant CO2e 20% or more below U.S. national baseline	+1 point

Documentation

Submit a copy of the *Materials Transportation Calculator* with calculated results. Retain cement mill test reports, delivery tickets, bills of lading, etc., indicating quantities and method of transportation for materials.

Credit 1.4: Sustainable Purchasing Plan — *2 points*

As the importance of industrial suppliers' sustainability practices grows, adopting sustainable practices emerges as a competitive edge in the industry—being green will be seen as profitable. Queries from the ready mix plant purchasing department or personnel regarding a supplier's environmental practices will engage a "vote with your dollar" ethic, steering suppliers towards an environmentally conscious mindset by emphasizing that environmental choices guide consumer decisions.

Buying from suppliers with good environmental records encourages these suppliers to maintain their track record and will help expand the market for sustainable materials.

Defining good environmental practices

Any number of indicators may classify a supplier as green. Practices employed during raw material extraction, manufacturing or fabrication, and transportation to the ready mixed concrete plant should all be considered in this credit. Environmental stewardship in extraction and manufacturing, use of non-toxic materials, use of recycled materials in raw feed and alternative fuels and low-emission transportation are examples of responsible practices to seek in a supplier.

Aggregate suppliers may have quarry reclamation plans in place. Most states require quarry reclamation plans, and many quarries have some version of an EMS or sustainability initiative in place. Quarries have been under pressure to maintain good environmental practices for some time now, and should generally be knowledgeable about environmental stewardship. Portland cement suppliers may implement energy reduction plans to lower energy use (for example by reducing clinker factor). Concrete admixture and cleaning product suppliers may omit hazardous chemicals from their ingredients, or offer biodegradable products. Suppliers may employ renewable energy, or have developed an environmental management system.

Establishing a Sustainable Purchasing Plan

A Sustainable Purchasing Plan (SPP) is a written document from the ready mixed concrete plant stating the intent to maximize environmentally and socially sustainable purchases and outlines supplier requirements. A concrete producer should develop and implement an SPP that encompasses materials for concrete production and products for facility and fleet maintenance.

The SPP should define the plant's environmental and social priorities and should include specific goals. For example, obtaining 90% of aggregates from quarries adhering to comprehensive quarry restoration plans could be one objective of the SPP. An SPP can specify types of products to purchase for both the concrete manufacturing process and for other plant uses, and can outline green practices to be required of suppliers. Evidence of a suppliers' good environmental track record may include having and adhering to an EMS, use of renewable energy sources or mandated reduced packaging.

Examples of products specified for non-manufacturing purposes that can be included in an SPP are: low or zero volatile organic compound (VOC) carpeting and paints, low mercury lamps, environmentally friendly cleaning products, or items with high recycled content. An SPP may also prioritize life cycle costing, or considering the financial and environmental costs of a product over its lifetime, as some products with initially low costs may need to be replaced sooner, or be difficult to dispose of or reuse.

Chemical products should also be considered in the SPP. Often, there are environmentally safe alternatives to hazardous products commonly used in the concrete industry. Cleaning agents and solvents are examples of products that often contain or are classified as hazardous materials. Avoid purchasing hazardous chemicals whenever possible—this not only eliminates potential health hazards at the plant, but minimizes EPCRA regulatory reporting as well.

The U.S. Environmental Protection Agency (EPA) offers tips on developing and implementing an SPP (termed Environmental Preferred Purchasing by EPA) at www.epa.gov/epp.

While in some cases it will be clear if purchased products comply with the SPP, it may be more difficult to determine if suppliers' practices comply with the stated goals of the SPP. Generally, a call to the supplier can help in determining the supplier's compliance with SPP requirements. It is important to take into account that while a supplier may have stated sustainability policies, the supplier may or may not be adhering to them. Ready mix plant managers are encouraged to be inquisitive, bearing in mind that the greater purpose in contacting suppliers with these pointed environmental and social concerns is to open the sustainability dialogue between the ready mixed concrete company and its suppliers.

Strategies

When choosing materials and suppliers consider the following strategies:

1. Develop and implement a Sustainable Purchasing Plan.
2. Prefer suppliers and materials with low environmental impacts whenever possible.
3. Inquire about environmental practices of materials suppliers, and about specific environmental qualities of the materials.
4. Exchange highly contaminating solvents and cleaning solutions for nontoxic and biodegradable alternatives (soaps and concrete remover for truck and equipment washing).
5. Utilize non-toxic low-VOC coatings for plant and equipment upkeep.
6. The use of products containing hazardous chemicals in quantities exceeding EPA established threshold amounts triggers EPCRA regulatory reporting requirements. Plants can be environmentally responsible, and avoid reporting requirements, by minimizing hazardous chemicals when possible.

Metrics

Develop and implement a Sustainable Purchasing Plan, encompassing the purchase of materials for concrete production, equipment, and products for facility and fleet maintenance.

Existence of Sustainable Purchasing Plan	1 point
Existence and implementation of Sustainable Purchasing Plan for more than 2 years	+1 point

Documentation

Submit copy of Sustainable Purchasing Plan with date of adoption. Retain documentation showing suppliers are meeting the goals established in the Sustainable Purchasing Plan.

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2. Production

The production life cycle phase of ready mixed concrete encompasses a wide range of environmental, social and economic issues. Management of air quality, water, chemical and petroleum products, energy usage, and relationship to the community are the areas of concern in this life cycle phase.

For individual ready mixed concrete plants to become truly sustainable, they must assess resource and energy consumption throughout the production process. To maximize the effectiveness of the credits in this section, a thorough review of plant practices is recommended to ascertain where immediate changes can be made, and to identify possible changes that can be implemented over the long-term. Rigorous quality control systems, and regular assessments of production methods, will optimize plant productivity with respect to environmental concerns.

Air Quality Management

Credit 2.1: Process Dust Emissions Control
Credit 2.2: Fugitive Dust Emissions Suppression

Lack of proper air quality management can be a source of community complaints and non-compliance at ready mixed concrete plants. For a plant to operate as a responsible corporate citizen and good neighbor, the facility must continuously strive to minimize particulate matter emissions from the plant and maintain compliance with applicable air quality regulations.

Particulate matter emissions to air, also known as dust emissions, are the major air quality concern at the ready mix plant site. The principal regulatory concern is the release of particulate matter (dust), particularly the size fraction known as “particulate matter less than 10 microns in diameter” which is called “PM_{10}.” These very small particles can pose a health and safety risk to persons who may breathe these particles.[18]

Dust emissions are discussed in two credits: process (or point source) emissions, and fugitive emissions. Please see *Environmental Management* Chapter 12, Air Quality Management for more information on dust emissions regulation. Appendix 3 of *Environmental Management* also gives the 2006 revision of AP 42, which is the EPA’s publication on air pollutant emission factors.

An analysis of control or suppression methods for dust emissions is necessary to assess points in the two air quality management credits. A tool, called the *Emissions Calculator,* has been provided to calculate the percentage of process source and fugitive emissions that are controlled. Each control or suppression method is weighted according to its relative importance.

Water Management

Credit 2.3: Reduction of Fresh Water Use in Plant Operations
Credit 2.4: Reducton of Fresh Water Use in Batching
Credit 2.5: Process Water Collection and Treatment
Credit 2.6: Stormwater Management

At a ready mixed concrete facility, three categories of water must be addressed: fresh water, process water and stormwater. For the purposes of these Guidelines, the following definitions are provided for the three categories of water. Fresh water is water from a municipal source (tap), surface water or on-site wells that can be consumed as drinking water. Process water is water used directly or indirectly in the production of concrete such as batching concrete, washing activities and dust control. Stormwater is any

[18] Mullings, Gary M., *Environmental Management in the Ready Mixed Concrete Industry,* Silver Spring, MD: National Ready Mixed Concrete Association, 2009, p. 121.

precipitation from rain and snowmelt events that flow over land or impervious surfaces.[19,20] Stormwater can become process water by coming into direct contact with source materials or commingling with process water. A successful water management program should:

- Minimize the use of fresh water.
- Limit the generation of process water.
- Collect, treat, and reuse as much process water as possible.
- Manage stormwater to prevent commingling with process water or otherwise becoming polluted.
- Collect and use stormwater for batching and other plant operations.

The amount of fresh water used at the plant can be significantly reduced through effective collection and recycling of process water and stormwater. Because the discharge of process water requires a permit and possibly treatment prior to discharge, recycling process water can be both environmentally and economically advantageous. Reducing stormwater runoff through infiltration and through stormwater harvesting can also provide significant environmental and economic benefit.

In an effective water management strategy, fresh water, process water, and stormwater are each managed efficiently in daily operations and water disposal is minimal. Please see *Environmental Management* Chapter 5, Water Management, for further information.

Chemical and Petroleum Products Management

Credit 2.7: Proper Storage of Chemical and Petroleum Products
Credit 2.8: Secondary Containment of Chemical and Petroleum Products
Credit 2.9: Employee Training Plan and Emergency Response Procedures

A variety of chemicals and petroleum products are stored and used at a typical ready mixed concrete plant. Chemical admixtures, usually supplied in a liquid form and incorporated into the concrete as it is batched, are stored in large plastic containers at the plant which are filled by bulk tanker trucks. Diesel fuel, motor oil, hydraulic oil, and other petroleum products are delivered to the plant and typically stored in aboveground storage tanks (ASTs) or in underground storage tanks (USTs). Cleaning solvents, truck wash products (which may contain acid), antifreeze, and batteries are also commonly stored at ready mixed concrete plants. Leaks or spills from any of these products has the potential to cause significant environmental damage and may also result in substantial financial penalties if the spill results from improper product handling or storage.

In the case of petroleum products, the EPA has established regulations designed to prevent the discharge of petroleum products into waters of the United States. These regulations are found in *40 CFR 112 - Oil Pollution Prevention*. The regulations also establish the requirements for a document known as a Spill Prevention Control and Countermeasure (SPCC) Plan. If a plant has combined aboveground petroleum storage capacity of more than 1,320 gallons (5000 l), an SPCC plan is part of the minimum requirements for the Guidelines. Part of an SPCC plan is having an employee training program for chemical and petroleum products, and emergency response procedures for chemical and petroleum product spills. These measures should be implemented whether or not a plant meets the criteria for having an SPCC plan.

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[19] http://cfpub.epa.gov/npdes/home.cfm?program_id=6

[20] Generally "Stormwater Associated with Industrial Activity" is regulated. It is defined as the discharge from any point source which is used for collecting and conveying stormwater and which is directly related to manufacturing, processing, or raw material storage areas at an industrial site. Facilities considered to be engaged in "industrial activities" include those activities defined in 40 CFR 122.26(b)(14). The term does not include discharges from facilities or activities excluded from the NPDES program. Because these Guidelines are meant to provide avenues for performance beyond regulations, Stormwater Associated with Industrial Activity is not discussed in the following credits.

Successful management of chemical and petroleum products in a ready mixed concrete plant should incorporate, but is not limited to, the following elements:

- Designated contacts and emergency coordinators
- Properly designed and maintained facilities for storage and transfer
- Adequate spill containment
- Adequate spill cleanup supplies and equipment
- Periodic inspections
- A documented employee training plan
- Established emergency response procedures

Energy Management

Credit 2.10: Reduced Carbon Footprint
Credit 2.11: Reduced Primary Energy Consumption
Credit 2.12: Renewable Energy Use

Energy management is key to an efficient, sustainable, and profitable concrete plant. Not only is energy expensive, but the use of traditional fossil fuels emits greenhouse gases (GHGs) into the atmosphere, and contributes to climate change. Therefore, the ultimate goals of this section are to lower the plant's carbon footprint, reduce annual operating energy of the plant by optimizing energy use, and to use renewable energy as a replacement for fossil fuels.

By optimizing energy use—lowering the amount of energy needed to produce a given amount of concrete—product costs and environmental impacts are reduced. In an NRMCA survey, approximately one third of respondents reported tracking energy use, and fewer utilized cost-benefit analyses or participated in programs to help establish progressive energy reduction goals.

