



ASPHALT

The Sustainable Pavement



ENERGY & RECYCLING



PERFORMANCE



WATER QUALITY



CLEAN AIR & COOL CITIES

Asphalt is the sustainable material for constructing pavements. From the production of the paving material, to the placement of the pavement on the road, to rehabilitation, through recycling, asphalt pavements minimize impact on the environment. Low consumption of energy for production and construction, low emission of greenhouse gases, and conservation of natural resources help to make asphalt the environmental pavement of choice.

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Energy and Recycling



Less energy consumed in building pavements

Asphalt pavements require about 20 percent less energy to produce and construct than other pavements.¹

Less energy consumed by the traveling public

Congestion leads to unnecessary consumption of fuel and production of emissions. Reducing congestion by constructing asphalt pavements just makes sense. Asphalt pavements are faster to construct and rehabilitate. And, a new or

newly rehabilitated asphalt pavement can be opened to traffic as soon as it has been compacted and cooled. There is no question of waiting for days or weeks for the material to cure.

America's leading recycler

According to an EPA/FHWA study,² the asphalt industry recycles more than 70 million tons of its own product every year, making it America's number one recycler. Asphalt recycling saves taxpayers about \$1.8 billion a year.

Other materials are routinely recycled into asphalt pavements. Some of the most common are rubber from used tires, glass, asphalt roofing shingles, and blast furnace slag.



Performance

The road doesn't wear out

Asphalt is the Perpetual Pavement. When appropriately designed and constructed, the road itself doesn't wear out. Maintenance is simple: only the top layer is removed and replaced. This can be done quickly, even overnight, and it saves taxpayers money. The material that has been reclaimed is then recycled. The newly overlaid road surface (which may also contain recycled material) is a good-as-new pavement. Total removal and reconstruction is not needed. This is a truly sustainable construction process.

Rubblizing for sustainability

When concrete pavements reach the end of their useful life, they must undergo expensive rehabilitation—unless they are rehabilitated through a sustainable process called



rubblization. The worn-out concrete is "rubblized" (fractured) and becomes the base for the new asphalt road. This saves fuel that would have been used by trucks hauling the old material away;

saves the virgin materials that would have been needed to build a new road base; and can give the traveling public a new Perpetual Pavement. In addition to the environmental and speed of construction advantages, cost savings can be significant.

Public safety

Smooth asphalt roads give vehicle tires superior contact with the road, improving safety.

Open-graded asphalt allows rainwater to drain through the pavement surface, reducing the amount of splash and spray kicked up by vehicles.

Noise reduction

Asphalt is the quiet pavement. Newer quiet pavement technologies include fine-graded dense pavements, open-graded surfaces, and two-layer open-graded pavements.³ Studies show that the noise-reducing properties of asphalt last for many years.⁴ Noise reduction of 3 to 10 dB(a) are common. Reducing noise by

3 dB(a) is about the same as doubling the distance from the road to the listener, or reducing traffic volume by 50 percent.

Asphalt moves traffic along

Asphalt pavements are faster to construct and rehabilitate. In crowded urban areas, where closing a road for rehabilitation or reconstruction would dump increased traffic on neighboring routes, asphalt is the answer. Highways and roads can be milled for recycling, then overlaid, during off-peak hours. An entire freeway can be resurfaced without commuters ever being inconvenienced.

Water Quality



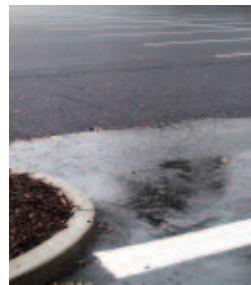
Stormwater management with porous asphalt

Porous asphalt pavement systems can replace impermeable surfaces for parking lots, roads, walking/biking paths,

and other applications. Porous pavements can turn runoff into infiltration; restore the hydrology of a site, or even improve it; improve water quality; and eliminate the need for detention basins.⁵

Asphalt pavements do not leach

Once constructed, asphalt pavements have minimal impact on the environment. Studies show that asphalt pavements and stockpiles of reclaimed asphalt pavement do not leach.^{6,7}



Environmental applications

Asphalt is used to construct liners and caps for landfills. The impermeable material is an effective barrier to potential leaks.

