INFORMATION

ON

ASPHALT USE

IN

WATER ENVIRONMENTS

The article, "Heat, Rain Draw Asphalt Poisons Into Florida's Lakes, Study Shows," appeared in the Florida edition of the *Wall Street Journal*. The same article titled, "*Southeast's Climate Helps Release Toxins From Asphalt, Study Shows,*" also appeared in the Southeast editions. Since then, several representatives from other industries have attempted to discredit asphalt and use the article to stop Hot Mix Asphalt pavement construction. Some went as far as to write letters to the State Departments of Transportation. Although the asphalt industry will not sacrifice its professional standards by resorting to similar tactics, the following information is offered for your use as needed to ensure the truth about asphalt is known. Bear in mind that the research performed by Dr. Livingston did not study asphalt and the 1980 Byrne report was a non-peer-reviewed dissertation by a doctoral student. After reading the 1980 Byrne study, it is evident that questions exist in the method and assumptions which could only be answered via other scientific studies. Unlike the conclusion reached by the *Wall Street Journal* writer, there is no sound scientific proof showing asphalt pavements causing harm in water environments.

CONTENTS

ASPHALT INSTITUTE

Edward L. Miller
President

December 21, 1994

Mr. Robert Johnson
Editor, Florida Journal
Wall Street Journal
8251 President's Drive
Orlando, Florida 32809

Dear Mr. Johnson:

I am writing in reference to an article which appeared in the Florida Journal section of the December 7, 1994, edition of the Wall Street Journal, written by Wall Street Journal staff reporter Christina Binkley. The title of the article is "Heat, Rain Draw Asphalt Poisons Into Florida's Lakes, Study Shows." Specifically, she opens the article with the following statement:

"Florida's hot, wet climate aids release of cancer-causing toxins from asphalt into the environment, with possibly dire effects on public health, according to a seven-year study by a Florida State University scientist."

The article then goes on to claim this was a study of asphalt pollutants and that supposedly PAHs continue to leach out of asphalt long after "asphalt has dried." The reporter also claims that a spokesman from the asphalt Institute in Lexington, Kentucky, states that asphalt emits fewer poisons than coal-based tars or pitches. I find this extremely interesting in that I am the spokesperson for the Asphalt Institute in Lexington, Kentucky, and have never made such a statement implying that asphalt emits poisons or that there is any connection with coal-based tars.. On the contrary, asphalt has been proven both effective and safe in water environments. I have enclosed a copy of our Information Series IS-186, "Asphalt Use In Water Environments" for your information. I also have other publications to include Tony Kriech's study titled, "Evaluation of Hot Mix Asphalt for Leachability," which clearly shows that asphalt does not leach into water environments.

EXECUTIVE OFFICES & RESEARCH CENTER
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LEXINGTON, KENTUCKY 40512-4052
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After discussing this issue with Mike Acott, National Asphalt Pavement Association President, and Carroll lance, Asphalt Contractors Association of Florida, Inc. Executive Director, I expect your paper to present proof of the statements made in the article which are voraciously defamatory toward asphalt. Please note that Dr. Livington's own words state:

"We have not carried out any research concerning the exact sources of such PAH nor have we done any research with regard to the potential contribution of asphalt to runoff."

If such proof cannot be presented, then I would fully expect a retraction of the article, that clearly receives the same prominence given to the original article.

The Asphalt Institute has always considered the Wall Street Journal as one of the few remaining excellent newspapers available. It is sad to see that an article such as this would be printed, which provides misinformation coupled with emotional appeal to mislead the public and damage the foundation of America's infrastructure system. I truly hope that the Wall Street Journal has the fortitude to recognize its responsibility of factual reporting to its readers.

Sincerely,

Edward L. Miller
President

bcc Primary Directors
- Mike Acott
- Carroll Lance
- Dick Snyder
- Bernie McCarthy
- Tony Kriech
- April Swanson
- Bill Haverland
- SAPAE
- Field Engineers

CENTER FOR AQUATIC RESEARCH AND RESOURCE MANAGEMENT

CARRMA

obert J. Livingston, Ph.D.
fessor and Director

Glenn C. Woodsum
Associate Director

16 December 1994

r. Carroll Lance, Executive Director
sphalt Contractors Association of Florida
O. Box 12549
llahassee, Florida 32317

ear Mr. Lance:

Recently, I wrote a report on the polynucleated aromatic ydrocarbons (PAH), portions of which were highlighted in our recent onference here in Tallahassee concerning urban runoff. Our research oncerns the distribution of various pollutants including PAH in our natural drainage systems in Leon County. My written document, which is an interim report to be completed by the spring of 1995, details some of the literature concerning PAH distribution and the effects of PAH on various forms of aquatic life and humans. We have not carried out any research concerning the exact sources of such PAH nor have we done any research with regard to the potential contribution of asphalt to such runoff. The only aspects of asphalt per se in my report were references to a Ph. D. dissertation written by Byrne (1980).

With my best to you for the upcoming holidays, I remain yours,

Sincerely,

Robert J. Livingston
Professor and Director

cc: Mr. Bernie McCarthy

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THE WALL STREET JOURNAL.
DOW JONES & COMPANY, INC., PUBLISHERS
8251 PRESIDENTS DRIVE – ORLANDO, FL 32809-7694

Mr. Edward L. Miller
President
Asphalt Institute
Research Park Drive. P.O. Box 14052
Lexington, KY 40512-4052

December 28, 1994

Dear Mr. Miller,

Thank you for your letter on the ``Heat, Rain Draw Asphalt'' story.

I believe I can clear up any confusion over the source of my story's reference to statements comparing petroleum asphalt to coal-based tars. Your organization's Research Report 78-1 (RR-78-1), published January 1978, entitled, ``Differences Between Petroleum Asphalt, Coal-Tar Pitch and Road Tar,'' delves into the subject in some detail. A portion of this report was provided to me by a researcher employed at the Asphalt Institute.

Regarding Dr. Livingston's research, I would refer you to his report dated Nov. 8, 1994, particularly to his references to Mr. Byrne, from whose research he draws conclusions for his own. Having interviewed Dr. Livingston and his assistants extensively, I stand by the facts of my story.

Since the article's publication, I have heard from another scientist who says he has drawn similar conclusions from his own work. But I understand that research continues and would be happy to read the Kriech or other research to which you refer, including your industry's ongoing study.

Best wishes for the New Year.

Sincerely,

Christina Binkley

Christina Binkley

NJDOT Chooses Asphalt for Environmentally Sensitive Project

by Orville Abbott
District Engineer, Asphalt Institute

For years the Trenton Complex has drawn fire from both environmental groups and gridlocked drivers. Numerous obstacles have slowed or stopped it—environmental, historical, social and economic. Difficulties were compounded because portions of the intricate project slice through fragile wetlands and industrial areas, as well as through a major historical and archaeological tract in south Trenton.

When complete, the $400 million hot-mix asphalt (HMA) project will bring a sigh of relief to Trenton residents and to tens of thousands of commuting suburbanites. The Complex will move commuters in and out of the New Jersey capital, providing a smooth alternative to downtown gridlock.

"The Complex represents years of environmental, historical, social and economic concerns," says Peter Therkelsen, New Jersey DOT (NJDOT) project engineer for the Complex. It was originally planned in the 1950s, but was reevaluated for social and economic changes in the late 1960s and 70s."

In the mid-1970s, the Trenton Complex was delayed because of environmental concerns. The primary concern was 57 acres of wetlands along the Delaware River. Consequently, in the late 1970s, the I-295 mainline was realigned away from wetlands to dry lands. Then, in 1981, the Trenton Complex was officially approved by the Federal Highway Administration (FHWA).

The Trenton Complex represents years of environmental, historical, social and economic concerns.