The first step in initiating an energy management program is establishing a baseline for plant energy performance. An EMS and an Energy Audit are both prerequisites of the Guidelines and may aid in establishing a baseline number for plant energy usage. An independent consultant or energy utility company can review past energy bills to help identify the plant's energy demand and pinpoint where costs may be reduced. Once a baseline is established, strategies to improve energy efficiency can be implemented and performance can be measured against the baseline.

Measuring energy use in different areas of the plant separately can help pinpoint problem areas and guide steps to reduce energy consumption. Energy meters may be used to monitor equipment power usage. New plants may choose to set up an electrical control cabinet specifically for monitoring energy consumption.

After establishing a baseline per unit of concrete produced (for example kWh/cy (KWh/m^3), or MMBTU/cy (MJ/m^3)), determine steps to reduce and optimize energy use. Demonstrate an evaluation of energy reduction alternatives such as off-peak usage, renewable energy alternatives and optimized equipment usage.

Finally, write and implement a measurable energy reduction plan, addressing energy usage issues by setting energy use reduction goals and assigning specific solutions, using the energy related credits as guidance. By tracking energy use, and setting high performance goals, annual operating costs can be significantly lowered while mitigating the environmental impacts of concrete plant operations.

Community Considerations

Credit 2.13: Noise Control
Credit 2.14: Employee Transportation
Credit 2.15: Biodiversity
Credit 2.16: Worker Safety

A plant's relationship to its surrounding community and employees is integral to improving its social sustainability. Community considerations include noise, employee transportation, biodiversity, and worker safety. Further details on community involvement and site aesthetics are discussed in *Environmental Management* Chapter 14, Visual Image*.*

Noise is defined as "unwanted sound"[21] and is primarily a concern of neighborhoods surrounding a ready mixed concrete plant. Also of concern are general plant housekeeping and the plant's demonstrated concern for its employees and neighbors. Maintaining attractive signage and entrance landscaping, minimizing track out via wheel washers, rumble grates or paving, and keeping a well-maintained fleet will improve site aesthetics. Receiving recognition (such as the NRMCA Fleet Graphics Award) for projecting an attractive community image is another demonstration of good housekeeping.

Plant employees, as part of the surrounding community, should be considered in any plan for social sustainability. Encouraging alternative transportation will reduce the need for parking spaces, and reduce carbon emissions.

Plants should consider biodiversity on the plant site to minimize disturbance of natural habitat and wildlife. Each plant should strive to include an ecological perspective to their projects. Undertaking a habitat enhancement program on a plant site adds ecological and functional value to both the immediate area and the entire ecosystem.

Safety of workers is an important part of any sustainability program. Concrete producers should implement safety programs for workers on the plant site and for concrete mixer truck drivers.

[21] Mullings, Gary M., *Environmental Management in the Ready Mixed Concrete Industry*, Silver Spring, MD: National Ready Mixed Concrete Association, 2009, p. 131.

Credit 2.1: Process Dust Emissions Control — *3 points*

Process, or point source, emissions occur at discrete and definable locations during activities such as truck batching, silo filling, cement and aggregate weighing and material handling.

Process sources are typically managed with control devices, such as baghouses, central dust collectors and shrouds. In most cases central mix plants have fewer process emission sources, making it easier to minimize dust emissions. High performing plants will generally recycle collected dust from baghouses and central dust collectors back into SCM or cement silos.

Strategies

Process source emissions reduction strategies include:

1. Regulate the loading rate of materials (loading more slowly may reduce dust emissions).
2. Regulate the loading sequence of materials.
3. Enclose the batch plant.
4. Develop and post procedures for delivery and off-loading of cement and aggregate.

Process source emissions control devices (in good working order) include:

1. Silo top baghouse or central vacuum collector system for cement/SCM silos.
2. Silo overfill warning system (high bin indicators) for cement/SCM silos.
3. Pinch valve, alarm system, or other high pressure protection system for cement/SCM silos.
4. Batcher filter vent or central dust collector at weight batcher(s).
5. Underground or covered transfer for coarse and fine aggregates.
6. Adjustable boot at truck loading hopper or mixer loading.
7. Shroud or central dust collector at truck loading hopper (dry batch plant).
8. Spray bar used at truck loading hopper (dry batch plant).
9. Central dust collector or baghouses at central mixer (central mix plant).

Dust collected in the filter system should be recycled back into the respective silo storage.

Metrics

≥ 50% weighted process emission controls	1 point
≥ 75% weighted process emission controls	+1 point
≥ 90% weighted process emission controls	+1 point

A worksheet has been provided in the *Emissions Calculator,* which will calculate the percentage of process emission controls.

Choose either the “Dry Batch Process Emissions” or “Central Mix Process Emissions” sheet in the *Emissions Calculator*. Select “Yes” or “No” for each process source emission strategy implemented at the plant. The worksheet will automatically calculate the weighted process emission controls. Existence of a central dust collector is weighted more heavily than other measures, as it controls a larger percentage of dust emissions.

Documentation

Submit a copy of the completed “Dry Batch Process Emissions” or “Central Mix Process Emissions” worksheet from the *Emissions Calculator*.

Credit 2.2: Fugitive Dust Emissions Suppression — *3 points*

Fugitive dust emissions are more difficult to pinpoint, and may arise from vehicle activity on-site, loading and transfer activities, and aggregate stockpiles, among other possible sources. These dust emissions may be minimized through plant enclosure and dust suppression (on the plant site), which often uses water at the source of the dust to prevent it from becoming airborne. Fugitive emissions can be minimized by establishing dust control protocols (such as spraying aggregate stockpiles, or imposing plant speed limits) and grounds modification (such as plant enclosure, or paving roadways). Water that is used for dust suppression should not be allowed to run off the plant site unless permitted by the appropriate jurisdiction(s).

Over three quarters of NRMCA sustainable concrete plant survey respondents reported paving some or all plant process areas, effectively minimizing fugitive dust emissions.

Strategies

Fugitive dust emissions reduction strategies include:

1. Dust suppression with water spray on plant roadways and yard.
2. Plant enclosure.
3. Post and enforce a speed limit of 5 mph (8 km/h) on plant grounds.
4. Pave roadways and necessary process areas.
5. Sweep paved areas with vacuum sweeper or mist paved areas.
6. Use chlorides or other dust control chemicals on unpaved process areas where allowed by applicable regulatory agencies.
7. Add vegetative cover on non-paved plant grounds.
8. Cover conveyor belts(s).
9. Install drive-over hopper(s).
10. Install underground aggregate bunkers.
11. Enclose aggregate stockpiles in bins (the height of the enclosed stockpiles should not exceed the height of the bins).
12. Sprinkle coarse and lightweight aggregate stockpiles.

Metrics

A worksheet has been provided in the *Emissions Calculator*, which will calculate the percentage of controlled fugitive emission controls implemented.

≥ 50% weighted fugitive emission controls	1 point
≥ 75% weighted fugitive emission controls	+1 point
≥ 90% weighted fugitive emission controls	+1 point

In the “Fugitive Emissions” sheet in the *Emissions Calculator*, select “Yes” or “No” for each fugitive emission strategy implemented at the plant. The worksheet will automatically calculate the weighted fugitive emission controls.

Documentation

Submit a copy of the completed Fugitive Emissions worksheet from the *Emissions Calculator.*

Credit 2.3: Reduction of Fresh Water Use in Plant Operations *4 points*

Fresh water is a precious and often expensive resource, and should be used only where the use of recycled process water and/or captured stormwater is not feasible. This credit discusses reducing the use of fresh water, both by reducing overall water used in plant operations and by replacing fresh water with recycled process water and captured stormwater. Water reduction techniques can be employed to reduce overall water usage, thereby lowering operation costs. In addition to lowering total water usage at the plant, fresh water can often be replaced with recycled process water or captured stormwater in plant processes, thereby reducing the amount of fresh water purchased annually. Significant savings in the costs of water may be achieved through the installation of a rinse/wash water recycle system and/or the installation of a cistern(s). For strategies on collecting and reusing process water and stormwater, see Credits 2.5 and 2.6, respectively.

Water consumption, beyond use in batching, is influenced by the type of plant, plant location, and plant size. Central mix plants tend to use less truck rinse water than transit mixer operations, which load dry material. Rural plants with longer average hauls are more likely to have transit mixers than urban plants with shorter hauls, and thus use more water.[22] Also, larger plants (particularly in urban areas) are more likely to have water recycling systems. Average water consumption (excluding batch water) was found to be 13 gallons per cubic yard (64.4 l/m^3).[23]

Using recycled process water and captured rainwater

Recycled process water and captured stormwater should be used wherever possible to avoid the use of fresh water – these types of water are less of an environmental burden by reducing municipal water treatment loads, and take a plant closer to self-sufficiency by reducing dependence on municipal sources of water. One best management practice includes using recycled process water for truck exterior washing and mixer drum washout. Another best management practice is to use captured stormwater for truck washing, mixer drum washout, and dust suppression. Use of color-coded pipes at different stations (e.g. green for recycled water, blue for municipal water) will distinguish fresh and recycled process and stormwater sources. Train all employees on water conservation and the proper use of all water reclamation equipment. Credit 2.5 and 2.6 provide strategies for recycling process water and capturing and using stormwater.

Using water reduction techniques

A number of strategies can be implemented on-site to reduce the amount of water used. Drum washouts use significant amounts of water and by using multiple lower volume rinses to complete washout, the amount of washout water needed can be nearly cut in half. While an efficient washout may be accomplished with one rinse using 250 gallons (946 l), a double rinse using 100 gallons (379 l) twice, 200 gallons (757 l) total, or a triple rinse using 50 gallons (189 l) three times, 150 gallons (568 l) total, are equivalent.[24] The "rock out" method may also be appropriate. This method consists of adding dry aggregate to the drum after any returned concrete is discharged, then running it at mixing speed to collect wet concrete. The dry aggregate with collected wet concrete is then discharged and allowed to dry for later use as recycled material.

Water can also be conserved when heating and cooling aggregate by heating a small amount of water to create steam to heat aggregates rather than heating all the mix water. If aggregate is sprayed for cooling or dust suppression, collect the runoff for reuse.

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[22] Marceau, Medgar, Michael Nisbet, Martha VanGeem, *Life Cycle Inventory of Portland Cement Concrete,* Skokie IL: Portland Cement Association, 2007, p. 13.
[23] Ibid., p.13
[24] Athena Sustainable Materials Institute, *Raw Material Balances, Energy Profiles and Environmental Unit Factor Estimates: Cement and Structural Concrete Products*, Ottawa, Canada, 1993, p. 68.

At fresh water use locations, separate pumps and meters will pinpoint where water use reduction strategies should be targeted. Water use can be reduced by installing flow-control nozzles or use small diameter hoses. Shut-off valves can be installed to eliminate truck overflows during tank filling.

Credit paths

There are two alternative paths for this credit, and plants can choose the most appropriate path. Path A awards points to plants tracking water use and measuring performance. Path B alternatively awards points to plants that have infrastructure in place to use recycled process water or rainwater for specific applications.

Strategies

Install the pumps, water lines, and controls necessary to supply recycled process water and/or captured stormwater for use in:

1. Truck exterior rinse after loading or washing at the end of the day (recycled process water and/or captured stormwater).
2. Yard and roadway dust suppression (capture stormwater).
3. Sprinkling aggregate stockpiles for dust control or heating/cooling (captured stormwater).
4. Mixer drum washout (recycled process water and/or captured stormwater).

For drum washouts:

1. Use multiple small volume rinses.
2. Use the “rock out” method.
3. Equip truck cleaning spray bars with timers to limit wash time and prevent overflow.
4. Equip truck cleaning hoses with high pressure low volume nozzles.
5. Use water-reducing (retarding) admixtures to stabilize the concrete residues in the mixer.

At fresh water use locations:

1. Limit wash time.
2. Install flow-control nozzles on hoses at rinse stations.
3. Use small diameter hoses.
4. Install shut-off valves on water hoses used to fill tanks.

Metrics

PATH A – PERFORMANCE Non-batching fresh water use percentage below U.S. national baseline of 13 gal/cy (64.4 l/m^3).