Drinking water reservoirs are often lined with asphalt. Asphalt cement is also used to line water pipes that supply potable water to humans.

Oregon and Washington state fish and wildlife agencies use asphalt pavement to line their fish rearing ponds.⁸





Clean Air & Cool Cities

Asphalt plants are environmentally sound

Emissions from asphalt plants, including greenhouse gases, are very low and well-controlled. Since 1970, the asphalt industry has decreased total emissions from plants by 97 percent while increasing production by 250 percent.⁹

Emissions from asphalt plants are so low, the EPA considers them as only minor sources of industrial pollution.¹⁰

Cool Cities

The urban heat island effect is not a black and white issue.¹¹ Porous asphalt pavements have been shown to lower nighttime surface temperatures as compared to impervious pavements. In at least one city, the hottest heat signature is at the airport, with its thick, dense, impervious runways.


Traffic relief

When cars and trucks are mired in congestion, they consume fuel and produce greenhouse gases. Asphalt's speed of construction allows planners and managers a way to fix congestion hot spots and bottlenecks, quickly and cost-effectively.



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Lower greenhouse gases, lower fuel consumption

The production and placement of asphalt pavements consumes less fuel and produces lower levels of greenhouse gases. According to a recent study, asphalt pavements require about 20 percent less energy to produce and construct than other pavements.¹ Less fuel consumption means less production of carbon dioxide and other greenhouse gases.

Since 1970, the asphalt industry has decreased total emissions from plants by 97 percent while increasing production by 250 percent.² Emissions from asphalt plants are so low, the EPA considers them as only minor sources of industrial pollution.³

The asphalt industry is also working on ways to reduce the temperatures at which asphalt pavements are produced and placed. Typically, asphalt paving temperatures are in the range of 280 to 320°F. Lowering these temperatures by 50°F or more would save fuel and reduce production of greenhouse gases and other emissions. Working in cooperation with the Federal Highway Administration, state Departments of Transportation, and other key stakeholders, the asphalt industry's research on several new warm-mix technologies holds great future promise.

Asphalt moves traffic along

When traffic backs up, cars and trucks consume fuel unnecessarily and produce excess emissions. One way to reduce both fuel consumption and emissions is

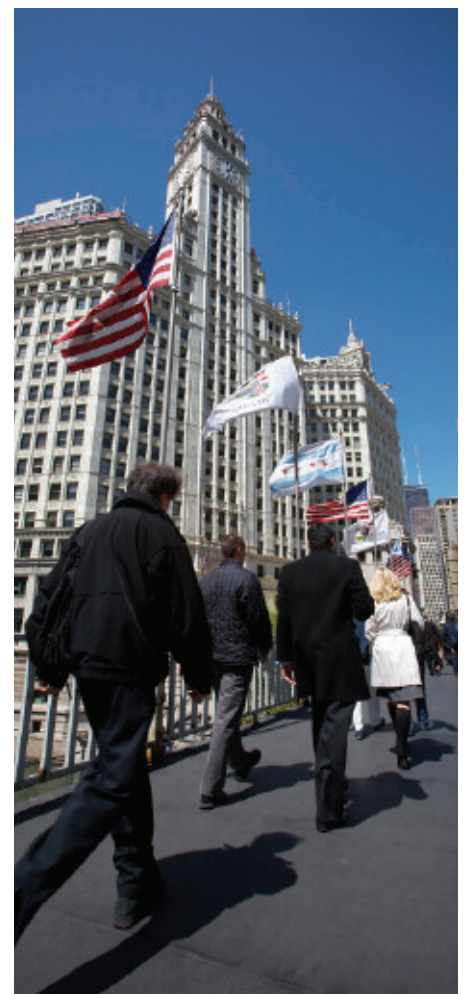
to keep traffic moving along. Asphalt's speed of construction allows planners and managers a way to fix congestion hot spots and bottlenecks, quickly and cost-effectively—often, all the work can be done at off-peak hours, so that the morning and evening commutes go smoothly. Because a newly rehabilitated asphalt road can be opened for traffic as soon as it has been compacted and cooled, keeping lanes coned off for curing is not necessary.