FHWA Agreement

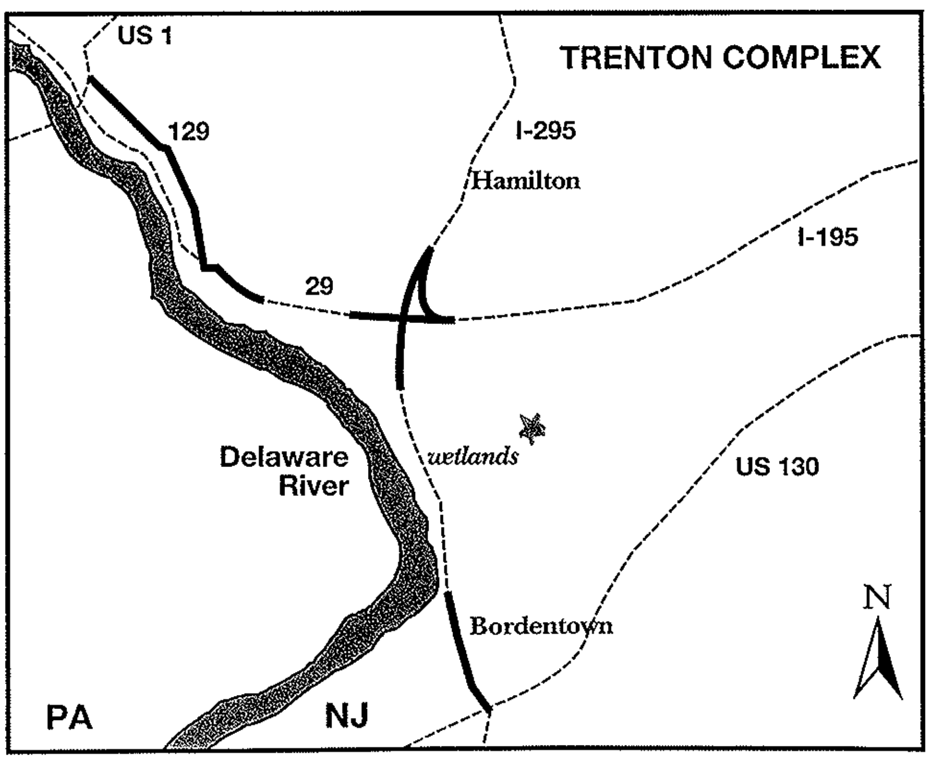
The final agreement with FHWA included commitments to span the controversial wetlands, span the mudflat area with a long bridge, place noise walls throughout the project, control landfill areas, use monitoring wells in landfill areas and preserve in every possible way the historic Abbott Farm district.

After the FHWA approved the project, the environmental permitting procedure began. These lengthy, involved procedures were handled by a Task Force with representatives from each governmental agency. The New Jersey Department of Environmental Protection (NJDEP) had a case manager for every concern.

Agencies involved in the environmental permitting process included the Army Corp of Engineers, U.S. Coast Guard, the New Jersey Department of Environmental Protection's Division of Wetlands, Division of Waterfront Development, Division of Stream Encroachment, Division of the Delaware-American River Canal and the Division of Landfills. Approval of the Delaware River Basin Commission was needed for dewatering and discharge.

HMA Is Choice

Despite years of discussion about where and how to build the Trenton



When complete, Route 1, Route 129, Route 29, I-295 and I-195 will all be connected.

The primary concern in the Trenton Complex was the 57 acres of wetlands along the Delaware River.

complex, the NJDOT decided early to use HMA to pave the major extensions in the Complex. The speed of construction and flexibility of asphalt also allowed the NJDOT to quickly construct a number of diversionary roads and get them under traffic. NJDOT also chose asphalt for the ease of placing and recycling the several temporary roads necessary to divert traffic around critical portions of the project.

Structure

The project includes an extension of I-295 through Bordentown, an interchange with I-195 and Route 29, and construction at two sections of Route 129. When complete, Route 1, Route 129, Route 29, I-295 and I-195 will all be connected.

Pavement specifications for mainline work on I-295 and I-195 required 10 inches of asphalt on 12 inches of aggregate base course. The 10 inches of HMA consists of 8 inches of base course containing 1½-inch maximum aggregate size and 2 inches of surface course containing ¾-inch maximum aggregate size.

Compaction on New Jersey projects is determined by measuring air voids in drilled cores. The specification requires 2 to 8 percent air voids in the finished pavement.

On any major pavement section, NJDOT requires that the pavement pass a smoothness test that limits the amount of surface variation. Based on ⅛-inch or greater differences in elevation when measured with the rolling straightedge (profilograph) over 10-foot increments, a total of 13 feet of vertical variation is allowed in a 1000-foot section. All of the new HMA sections readily meet this requirement. Thus far, contractors have placed a total of 335,000 tons of HMA on the Trenton Complex.

At this point, the project is more than 50 percent complete. Opening of the entire project to traffic is scheduled for December 1994. Although an intricate, lengthy project, the use of HMA on the Trenton Complex has facilitated and expedited its completion without environmental tangles. ▲

New Asphalt Institute Courses

New Asphalt Pavement Technology and *Basic Principles of Asphalt Pavements* are two new courses designed by the Asphalt Institute Education Task Force. *New Asphalt Pavement Technology* presents state-of-the-art technology including SHRP mix design, modified asphalts, design of pavement structures using non-destructive testing, and use of scrap rubber. *New Asphalt Pavement Technology* will be offered as a two-day course at seven different cities during 1993.

Basic Principles of Asphalt Pavements, a streamlined version of the Asphalt Pavement Short Course, will provide a general understanding of asphalt materials, mix design, thickness design, construction, maintenance and rehabilitation. This three-day, information-packed course will be offered four times each year—twice in the spring and in the fall.

See next page for the Spring 1993 schedule for these new courses.

TI

Chinese Highway Officials from Chungchun in the province of Jilin recently visited the Asphalt Institute's (AI) International Laboratory Complex in Lexington, Kentucky. AI Asphalt Binder Technologist Ray Warren (left) explains the Superpave Binder Specifications to the contingent. AI Research and Engineering Services Director Bob McGennis (right) conducted the laboratory tour.

Industry-Wide

John R. Barr is the Asphalt Institute's Chairman of the Board of Directors for 1995. He is Branded Marketing Manager of the Rocky Mountain Business Unit for Conoco Inc. Barr has served as Primary Director, Chairman of the Finance Committee, and as Vice Chairman of the Board for the Institute. Watch for his message about the future direction of the Institute in the next issue of **ASPHALT** Magazine.

Congressional Committees will undergo significant changes when the Republican Party selects new leaders in January 1995. Rep. Bud Shuster (R-PA) is expected to chair the House Public Works and Transportation Committee and Rep. Thomas Petri (R-WI) will probably chair the House Public Works and Transportation Subcommittee. Rep. Frank Wolf (R-VA) will chair the House Transportation Appropriations Subcommittee. On the Senate side, Senator John Chafee (R-RI) will probably chair the Environmental and Public Works Committee and Senator Alfonse D'Amato (R-NY) is a likely candidate for chair of the Transportation Appropriations Subcommittee.

The new Congress will make an early effort to designate the National Highway System (NHS). Both the highway industry and the Federal Highway Administration will push for NHS legislation prior to the September 30, 1995 deadline.

Asphalt Institute representatives Bernie McCarthy, Roger Smith and Bob Humer, Asphalt Industry Chemistry Task Force Chairman Tony Kriech, Joe Kureck of Heritage Research, and members of the California Asphalt Pavement Association met with researchers for the South Coast Air Quality Management District (SCAQMD) concerning their study of organic pollutants from asphalt emissions. The SCAQMD's concern about smog led to this study of emissions from asphalt--both short and long term. The Institute feels that this research will require close monitoring by the asphalt industry to insure that SCAQMD uses sound science in reaching its conclusions.

Around the Nation

The people of Massachusetts voted in the November election to dedicate the state's gas tax to highways and bridges. The dedicated gas tax campaign was led by the Construction Industries of Massachusetts.

The 41st Arizona Legislature passed a bill declaring asphalt pavement as an environmentally safe material that "will not decompose or leach substances for which aquifer water quality standards have been established." Broken concrete, brick, rock, gravel, sand and soil were also listed in the safe category. Passage of the bill was an important confirmation of asphalt's compatibility with water environments in the state of Arizona.

New York DOT specified Superpave Performance Grade (PG) asphalts in six projects in 1994. NYDOT expects to include PG asphalts in seven to ten of its projects in 1995. The agency intends to specify a Superpave Level 1 mix design in at least one of these projects.

The North Central User/Producer Group in their November meeting set a date to implement the PG grading system. The Group named January 1, 1997, as the implementation date of the PG system for asphalt binder--with voluntary reporting to begin January 1, 1996. The Group set January

ASPHALT FOR BICYCLE TRAILS

by Fred Waller, Regional Engineer, Asphalt Institute

Around the turn of the century, bicyclists throughout the U.S.A. got tired of riding through cow pastures and on streets that were always muddy or dusty and united to initiate the Good Roads Movement. Now, 100 years later, a new generation of cyclists are gently, but insistently, pushing for good bicycle trails.

Although bicycle trails have been a low priority in the minds of transportation planners for years, the health, conservation and environmental concerns of Americans have escalated these trails to a place of increasing importance. A recent report by the U.S. Department of Transportation–*The National Bicycling and Walking Study*–tells cities, towns and rural communities how to develop a bicycle-friendly environment. The Study exhorts cities to double the current percentage of total commuter trips made by bicycling and walking from 7.9 to 15.8 percent. The Intermodal Surface and Transportation Efficiency Act (ISTEA) of 1991 requires that all state DOTs have a Bicycle Division. Further, ISTEA has required that each state have a viable 20-year bicycle-pedestrian plan.

