Bay Area Pervious Concrete Presents:

Storm Water Solutions

The problem: Impervious Surfaces.

Imperviousness refers to the inability of a surface to allow water to percolate through. A sponge is pervious, a countertop is impervious, cardboard is somewhere in between. Sandy soils are pervious; asphalt is not. On an impervious surface, water is forced to travel downhill until it finds a place it can sink into soil or enter a wetland. As it travels - or runs off - these impervious areas, water can pick up potentially toxic substances (like oil or fertilizer) and carry these materials to the sources of our water.

The important thing to know is what percentage of your watershed is covered by impervious surfaces. These include roads, parking lots, driveways, sidewalks, rooftops, patios, pools, and severely compacted soils (usually from development activities like grading, excavation, and landscaping). You may have noticed that the first three items - and by far the largest contributions to impervious surface area in almost any community - in this list are surfaces built for our automobiles.

In a natural landscape, the maximum amount of runoff occurs after the beginning of a storm or major melt. As impervious surface area increases, the storm and melt water coming off of them increases velocity, quantity, temperature, and pollution load. Any one of these attributes contributes to the degradation of natural hydrology and water quality. Noticeable degradation to water bodies begins when the watershed reaches 10-20% imperviousness.

How Do They Contribute to Decreased Water Quality?

In urbanized areas, we have been forced to deal with runoff water by building large sewer systems that channel this water directly to lakes, rivers, and other surface water rather than into the groundwater. Because of the toxins this runoff picks up as

it travels, expensive water purification systems are often built to cleanse the water before it reenters the natural water cycle. As water runoff increases and is channeled to travel in straight paths, a watershed community will find:

- Increased erosion
- Increased toxic load
- Increased sediment load
- Increased temperature
- Increased flooding
- Diminished groundwater reserves
- Diminished activity in feeder streams
- Diminished areas for habitat
- Diminished fish populations
- Diminished surface water levels
- Fewer areas for recreation
- Diminished overall water quality

Runoff Borne Pollutants

This table shows common pollutants borne from runoff and their major sources. The impacts of these pollutants vary:

Table of Pollutants and runoff-borne sources

Pollutant	Highest Level	2nd Highest Level	3rd Highest Level
E. Coli	Residential Feeder Streets	Residential Collector Streets	Residential Lawns
Sediments	Industrial Collector Streets	Industrial Arterial Streets	Residential Feeder Streets
Total Phosphorus	Residential Lawns	Industrial Collector Streets	Residential Feeder Streets
Zinc	Industrial Roofs	Industrial Arterial Streets	Commercial Arterial Streets
Cadmium	Industrial Collector Streets	Industrial Arterial Streets	Commercial Arterial Streets
Copper	Industrial Collector Streets	Industrial Arterial Streets	Residential Collector Streets

E Coli: High concentrations can prevent swimming, boating, and other recreational activities.

Sediments: Fills in ponds and reservoirs with mud; contributes to decline of submerged aquatic vegetation by increasing turbidity and reducing the light available for photosynthesis. Acts as a sink for nutrients and toxicants and as a source when disturbed and re-suspended. Makes water appear muddy, decreasing its recreational value.

Total Phosphorus: A contributing factor in eutrophication (nutrient over-enrichment) in receiving waterbodies and subsequent algal blooms. Algal blooms contribute to the decline of submerged aquatic vegetation by reducing the light available for photosynthesis, further degrade water quality by decreasing the level of dissolved oxygen, and may cause changes in the composition of plankton and fish species.

Zinc: Toxic to aquatic life and can contaminate drinking water.

Cadmium: Can be bioaccumulated; creates toxic health hazards within the food chain and increases long-term toxic stress for the entire ecosystem.

Copper: An important trace nutrient, it can be bio-accumulated and, thereby, create toxic health hazards within the food chain and increase long-term ecosystem stress.

Why Infiltration is a Good Thing

The way water moves through soil is called infiltration. Infiltration is the way underground water sources are replenished. Infiltration also helps maintain water quality because many soils and plants filter out certain pollutants as water moves through them. An impervious surface is one that does not allow water to infiltrate to the soil layer.

Infiltration maintains the natural hydrology and biology of the watershed, especially the headwaters.
When infiltration is not allowed to occur, a small stream may carry little or no water when it is not raining because there is so little stored groundwater to provide continuous flow. This means that everyone that counted on this stream for life, recreation, habitat, food, or water must find a new source.
Infiltration recharges water-bearing aquifers. It may take decades and sometimes centuries for rain or snow melt to reach the deep layers of the earth from which many private and municipal wells draw water for human consumption. However, that water does come from the surface. Diversion of surface waters eventually affects the quantity of groundwaters.
Infiltration improves the quality of the water passing through.
Earth, with its wetlands and soils, is the original and still the largest water filtration system around.
Infiltration protects recreational interests. As impervious areas increase, streams become "flashy", which tends to erode stream banks, water levels drop significantly in the summer, water temperature increases thereby reducing the variety of fish. Waters will also likely have higher levels of pathogenic organisms and toxic chemicals. None of this makes for good recreation and tourism.
It protects downstream areas from flooding. When headwater streams become "flashy" so do the next larger order of streams below them, and the rivers below those. This results in more severe flooding. Infiltration allows large quantities of water to be stored in the ground and released slowly - long after the storm passes.