PATH A – PERFORMANCE	
Fresh water use is 10% or more below U.S. national baseline	1 point
Fresh water use is 20% or more below U.S. national baseline	+1 point
Fresh water use is 30% or more below U.S. national baseline	+1 point
Fresh water use is 40% or more below U.S. national baseline	+1 point

[US Customary] $$\textit{non-batching fresh water use } (\%\ below\ baseline) = \frac{13 - plant\ use\left(\frac{gal}{cy}\right)}{13} \times 100$$

[SI Units] $$\textit{non-batching fresh water use } (\%\ below\ baseline) = \frac{64.4 - plant\ use\left(\frac{l}{m^3}\right)}{64.4} \times 100$$

PATH B – PRESCRIPTIVE Use recycled water or rainwater for the uses specified.

PATH B – PRESCRIPTIVE	
Recycled process water and/or captured stormwater used for all truck exterior rinses	1 point
Captured stormwater used for dust suppression	1 point
Capture stormwater used to sprinkle aggregate bins for dust control or heating/cooling	1 point
Recycled process water and/or captured stormwater and/or rock out method used for all mixer drum washouts	1 point

Documentation

PATH A – PERFORMANCE Submit a letter from company's accountant or corporate officer stating the total quantity of municipal water purchases and onsite well water used for non-batching purposes at the plant for the 12-month period.

PATH B – PRESCRIPTIVE Submit a brief narrative describing the water collection and treatment system and the infrastructure in place to allow the use of process water at the location of each credit claimed. Retain documentation of any plant protocols requiring the use of recycled water.

Credit 2.4: Reduction of Fresh Water Use in Batching — *3 points*

Fresh water use in batching concrete can be reduced by replacing fresh water with recycled water, and chemical admixtures may lower the amount of water necessary in a mix. Average batch water usage is currently at around 25 gallons per cubic yard (124 l/m^3).

Partially or fully replacing fresh water used as mixing water will have a significant impact in minimizing the amount of fresh water used in concrete batching. The American Society for Testing and Materials (ASTM) has permitted recycled water for use in ready mixed concrete batching since 1978,[25] and currently ASTM C 1602 *Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete* addresses the requirements for water sources used as mixing water. Chemical admixtures can also reduce the need for fresh water in concrete batching. Consider the use of water reducing and plasticizing chemical admixes rather than adding more mixing water and cement to obtain the required consistency of fresh concrete.

Please see *Environmental Management* Appendix 6, Recycled Water for Concrete Article, for details of a study done on the effects of recycled water on concrete strength. The NRMCA has also published "Recycled Water in Ready Mixed Concrete Operations," which is available through their website.[26]

Strategies

To reduce the amount of fresh water in concrete batching consider the following strategies:

1. Encourage specifications for water in accordance with ASTM C 1602, maximizing use of recycled water.
2. Implement and/or increase the use of water reducing chemical admixtures (water reducers, high and mid-range superplasticizers, etc.).
3. Optimize mix proportions to minimize the amount of cement, SCM, and water in the mix.

Metrics

Batching fresh water use percentage below U.S. national baseline of 25 gal/cy (124 l/m^3).

Water in batching 10% or more below U.S. national baseline	1 point
Water in batching 20% or more below U.S. national baseline	+1 point
Water in batching 30% or more below U.S. national baseline	+1 point

[US Customary]

$$batching\ fresh\ water\ use\ (\%\ below\ baseline) = \frac{25 - plant\ use\ \left(\frac{gal}{cy}\right)}{25} \times 100$$

[SI Units]

$$batching\ fresh\ water\ use\ (\%\ below\ baseline) = \frac{124 - plant\ use\ \left(\frac{l}{m^3}\right)}{124} \times 100$$

Documentation

Submit a letter from the company's accountant or corporate officer stating the total amount of municipal fresh water purchases and onsite well water used for batching purposes for the 12-month period.

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[25] Lobo, Colin and Mullings, Gary, "Recycled Water in Ready Mixed Concrete Operations," *Concrete InFocus*, Spring 2003, p. 1.

[26] http://www.nrmca.org/research/33%20CIF%2003-1%20wash%20water.pdf

Credit 2.5: Process Water Collection and Treatment *3 points*

Minimizing fresh water use at a concrete plant depends significantly on the use of recycled process water and captured stormwater (see Credit 2.6) in plant operations. On average, approximately 7 gallons of water is discharged of for every cubic yard (35 l/m^3) of concrete manufactured.[27]

The efficient collection, storage, treatment and reutilization of process water is therefore of considerable importance in an overall water management strategy. Potential liabilities and increasing regulatory restrictions involved in discharging process water make its collection and reuse even more critical. Effective process water management includes minimizing process water generation, collecting process, and treating process water for reuse and/or discharge if and when necessary.

The generation of process water can be reduced by preventing the commingling of process and stormwater. Curbing, valley gutters and grading can be used to prevent stormwater from flowing through areas where process water may be present and therefore commingling with process water. Another strategy is to curb the perimeter of a process water settlement basin approximately one foot above ground level (or higher, to achieve sufficient freeboard) in order to minimize or eliminate the entry of stormwater from commingling with process water within the basin. Another strategy is to establish a closed loop water recycling system at aggregate stockpiles that captures and recycles precipitation and sprinkler runoff.

The collection of process water can be facilitated by paving process areas. These areas typically include:

1. Truck loading.
2. Truck rinse station.
3. Truck washout area.
4. Returned concrete processing area.
5. Aggregate storage bins.

Process water should flow into a collection area, generally the first in a series of basins that comprise the settlement basin system. A settlement basin system is the most common form of process water treatment, consisting of a series of basins in the ground that facilitate the progressive settlement of solids from process water by slowing and restricting the flow of process water as it travels through the basins. The location, sizing, depth, and flow pattern of a settling basin system are key elements in determining its effectiveness. The system design should consider the production volume, potential stormwater flow, and retention capacity requirements of the plant. It is also of note that lined basins are easier to maintain than unlined, and pose a potentially lower environmental risk.

The most sustainable practice involves the capture, containment, treatment and reuse of process water at a concrete plant, without the need for discharge. This results in overall lower fresh water use, reduced water waste, and can result in economic benefit by reducing water bills. The desired end use of process water to be recycled, typically dictates the type of treatment used, which typically includes solids treatment in a settlement basin and/or pH adjustment when required. For many systems, closed loop recycling may require little or no treatment (batching water), while other uses may require a higher level of treatment (truck washing or dust control).

If process water is discharged, water quality of the discharge is of utmost importance. High pH levels, high solids content, petroleum products and other chemicals in water are harmful to wildlife and the surrounding environment. Process water discharge is regulated by the EPA and state and local regulators, and requires an NPDES permit. The pH range, total suspended solids and other pollutants in discharged water must fall within the limits stated on the permit and will typically require treatment of the process wa-

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[27] Marceau, Medgar, Michael Nisbet, Martha VanGeem, *Life Cycle Inventory of Portland Cement Concrete,* Skokie IL: Portland Cement Association, 2007, p. 13.

ter prior to discharge. Treatment of process water is typically done in the final settlement basin or reservoir at the end of the settlement or solid separation phase.

A comprehensive discussion of process water treatment, use and discharge is presented in *Environmental Management* Chapter 8, Settling Basins. See Chapter 6, Job Site Chute Rinse-off, for information on job site water management as well, and Chapter 7, Solid Materials Management, for the subsection discussing reclaiming solids and water from truck washout.

Strategies

Strategies for managing process water include:

1. Implement a program to reduce the plant's generation of process water. This could include reducing overfilling of mixer truck water tanks, reducing water used to wash out mixer drums and reducing water for truck exterior washing.
2. Implement a program to reuse/recycle process water in plant operations to supplement fresh water from municipal, surface water, or groundwater sources. This could include process water reuse in concrete batching, washing activities and dust control.
3. Implement a program to prevent the commingling of stormwater and process water that results in the generation of additional process water. This could include curbing and grading the site to prevent the commingling of process water and stormwater.
4. For process water that is discharged, implement site features to ensure that the discharge complies with all aspects of the discharge requirements of the plant's NPDES permit. If appropriate, establish a settling basin system with appropriate solids removal facility, pH treatment area, and discharge location. Line sedimentation basins to minimize potential seepage. It may be helpful to engage an environmental manager or consultant about establishing a new or modifying an existing process water treatment system. An alternative might be to use slatted conveyor belts to remove solids from process water. Diatomaceous earth rollers and flocculants may serve similar purposes.

Metrics

Use strategies listed above and others to reuse/recycle process water generated, as well as strategies to reduce volume of process water generated. Process water is discharged from concrete plant site in compliance with NPDES permit conditions and requirements.

Reuse/recycle more than 10% of process water generated. Discharge remaining process water in compliance with NPDES permit.	1 point
Reuse/recycle more than 40% of process water generated. Discharge remaining process water in compliance with NPDES permit.	+1 point
Reuse/recycle more than 70% of process water generated. Discharge remaining process water in compliance with NPDES permit.	+1 point

Documentation

Submit a brief narrative describing the process water management plan for the concrete plant, including reuse/recycling and/or discharge activities, including confirmation of the percentage and method of process water reuse/recycling. Should the plant include discharge facilities such as a settlement basin and/or pH treatment unit, provide a brief narrative describing the facilities and accompanying photographs and site plan identifying the process water treatment facilities. Retain records of process water reuse such as batch records that include process water, records of fresh water used at the plant, and purchased equipment and documentation from planning stages.

Credit 2.6: Stormwater Management — *4 points*

A stormwater management plan at a ready mixed concrete plant should focus on the following sustainable practices:

- Ensure that stormwater leaving the concrete plant site (being discharged) is as clean as possible by avoiding contact with source materials and is in compliance with all discharge requirements of the plant's NPDES stormwater discharge permit.
- Avoid commingling of stormwater with process water.
- Collect stormwater whenever possible to supplement fresh water obtained from municipal, surface water or groundwater sources, a technique known as stormwater harvesting.

Stormwater associated with industrial activity can be a major contributor of pollutants to waterways. Concrete plants that discharge stormwater are required to obtain an appropriate NPDES stormwater discharge permit (which generally prohibits the discharge of commingled or process waters). Stormwater discharge permits require the concrete plant facility to prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) and to implement a program of appropriate Best Management Practices (BMPs), including both baseline BMPs such as housekeeping, spill prevention, inspections and record-keeping, and site-specific BMPs. Stormwater permits typically require sampling and visual and/or analytical analysis of stormwater discharges.

Since most NPDES stormwater discharge permits prohibit the discharge of commingled/process water, and the commingling of stormwater and process water may result in increased volumes of process water requiring careful management, it makes sense to separate stormwater and process water to the highest degree possible. A number of design strategies can be utilized to guide stormwater flow away from process locations and process water collection areas. Barriers around process locations will prevent stormwater from flowing into the process locations. The same effect may also be achieved by locating process areas outside of potential stormwater drainage areas.

Stormwater harvesting is a sustainable practice since it reduces the use of fresh water, minimizes runoff, and reduces stormwater discharge pollution. Stormwater can be collected on a concrete plant site in basins or storage tanks, also known as cisterns, for later use. This can result in lower fresh water use, preservation of natural resources, reduced energy consumption associated with surface water or groundwater pumping and cost savings by lowering water bills. In dry climates with little precipitation, much of the stormwater runoff generated at a concrete plant can be harvested for reuse; at plants in areas with greater volumes of precipitation, only a fraction of the total rainfall may be able to be harvested. The EPA has published a handbook, *Managing Wet Weather with Green Infrastructure: Municipal Handbook Rainwater Harvesting Policies,*[28] describing the benefits of rainwater collection and the basic infrastructure needed to do so.

It is possible to operate a concrete plant that discharges no stormwater at all under typical rainfall events, which may be accomplished through a system of on-site capture and storage areas or structures to accommodate the rainfall until it can be used in plant activities, without any off-site discharge to surface water bodies. This type of plant is called a "zero discharge" plant, and may be exempt from the need of an NPDES stormwater discharge permit. Many states establish a design storm event below which they consider complete retention to represent "zero discharge," while any storm event greater than this limit is exempt from regulation. Without this limit, all concrete plants would discharge under extremely large storm events that occur only infrequently. Many states offer a "zero discharge" certification or other confirmation of exemption from the need for NPDES permitting. It is further noted that in the case of "zero discharge" plants, many have chosen to purposely commingle stormwater and process water into their collection areas, thereby avoiding the need for separate collection and storage areas, provided the commingled water is then reused/recycled for the same purpose.