But planning and constructing more bicycle trails is only one way to increase the use of bicycles. "What you need to keep in mind," says Josh Lehman, Massachusetts State Bicycle & Pedestrian Transportation Coordinator, "is that the real mileage for bicycling is in roadways." Lehman says this means improvements to existing streets and roads in the form of dedicated bicycle lanes. Miles of bicycling lanes can be added to U.S. roads by adding extra wide shoulders at the time of initial construction or, in some cases, adding shoulders to existing roads for use as bicycle lanes.

Either way, both the "off-road" or independent bicycle trails or the "on-road" bicycle lanes fit the tires and tastes of young and old Americans. Some of these cyclists are novices who want to get the feel of the pavement before they begin riding on city streets. Others are ready to ride coast to coast on America's two-lane black tops. "A combination of bicycle lanes on existing roads, together with independent bicycle trails, usually works best for a community," says Bill Webster, Parks and Recreation Project Coordinator for the city of Chapel Hill, North Carolina. "If you have the money, independent trails are best for young cyclists. For adult riders, bicycle lanes on existing roads work best."

DESIGN AND DEMOGRAPHICS

The design of a bicycle trail depends on who will be using it and where it is located. "We design it to fit the needs of the people," says Cathy Lewis, Bicycle/Pedestrian Coordinator for the Boston Metropolitan Planning Organization. "Some of those people want to go fast and some want to go slow. Paved paths and bicycle lanes are great for commuters, walkers, joggers, baby buggies and rollerbladers, but mountain bikers are probably going to want to travel on natural terrain."

Raleigh, North Carolina, and its surrounding area is one of the nation's leaders in the development and growth of recreational trails. "We probably have the most organized effort in America," says Curtis Yates, Director of the Office of Bicycle and Pedestrian Transportation for the North Carolina DOT. "We have bicycle paths, rail-trails and streets with marked bicycle lanes. We depend on the American Association of State Highway and Transportation Officials (AASHTO) guidelines and the North Carolina Bicycle Facilities Planning and Design Guidelines for design guidance.

BICYCLE AND PEDESTRIAN DIVISION

Yates says his Bicycle & Pedestrian Division first does a feasibility study. Then, if the project is an independent trail, the division develops and constructs the trail from beginning to completion. But many North Carolina roads have "incidental" projects. Often, a bicycle trail can be included in a highway design at a substantial savings over an independent bicycle trail. If this is the case, the Bicycle and Pedestrian Division cooperates with the NCDOT in the planning and design of the incidental project.

Yates adds that Tom Norman, his chief design engineer, along with two additional staff engineers review every NCDOT document that goes through the design process. They sometimes recommend changes in the form of adding bicycle lanes or pedestrian enhancements. Norman and his staff review about 20 NCDOT road design plans per week.

According to Yates, designing and selecting pavement sections for bicycle paths is in many ways similar to designing and selecting highway pavement sections. First, his division does a soils investigation to determine the load carrying capabilities of the native soil and the need for any special provisions. Then they design the trails · sustain wheel loads for emergency, patrol, maintenance and other motor vehicles. Because motor vehicles will use the path, adequate edge support

NO MOTOR VEHICLES

with stabilized shoulders or additional pavement width may be necessary. Twelve-foot-wide paths stop edge raveling and cut costs by eliminating the separate construction of shoulders.

Other states are emulating North Carolina's leadership in bicycling programs and trail design. But North Carolina has a major advantage. It has the authority to control and implement its plans because the NCDOT is responsible for all urban, county and state highways in the state.

WIDTH VERSUS SMOOTHNESS

Some cyclists say that having enough room on the trail or road lane is the most important element in the bicycle program. Others say that a smooth, regular surface is paramount. "We advocate AASHTO standards or wider," says Peter Moe, Project Coordinator for the Bicycle Federation of America. "We are less concerned with the bicycle path surface and more concerned with getting proper space for the cyclist. There are a range of suitable surfaces and asphalt is certainly one of them." But Josh Lehman in Massachusetts says that "our primary interest is a smooth surface." He reminds us that the earliest advocates of smooth roads, even before the automobile, were cyclists. Smoothness for on-street/on-road bicycle lanes is important because holes and bumps can cause cyclists to swerve into the path of traffic.

"As far as which is primary—adequate width or smoothness," says Bill Webster in Chapel Hill, "my answer is both are critical. If people are going to use the trail for transportation, then you need both width and smoothness. If the trail is for recreation, then that's another story."

Lehman says that in Massachusetts "we're looking for a smooth riding surface and asphalt supplies that. The basic problem is the subsurface. If it's properly prepared, the asphalt will work."

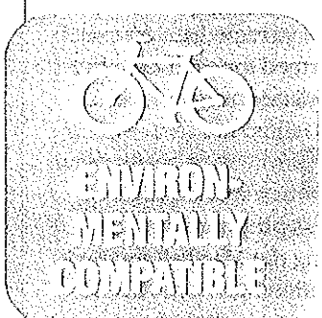
All the projects that Boston Bicycle Coordinator Cathy Lewis has worked with are paved. An example is the Minuteman Commuter Bike Path. It was planned as a commuter bicycle path, but it has a variety of users. During rush hour, however, Boston MPO studies show that the path is used primarily by commuting cyclists. In off hours, others use the path. It is 12 feet wide and 11 miles long. The smoothness of the asphalt bike path has contributed to its popularity.

AN ASPHALT RIBBON

Curtis Yates observes that an asphalt ribbon runs through the whole bicycle path program. "I know of no place where asphalt is not being used," he says. "We go for Full-Depth, from 2 to 3 inches on 10-foot-wide paths. We also use boardwalks for the greenway systems–through wetlands and marshes." He cites the North Carolina Bicycle Facilities Guidelines which states that "hard, all-weather pavement surfaces are usually preferred over those of crushed aggregate, sand, clay or stabilized earth since these materials provide a much lower level of service."

Bill Webster points to the maintenance advantages of paved bike trails. "When choosing materials," he says, "we usually don't choose organic materials because they cause maintenance problems. But we do use natural materials to construct some of

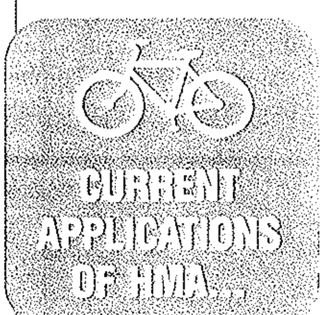
our trails, including what we call 'Chapel Hill gravel.'" Webster says that asphalt is the one material that provides a well-maintained trail. He adds that "it also provides a good usable surface for disabled and older people."



Although wood or other materials are often used, studies show that state agencies, MPO's, counties and cities should have no reservations about using asphalt in environmentally sensitive areas. When used near rivers, streams, wetlands, or other water environments, there is no evidence of asphalt leaching into the adjacent environment.

The U.S. Environmental Protection Agency (EPA) identified the Toxic Characteristic Leachability Procedure (TCLP) as the most consistent and rigorous test for determining the toxicity of a substance. Eight metals and 32 organic compounds identified as contaminants by the EPA are in the TCLP analysis. A 1990 study performed by the Heritage Research Group in Indianapolis entitled *Evaluation of Hot-Mix Asphalt for Leachability* by Anthony J. Kriech used TCLP leachate to test fresh hot-mix asphalt for the presence of 40 EPA contaminates and the high-molecular weight PAH's routinely tested for by EPA. The asphalt tested was a mixture of AC-20 asphalt cement and slag, stone and sand that met Indiana DOT specifications for asphalt surface mixes.

Of the 40 contaminants identified by the EPA as hazardous, chrome was the only compound that had a level above detectable limits. Measured at 0.1 part per million (ppm), this is still 50 times below hazardous levels. Since asphalt typically does not contain chrome, this small level possibly comes from the slag aggregate, which is a by product of the steel-making process.

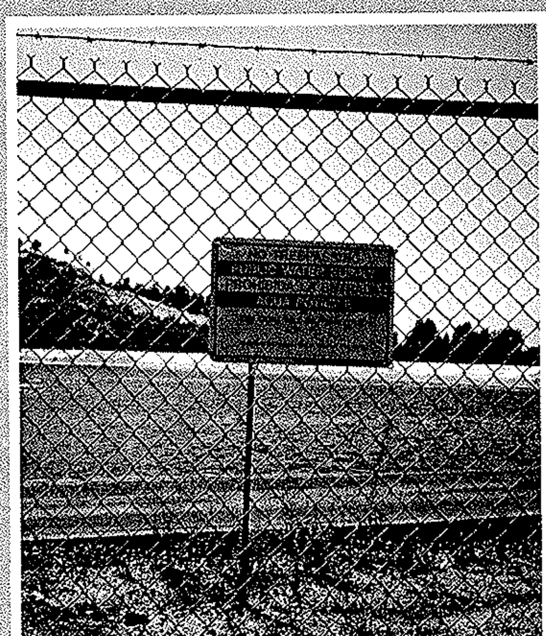


In Water Environments, hot-mix asphalt is currently being used as liners for drinking water reservoirs and as liners in fish rearing ponds. The Metropolitan Water District of Southern California (MWDSC) has been using HMA-lined water reservoirs for more than four decades. Currently, the California Water Resources Board is completing construction on the Devil's Canyon Reservoir to store MWDSC drinking water. The 19-inch thick asphalt liner for the huge facility will hold 800-acre-feet of water. The East Bay Municipal Utility District (EBMUD) in Oakland, California, has also been using hot-mix asphalt to line domestic water supply reservoirs since the 1950s. A total of ten reservoirs store water in the EBMUD system.