Driving on smooth roads also saves fuel. Studies at a Nevada test track showed that vehicles driving on smooth roads consumed 4.5 percent less fuel, on average, than on rough pavement.⁴ Asphalt can make rough roads smoother, quickly, cost-effectively, and without prolonged road closures.

Urban heat island reduction: how asphalt pavements can help

The urban heat island (UHI) effect—the phenomenon that makes cities 2 to 10°F warmer than nearby rural areas on a hot summer day—is not a black and white issue. Many factors contribute to heat retention in urban areas. And, many strategies for reducing the UHI effect are being explored.⁵

Because pavements cover a large percentage of urban areas, and because improvements to pavements occur more frequently than improvements to buildings, pavement-related strategies for cooling off the city core are of interest.



Some attention has been given to the idea of making pavements more reflective, on the theory that a lighter-colored or more reflective surface may keep things cooler. But on closer look, it is seen that many factors other than color and reflectivity—including pavement thickness and the type of surface used—can influence the way a pavement retains, radiates, and/or

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releases heat. When and how heat is released is also of importance.

Porous asphalt pavements have been shown to lower nighttime surface temperatures as compared to other pavements. A thermal image taken by satellite (ASTER) over Phoenix in October 2003 (Figure 1) shows that an impervious freeway which has been resurfaced with open-graded asphalt is actually cooler at night than nearby freeways without the asphalt surface. Also influencing the cooling of pavements is the presence of sound walls (which can trap heat), vegetation cover on the adjacent landscape, whether the pavements are at or below grade, and the thickness of the pavement itself. In the same ASTER image, the hottest heat signature is at the airport, where the impervious runways are 23 inches thick.

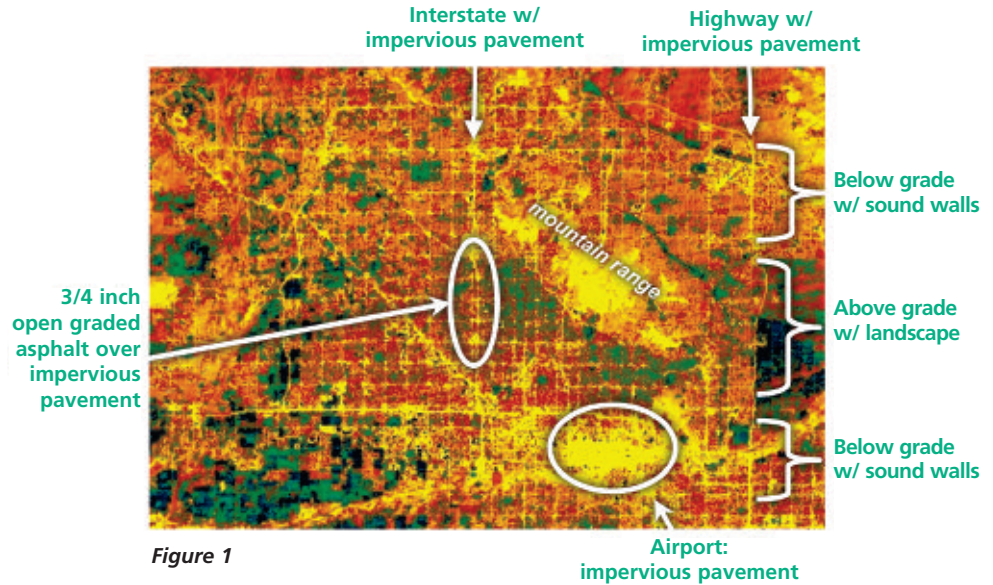


Figure 1

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Better Water Quality

Porous asphalt...