[28] http://www.epa.gov/npdes/pubs/gi_munichandbook_harvesting.pdf

The reduction of total runoff should be a goal of a concrete plant, particularly those that discharge to surface waters. This can be accomplished through the use of pervious areas on the plant site. This not only reduces runoff but also allows stormwater infiltration into the ground, which replenishes aquifers. Pervious areas may be in the form of vegetated areas or pervious pavements.

Note that in some locations, the discharge of stormwater itself may be considered a sustainable practice, such as in climate conditions where stormwater discharge may be required in order to avoid a negative impact to surface waterways associated with low-flow conditions. Certain locations may mandate the continuance of stormwater discharges via regulation in order to preserve surface water flow conditions. In these cases, the discharge of stormwater would be considered a sustainable practice.

Additional detail on managing and reusing stormwater can be found in *Environmental Management* Chapter 5, Water Management, and Appendix 5, Stormwater Best Management Practices.

Strategies

Reduction of stormwater pollutant levels

A concrete plant should strive to eliminate contact between stormwater and source materials present at the concrete plant to the highest degree possible. Source materials are any materials present at a concrete plant that may be capable of imparting pollutants to stormwater, such as cement, fine sand, oils and greases, admixtures, chemicals, solvents, etc. A concrete plant should also implement BMPs designed to reduce or prevent potential pollutant levels in stormwater, which is typically required by the plant's NPDES stormwater discharge permit as part of a SWPPP. For those facilities without an SWPPP, such as those exempt from the need for NPDES stormwater discharge permitting due to being a "zero-discharge" facility, the concrete plant should still design and implement appropriate BMPs to reduce or eliminate stormwater pollutant levels.

Prevention of stormwater – process water commingling

For managing stormwater and preventing stormwater commingling with process water consider the following strategies:

Structural strategies that will help minimize the commingling of stormwater with process water include:

1. Provide paved, curbed and appropriately graded surfaces at the following main process locations:
    i. Truck loading
    ii. Truck rinse station
    iii. Truck slump rack
    iv. Truck washout area, preferably lined
    v. Reclaiming unit area
    vi. Reclaimed solids storage area
    vii. Returned concrete processing area
    viii. Aggregate storage bins
2. Install and maintain underground stormwater drainage system (catch basins and pipes).

Operational strategies that will help minimize the commingling of stormwater with process water include:

1. Minimize traffic, vehicle and employee, through process water collection areas.
2. Appropriately locate and/or contain aggregate stockpiles.

Stormwater harvesting, discharge prevention, zero-discharge facility

A concrete plant can implement a program to capture and store all, or part, of the stormwater generated for later use in concrete plant activities such as concrete production, washing activities, dust control, or irrigation. Collection structures can include retention basins, storage tanks or other similar features. This water can be used to supplement or entirely replace fresh water used in plant activities. Means should be present at the concrete plant to reuse the collected water in an appropriate manner, other than discharging off-site to a surface water body or municipal stormwater collection system. In some cases, process water may be purposely commingled with stormwater in these collection areas for later reuse, provided this commingled water is not discharged to surface water. This may eliminate the need for separate management structures or areas for process water and stormwater.

The concrete plant should implement strategies to reduce the total volume of stormwater that is either discharged from the facility or which is required to be collected, stored and managed. This could include the establishment of pervious areas in the form of vegetated areas or pervious pavement.

Concrete plants should strive to establish the plant as a zero discharge facility, where all water, process or storm, is managed and used in day-to-day operations of the facility. Where available, a zero-discharge certification may be obtained from a local or state regulatory body, after submitting appropriate documentation to the applicable regulatory agency. In areas where this type of certification is not available, a plant can obtain a letter from a third party professional engineer (not employed by the ready mixed concrete company) stating the that the plant is a zero-discharge plant.

Metrics

STORMWATER HARVESTING A point is awarded if the plant collects stormwater on-site and then uses the stormwater in plant operations to supplement the use of fresh water. An additional point is awarded if the plant can quantify the amount of stormwater harvested and used in place of fresh water.

RUNOFF REDUCTION A point is awarded for features or practices that reduce stormwater runoff from the plant site. An additional point is awarded if the plant can quantify the reduction of stormwater runoff.

STORMWATER HARVESTING	
Concrete plant has systems or practices in place to capture and collect stormwater and use in plant operations to supplement fresh water use.	1 point
Quantify the amount of stormwater harvested and used in place of fresh water.	+1 point
RUNOFF REDUCTION	
Concrete plant has practices in place to reduce stormwater runoff.	1 point
Quantify the amount of stormwater runoff reduction.	+1 point

Documentation

STORMWATER HARVESTING
Submit a brief narrative, photographs, and site plan describing how the plant captures and uses stormwater in place of fresh water.

Provide documentation that there is a system in place to quantitatively measure the volume of stormwater harvested and used in plant operations. Examples of this documentation could include, but not be limited to, an overall water budget at the concrete plant with numerical estimates of stormwater and fresh water used at the concrete plant over the 12 month period.

Note: Should the concrete plant be able to document a significant reduction in fresh water use, this credit may be able to qualify for Additional Sustainable Practices as described in Credit 6.1.

RUNOFF REDUCTION
Submit a brief narrative, photographs, and site plan describing how the plant controls and reduces stormwater runoff.

Provide documentation that there is a system in place to quantitatively measure the volume of stormwater runoff reduced. Examples of this documentation could include a civil engineer’s report or analysis documenting runoff reduction.

Note: Should the concrete plant be able to document that it is a zero discharge facility, this credit can qualify for Additional Sustainable Practices as described in Credit 6.1.

Credit 2.7: Proper Storage of Chemical and Petroleum Products *2 points*

The risk of leaks and spills can be minimized by proper design of storage facilites and the incorporation of monitors and fail-safe devices on chemical and petroleum product storage tanks and transfer points. A number of strategies are available to the ready mixed concrete producer to reduce the risk of a spill and minimize the impact should a spill occur. An in-depth discussion of these strategies can be found in *Environmental Management* Chapter 9, Admixtures, Chemicals and Fuel. Specific information on the fleet maintenance facility can be found in Chapter 11, Fleet Maintenance Facilities.

Strategies

Best management practices for chemical and petroleum product management include:

1. Provide overfill alarms on all ASTs and USTs.
2. Provide spill containment (curbing or a fuel port) at AST, or underground tank fill locations.
3. Provide breakaway hose connections at fueling stations.
4. Pave the truck/equipment fueling area.
5. Provide adequate lighting at fueling stations.
6. Provide and clearly label the emergency shut off switch at the fueling station.
7. Provide security fencing of the plant perimeter or at a minimum for all required exterior petroleum storage tanks, pumps, piping, and hoses.
8. Protect ASTs from impact by installing bollards or other barriers.
9. Store admixture tanks in a covered or enclosed location.
10. Clearly identify and label the contents of all tanks and drums.
11. Maintain emergency response equipment, materials, and an Emergency Spill Kit in a central and accessible location.

Metrics

Implement the best management practices listed in the Strategies section.

At least 7 strategies implemented	1 point
All 11 strategies implemented	+1 point

Documentation

Submit photos and a copy of the plant site plan identifying storage and containment facilities, as well as safety measures such as emergency shut off switches and Emergency Spill Kit. Retain copies of the plant SPCC plan, the plant routine facility inspections, SPCC inspections checklist, and comprehensive site inspections.

Credit 2.8: Secondary Containment of Chemical and Petroleum Products 2 points

Properly designed and maintained secondary containment is the most effective protection against a chemical or petroleum product spill. It is essential that the secondary containment be properly maintained if the containment structure is to be effective.

Secondary containment is defined as an impermeable structure that is large enough to contain the entire contents of the largest single container plus an allowance for precipitation (if the secondary containment is exposed to weather). Typical secondary containment structures for ASTs include cast-in-place concrete walls, concrete filled block walls, double walled tanks, and earthen dikes (often with a liner). Secondary containment for 55 gallon (208 l) drums can be accomplished with spill containment pallets. In the event of a spill a properly designed and maintained secondary containment structure will prevent the spill from migrating off-site or into water management structures.

Strategies

Strategies for secondary containment include:

1. Provide appropriately sized secondary containment for all petroleum products and chemicals.
2. Provide a locking valve at all secondary containment discharge locations.

Metrics

Appropriately sized secondary containment in place.

Provide appropriately sized secondary containment for all chemical or petroleum products stored in tanks or containers of 55 gallons (208 l) or greater.	2 points

Documentation

Submit photos, plant site plan, and calculations demonstrating appropriately sized secondary containment facilities.

Credit 2.9: Employee Training Plan and Emergency Response Procedures 2 points

It is the responsibility of the ready mixed concrete producer to ensure that employees are properly trained in the safe handling of hazardous chemicals and petroleum products. It is also essential that emergency response procedures be established and that employees are familiar with the procedures in the case of a spill or other emergency.

Training in the safe handling of chemical and petroleum products should be part of all new employee orientations. Additional training, particularly for employees involved routinely in the handling of chemical or petroleum products, should be conducted annually or semi-annually. A formal training plan should be developed and reviewed periodically for changes and updates in product handling regulations and best management practices.

Strategies

Develop an Employee Training Program for chemicals and petroleum products. This should include:

1. Review of MSDS sheet terminology and sheet location.
2. Review of site plan and storage locations for chemicals and petroleum products.
3. Provide written safety and handling requirements of chemicals and petroleum products.
4. Review locations of spill response and personal protective equipment.
5. Provide written emergency contact list in the event of a spill.

Write and post Emergency Response Procedures (or equivalent) for chemical and petroleum product spills. This should include:

1. Written emergency contact list (including 24 hr phone numbers) of plant personnel or other emergency contacts.
2. Verbal and written notification requirements for federal, state, and local agencies in the event of a spill or discharge (including the information required to be submitted in the report).
3. Designated Emergency Spill Coordinator and Alternate Emergency Spill Coordinator responsible for ensuring the reports are submitted in a complete and timely manner.
4. Step-by-step response procedures in the event of a spill.

Metrics

An Employee Training Program with all of the elements outlined above.

Written Emergency Response Procedures with all of the elements outlined above.

Employee Training Program for chemicals and petroleum products including all 5 elements	1 point
Emergency Response Procedures for chemical and petroleum product spills including all 4 elements	1 point

Documentation

Submit a brief narrative describing Emergency Response Procedures and Employee Training Program for chemical and petroleum spills. Retain copies of the Emergency Response Procedures and the Employee Training Program on file. Maintain records of employee training. Maintain copies of “Incident Report Forms”, daily diaries, or equivalent, for documenting spills and subsequent response.

Credit 2.10: Reduced Carbon Footprint *6 points*

For the purposes of the Sustainability Guidelines, a plant's carbon footprint refers to the total amount of CO_2 and other greenhouse gases (GHGs) emitted due to the plant's concrete production, encompassing raw material extraction, production method, delivery to job sites, and eventual disposal or reuse. A carbon footprint is measured in CO_2 equivalents or CO_2e, which is simply a unit referring to CO_2 and other GHGs in combination.

While nearly every process related to concrete production will contribute to the carbon footprint, the most energy intensive areas of concrete production are cement consumption, non-renewable plant energy consumption, and fuel consumption for concrete delivery. These topics are discussed in other credits in the Guidelines (see Strategies section for references), and by addressing these areas where a plant can reduce its carbon footprint.

A tool, the *CO2 Calculator*, has been developed to help calculate a plant's carbon footprint. The calculator uses aggregated information from the plant to determine the plant's carbon footprint, measured in annual CO_2e/cy (CO_2e/m^3). Data concerning plant location, delivery loads and distances, raw material use, electricity and fuel consumption are used in calculating this number.

Strategies

To reduce the carbon footprint of concrete produced, consider the following strategies:

1. Increase use of recycled aggregate. See Material Acquisition Credit 1.1.
2. Reduce portland cement consumption. See Material Acquisition Credit 1.2.
3. Reduce primary energy consumption. See Production Credit 2.11.
4. Use renewable energy. See Production Credit 2.12.
5. Increase delivery fleet fuel efficiency. See Construction Credit 3.1.
6. Increase amount of concrete diverted from disposal. See Material Reuse and Recycling Credit 5.2.