Oregon and Washington state fish and wildlife agencies began using HMA to line their fish rearing ponds in 1987. Typically 1/2-acre in area, the ponds are home to chinook salmon and other fry for about 18 months before the fish are released into rivers and streams. Both the Washington and Oregon state agencies are pleased with the effectiveness of the HMA liners and plans to use them for additional fish hatcheries in the future. These and other uses of asphalt in sensitive environments make its use an attractive option for bicycle paths.

Bicycle paths can be finished with a variety of materials, but for ease of maintenance and ability to fit into sensitive environments, asphalt is an attractive choice. ▲

Asphalt Use in Water Environments



ASPHALT INSTITUTE

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Introduction

The successful use of asphalt in hydraulic applications such as domestic water reservoirs, fish rearing ponds, and canal liners is well-documented. Hot-mix asphalt (HMA) has been used in these applications for more than half a century. Hot-mix asphalt is durable, flexible, and can be designed to be either impermeable or porous. As an inert material, it is resistant to the action of almost all acids, alkalies, and salts.

Occasionally, questions arise concerning the environmental safety involved with using asphalt in applications where water is directly contacting the asphalt material. Based on unfounded concerns that asphalt would leach toxic, hazardous materials into the water, some agencies have even proposed regulations prohibiting the use of HMA where it may come in contact with water.

No scientific data exists on which to base claims concerning asphalt leaching hazardous compounds into water. Even as improvements have been made in testing procedures and the ability to detect smaller and smaller amounts of hazardous materials has increased, asphalt has not been shown to be as a source of toxic substances. Recent studies using state-of-the-art testing procedures as governed and approved by the Environmental Protection Agency (EPA) demonstrate that asphalt does not leach harmful quantities of contaminants.

Research continues to illustrate the inert properties of HMA and validate the decisions to use hot-mix asphalt in water environments. This publication addresses the use of asphalt materials in locations that will be in contact with water.

What is asphalt?

Chemically defined, asphalt is "a complex combination of high molecular weight organic compounds containing a relatively high proportion of hydrocarbons having carbon numbers greater than C25 with high carbon-to-hydrogen ratios." (Chemical Abstract Services registry number 8052-42-4.) While composed primarily of complex hydrocarbon molecules, asphalt also contains such atoms as oxygen, nitrogen, and sulfur.

The principal source of asphalt used in modern construction is the refining of crude petroleum. Crude petroleum is composed of a variety of compounds, and a refinery is used to separate the crude petroleum into its various constituents. Briefly described, the refining process involves heating the crude petroleum to approximately 750°F to vaporize the lighter, more volatile fractions. These light fractions are removed and condensed, and then further refined into such petroleum products as naphtha, gasoline, kerosene, fuel oil and lubricants.

After one or more refining processes have removed the lighter petroleum compounds, the non-volatile portion that remains is the vacuum residuum or asphalt. All of the refining and manufacturing procedures are aimed at making products that meet governing national or state specifications. The two largest standards setting organizations for asphalt cement are the American Society for Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO).

Asphalt in Paving

There are three forms of asphalt used in paving applications. **Asphalt cement**, at ambient temperatures, is a black, sticky, semisolid, highly viscous material. Asphalt cement is called thermoplastic because it softens as it is heated and hardens as it cools.

The most common use for asphalt cement is in the production of hot-mix asphalt (HMA) for pavements. HMA is an asphalt/aggregate mixture that is produced at a central mixing facility. To dry the aggregate and obtain sufficient fluidity of the asphalt cement, both must be heated prior to mixing, hence the term hot-mix. While still hot, the HMA is transported to the paving site, where it is placed and compacted. Upon cooling, the mixture hardens.

Emulsified asphalt and **cutback asphalt** are products that are liquified so that they are fluid at ambient temperatures. Emulsified asphalt is a combination of asphalt and water that uses an emulsifying agent to blend two normally immiscible materials. Cutback asphalt is asphalt cement that has been liquified by blending with a petroleum solvent (or diluent) such as naphtha, gasoline, or kerosene.

Asphalt emulsions and cutback asphalts are typically used in spray applications such as surface treatments (chip seals, tack and prime coats), as well as cold-mix applications such as maintenance stockpile materials and road mixing. When exposed to the air and the material it is sprayed on, the water or diluent evaporates and the asphalt remains to perform its binding function. The setting of the asphalt emulsion is an irreversible reaction and the asphalt cannot be re-emulsified when contacted with water.

Due to the evaporation of the volatiles that make it fluid, the use of cutback asphalt is subjected to regulations due to air quality concerns (volatile organic compounds). While the correct application of cutback asphalt allows the volatiles to evaporate and leave the original asphalt cement, improper application may result in incomplete dispersal of the diluent. Due to possible contamination of the water resources when used in these situations, it is recommended that cutback asphalts not be applied in water environments as discussed herein.

Hot-mix asphalt provides a durable, impermeable reservoir lining that is erosion resistant and withstands loading stresses.

The Metropolitan Water District of Southern California is lining reservoirs with a hot-mix asphalt subdrain system consisting of an open-graded asphalt mixture sandwiched between layers of impermeable, hydraulic HMA.

EPA Testing

The current protocol identified by the EPA as the most consistent and rigorous for determining the toxicity of a substance is the Toxic Characteristic Leachability Procedure (TCLP). As an indicator of the effects of acidity on the leaching characteristics of a material, the TCLP is considered to be more aggressive than pH-neutral water leaching tests.

Eight metals and 32 organic compounds identified as contaminants by the EPA are included in the TCLP analysis. Because of asphalt's high molecular weight, there is a concern that leachable polynuclear aromatic hydrocarbons (PAH's) could be present. The TCLP analysis can also involve testing for leachable PAH's and other compounds of concern.

A study performed by Heritage Research Group (1) used TCLP leachate to test fresh hot-mix asphalt for the presence of the 40 EPA contaminants and the high-molecular weight PAH's routinely tested for by the EPA. The HMA tested was a mixture of AC-20 asphalt cement and slag, stone and sand that met Indiana DOT specifications for asphalt surface mixtures.

Of the 40 contaminants identified by the EPA as hazardous, chrome was the only compound that had a level above detectable limits. Measured at 0.1 part per million (ppm), this is still 50 times below hazardous levels. Since asphalt typically does not contain chrome, this small level is possibly coming from the slag aggregate, which is a byproduct of the steel making process.

The detection limits for leachable PAH's are extremely low, allowing measurement well below one part per billion (ppb). Only naphthalene was detectable, being measured at one-quarter ppb, well below any established guideline. Naphthalene is the most volatile PAH, and is not carcinogenic like some of the other PAH's, such as Benzo(A)pyrene, none of which were found to be present.

Hydrocarbons

A study recently performed by the state of Minnesota also involved TCLP testing of hot-mix asphalt (2). Leachate tests were performed on cores from pavements constructed with and without sewer sludge ash added. (The use of sewer sludge ash as an aggregate is being investigated. The ash contains elements identified as hazardous by the EPA, and the TCLP leachate testing was included in the analysis.)

The results of the TCLP analysis on all the pavements have shown that "leachate concentrations for all monitored parameters were well below . . . drinking water standards" for the hot-mix asphalt tested. Thirty-six of the 40 compounds included in the analysis were below detectable limits, which vary by compound from 0.25 parts per million to 0.1 parts per billion.

Current Applications

The Metropolitan Water District of Southern California (MWDSC) continues to use HMA to line water reservoirs – a practice they have employed for more than four decades. Currently in use are two untreated water reservoirs with a total capacity of 1.8 billion gallons and five treated water reservoirs with a total capacity of 1.1 billion gallons.

Photo by Ed Schlect

Fish hatcheries in Oregon and Washington release millions of hatchlings each spring from ponds lined with hot-mix asphalt.

MWDSC is presently constructing a 146-million gallon asphalt lined reservoir that will contain a built-in HMA subdrain system. It consists of 4-inches of dense-graded HMA on the surface, 4-inches of open-graded HMA in the middle, and 2-inches of dense-graded HMA placed on the subgrade. The open-graded layer serves as a drainage and leak detection layer between the two impermeable, dense-graded asphalt layers.