- Conserves water
- Allows for better use of land
- Reduces runoff
- Promotes infiltration
- Cleans stormwater
- Replenishes aquifers
- Protects streams



Porous asphalt offers a powerful tool in the toolbox for storm-water management.

In the natural environment, rainfall sinks into soil, filters through it, and eventually finds its way to streams, ponds, lakes, and underground aquifers. The built environment, by way of contrast, seals the surface. Rainwater and snowmelt become runoff which may contribute to flooding. Contaminants are washed from surfaces directly into waterways without undergoing the filtration that nature intended.¹

For these reasons, managing stormwater is a significant issue in land use planning and development. Stormwater management tools can serve to mitigate the impact of the built environment on natural hydrology. Unfortunately, however,

they also can lead to unsound solutions such as cutting down stands of trees in order to build detention ponds.

Porous asphalt pavements allow for land development plans that are more thoughtful, harmonious with natural processes, and sustainable. They conserve water, reduce runoff, promote infiltration which cleanses stormwater, replenish aquifers, and protect streams.

A typical porous pavement has an open-graded surface over an underlying stone recharge bed.² The water drains through the porous asphalt and into the stone bed, then, slowly, infiltrates into the soil. If contaminants were on the surface at the time of the storm, they are swept along with the rainfall through the stone bed. From there they infiltrate into the subbase so that they are subjected to the natural processes that cleanse water.

Construction and performance

Porous asphalt pavements are fast and easy to construct. With the proper information, most asphalt plants can easily prepare the mix and general paving contractors can install it.

The stone bed, often eighteen to thirty-six inches in depth, provides a tremendous subbase for the pavement. As a result, porous asphalt pavements tend not to exhibit cracking and pothole formation problems. The surface wears well. Under the stone bed is a geotextile which keeps fine particles from moving into the stone bed from below and filling in the spaces.

Porous asphalt has been proven to last for decades, even in extreme climates, and even in areas with many freeze-thaw cycles.³

The underlying stone bed can also provide stormwater management for adjacent impervious areas such as roofs and roads. To achieve this, stormwater is conveyed directly into the stone bed, where perforated pipes distribute the water evenly.

Economics

Porous pavement is a sound choice on economics alone. A porous asphalt pavement surface costs approximately the same as conventional asphalt. Because porous pavement is designed to “fit into” the topography of a site, there is generally less earthwork. The underlying stone bed is usually more expensive than a conventional compacted sub-base, but this cost difference is offset by eliminating the detention basin and other components of stormwater management systems. On projects where unit costs have been compared, the porous pavement has been the less expensive option. Porous pavements are therefore attractive on both environmental and economic grounds.¹

An installation at the University of North Carolina in Chapel Hill included parking lots where some sections were constructed from porous asphalt and others used porous concrete. The cost differential was approximately 4:1 – that is, the porous concrete pavement cost four times as much as the porous asphalt pavement.¹



Better Water Quality

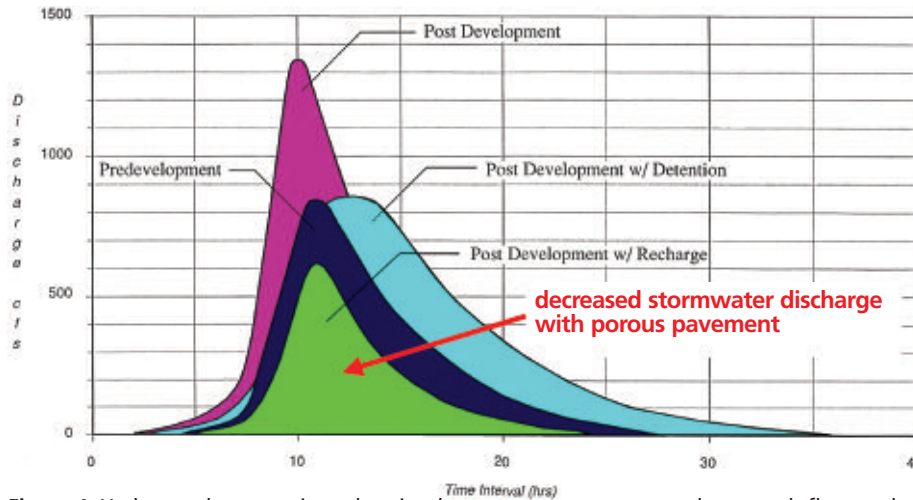


Figure 1: Hydrograph comparison showing how porous pavement reduces peak flow and total volume of runoff