The goal should be to emulate as much as possible the natural stream and groundwater hydrology of your area. This means retaining stormwater runoff on site and provide for vegetative filtering before the runoff reenters the watershed, thereby limiting the pollutants it has picked up.

In general, the more porous the soil, and the more heavily planted the landscapes, the less water runs off and more infiltrates. The less porous the soil and the more hard surfaces exist on the landscape, the more water runs off.

Mitigation Techniques:
When installing a new parking lot, street, sidewalk, or driveway, consider the benefits of using pervious concrete in lieu of traditional concrete or asphalt.

THE ENVIRONMENTAL BENEFITS OF PERVIOUS CONCRETE

In the simplest terms, the best environmental benefit of pervious concrete is that it returns rain water to the ground, recharging ground water and aquifers, and eliminating storm water run-off.

The United States Environmental Protection Agency (EPA) recognizes pervious concrete as a Best Management Practice for providing first flush pollution control and storm water management. By allowing the first flush of rainfall to percolate into the ground, any pollutants are naturally treated via the soil chemistry. Since pervious concrete allows all the rainwater to pass through it, the runoff from paved areas is reduced, which reduces the need for separate storm water retention ponds and allows for using smaller capacity storm sewers. It also acts as a natural filter and can reduce pollutants from entering streams, ponds and rivers. Pervious concrete can reduce the impact of development on trees by allowing both water and air to infiltrate a tree's root system. Trees offer shade and produce a beneficial cooling effect on their own. Plus, the lighter color of concrete pavements absorbs less heat from solar radiation than darker pavements, such as asphalt. In addition, the open pore structure of pervious prevents it from storing as much heat as asphalt, thereby helping to lower the "heat island" effects in highly developed areas. Safety is another benefit of pervious concrete during rainstorms since it eliminates ponding, glare at night, and the risk of hydroplaning. In freezing temperatures, the elimination of standing water on the surface of pavement also prevents the danger of thin coatings of ice, called "black ice."

Environmental Benefits Checklist

- Allows storm water to infiltrate into the ground to replenish ground water aquifers.
- Retains storm water so that retention ponds are not needed for parking lots.
- Keeps pavement surfaces dry even in wet situations, such as greenhouses.
- Allows parking lots to be ice-free in freeze/thaw areas since snow melt immediately drains off the surface.
- Allows water and air to get to the roots of trees within a parking area.
- Aerobic bacteria that develop within the pavement and base can break down oil and remove other pollutants from the water that washes off the surface.
- Light reflectivity is higher than with asphalt surfaces, reducing any heat island effect.
- Allows a project to claim LEED® points. (Leadership in Energy and Environmental Design is a rating system developed by the U.S. Green Building Council to evaluate the environmental performance of a building.)
- Can collect irrigation and retain water to be used for irrigation.

	Pollutant Removal (%)				
Study	TSS	TP	TN	COD	Metals
Prince William, VA	82	65	80	-	-
Rockville, MD	95	65	85	82	98-99

ECONOMIC BENEFITS OF PERVIOUS CONCRETE

A parking lot properly constructed from pervious concrete has a life span three times as long as an asphalt lot, thereby providing excellent long term benefits. It is true that the initial costs for pervious pavement may be slightly higher due to the preparation of the sub-base, but those who look long term will realize the economic benefits.

As far as the material goes, pervious concrete is installed in a thicker quantity than conventional concrete, usually five to six-inches vs. four-inches. However, one must look beyond the costs per square foot, at the overall system. Pervious concrete is a sustainable product that saves money in the long run for the following reasons:

- Lower installation costs due to the elimination of costly curbs, gutters, storm drain outlets and retention basins that cost two to three times more to construct than pervious. Less money will be needed for labor, construction and maintenance of ponds, pumps, drainage pipes and other storm water management systems.
- Allows for the use of existing storm sewer systems for new developments.
- Increase land utilization since there is no need to purchase additional land for large retention ponds and other filtering systems. Land developers can get a better return on investment with efficient land use that does not have to allow for large detention ponds since the pavement itself acts as a detention area.
- Lower life-cycle costs equal to that of conventional concrete that if properly constructed will last for 30 to 40 years. Pervious requires fewer repairs than asphalt, and can be recycled once it has reached its lifecycle.
- Recent reports from multiple regions around the U.S. indicate that the cost for asphalt binder has recently increased as much as 50% and more, resulting in dramatic cost increases for asphalt pavement.
- Easy maintenance that consists primarily of prevention of clogging through pressure washing and power vacuuming.
- Supports local economies by having its mix design adapt to different regions, making use of available materials for coarse aggregates. Since time is a critical factor after the batching, local companies are used for transportation and materials.

CONCLUSION

Pervious concrete pavement is a very cost-effective and environmentally friendly means to support green, sustainable growth. Its ability to capture storm water and allow it to seep into the ground enables pervious concrete to play a significant role in recharging groundwater, reducing storm runoff, and meeting U.S. Environmental Protection Agency (EPA) storm water regulations. Its use is considered among the Best Management Practices recommended by the EPA and other agencies for the management of storm water runoff. Using pervious concrete technology creates more efficient land use by eliminating the need for retention ponds, swales and other storm water management techniques, thereby lowering overall project costs on a first-cost basis. Pervious concrete does not contribute to toxic runoff as asphalt does, plus it lessens the heat island effect that asphalt pavement contributes to. The natural drainage of pervious also prevents ponding, hydroplaning and the skidding dangers of black ice on pavement.