The East Bay Municipal Utility District (EBMUD) in Oakland, California has also been using hot-mix asphalt to line domestic water supply reservoirs since the 1950s. Various combinations of dense-graded HMA, prefabricated asphalt panels and membranes, and open-graded HMA have been used by the EBMUD to collect and contain domestic water supplies. A total of 10 reservoirs store 265 million gallons of water in the EBMUD system.

In 1987, Oregon and Washington fish and wildlife agencies began using HMA to line fish rearing ponds. Typically 1/2 acre in area, the ponds are home to chinook salmon and other fry for about 18 months before the fish are released into rivers and streams.

Table 1
Typical Gradations for Asphalt Mixtures in Hydraulic Applications

		Dense-Graded (Low Voids)	Open-Graded (High Voids)
Sieve Size		Percent Passing	
25.0 mm	(1 in.)		100
19.0 mm	(¾ in.)		93-100
12.5 mm	(½ in.)	100	—
9.5 mm	(⅜ in.)	95-100	35-65
4.75 mm	(No. 4)	70-84	5-25
2.36 mm	(No. 8)	52-69	2-15
1.18 mm	(No. 16)	38-56	0-7
600 μm	(No. 30)	27-44	0-3
300 μm	(No. 50)	19-33	
150 μm	(No. 100)	13-24	
75 μm	(No. 200)	8-15	
Asphalt cement, percent by wt. of total mix		6.5-9.5	2.0-4.0

Mix Selection

The design of dense-graded hot-mix asphalt for hydraulic applications varies somewhat from HMA for highway construction. A hydraulic asphalt mixture is typically designed with a higher asphalt content than for mixes used on roads, to produce a high durability, impermeable mix. A mix that compacts easily and yields a lower air void content is desirable for hydraulic applications. Table 1 gives typical specifications for dense- and open-graded mixtures used in water environments. The Asphalt Institute's *Asphalt in Hydraulics* manual (MS-12) fully details the use of asphalt mixtures in hydraulic applications.

Conclusions

State-of-the-art procedures used for analyzing toxicity have demonstrated that hot-mix asphalt does not leach hazardous materials. Agencies continue to specify HMA liners for drinking water reservoirs and fish rearing ponds, where the water quality must meet rigorous drinking water standards. Until test data exists to indicate otherwise, the regulations against the use of HMA in water environments are inappropriate.

Cutback asphalt is a possible source for water contaminates. Caution should be exercised when specifying its use in water environments.

Details of the results presented in these references can be obtained from the Asphalt Institute.

References

1. Kriech, Anthony J., "Evaluation of Hot Mix Asphalt for Leachability," Heritage Research Group, Indianapolis, Indiana, October 1990.
2. "Sewage Sludge Ash in Bituminous Paving," Report to the Minnesota Legislative Commission on Waste Management, joint development by staffs of the Minnesota Department of Transportation, Minnesota Pollution Control Agency, and Metropolitan Waste Control Commission, St. Paul, Minnesota, October 1990.

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Oregon and Washington Fish Hatcheries Lined with Asphalt

by Ed D. Schlect

District Engineer, Asphalt Institute

More than 30 fish hatchery ponds are operated by Oregon and Washington and many of them are lined with hot-mix asphalt (HMA). The states' fish and wildlife officials say the ponds are durable and produce good-quality fish.

HMA is one of the most commonly used liners for hatchery ponds, according to Ray Sheldon, hatchery operations coordinator for the Oregon Department of Fish and Wildlife. "We've had good results rearing quality fish" in the ponds, says Sheldon.

One of Oregon's ponds, the Clackamas fish hatchery at McCiver State Park, releases more than 1.5 million chinook each spring into the Clackamas River. The hatchery houses the fish about 18 months before releasing them into the river.

In Washington, the State Department of Fisheries and the Department of Wildlife operate more than 25 hatcheries. At least two Indian tribes in the state also maintain hatchery ponds lined with HMA.

A typical Washington state fish hatchery pond is 5 to 7 feet deep and covers a one-half acre surface area. The liner is 2 or 3 inches of HMA on 8 inches of granular base. Liners consist of 3/8-inch nominal maximum-size aggregate with 6.5 percent asphalt cement. The higher volume of asphalt cement ensures a low-void, impermeable mix.

When the ponds are empty, pressure relief valves in the pond bottom relieve hydrostatic pressure under the liner. Some ponds are designed with pressure relief valves throughout the pond floor while others use valves only in the drain channel. All joints between the HMA liner and the headwalls and outlet gates are sealed with rubberized asphalt liners.

Many of the HMA ponds are sealed with an asphalt emulsion because a bacteria detrimental to fish life can find a habitat in the surface voids of the HMA. Current specifications require either a proprietary asphalt emulsion sealer, a CSS-1 or a CSS-1h.

Both Washington and Oregon state agencies are pleased with the effectiveness of the HMA liners and plan to use them for additional fish hatcheries in the future. ▲

A typical Washington state fish hatchery pond is 5 to 7 feet deep and covers a one-half acre surface.

Asphalt Liners In California Reservoirs Resist Loading Stress and Erosion

by Robert P. Humer
District Engineer, Asphalt Institute

For more than four decades the Metropolitan Water District of Southern California (MWDSC) has used hot-mix asphalt (HMA) to line its water reservoirs. The liners control erosion, prevent seepage and absorb loading stresses. MWDSC has recently completed two more asphalt-lined water storage reservoirs in its expanding system—a finished water reservoir at the R. A. Skinner Filtration Plant and a raw water storage reservoir at the Etiwanda Control Facility.

Skinner

The Skinner Reservoir, near the city of Murrietta Hot Springs, consists of a 340-acre-foot (111-million-gallon) finished water—finished water is drinking water—storage reservoir with floating Hypalon cover. MWDSC placed 3 inches of open-graded HMA on its sides and bottom for erosion control.

On the $22 million Skinner project, the contractor prepared the subgrade on the native Bedford Canyon formation. He removed the unsuitable material and replaced it with select clay fill. General contractor Kiewit Pacific and paving contractor Matich Corporation of Banning, California, then constructed the 3-inch-thick porous asphalt liner with 22,500 tons of HMA. According to Eric Anderson, MWDSC resident engineer, the lining will not only prevent erosion, but also will relieve back pressures and prevent upheaval of the reservoir lining when drawdowns on the water level occur.

Standard Paving Equipment

Matich Corporation first paved the sloping sides of the reservoir, then the bottom. "Because the sides were designed on a 3 to 1 slope, Matich was able to place the 3-inch lift with standard paving equipment without the help of a winch," says Ben Huntsman, head of the MWDSC testing laboratory. The paver started at the top of the slope and paved to the bottom.

Compaction was accomplished with an 8-ton, 2-axle tandem roller attached to steel cables and pulled up by a winch. The rolling pattern on the slopes was up and down with no compaction percentage specified. Bottom rolling was done with a double drum roller. The 3/4-inch topsize porous mix contained 5 percent AR-4000 asphalt cement.

Etiwanda

At Etiwanda, in the city of Rancho Cucamonga, MWDSC constructed a 10-inch-thick lining composed of layers of hydraulic and porous HMA on the sides and bottom of the 450-acre-foot (146-million-gallon) raw water reservoir. Raw water is the resource used for finished drinking water. Advanco Constructors of Upland, California, was the general contractor and Best Western Paving of Walnut, California, did the paving.

Cost of the Etiwanda liner was approximately $4 million of the $22.5 million project total. It was composed of 2 inches of hydraulic asphalt, and 4 inches of porous HMA topped with 4 inches of hydraulic asphalt. Approximately 120,000 tons of HMA were placed on the project.

Subcontractor Southern California Grading, Inc. first removed an extra 5 feet of subgrade material and replaced it with select fill material. The fill was placed in 8-inch lifts and compacted to 95 percent of laboratory density (ASTM D-1557). After priming, Best Western placed the 2-inch lift of impervious, hydraulic asphalt on the reservoir's sides and bottom.

MWDSC construction supervisors (left to right) Steve Kobzeff and Tom Stephens, Asphalt Institute district engineer Bob Humer, and Bill Rider and Ben Huntsman of the MWDSC testing laboratory stand in the excavated Etiwanda reservoir a few days before HMA paving begins.

Porous HMA

The PVC drainage system was then placed on the 2-inch liner and covered with 3/4-inch crushed drain rock. Best Western then placed a 4-inch layer of porous HMA on the drainage system and topped it with 4 inches of hydraulic asphalt placed in two lifts.

Best Western placed the 4-inch-thick layer of porous HMA in one lift, rolling the mat just enough to seat the aggregate particles firmly. Excessive rolling could have caused aggregate degradation.

Resident engineer Don Slider says that the Etiwanda liner was specifically designed to withstand long-term loading stresses without cracking and to absorb short-term loadings such as wave impact. Long-term stresses are caused by settlements in the supporting subgrade or porous asphalt layer.