Source: Cahill Associates

Impact on groundwater

Asphalt pavements are compatible with clean water. Studies show that asphalt pavements and stockpiles of reclaimed asphalt pavement do not leach.^{4,5}

Contaminants on the surface of pavements tend to become part of runoff, but with a porous pavement, they are washed into the stone bed. From there they flow down into the soil, where beneficial bacteria and other natural processes cleanse them. Data are limited, but indicate a very high removal rate for total suspended solids, metals, and oil and grease.¹

Figure 1 shows the effect of a porous asphalt pavement on the hydrology of a developed site.

Cooler cities

Porous asphalt pavements have been shown to mitigate the urban heat island effect. Open-graded asphalt roads and highways—which use the same surface material as porous parking lots—have been shown to lower nighttime surface temperatures as compared to impervious pavements. In at least one city, the hottest heat signature is at the airport, with its thick, dense, impervious runways.⁶

Comparisons to other asphalt pavements

The surface of a porous asphalt pavement wears well. While slightly coarser than some pavements, it is attractive and acceptable. Most people driving or

walking on the pavement will not notice (or believe) that it is porous.

Like all asphalt pavements, porous pavements are ADA-friendly.

Environmental applications

Asphalt pavements have been used for many years to enhance water quality. At landfills, asphalt liners and caps keep contaminants from leaking into groundwater. Drinking water reservoirs lined with asphalt pavement have been used in California since the 1950s. Salmon hatcheries and fish rearing ponds in the Pacific Northwest use asphalt liners.⁷

Variations on the theme

Porous asphalt can be used successfully in parking lots, walkways, and playgrounds. Several current suburban projects are exploring its use in subdivision roads. A few porous highways and city streets have been constructed, both in the U.S. and in Europe, and have performed well.

The open-graded asphalt surface used for porous pavements has been used extensively to surface high-volume highways that carry heavy trucks. Its benefits include noise reduction, a decrease in splash and spray kicked up by vehicles in heavy downpours, and mitigation of the urban heat island effect.

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Recycling & Energy Reduction



Asphalt pavements are America's most recycled product

According to the U.S.

Environmental Protection Agency and the Federal Highway Administration, about 90 million tons of asphalt pavement is reclaimed each year, and over 80 percent of that total is recycled.¹

Reclaimed asphalt pavement (RAP) can be recycled into pavement that is as high, or even higher, in quality as pavements made of all-virgin materials. And, the same material can be recycled again and again; it never loses its value. The asphalt cement—the glue that holds the pavement together—retains its ability to function as glue or cement, so that it is reused for its original purpose. The aggregates (rocks, sand and gravel) in the original pavement are also conserved. Many pavements that are more than 20 years old are actually worth more than they were when originally constructed.

It is estimated that recycling of asphalt pavements saves the American taxpayer \$1.8 billion per year. It also saves hundreds of acres of landfill space each year.

Materials from other industries are routinely recycled into asphalt pavements instead of going into landfills. Some of the most common are rubber from used tires, glass, asphalt roofing shingles, and blast furnace slag.



Asphalt plants also recycle the fine mineral particles that are generated in the process of producing asphalt pavement material. This routine recycling of co-generated material helps to conserve natural resources.

Less energy consumed in building pavements

Asphalt pavements require about 20 percent less energy to produce and construct than other pavements.²

Rubblization of concrete pavement with an asphalt overlay also saves energy. The rubblized pavement does not need to be hauled away; new base material does not need to be trucked in; and landfill space is saved. In addition, the need for mining, crushing, and processing of virgin materials is reduced.³

Recycling & Energy Reduction

Less energy consumed by the traveling public

Reducing congestion—which wastes fuel—by constructing asphalt pavements just makes sense. Asphalt pavements are faster to construct and rehabilitate.