Metrics

CO_2e/cy (CO_2e/m^3) percentage below U.S. baseline. CO_2e/cy (CO_2e/m^3) is obtained from the CO2 Calculator.

The U.S. baseline is 634 lb CO_2e/cy (376 kg CO_2e/m^3), based on sustainable concrete plant survey responses.

CO2e 5% or more below U.S. baseline	1 point
CO2e 10% or more below U.S. baseline	+1 point
CO2e 15% or more below U.S. baseline	+1 point
CO2e 20% or more below U.S. baseline	+1 point
CO2e 25% or more below U.S. baseline	+1 point
CO2e 30% or more below U.S. baseline	+1 point

[US Customary]

$$CO2e\ (\%\ below\ baseline) = \frac{634 - plant\ CO2e\left(\frac{lb\ CO2e}{cy}\right)}{634} \times 100$$

[SI Units]

$$CO2e\ (\%\ below\ baseline) = \frac{376 - plant\ CO2e\left(\frac{kg\ CO2e}{m^3}\right)}{376} \times 100$$

Documentation

Submit a copy of the *CO2 Calculator*'s output page.

Credit 2.11: Reduced Primary Energy Consumption — *6 points*

A plant's primary energy consumption is defined as all energy used for materials manufacturing and transportation, ready mixed concrete plant operations, and transportation of concrete to construction sites. By reducing total primary energy consumption a plant can increase energy efficiency and decrease operating costs. For this credit, the *CO2 Calculator* is used to calculate a plant's primary energy consumption in annual MMBTU/cy (MJ/m^3) and compared to a U.S. national baseline. This is calculated using information about material use and transportation, plant electricity and fuel use and truck fuel use.

Reduce cement consumption

While nearly every process related to concrete production will contribute to primary energy consumption, the most energy intensive areas of concrete production are cement consumption, plant energy consumption, and fuel consumption for concrete delivery. These topics are discussed in other credits in the Guidelines (see Strategies section for references), and by addressing these areas where a plant can reduce its energy consumption.

Reduce use of electricity

Approximately 80-90% of the electricity used at a concrete plant is consumed by electric motors.[29] During start-up, a motor can draw anywhere from 2 to 10 times its operating current. There are methods of controlling initial power-up current intake, including soft starts and variable frequency drives. With soft starts, a circuit reduces current flow during a large motor's power-up. A variable frequency drive (VFD) is a system that will control the rotational speed of an AC motor by controlling the frequency of the electrical supply powering the motor.

Reduce fuel use

A significant portion of the embodied energy of concrete is due to diesel and natural gas used during plant operations.[30] Fuel can be saved by streamlining aggregate handling. Front end loaders typically consume 5-10 gallons (18.9-37.9 l) of diesel fuel per hour. By switching to electric conveyor belts, significant diesel savings can be made, as well as reduced labor costs. Underground aggregate storage bins will facilitate the use of conveyors as opposed to front end loaders as well.

Tracking energy use

The *CO2 Calculator* can be used to develop energy reduction goals in addition to tracking energy consumption for obtaining points in this credit. To obtain annual primary energy consumption, annual material use and transportation data along with plant annual electricity and fuel usage data must be entered in the *CO2 Calculator*. This information is automatically aggregated to output MMBTU/cy (MJ.m^3). This output number describes total primary plant energy usage and points are assigned in this credit for the annual reduction of MMBTU/cy (MJ/m^3) below a U.S. national baseline.

Strategies

To reduce annual primary energy consumption, consider the following strategies:

1. Increase use of recycled aggregate. See Material Acquisition Credit 1.1.
2. Reduce portland cement consumption. See Material Acquisition Credit 1.2.
3. Increase delivery fleet fuel efficiency. See Construction Credit 3.1.
4. Install power management equipment, such as soft starts and VFDs.
5. Use energy efficient plant equipment. Boiler alternatives may include fuel cells or heat exchangers and all equipment purchased should be high efficiency.

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[29] Marceau, Medgar, Michael Nisbet, Martha VanGeem, *Life Cycle Inventory of Portland Cement Concrete*, Skokie IL: Portland Cement Association, 2007, p. 12.
[30] Ibid.

6. Control mix water temperature to lower energy use.
7. Have aggregate temperature control system in place.
8. Insulate water storage tanks to minimize heating/cooling energy consumption.
9. Use plant grounds intensively to avoid sprawl and therefore decrease internal transportation times.
10. Remember simple, common sense strategies, like turning off lights that are not in use and shutting off unneeded equipment. Install automatic shut-off mechanisms for all equipment when not in use.
11. Install programmable thermostats.
12. Install high efficiency boilers and light bulbs.

Metrics

Primary energy consumption percentage below U.S. national baseline. Primary energy is obtained from the *CO2 Calculator*.

The U.S. national baseline is 2.73 MMBTU/cy (3767 MJ/m^3), based on sustainable concrete plant survey responses.

Primary energy consumption 5% or more below U.S. national baseline	1 point
Primary energy consumption 10% or more below U.S. national baseline	+1 point
Primary energy consumption 15% or more below U.S. national baseline	+1 point
Primary energy consumption 20% or more below U.S. national baseline	+1 point
Primary energy consumption 25% or more below U.S. national baseline	+1 point
Primary energy consumption 30% or more below U.S. national baseline	+1 point

[US Customary]

$$Energy\ consumption\ (\%\ below\ baseline) = \frac{2.73 - plant\ energy\ consumption\left(\frac{MMBTU}{cy}\right)}{2.73} \times 100$$

[SI Units]

$$Energy\ consumption\ (\%\ below\ baseline) = \frac{3767 - plant\ energy\ consumption\ \left(\frac{MJ}{m^3}\right)}{3767} \times 100$$

Documentation

Submit a copy of the *CO2 Calculator* results. Retain documentation of material purchases, transportation, purchased energy, and fuel use.

Credit 2.12: Renewable Electricity Use *4 points*

By replacing fossil fuel use with renewable energy, the carbon footprint of plant operations can be lowered. The EPA has authored the *Guide to Purchasing Green Power*, which is a comprehensive guide to purchasing renewable energy, available on their website[31], which describes the three main options for renewable electricity use: renewable electricity products, renewable energy certificates (RECs), and on-site renewable generation. Renewable electricity includes electricity generated by wind, solar power, hydro power, geothermal, and biomass.

Third party certification for renewable energy

For the purposes of this credit, renewable electricity products and REC purchases must be from Green-e certified sources (or equivalent). Green-e is an independent third party that certifies renewable energy suppliers are (1) operating at current green performance standards and (2) provides independent third-party verification that these standards are met. Any equivalent certification regime must meet these criteria, and the plant must provide pertinent documentation. A searchable database of renewable energy suppliers is available online through the Green-e website.[32]

Types of renewable energy purchases

Renewable electricity products are generally available from utility companies or power marketers, and are primarily purchased as a fixed quantity or as a percentage of monthly electricity use. A REC represents the environmental, social, and other beneficial attributes of power generated from renewable sources (for example, RECs can represent the emissions reduction resulting from renewable electricity generation). RECs are sold separately from electricity, and can be purchased to offset any amount of conventional electricity use. On-site renewable energy possiblities vary greatly from site to site.

Renewable energy sources

For solar power, sunlight is converted directly into energy, such as with photovoltaics (PVs, or solar panels), and indirectly, such as with concentrating solar power (CSP) systems. In solar panels, a thin film of semiconductor material converts sunlight into electricity. CSP systems typically focus the sun's energy to boil water, which is then used to provide power. One NRMCA member plant outside of Boston is generating over 100,000 kW using on-site solar panels, and estimates fully paying off the investment for this project in a little over five years.[33]

Hydroelectric power is generated by moving water; a dam is built in a river near a large drop in elevation, which propels water through turbines to turn a generator and create electricity. Green-e recognizes small and mid-scale hydro as renewable. Wind power is harnessed through the movement of turbines, which are generally mounted on towers over 100 feet (30.5 m) tall to capture the faster and less turbulent wind. Geothermal energy is power supplied by the earth's heat, generally accessed through geothemal wells. Biomass is organic material, mostly grown plant matter, that is burned for energy.

Strategies

To increase the use of renewable electricity consider the following strategies:

1. Purchase renewable electricity or REC from Green-e certified suppliers, or equivalent.
2. Generate renewable electricity on-site.

[31] http://epa.gov/greenpower/documents/purchasing_guide_for_web.pdf
[32] http://www.green-e.org/base/re_products
[33] Vickers, Greg, *The Sustainable Energy-efficient Concrete Plant of the Future – NRMCA Spring 2009 Webinar Series*, 6 May 2009.

Metrics

Percentage of renewable electricity or RECs purchased from Green-e certified renewable sources plus renewable electricity generated on-site.

≥ 5% electricity from renewable sources	1 point
≥ 10% electricity from renewable sources	+1 point
≥ 20% electricity from renewable sources	+1 point
≥ 30% electricity from renewable sources	+1 point

$$renewable\ electricity\ (\%) = \frac{renewable\ electricity\ (kWh)}{total\ electricity\ (kWh)} \times 100$$

Documentation

Submit a copy of the energy audit indicating renewable energy and/or RECs purchased from Green-e certified renewable sources. If renewable energy is generated on-site, submit the plant site plan indicating location of power generation equipment. Retain documentation of any equipment purchases and planning stages.

Credit 2.13: Noise control **2 points**

Noise level is an area of concern for many concrete plants, as noise levels have the potential to directly affect the surrounding community, and plant employees. While sound is inherent to ready mixed concrete facility operations, there are many areas where noise can be minimized. Consider existing and potential future neighbors, site topography (hills, vegetation), and wind directions when laying out or reconstructing plant facilities.

Landscaping, berms and sound walls can provide effective noise barriers to reduce noise levels outside the plant. Over two-thirds of NRMCA survey respondents report using landscaping to control noise levels. Significant noise-generating activities should be reserved for the daytime, or whenever they will least affect the surrounding community. Other operational changes can also be made to minimize noise. An extensive list of methods for reducing noise levels can be found in *Environmental Management* Chapter 13, Noise and the Ready Mixed Concrete Industry.

A noise management plan that outlines appropriate noise levels for specific times of the day should be developed and posted to ensure that noise regulations and goals are met. Noise measurements can be taken at different locations and times to form the development of the noise management plan.

Strategies

Structural Strategies to reduce noise include:

1. Strategically locate plant and significant noise sources, such as the truck rinse/slump rack and aggregate handling facilities, to minimize possible disturbance to existing and potential future neighbors.
2. Construct berms, sound walls or solid fencing to serve as effective sound barriers for the plant.
3. Plant vegetation to serve as sound barriers for the plant.

Operational Strategies to reduce noise include:

1. Replace buzzers, horns and/or loudspeakers with lights and directional arrows.
2. Set truck backup alarms to minimum legal limit.
3. Only use silo and baghouse vibrators during normal work hours.

Metrics

Develop a noise management plan and implementation of noise mitigation strategies.

Existence of a noise management plan and implement 2 of 6 strategies	1 point
Existence of a noise management plan and implement 5 of 6 strategies	+1 point

Documentation

Submit a brief narrative describing the noise management plan, including plant protocols governing noise. Submit photos and the plant site plan indicating berms, sound walls and/or vegetation used to reduce noise.

Credit 2.14: Employee Transportation — *2 points*

Employee transportation to and from the plant should be considered in any comprehensive sustainability plan, as the impact of emissions and resource consumption associated with single occupant vehicle use is a component of the plant's environmental impact. A plant can help limit the environmental impact attributed to single occupant vehicle use by promoting and implementing alternative transportation strategies.