The porous HMA in the liner serves as a drainage layer between the two layers of impermeable hydraulic HMA. The porous mix contained 2.5 percent AR-8000 asphalt cement. See Table 1 for gradation of the porous mix.

Sieve Size	Percent Passing
1-inch	100
3/4-inch	93-100
1/2-inch	—
3/8-inch	35-65
No. 4	5-25
No. 8	2-12
No. 16	0-7
Asphalt cement, pct. by wt.	2.5 percent

Table 1
Gradation of Porous HMA at Etiwanda Reservoir

Sieve Size	Percent Passing
1/2-inch	100
3/8-inch	95-100
No. 4	70-84
No. 8	52-69
No. 16	38-56
No. 30	27-44
No. 50	19-33
No. 100	13-24
No. 200	8-15
Asphalt cement, pct. by wt.	8.3 percent

Table 2
Aggregate Gradation of Hydraulic Asphalt at Etiwanda Reservoir

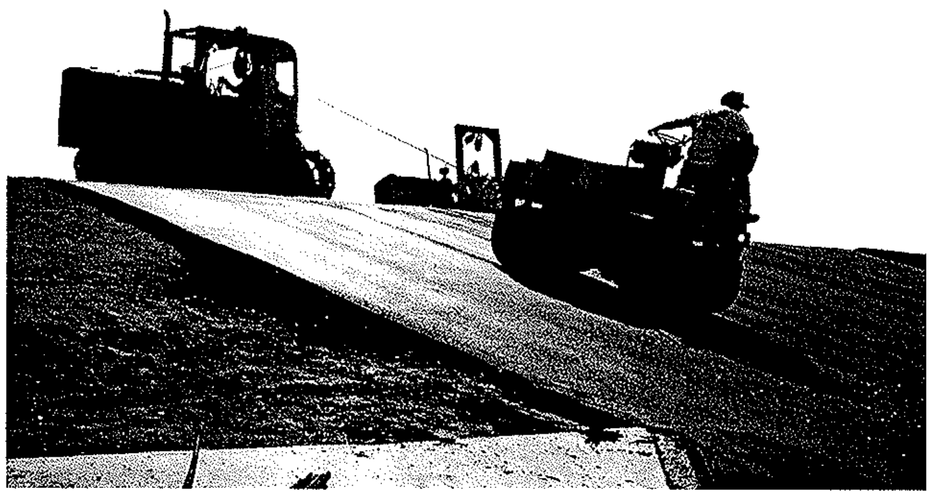
Hydraulic HMA

Both layers of hydraulic HMA were mixed at the hot-mix facility at 280 to 300 degrees F, which matched the laboratory mixing temperature specified in the Asphalt Institute's mix design manual. The mix contained 8.3 percent asphalt cement. Table 2 shows the gradation for the hydraulic HMA.

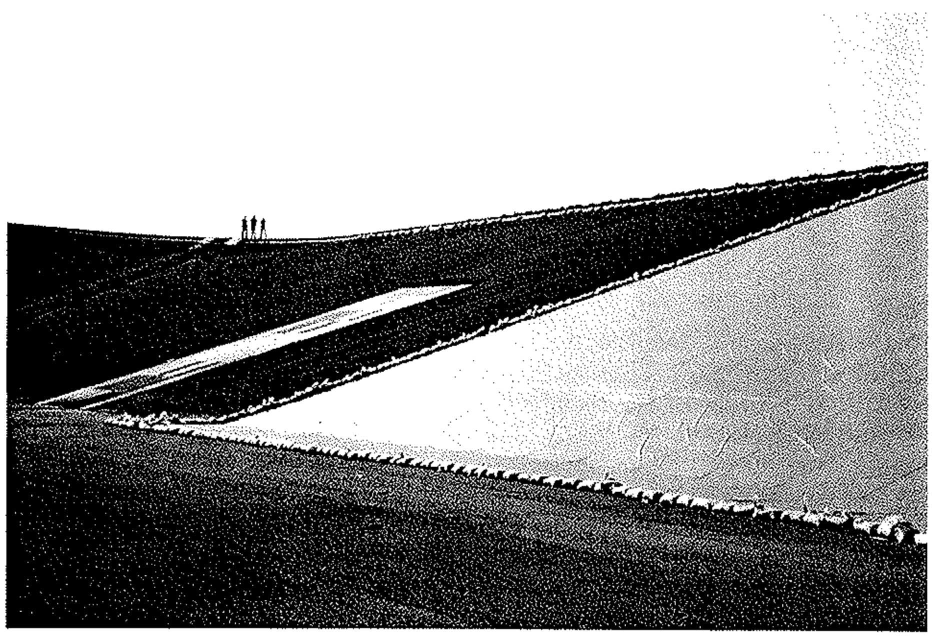
Gradations for both the porous liner and the hydraulic HMA match the guidelines contained in the Institute's *Asphalt In Hydraulics (MS-12)* manual.

MWDSC specified that the 4-inch top layer of hydraulic HMA be compacted to 96 percent of 35-blow Marshall laboratory density. After compaction, the pavement on the reservoir floor contained less than 3.1 percent voids. After placing the final 4-inch layer of hydraulic asphalt, an asphalt sealer was applied on the completed surface of the reservoir lining.

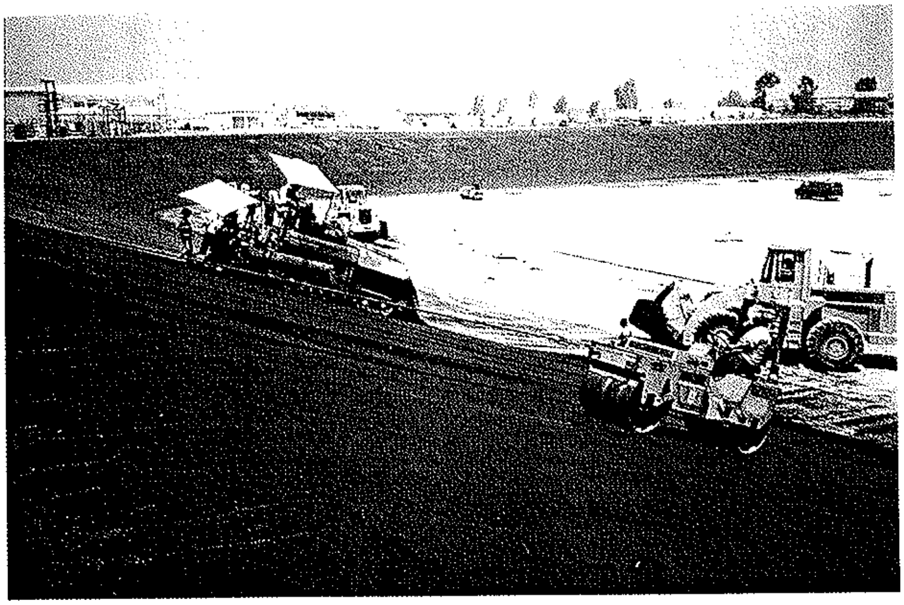
The Etiwanda project began in July 1990 and will be completed in March 1992. As part of its continuing expansion, MWDSC will begin construction of another asphalt-lined reservoir with an 150-acre-foot (49-million-gallon) capacity in the near future. ▲



Pavement density on the slopes at Etiwanda was at least 94 percent of 35-blow Marshall.



After paving, contractors assemble the floating Hypalon cover at Skinner Reservoir.



Because the sides on Etiwanda Reservoir in Rancho Cucamonga, California, were designed on a 3 to 1 slope, contractor Best Western paved them without a winch. For proper compaction on the slopes, however, the contractor attached steel cables to the roller and pulled it up by a winch.

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LEACHABILITY

OF

COLD MIX ASPHALTS

November 25, 1992

by: Anthony J. Kriech

Introduction

Heritage Research has recently completed a study of the leachability of cold mix asphalt (CMA). CMA is a mixture of aggregate and asphalt mixed at ambient temperatures. The asphalt used in the study includes:

ASPHALT	MEETS SPECIFICATION
AE-150 - Asphalt Emulsion	INDOT 902.04 - ASTM D977
MC-3000 cutback asphalt	INDOT 902.03 - ASTM D2027
CM-150 cold mix multigrade asphalt (a modified gelled asphalt)	See Appendix A

All three of these asphalts are used widely in Indiana for making CMA.

Recently there has been a concern about whether CMA could be leaching materials in the ground water from stockpile storage of the mixture. Previous studies of Hot Mix Asphalt[1,2,3] have found the leachability of asphalt aggregate mixtures to be extremely low. However, cold mix asphalts have not been studied in Indiana to the authors knowledge.

Sampling and Analytical

The CMA mixture was prepared using standard mixes utilized in Shelby County in 1992. The aggregate was a limestone from Cave Stone in Flat Rock, Indiana, meeting the aggregate gradation listed in Table A. The AE-150 asphalt emulsion and CM-150 multigrade were taken from a production from Asphalt Materials Inc. in Indianapolis. The MC-3000 was obtained from Laketon Refining in Laketon, Indiana and was taken from production storage. The typical properties of these three asphalts are listed in Table B.