Asphalt pavement rehabilitation can be accomplished during off-peak hours. On highly traveled routes, much of this work can be done at night. One or more lanes can be closed after the evening rush hour, milled for recycling, resurfaced, and then

opened for traffic the following morning. Most motorists do not have to deal with the inconvenience of construction delay.

Because a new or newly rehabilitated asphalt pavement can be opened to traffic as soon as it has been compacted and cooled, there is no question of waiting for days or weeks, with traffic being detoured or squeezed into fewer lanes, for the material to cure.

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Performance Means Sustainability



Roads that don't wear out

One of the keys to sustainability is long life. With Perpetual Pavements, asphalt pavements have an extremely long lifespan.¹

A Perpetual Pavement is constructed so that distress occurs in the top layer only. The only rehabilitation required is removal of the surface and resurfacing with an asphalt overlay. Using current pavement technologies, this can be done on an infrequent basis—every 15 to 20 years. The reclaimed material is then recycled. Perpetual Pavement is the ultimate in sustainable design and construction.

While the Perpetual Pavement name is relatively new, the concept is not. In fact, more than 35 pavements have received the Perpetual Pavement Award since 2001. These award-winning roads, streets, highways, and airport runways have been in place for at least 35 years, with a minimum of maintenance and no full-depth reconstruction.

Rubblization

When concrete pavements reach the end of their useful life, they must undergo expensive, time-consuming rehabilitation. This process squanders precious natural resources, in addition to inconveniencing the traveling public. Prolonged road closures also lead to congestion, which consumes energy and produces excess emissions. Asphalt's answer is a sustainable process called rubblization, in which the concrete pavement is left in place, rubblized (frac-

tured), and used as the base for a new Perpetual Pavement.

In addition to the environmental advantages, cost savings can be significant. The rubblization process is much faster than the remove-and-replace option. It can also be accomplished through temporary lane closures, without the necessity for traffic to be detoured onto parallel routes.



Public safety

Smooth asphalt roads give vehicle tires superior contact with the road.

One type of asphalt surface, known as open-graded friction course, allows rainwater

to drain through the surface layer and off to the sides, reducing the amount of splash and spray kicked up by vehicles.

Noise reduction

Asphalt is *the* quiet pavement. Quiet pavement technologies include open-graded surfaces, fine-graded surfaces, and two-layer open-graded pavements.² Studies show that the noise-reducing properties of asphalt last for many years.³

Noise reductions of 3 to 10 dB(a) are common. Reducing noise by 3 dB(a) is about the same as doubling the distance from the road to the listener, or reducing traffic volume by 50 percent.

For more information on quiet pavement technology, visit www.quietpavement.com.

Congestion reduction

Asphalt pavements are faster to construct and rehabilitate. In crowded urban areas, where closing a road for rehabilitation or reconstruction would dump increased traffic on neighboring routes—adding to congestion—asphalt is the answer. Highways and roads can be milled for recycling, then overlaid, during off-peak hours, so that most motorists are never inconvenienced.

Smoothness and conservation

Studies at a pavement test track in Nevada have shown that driving on smoother surfaces can reduce fuel consumption in the neighborhood of 4.5 percent.⁴

When trucks are driven on rough surfaces, the tires bounce and deliver heavy,

Performance Means Sustainability

punishing impacts to the pavement. Some experts estimate that a 25 percent increase in smoothness can result in a 9 to 10 percent increase in the life of pavements.

Building smooth asphalt roads is simple and cost effective. Keeping them that way is fast, easy and inexpensive.

Taking the punishment

Any doubts about whether asphalt is durable can be answered at racetracks and airports. These pavements are punished by heavy loads, but asphalt stands up to them.

When vehicles reach speeds of 200 mph and more, and a car's undercarriage clears the pavement by about one inch, the pavement had better be smooth. That's why nearly all racetracks—for both Formula One and NASCAR racing—use asphalt.

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