Strategies

1. Designate reserved parking spaces for carpool vehicles (2 or more passengers.) The number of designated carpool spaces should be equal to at least 5% of the total parking capacity, or 2 parking spaces, whichever is greater.
2. Designate reserved parking spaces for hybrid and/or alternative fuel vehicles. The number of designated hybrid and/or alternative fuel vehicle spaces should be equal to at least 5% of the total parking capacity, or 2 parking spaces, whichever is greater.
3. Facilitate a vanpool program to reduce single occupant vehicle use and/or develop a carpooling program and provide assistance in coordinating rideshares for employees
4. Have a plant location within ¼ mile of a commuter rail station, subway station or bus station.
5. Provide at least one incentive to encourage employees to use public transportation or alternate transportation modes. Potential incentives could include transit pass or vanpool subsidies, purchase of public transportation passes on a pre-tax basis or an Emergency Ride Home program to assist employees who carpool to leave work in the event of an emergency.

Metrics

Implement alternative transportation strategies listed in the Strategies section.

Implement at least 2 of 5 strategies	1 point
Implement at least 4 of 5 strategies	+1 point

Documentation

Submit photos and a copy of the plant site plan indicating designated car pool and low-emitting/fuel-efficient vehicle preferred parking spaces. Submit a short narrative describing the plant's proximity to public transportation stops. Submit a brief narrative describing any incentives, subsidies or alternative transportation programs implemented by the plant.

Credit 2.15: Biodiversity — *3 points*

Undertaking habitat enhancement projects on a plant site adds ecological and functional value to both the immediate area and the entire ecosystem. Furthermore, connective efforts have shown greater results than isolated actions. It is important to understand the site's ecologic location and its relation to native flora and fauna.

Ready mixed concrete plant sites are typically small in size, under 10 acres (40,469 m^3), with limited land not devoted to operations and therefore limited opportunities for biodiversity. Therefore, a unique approach serving the specific needs and potential of ready mixed concrete plants is required. The Wildlife Habitat Council (WHC) has developed a biodiversity toolkit adapted to ready mixed concrete plants as part of their *Wildlife at Work*^{sm} program and certification. This program provides detailed information and how-to instructions on voluntarily implemented biodiversity projects. The toolkit is designed to introduce concrete producers to potential biodiversity strategies and the benefits they can bring to ready mixed concrete plant sites. Information about the WHC biodiversity program for ready mixed concrete plants can be found at www.nrmca.org/sustainability.

The *Wildlife at Work*^{sm} program is best achieved through the development of a comprehensive, employee-based wildlife habitat enhancement program. A comprehensive program involves volunteer recruitment, outreach activities, writing of a wildlife management plan, and habitat project implementation. This process is generally undertaken with the goal of achieving *Wildlife at Work*^{sm} *Certification*. Each site has its own unique method for accomplishing each step involved in a wildlife habitat enhancement program. However, all sites should strive to include an ecological or larger scale perspective to their projects. Each initiative implemented on a site fits into a bigger picture, and the different projects that make up the program should tie together.

Strategies

The WHC *Wildlife at Work*^{sm} standard habitat enhancement recommendations provided to ready mixed concrete plants include:

1. Identify and manage exotic, invasive species.
2. Create habitat for pollinators.
3. Establish an avian management program.
4. Enhance visual berms.
5. Wetland / pond structural enhancement.
6. Conservation education.

Metrics

Participate in WHC *Wildlife at Work*^{sm} program and adopt habitat enhancement strategies at the plant (www.nrmca.org/sustainability.)

Achieve WHC *Wildlife at Work*^{sm} *Certification.*

Participate in WHC *Wildlife at Work*^{sm} program and adopt 1 habitat enhancement strategy	1 point
Participate in WHC *Wildlife at Work*^{sm} program and adopt 2 or more habitat enhancement strategies	+1 point
Achieve WHC *Wildlife at Work*^{sm} *Certification* for at least 1 habitat enhancement strategy	+1 point

Documentation

Submit documentation that the plant is enrolled in the WHC *Wildlife at Work*^{sm} program. Submit a brief narrative and photos describing the strategies implemented. Submit documentation demonstrating the plant has achieved WHC *Wildlife at Work*^{sm} *Certification*.

Credit 2.16: Worker Safety — *3 points*

Ready mixed concrete plants are industrial operations relying on heavy equipment and vehicles with potential for accidents. Safety of workers is a critical objective for any concrete plant and a necessary part of any sustainability program. Concrete production facilities track work-related injuries and illnesses (incidents) on OSHA Form 300 and OSHA Form 300A. Plants should adopt a written safety program that includes formal safety training for workers and provide incentives for workers who maintain safe practices.

Strategies

Strategies to reduce the plant's incident rate include:

1. Implement a safety program at the plant.
2. Educate all workers on plant safety procedures.
3. Provide incentive for plant workers for low work-related injuries and illnesses.

Metrics

A *Safety Worksheet* has been provided which calculates incident rate based on information recorded in OSHA Form 300 and OSHA form 300A.

Points are awarded for plant Incident Rate below U.S. national average Incident Rate of 6.3.[34] Calculate plant Incident Rate for the latest calendar year using *Safety Worksheet*.

Incident Rate ≤ 6.3	1 point
Incident Rate ≤ 3.15	+1 point
Incident Rate ≤ 1.58	+1 point

Documentation

Submit a copy of *Safety Worksheet*. Retain copies of OSHA Form 300A.

[34] OSHA reports the ready mixed concrete industry had an average incident rate of 6.3 between 2002 and 2008.

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3. Delivery and Construction

The greatest impact of the construction life cycle phase of ready mixed concrete production is concrete delivery, which affects concrete's embodied energy and carbon footprint. Improving fleet operation and management through fuel economy, updated and properly maintained vehicles, and well-trained drivers will minimize the environmental burdens incurred in the construction phase and streamline the construction process. Improving concrete installation efficiency is also of concern, an issue discussed in this section in terms of producing innovative specialty products.

Delivery Fleet

Credit 3.1: Fuel Efficiency Improvements
Credit 3.2: Fleet Emissions Reduction
Credit 3.3: Driver Training

Emissions (specifically, CO2 emissions) are the most notable environmental impact of a delivery fleet. Emissions are both a financial burden and an environmental burden, but they can be reduced with careful attention to fuel choice, average truck delivery time, fuel efficiency and driver operation, all of which are addressed in this section. The following recommendations can help reduce both the embodied energy of concrete and the carbon footprint of the plant.

Green Building Products

Credit 3.4: Green Building Products

By developing and producing innovative products, the ready mixed concrete industry can be an active participant in reducing the environmental impacts of construction, conserving natural resources, reducing labor costs and installation time. Reducing setting time and improving workability may minimize the environmental and economic impacts of the construction process.

Credit 3.1: Fuel Efficiency Improvement *4 points*

This credit establishes methods for increasing fleet fuel efficiency through decreasing the amount of fuel needed by a truck to haul a cubic yard (m^3) of concrete a certain distance. While all types of fuel are considered in this credit, it is assumed that diesel is the primary type used. Increasing fuel efficiency reduces the environmental impact of fuel extraction, processing, and use.

Fuel efficiency tracking

To optimize fuel efficiency, it is essential to have the ability to track and compare fuel usage in the mixer fleet under service conditions. Once a system has been established to monitor and track fuel efficiency, inefficient trucks can be identified and evaluated individually to judge when they should be replaced or retrofitted, due to waning performance or poor fuel efficiency. Having a tracking system in place also makes it easier to evaluate the effectiveness of new strategies, comparing pre- and post-implementation data to determine next steps in furthering fleet fuel efficiency. Methods of gathering information can be simple, such as tracking miles or hours driven against fuel used each day. More detailed information can be gathered by installing diesel flow meters in trucks. These meters provide data on fuel usage both in real time and as downloadable information.

Writing a goal-oriented fuel consumption plan

A fleet fuel consumption plan, with performance goals in meaningful units (such as mi/cy, gal/cy, mi/gal, engine hours/cy, km/m^3, l/m^3, km/l, h/m^3, etc) is an important step in improving fuel efficiency. The plan should include measures for tracking individual truck as well as overall fleet performance over time. Diesel flow meters provide data on fuel usage, and can aid in successful fuel management by tracking how much fuel is used for any given application. This information will help identify areas for improvement, and guide the development of fuel use reduction plans. Fuel consumption plans may also include timelines for purchasing new trucks and retrofitting engines.

Route efficiency

GPS technology, especially when used in conjunction with flow meters, can provide an even greater level of detail on fuel usage and efficiency. A majority of NRMCA sustainable concrete plant survey respondents utilized a route planning system, such as GPS, to optimize routes and minimize distance traveled. Optimizing travel routes by finding the most time- and fuel-efficient routes decreases the amount of fuel needed to transport concrete to a job site. This in turn decreases the embodied energy and carbon footprint of concrete operations. In addition to overall route distance, consider the grade of the route and estimated idle time to choose the most fuel-efficient delivery route.

Travel speeds

According to the American Trucking Associations (ATA), a truck traveling at 75 mph (120 km/h) consumes 27% more fuel than one traveling at 65 mph (105 km/h).[35] Setting a fleet maximum speed limit can reduce fuel use and decrease expenditures.

Truck idling

The ATA differentiates between discretionary idling (for truck cab heating and cooling) and non-discretionary idling (in traffic). It is estimated that a truck uses 0.8 gallons of fuel per hour (3.0 l/h) when idling.[36] Reducing both discretionary and non-discretionary idling reduces fuel use and emissions. Reducing idle time can also lower truck maintenance costs due to decreased annual engine hours.

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[35] American Trucking Associations, “Strategies for Reducing the Trucking Industry’s Carbon Footprint”, May 2008.
[36] http://www.truckline.com/AdvIssues/Environment/Pages/IdlingReduction.aspx

Strategies

To improve fleet efficiency consider the following strategies:

1. Develop a fleet fuel consumption plan, with fuel efficiency goals, route planning measures, idling reduction plans, and any other components to maximize fuel efficiency within the delivery fleet.
2. New truck purchases should be lightweight and fuel-efficient models. Retrofit trucks with fuel-efficient engines.
3. Implement a route planning efficiency program, such as GPS tracking and minimal left turn planning, for each delivery.
4. Implement an idling reduction plan that includes strategies to measure and reduce truck idle time during loading and delivery, with a timeline for plan implementation and goal achievement. Practice just in time delivery to minimize idling at the job site, or off peak delivery to minimize idling in traffic.

Metrics

Develop a fleet fuel consumption plan. Reduce fuel use below regional averages (see table below). Use U.S. average if the plant is not located in one of the U.S. regions.

Measure fuel consumption for concrete delivery trucks only. Do not include other plant equipment.

Existence of fleet fuel consumption plan	1 point
Fuel consumption 10% or more below regional baseline	1 point
Fuel consumption 15% or more below regional baseline	+1 point
Fuel consumption 20% or more below regional baseline	+1 point

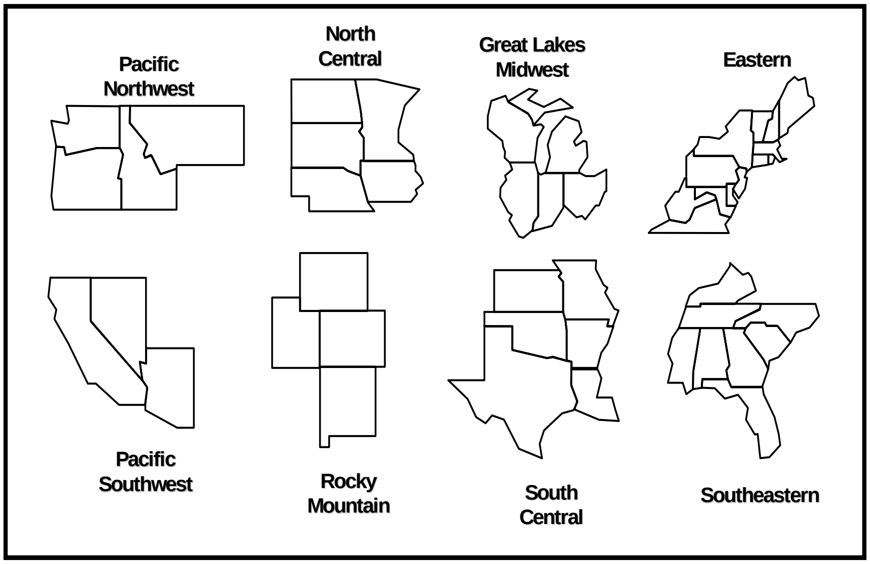
[US Customary]

$$fuel\ performance\ (\%\ below\ baseline) = \frac{regional\ baseline\ (\frac{gal}{cy}) - fleet\ fuel\ use(\frac{gal}{cy})}{regional\ baseline\ (\frac{gal}{cy})} \times 100$$

[SI Units]

$$fuel\ performance\ (\%\ below\ baseline) = \frac{regional\ baseline\ (\frac{gal}{cy}) - fleet\ fuel\ use(\frac{gal}{cy})}{regional\ baseline\ (\frac{gal}{cy})} \times 100$$

NRMCA 2007 fleet survey, regional baseline fleet consumption	gal/cy	l/m^3
Eastern	1.03	5.10
Southeastern	1.16	5.74
South Central	1.74	8.61
Rocky Mountains	1.74	8.61
Great Lakes Midwest	1.06	5.25
North Central	1.06	5.25
Pacific Southwest	0.89	4.41
Pacific Northwest	0.89	4.41
US Average	1.16	5.74



NRMCA regions

Documentation

Submit a brief narrative of the fleet fuel consumption plan. Submit a letter from company's accountant or corporate officer indicating how many gallons (l) of diesel fuel were used for concrete delivery and how many cubic yards (m^3) of concrete were produced at the plant during the 12-month period. Retain a copy of fleet fuel consumption plan on file.