Each asphalt was mixed with a representative amount of aggregate to produce a 4.2% residual asphalt content. The mixture was allowed to set undisturbed for 24 hours before testing was initiated. This represents a minimum normal amount of reaction time between asphalt and aggregate before use. All sample mixtures were checked to ensure they complied with the 9.5mm maximum particle size.

Each mixture was submitted to Heritage Laboratories Inc., an EPA certified laboratory. The test methods are listed below:

TEST	METHOD/PROCEDURE
TCLP Procedure	SW 846-1311
Volatiles	SW 846-8240
Semi Volatiles GC/MS	SW 846-3510
Polynuclear Aromatic Hydrocarbons	SW 846-8310
Metals	SW 846-3010

REFERENCES

1 Kriech, Anthony J. *Evaluation of Hot Mix Asphalt for Leachability.* October 15, 1990.

2 Kriech, Anthony J. *Evaluation of RAP for Use as a Clean Fill.* January 30, 1991.

3 Kriech, Anthony J. *Leachability of Asphalt and Concrete Pavements.* March 5, 1992

Results

The leachable metals are found in Table C and are given in parts per million. The test results for volatiles are listed in Table D. The semivolatiles can be found in Table E. Polynuclear Aromatic Hydrocarbons (PAH's) are given in Table F. The volatiles, semivolatiles and PAH's are all given in parts per billion.

Comments

1. No metals leached from any of the mixtures above detection level. Testing on limestone aggregate, similar to the one used in the study, found that barium typically leaches up to 5ppm. However, coated with asphalt the leachability of the aggregate is lowered.

2. The volatiles and semivolatiles tested for in the study were not found in any of the samples above detection levels.

3. The PAH compounds, which are found in asphalt in trace quantities, were also tested and found to be present in very low levels. The top four in the test are non-carcinogenic and appear on the list as indicators for coal tar material, not asphalt. Secondly, the method used by Heritage Laboratories Inc. is extremely sensitive, allowing measurements below 1 part per billion. The levels reported in the study are well below in known regulatory standard for these compounds.

Conclusions

1. Based on this study, cold mix Asphalt has very low leachable PAH's. These levels are very similar to HMA pavements, concrete pavements and soils from the shoulder of roads [2,3]. Recently, the Illinois EPA determined that HMA asphalt could be considered a clean fill material, based on very similar levels as reported in those studies.

Based on the evidence there does not appear an environmental leachate problem associated with cold mix asphalt stockpiles. This study does not preclude the need to use good engineering practice in locating, mixing and storing cold mix asphalt. Asphalt storage tanks and CMA's stockpile should not be located next to bodies of water, because liquid asphalt (which is used in mixing) can foul water supplies if spilled before it reacts and mixes with the aggregate. Proper use of cold mix should provide an environmentally safe material for county roads.

TABLE A
AGGREGATE GRADATION

SIEVE SIZE	% by wgt.
% Passing 1/2 inch	100.0
% Passing 3/8 inch	80.6
% Passing #4	16.9
% Passing #8	4.7
% Passing #16	2.3
% Passing #30	2.0
% Passing #50	1.6
% Passing #100	1.2
% Passing #200	0.9

TABLE B

ASPHALT TEST RESULTS

AE-150	
TEST	**RESULT**
Furol Vis of 25°C, sec.	185
Residue from Distillation %	68.9
Oil Portion of Distillate %	1.1
Stone Coating	pass
Sieve Test %	0.0
Float on Residue 60°C	1200+
Penetration 25°C, 50g, 5 sec.	180

CM-150	
TEST	**RESULT**
Viscosity @ 25°C, 1 sec^{-1}P.	2750
Flash Point °C	105
Distillation	
To 225°C	0
To 260°C	0
To 316°C	61
Residue %	90
Pen of Residue	155
Float 60°C, sec.	1200+
Solubility %	99.0
Water %	0.0

MC-3000	
TEST	**RESULT**
Flash Point °C	80
Kinematic Vis @ 60°C, es.	3500
Distillation	
To 225°C	0
To 260°C	0
To 316°C	32
Residue %	88
Pen of Residue	230
Ductility @ 25°C cm.	100+
Solubility %	99.95

TABLE C

TCLP FOR METALS FOR COLD MIXES (mg/l)

Description	AE-150	MC-3000	CM-300
BARIUM ppm	BDL	BDL	BDL
CADMIUM ppm	BDL	BDL	BDL
CHROMIUM ppm	BDL	BDL	BDL
LEAD ppm	BDL	BDL	BDL
SILVER ppm	BDL	BDL	BDL
ARSENIC ppm	BDL	BDL	BDL
SELENIUM ppm	BDL	BDL	BDL
MERCURY ppm	BDL	BDL	BDL

TABLE D

VOLATILE ORGANICS FOR COLD MIXES (ug/L)

Description	AE-150	MC-3000	CM-300	Det. Limit
BENZENE	BDL	BDL	BDL	50
CARBON TETRACHLORIDE	BDL	BDL	BDL	50
CHLOROBENZENE	BDL	BDL	BDL	50
CHLOROFORM	BDL	BDL	BDL	50
1,2-DICHLOROETHANE	BDL	BDL	BDL	50
1,1-DICHLOROETHYLENE	BDL	BDL	BDL	50
METHYL ETHYL KETONE	BDL	BDL	BDL	100
TETRACHLOROETHYLENE	BDL	BDL	BDL	50
TRICHLOROETHYLENE	BDL	BDL	BDL	50
VINYL CHLORIDE	BDL	BDL	BDL	100

TABLE E

TCLP SEMIVOLATILES ORGANICS FOR COLD MIXES (ug/l)

DESCRIPTION	AE-150	MC-3000	CM-300	DET. LIMIT
1,4-DICHLOROBENZENE	BDL	BDL	BDL	50
2,4-DINITROTOLUENE	BDL	BDL	BDL	50
HEXACHLOROBENZENE	BDL	BDL	BDL	50
HEXACHLOROBUTADIENE	BDL	BDL	BDL	50
HEXACHLOROETHANE	BDL	BDL	BDL	50
NITROBENZENE	BDL	BDL	BDL	50
PYRIDINE	BDL	BDL	BDL	250
2-METHYL PHENOL	BDL	BDL	BDL	50
3-METHYL PHENOL	BDL	BDL	BDL	50
4-METHYL PHENOL	BDL	BDL	BDL	50
PENTACHLOROPHENOL	BDL	BDL	BDL	250
2,4,5-TRICHLOROPHENOL	BDL	BDL	BDL	50
2,4,6-TRICHLOROPHENOL	BDL	BDL	BDL	50

TABLE F

POLYNUCLEAR AROMATIC HYROCARBONS BY HPLC FOR COLD MIXES (ug/L)

Description	AE-150	MC-3000	CM-300	Det. Limit
NAPHTHALENE	4.4	8.0	14	0.16
ACENAPHTHYLENE	BDL	BDL	BDL	0.25
ACENAPHTHENE	0.41	BDL	2.7	0.16
FLUORENE	1.8	0.34	1.0	0.019
PHENANTHRENE	1.3	0.74	1.1	0.16
ANTHRACENE	0.14	BDL	0.090	0.021
FLUORANTHENE	BDL	BDL	0.19	0.021
PYRENE	BDL	BDL	0.10	0.075
BENZ (A) ANTHRACENE	BDL	BDL	BDL	0.13
CHRYSENE	BDL	BDL	BDL	0.041
BENZO (B) FLUORANTHENE	BDL	BDL	BDL	0.029
BENZO (K) FLUORANTHENE	BDL	BDL	BDL	0.013
BENZO (A) PYRENE	BDL	BDL	BDL	0.23
DIBENZO (A,H) ANTHRACENE	BDL	BDL	BDL	0.085
BENZO (G,H,I) PERYLENE	BDL	BDL	BDL	0.14
INDENO (1,2,3-CD)PYRENE	BDL	BDL	BDL	0.028

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LEACHABILITY OF ASPHALT AND CONCRETE PAVEMENTS

March 5, 1992

by: Anthony J. Kriech

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INTRODUCTION:

The IAPA (Illinois Asphalt Pavement Association) contracted with Heritage Research Group to study the leachability of both Portland Cement Concrete (PCC) and Hot Mix Asphalt Pavements (HMA). Granular materials, including soil from the edge of each pavement type, were also tested to determine leachability. The design of this experiment was through the joint cooperation of the Illinois Environmental Protection Agency, Illinois Department of Transportation and IAPA. The purpose of the study was to determine the suitability of using concrete, asphalt, or soils from the surrounding roadway for use as clean fill. The concern is that the incidental spills onto the road from cars and trucks could contaminate the pavement and surrounding road side, and make these road materials unsuitable for use in clean fill situations below the water table. Specifically, unsubstituted Polynuclear Aromatic Hydrocarbons (PAH's) and heavy metals were studied. These were chosen because volatile and semi-volatile compounds, which may be spilled on the road, evaporate quickly. Previous studies by Heritage Research Group[1,2] have not found these compounds present. Only the metals and high molecular weight organic compounds tend to remain.