Credit 3.2: Fleet Emissions Reduction — *5 points*

The EPA's Heavy Duty Highway Diesel Program requires a 97% reduction in sulfur content of highway diesel fuel, putting maximum emission levels at 15 ppm. Under the Ultra Low Sulfur Diesel program, new diesel engines are equipped with sulfur-sensitive technology that must be paired with ultra low sulfur diesel (ULSD) fuel to function correctly. ULSD is now available at retail locations and should be used in all fleet vehicles.[37] Because the newer diesel engines, paired with ULSD, have lower emissions, fuel efficiency will increase as old trucks are retrofitted or new trucks are purchased. Modern engines emit 90% less particulate matter and 50% fewer nitrogen oxides than a 20 year old engine;[38] therefore, whenever possible replace engines over 20 years old with new low-emission engines, or retrofit trucks with modern engines that meet current emission standards. The EPA lists retrofit technologies verified to reduce fleet emissions on their website, with 2007 being the most up-to-date engine version.[39]

Truck maintenance also factors into fleet performance. Poorly maintained trucks pose an environmental threat due to increased emissions from inefficient fuel use, petroleum product spills from leaking hoses, concrete spills from poorly cleaned mixer drums, and use of harsh or acidic solutions to clean concrete buildup from the exterior of trucks. Trucks should be properly maintaned to ensure optimal functioning and minimal environmental impact.

Alternative fuels are not yet used widely, but there are many currently in the experimental stage. Among alternative fuels, biodiesel has surfaced as one of the most viable options. Studies show that biodiesel use can reduce CO2 and particulate matter emissions up to 70%.[40] By preferring alternative fuels over traditional diesel fuel, the carbon footprint of transportation can be decreased, and air pollution by particulate matter can be minimized.

Please see *Environmental Management* Chapter 11, Fleet Maintenance Facility Management, for further information.

Strategies

To reduce fleet emissions consider the following strategies:

1. Retrofit trucks using engines that meet current emissions standards.
2. Track fleet maintenance intervals.
3. Park vehicles and maintain equipment in the same locations, to help locate spills and leaks.
4. Pave parking and maintenance areas where possible.
5. Use alternative fuels and/or high-efficiency fuel types such as ultra low sulfur diesel/biodiesel and/or natural gas.
6. Require NRMCA truck certification, or equivalent, for all trucks.

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[37] http://epa.gov/otaq/highway-diesel/regs/2007-heavy-duty-highway.htm
[38] http://www.truckline.com/AdvIssues/Environment/Pages/IdlingReduction.aspx
[39] http://www.epa.gov/otaq/retrofit/verif-list.htm
[40] *A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions*, EPA Draft Technical Report, October 2002. http://www.epa.gov/region09/waste/biodiesel/resources/analysis-biodiesel-impacts.pdf.

Metrics

Percentage of fleet with 2007 or newer engines.

Percentage use of alternative fuels.

Percentage of NRMCA certified trucks.

≥ 75% of fleet updated with 2007 or newer engines	1 point
100% of fleet updated 2007 or newer engines	+1 point
Alternative fuels represent ≥ 10% of total fuel use	1 point
Alternative fuels represent ≥ 20% of total fuel use	+1 point
NRMCA truck certification, or equivalent, for 90% or more of fleet	1 point

Percentage of updated fleet:

$$updated\ fleet\ (\%) = \frac{trucks\ with\ 2007\ or\ newer\ engines}{total\ trucks} \times 100$$

Percentage of alternative fuel use:

[US Customary] $$alternative\ fuel\ use\ (\%) = \frac{alternative\ fuel\ use\ (gal)}{total\ fuel\ use\ (gal)} \times 100$$

[SI Units] $$alternative\ fuel\ use\ (\%) = \frac{alternative\ fuel\ use\ (l)}{total\ fuel\ use\ (l)} \times 100$$

Percentage of NRMCA certified trucks:

$$certified\ trucks\ (\%) = \frac{trucks\ with\ NRMCA\ certification}{total\ trucks} \times 100$$

Documentation

Submit letter from company's accountant or corporate officer stating how many trucks with 2007 or newer engines and the total number of trucks that were assigned to the plant for the 12-month period. Submit a letter from company's accountant or corporate officer indicating the total amount of alternative and diesel fuel purchased for concrete delivery for the plant during the 12-month period. Submit certification numbers for NRMCA certified trucks assigned to the plant and the total number of trucks assigned to the plant.

Credit 3.3: Driver Training — *2 points*

Drivers play a key role in fuel management. Training programs for drivers can improve and maintain fleet efficiency, while responsibly managing plant and job site environmental impacts. The driver also plays a key role in spill prevention by following proper fueling procedures and inspecting the vehicle daily for fuel or petroleum product leaks. At the job site, the driver must be trained to recognize potential environmental issues such as a chute rinse-off area that discharges into a stream, creek, roadway, or adjacent property.

The NRMCA offers a Concrete Delivery Professional (CDP) certification for drivers, confirming knowledge of products, safety procedures, vehicle maintenance and operations, and environmental issues. In addition to familiarizing all drivers with the practices discussed in these Guidelines, the CDP certification, or equivalent, will serve as further quality control for the delivery fleet.

Strategies

Provide driver training for newly employed drivers and at a minimum annually thereafter. Require NRMCA CDP certification, or equivalent driver training program for drivers. Equivalent programs can include driver training programs that include some form of documentation that drivers have gained the knowledge presented during the training.

Metrics

Percentage of drivers with CDP, or equivalent, certification.

At least 50% of drivers CDP certified, or equivalent.	1 point
At least 75% of drivers CDP certified, or equivalent.	+1 point

$$certified\ drivers\ (\%) = \frac{drivers\ with\ NRMCA\ CDP\ certification}{total\ drivers} \times 100$$

Documentation

Submit records of NRMCA CDP certification or equivalent program for all drivers at the plant and the total number of drivers at the plant. Provide a brief narrative describing equivalent program.

Credit 3.4: Green Building Products — *2 points*

There are a number of innovative concrete products that can aid in the reduction of the environmental impacts of construction. This credit recognizes the concrete producers influence on the use of green building products through education, research and advocacy. For the purposes of these Guidelines, green building products contributing to this credit are the following:

- Pervious concrete, which reduces stormwater runoff from building sites.
- Self-consolidating concrete (SCC), which reduces placement time and labor.
- Flowable fill, which provides an efficient way to backfill utility trenches, as well as providing a solid base for pavements and foundations without the need for heavy excavating equipment and time-consuming compaction efforts.
- Insulated concrete forms (ICFs), insulated tilt-up walls or insulated removable forms, which can improve a structure's energy efficiency.
- Using "cool" pavements with solar reflectivity index greater than 29 for parking areas and roadways can help reduce urban heat islands.
- Using concrete to support green roofs (vegetated roofs) can help reduce urban heat islands and manage stormwater.
- High early strength concrete, greater than 4,000 psi (28 MPa) at 72 hours, can reduce construction time and minimize traffic delays or construction delays.
- High strength concrete, greater than 8,000 psi (55 MPa), can be resource efficient by minimizing the quantity of concrete required for a project.
- Durable concrete with Rapid Chloride Permeability (RCP) test results of 2000 coulombs or lower in accordance with ASTM C1202 at 28 days.

Additional points are available for developing other innovative specialty products focusing on sustainability. Please see the Additional Sustainable Practices section.

Strategies

To encourage development of green building products consider the following strategies:

1. Promote the use of green building products.
2. Research new products to stay aware of product innovations.

Metrics

Percentage of concrete produced that can be characterized as green building products.

≥ 10% of concrete produced is a green building product	1 point
≥ 20% of concrete produced is a green building product	+1 point

[US Customary]

$$green\ building\ products\ (\%) = \frac{green\ building\ products\ (cy)}{total\ concrete\ produced\ (cy)} \times 100$$

[SI Units]

$$green\ building\ products\ (\%) = \frac{green\ building\ products\ (m^3)}{total\ concrete\ produced\ (m^3)} \times 100$$

Documentation

Submit a brief narrative describing the types and amounts of green building products delivered from the plant and the total concrete produced at the plant during the 12-month period.

4. Product Use

The use phase has the largest environmental impact of all of the life cycle phases. The ready mixed concrete plant can be an active participant in reducing these environmental impacts through green building education and participation in green building advocacy.

Green building initiatives, such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED), Green Globes, Green Highways Partnership, and Greenroads, allow the construction industry to participate in the green building movement by providing environmentally responsible products and expertise.

With inherent properties such as high thermal mass, durability, light coloration, and the potential for high recycled content, concrete is a proven component in constructing efficient, sustainable structures. The *Ready Mixed Concrete Industry LEED Reference Guide*[41] provides guidance on how concrete use can contribute to achieving LEED certification. Structural concrete, such as insulating concrete forms (ICFs) and tilt-up concrete walls provide thermally efficient envelope systems. Paving with light colored concrete (concrete with a high solar reflectivity index, or SRI) can reduce urban heat island effect, and pervious concrete can improve site water management.

Through education of plant staff and specifiers of concrete, as well as participation in committees or organizations relating to sustainability and green building standards, the ready mixed concrete plant personnel can contribute to reducing environmental impacts of buildings and infrastructure during the use phase of the concrete life cycle.

Credit 4.1: Green Building Education for Staff
Credit 4.2: Green Building Education for Specifiers
Credit 4.3: Sustainability Advocacy

[41] *Ready Mixed Concrete Industry LEED Reference Guide*, Third Edition, RMC Research & Education Foundation, http://www.rmc-foundation.org/images/RMCREF%20LEED%20Guide%20Revised%2001-10.pdf

Credit 4.1: Green Building Education for Staff — *3 points*

Because a ready mixed concrete plant's staff is immediately responsible for implementing sustainable practices at the plant, as well as informing concrete users of its role in sustainability and its use in green building, it is essential that this group is well-educated and up-to-date on concrete and sustainability issues. It is recommended that staff complete a certain number of green building related Professional Development Hours (PDHs) annually.

Strategies

Encourage staff at all levels to complete continuing education courses related to the environmental aspects of concrete's production, use and role in green building. NRMCA Seminars, Training and Education Programs (STEPS), ACI education programs, and courses offered by the Portland Cement Association are examples of educational opportunities related to sustainability or process improvement.

Metrics

Complete a plant-wide total of 40 or more hours of PDHs for people working at the plant. Course work should be relevant to sustainability and green building.

Either someone on staff or someone assigned to the plant maintains a LEED AP or LEED GA accreditation

Staff received ≥ 40 PDHs in courses relevant to sustainability and green building	1 point
LEED AP or LEED GA on staff	1 point
NRMCA Certified Concrete Green Building Expert on staff	1 point

Either someone on staff or someone assigned to the plant maintains an NRMCA Concrete Green Building Expert Certification.

Documentation

Submit a brief narrative describing the staff education delivered to plant personnel during the 12-month period. Submit a brief narrative and the name(s) of LEED AP and/or LEED GA on staff or assigned to the plant describing their relationship to the plant and how they assist the plant on green building projects. Submit name(s) of Certified Concrete Green Building Experts on staff or assigned to the plant describing their relationship to the plant and how they assist plant personnel on green building projects. Retain documentation of PDHs, certifications or documentation of course completion.

Credit 4.2: Green Building Education for Specifiers ***2 points***

The concrete producer should be an educational resource for all users and specifiers of concrete, including architects, engineers, and contractors. By providing information about the sustainable attributes of ready mixed concrete, the plant's staff is in a position to introduce innovative techniques and products to design and construction professionals who can use them to reduce the environmental impacts of buildings and infrastructure.

Strategies

Host training seminars focused on concrete's role in sustainability for contractors, engineers, architects and other users and specifiers of concrete. Offer Professional Development Hours (PDHs) for training provided. Consider partnering with the NRMCA or other trade or professional associations to present seminars or demonstrations.

Metrics

Total PDHs delivered to architects, engineers, contractors, and other users and specifiers of concrete, relevant to sustainability and green building.

For example, if a salesman assigned to the plant delivered two one–hour seminars to 10 architects each month in the last year, the total number of PDHs is 20 per month, or 240 hours in the past year.

≥ 120 PDHs delivered in 12 month period relevant to sustainability and green building	1 point
≥ 240 PDHs delivered in 12 months period relevant to sustainability and green building	+1 point

Documentation

Submit a brief narrative describing the education programs presented and the total number of PDHs delivered.

Credit 4.3: Sustainability Advocacy — *1 point*

Becoming an advocate for sustainability, particularly the sustainable attributes of concrete and innovative ways to specify and use concrete, offers the potential to raise awareness and increase the use of sustainable concrete products in the built environment. Participation in committees, groups and organizations that focus on sustainability and green building standards will enable the ready mixed concrete plant to contribute towards reducing building and infrastructure impacts through the use of sustainable concrete products.

Strategies

Participate in any of the following local, state or national committees related to sustainable building:

1. NRMCA Sustainability Committee.
2. Environmental Task Group of the NRMCA Operations, Environment and Safety Committee.
3. USGBC local chapter.
4. ACI Sustainability Committee.
5. ASTM concrete-related committees.
6. Green Building Initiative committees.
7. Other similar sustainability related group(s) or committee(s).

Metrics

Either someone on staff or someone assigned to the plant participates in any of the committees, groups or organizations listed in the Strategies section.

Participation in one or more of the listed local, state, or national committees, groups and organizations	1 point

Documentation

Submit the names of individuals and the organizations, committees and/or programs in which they participate and their relationship to the plant. Retain records of correspondence, meetings, demonstrations, or any other advocacy activity.

5. Material Reuse and Recycling

This section focuses on how to handle materials in the final life cycle stage. Excess concrete, in both plastic and hardened states, is a primary concern in the ready mixed concrete industry. Solid waste is comprised mostly of returned concrete, which is the major waste concern among ready mixed concrete producers; return rates average around 5% of production volume, but have been reported as high as 15% in some cases.[42] The sustainable concrete plant survey indicated an average returned concrete rate of approximately 2%, 19% of which is sent to a landfill.

Comprehensive waste management programs will reduce the environmental burdens of waste disposal, and reusing returned concrete and other waste products in the manufacturing process alleviates the burden of raw materials extraction as well.

Please see *Environmental Management* Chapter 7, Solid Materials Management, for further information on collecting and processing returned concrete.

Credit 5.1: Excess Concrete Reduction
Credit 5.2: Diversion of Returned Concrete From Disposal
Credit 5.3: Other Recycling Initiatives

[42] Mullings, Gary M., *Environmental Management in the Ready Mixed Concrete Industry,* Silver Spring, MD: National Ready Mixed Concrete Association, 2009, p. 58.

Credit 5.1: Excess Concrete Reduction ***3 points***

Minimizing the amount of extra concrete for each project conserves resources by resulting in less returned concrete after placement. Making accurate estimates of the amount of concrete needed for a project and minimizing the ordering safety factor (the set amount of overage sent to the job site) may reduce the excess concrete sent to the job site.

Strategies

To reduce excess concrete delivered to job sites consider the following strategies:

1. Improve material take-off accuracy.
2. Minimize the ordering safety factor amount.

Metrics

Reduction of annual returned concrete percentage.

≤ 3% returned concrete	1 point
≤ 1% returned concrete	+2 points

[US Customary] $$returned\ concrete\ (\%) = \frac{annual\ concrete\ returned\ from\ projects\ (cy)}{annual\ concrete\ delivered\ to\ projects\ (cy)} \times 100$$

[SI Units] $$returned\ concrete\ (\%) = \frac{annual\ concrete\ returned\ from\ projects\ (m^3)}{annual\ concrete\ delivered\ to\ projects\ (m^3)} \times 100$$

Documentation

Submit a brief narrative describing the total amount of concrete returned and the total amount of concrete produced at the plant during the 12-month period along with returned concrete percentage calculations. Retain documentation of delivered and returned concrete quantities.

Credit 5.2: Diversion of Returned Concrete from Disposal — *3 points*

Disposal is defined as materials discarded in an unproductive manner, for example being landfilled or discarded in a quarry or back lot. By diverting waste from disposal, both the environmental impacts of disposal and the associated transportation and actual costs of certain types of disposal (landfilling) can be avoided. Concrete can be reused in a number of ways at the plant and in construction. Returned concrete is generally reused in one of three ways: on the plant site for some beneficial use, made into a saleable product, or processed for reuse in concrete batching.

On the plant site

Using returned concrete on plant grounds either as fill or to pave yard surfaces is a low cost method of facility improvement. Returned concrete can be windrowed and used to create other products for use on-site. Windrowing is the process of discharging wet returned concrete onto the ground and agitating and/or crushing it after it has hardened. Windrowed concrete is often used as fill, road base, or rip rap.

Saleable products

Creating saleable products such as concrete blocks may become a source of steady income. Concrete blocks are made by pouring returned plastic concrete into a reusable block mold. These molds come in a variety of shapes and surface textures and should be properly maintained to ensure a long service. Windrowing and crushing can also be used to create products for sale.

Reuse in concrete batching

Windrowed concrete can be screened and reused as coarse and fine aggregate. Please see Section 1, Material Acquisition, for a discussion of using returned concrete as coarse aggregate in concrete batching.

Top loading, or batching new concrete on top of the returned concrete from a previous job, is a highly effective way to deal with returned concrete. Studies show that top loading has a negligible effect on the properties of the new batch of concrete as long as the concrete in the drum represents no more than 5% of the total concrete volume.[43] When employing this method, it is essential to be mindful of the returned concrete's composition and take care to meet quality specifications. Hydration stabilizing admixtures (also called HSAs, or extended set retarders) may aid in quality control by slowing the hydration of cement. Purchasers should be made aware of any top loaded concrete being used for a project.

Fresh concrete may also be discharged into a mechanical reclaiming system to reclaim component ingredients. Mechanical reclaiming systems represent a significant capital investment for most plants, but may provide an attractive return on investment by helping to reduce or avoid disposal costs. A mechanical reclaiming system can come in any number of forms, but all systems will separate coarse aggregates and fine aggregates from the slurry (the combination of cementitious materials and water, also known as gray water). Cleaned reclaimed aggregate can be mixed back into aggregate stockpiles or used as fill or road base material. The process water may be recycled for use in concrete batching. See Section 2, Production, for a discussion on reusing process water.

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[43] Mullings, Gary M., *Environmental Management in the Ready Mixed Concrete Industry*, Silver Spring, MD: National Ready Mixed Concrete Association, 2009, p. 58.

Strategies

To increase concrete diverted from disposal consider the following strategies:

1. Reuse returned concrete on plant grounds for paving, fill, etc.
2. Create concrete blocks from returned concrete.
3. Windrow returned concrete for use as fill, road base, rip rap, etc.
4. Employ top loading to manage returned plastic concrete.
5. Employ a mechanical reclaiming system to separate concrete ingredients for reuse in the manufacturing process.

Metrics

Percentage of waste diverted from disposal.

≥ 50% returned concrete diverted from disposal	1 point
≥ 75% returned concrete diverted from disposal	+1 point
100% returned concrete diverted from disposal	+1 point

[US Customary]

$$diverted\ waste\ (\%) = \frac{returned\ concrete\ diverted\ (tons)}{total\ returned\ concrete\ (tons)} \times 100$$

[SI Units]

$$diverted\ waste\ (\%) = \frac{returned\ concrete\ diverted\ (t)}{total\ returned\ concrete\ (t)} \times 100$$

Documentation

Submit a brief narrative describing how returned concrete is diverted from landfills, the total amount of returned concrete diverted from landfills, the total returned concrete and the calculations of diverted waste at the plant for the 12-month period. Submit a copy of a plant site plan, delineating equipment used to reclaim concrete and windrow areas. Retain records of returned concrete, reclaimed concrete quantities and all concrete disposed of in landfills.

Credit 5.3: Other Recycling Initiatives ***2 points***

There are a number of other types of waste created at the ready mixed concrete plant, including paper, glass, plastics, aluminum cans, cardboard, light bulbs, tires, batteries, used petroleum products, electronic equipment, and miscellaneous construction debris. These wastes can be recycled through a combination of municipal, industrial and independent recycling programs. Often there are independent or industrial recycling initiatives for batteries and electronic equipment. Public databases, such as earth911.com, can prove helpful in finding recycling centers for specific materials.

Strategies

To improve recycling practices at the plant consider the following strategies:

1. Create a comprehensive written recycling program.
2. Provide appropriate facilities on-site for collection.
3. Stay abreast of local or national recycling options and regulations.

Metrics

Existence of plant-wide recycling program, evidenced by a written recycling program and appropriate collection facilities

Existence of plant-wide recycling program including the appropriate collection facilities for on-site collection	2 points

Documentation

Submit a brief narrative describing the plant-wide recycling programs, such as posted lists of recyclable items, recycling bins and/or recycling service agreements.

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6. Additional Sustainable Practices

Credit 6.1: Additional Sustainable Practices — ***5 points***

Five potential additional points are available to plants that incorporate practices beyond those recommended by the Guidelines into day-to-day operations. This may be in the form of a particularly progressive environmental policy in one of the five main credit categories, or may be a completely new category defined by plant personnel.

The purpose of this section is to encourage exceptionally high performance in credits established in the Guidelines and to encourage innovative sustainable practices. Therefore, practices qualifying for additional points will be assessed for eligibility on a case-by-case basis. Some suggestions for exceptional performance and innovative practices are listed in the Strategies section; however, plants are encouraged to develop their own sustainable practices.

Strategies

Strategies for achieving additional points may include:

1. Achieving exemplary performance in an existing Guideline credit. An exemplary performance point may be earned for achieving double the credit requirements or achieving the next incremental percentage threshold of an existing credit. One point is awarded for each exemplary performance achieved.
2. Conducting a comprehensive evaluation of 50% of mix designs to lower environmental footprint. Examples include Ecosmart Concrete and the Athena Institute Impact Estimator.
3. Sustainable landscaping, such as incorporating only native plants on-site, xeriscaping, or using only captured rainwater for irrigation.
4. Conduct research and testing to develop innovative sustainable concrete products.
5. Organized community involvement as a company, such as participation with Habitat for Humanity, United Way, or other socially beneficial activities.
6. Achieving recognition for sustainable practices in the form of awards, such as the NRMCA Environmental Excellence Award.
7. Maintaining standards that encourage a consistent, high quality product such as NRMCA Certified Production Facility certification.
8. Other innovative sustainable practices.

Metrics

Number of practices implemented. If a practice is determined to be exceptionally progressive, it may qualify for more than one point.

1 sustainable practice implemented/achieved	1 point
2 sustainable practices implemented/achieved	+1 point
3 sustainable practices implemented/achieved	+1 point
4 sustainable practices implemented/achieved	+1 point
5 sustainable practices implemented/achieved	+1 point

Documentation

In line with documentation requirements for the rest of these Guidelines, submit any related narrative, photographs, letters, paperwork, performance tracking, correspondence, certifications, or other documentation that will serve as evidence of sustainable practices.

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