SITE LOCATIONS:

The Illinois Department of Transportation located a section of pavement on Route #4 south of Springfield. The unique feature of the pavement section was that it contained Portland Cement Concrete, which was built in 1976 and a Hot Mix Asphalt pavement, which abuts this section and was also built at the same time. Because these sections are contiguous, the traffic on each are identical. Three sites were randomly selected in each pavement type, as to longitudinal location. Coring occurred on December 17, 1991 by IDOT District personnel. Once a site was selected, three four inch specimens were taken across the pavement. The first is between the wheel paths, the second was in the outer wheel path, and the third was taken outside the outer wheel path. A sample of soil and granular material was also taken from the shoulder of the road. The sample identification and locations are listed in Figure A. The "W" proceeding the numbers indicates white (PCC) pavements and "B" indicates black (HMA) pavements.

Heritage Research also received some laboratory prepared samples from IDOT laboratories. Sample W-0 is a Portland Cement Concrete laboratory cylinder. The composition is listed in Figure B. Sample B-0 is a Hot Mix Asphalt sample prepared by IDOT and the compositional mix design is listed in Figure C. These samples were used as controls and are free of any potential contamination, which the road samples may have received since they were placed in 1976.

SAMPLE PREPARATION:

To prepare the sample for Toxic Characteristics Leachability Procedure (TCLP) in accordance with EPA guidelines, the samples were crushed to pass the 9.5 mm. sieve size. An impact crusher was used to reduce the samples to below this size.

Representative materials from each sample location were combined with other samples sites to test various hypothesis about pavement contamination. The first was that contamination may be greater between the wheel path, because this is where crankcase drippings tend to fall. To test this theory, all samples from between the wheel path were combined for each pavement type to make one sample. A second hypothesis was that the samples taken from the wheel path would be cleaner, because the tires are constantly wearing this pavement away. This idea was tested by combining all samples in the wheel path for each pavement. Samples outside the wheel path were also combined to make a sample to determine if there was a similar trend in the data. The soil samples from the shoulder were also combined to determine if the soil was higher or lower than the pavement in leachability. Finally, one transverse sample was taken from one location of each pavement type and compared to longitudinal samples to test for site specific contamination. All of these combined samples were compared to the laboratory samples of each pavement type, which had been prepared in the laboratory as a control. Table A lists the combination of sites used to make each sample for TCLP testing.

METHODS:

After the combined samples were prepared by Heritage Research, they were submitted to EMS Heritage Laboratories for TCLP testing. EMS Heritage is an EPA certified laboratory. The test methods used are listed below.

Test	Method/Procedure
TCLP Procedure	SW-846-1311
PAH's	SW-846-8310
Metals	
Barium	SW-846-7080
Cadmium	SW-846-7130
Chromium	SE-846-7190
Lead	SW-846-7420
Silver Arsenic	SW-846-7760
Selenium	SW-846-7740
Mercury	SW-846-7470

SAMPLE ANALYSES:

A summary of the test results from the TCLP are listed in Table B for the Portland Cement Concrete Pavement and soil located next to this pavement type. Table C lists the leachability of Hot Mix Asphalt samples and soil corresponding to this pavement.

Please note that PAH's are measured in μg/L, which is parts per billion. The metal leachability is in mg/L or parts per million. The detection limit of the barium analyses varied with the sample. Because of high calcium in the leachate of some samples, the detection levels varied from 0.2 to 2.0. Matrix effects do impact on the detection level achievable in these samples.

COMMENTS:

1. Both the PCC and HMA laboratory prepared samples from IDOT had measurable amounts of metals leaching, but no measurable PAH's. The PCC sample indicated a small amount of leachable chrome. The HMA had measurable barium in the leachate.

2. Samples taken in the PCC section, whether taken longitudinally or transversely, showed trace amounts of naphthalene and phenanthrene in two samples. Both samples contained material from site W-3, so it could be the same contaminant. Four samples contained a small amount of Naphthalene. These values were, in all cases, less than one part per billion. One sample from the wheel path had measurable barium on the leachate.

3. The soil samples taken from the PCC shoulder produced no leachable PAH's. However, a measurable (3.5 ppm.) level of barium was found.

4. The HMA pavement appeared quite similar to the PCC pavement in leachate results. Only naphthalene and phenanthrene were found in the pavement leachate. In all cases, the level was under one part per billion. Metal leachate was confined to barium, which was present in both the laboratory and field samples. This would indicate that barium is not coming from contamination, but rather is most likely coming from the aggregate in the mixture. These values would probably be lower if the sample was not crushed, which exposes the uncoated aggregate surfaces and increasing the exposed surface area greatly.

5. The soil from the HMA shoulder also contained a measurable level (0.76 parts per billion) of naphthalene. Since the laboratory samples did not have measurable levels, it is possible that this came from surface contamination. Used crankcase oils and tire composition contains measurable quantities of both naphthalene and phenanthrene, and could be potential sources for these very low, but measurable values.

6. The hypothesis that contamination would be greater between the wheel paths than at other location was not supported by these results. Overall, the level of leachable PAH materials was too low to determine trends in the data.

CONCLUSIONS:

This study found that both PCC and HMA pavements each have very low levels of leachable metals and PAH materials. The relative low levels of leachable materials from both pavement types are quite similar. Soils from the shoulder of the road are quite similar in characteristics to the PCC and HMA pavements.

REFERENCES:

1. Kriech, Anthony J. *Evaluation of Hot Mix Asphalt for Leachability.* HRG #3959AOM3. October 15, 1990.

2. Kriech, Anthony J. *Evaluation of RAP for Use as a Clean Fill.* HRG #4122EM02. January 30, 1991.

TABLE A

Sample Identification

Sample #	Sample Identification	Description
1	W-0	PCC Uncontaminated, Laboratory Specimen
2	W-1, 2, 3	PCC Transverse Across the Pavement
3	W-1, 5, 9	PCC Between Wheel Path, Longitudinal Sample
4	W-2, 6, 10	PCC In Wheel Path, Longitudinal Sample
5	W-3, 7, 11	PCC Outside Wheel Path, Longitudinal Sample
6	W-4, 8, 12	PCC Soil from Shoulder, Longitudinal Sample
7	B-0	HMA Uncontaminated, Laboratory Specimen
8	B-1, 2, 3	HMA Transverse Across the Pavement
9	B-1, 5, 9	HMA Between Wheel Path, Longitudinal Sample
10	B-2, 6, 10	HMA In Wheel Path, Longitudinal Sample
11	B-3, 7, 11	HMA Outside Wheel Path, Longitudinal Sample
12	B-4, 8, 12	HMA Soil from Shoulder, Longitudinal Sample

TABLE B

ILLINOIS TCLP TEST RESULTS FOR PORTLAND CEMENT CONCRETE CORES

Sample Number	1 (Control)	2	3	4	5	6 (Soil)	---
Site Number	W-0	W-1,2,3	W-1,3,9	W-2,6,10	W-3,7,11	W-4,8,12	EMS Heritage Det. Limit
PAH's, μ/L.							
Naphthalene	BDL	0.44	0.21	0.23	0.26	BDL	0.16
Acenaphthylene	BDL	BDL	BDL	BDL	BDL	BDL	0.25
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	0.16
Fluorene	BDL	BDL	BDL	BDL	BDL	BDL	0.019
Phenanthrene	BDL	0.44	BDL	BDL	0.26	BDL	0.16
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	0.021
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	0.021
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.075
Benzo(A)Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	0.013
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	0.041
Benzo(B)Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	0.029
Benzo(K)Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	0.013
Benzo(A)Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.023
Dibenzo(A,H)Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	0.085
Benzo(G,H,I)Perylene	BDL	BDL	BDL	BDL	BDL	BDL	0.14
Indeno(1,2,3-cd)Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.028
Metals, mg/L.							
Barium	BDL	BDL	BDL	1.2*	BDL	3.5	2.000
Cadmium	BDL	BDL	BDL	BDL	BDL	BDL	0.020
Chromium	0.072	BDL	BDL	BDL	BDL	BDL	0.050
Lead	BDL	BDL	BDL	BDL	BDL	BDL	0.200
Silver	BDL	BDL	BDL	BDL	BDL	BDL	0.040
Arsenic	BDL	BDL	BDL	BDL	BDL	BDL	0.005
Selenium	BDL	BDL	BDL	BDL	BDL	BDL	0.010
Mercury	BDL	BDL	BDL	BDL	BDL	BDL	0.005

*This sample had a detection limit for barium of 0.2.

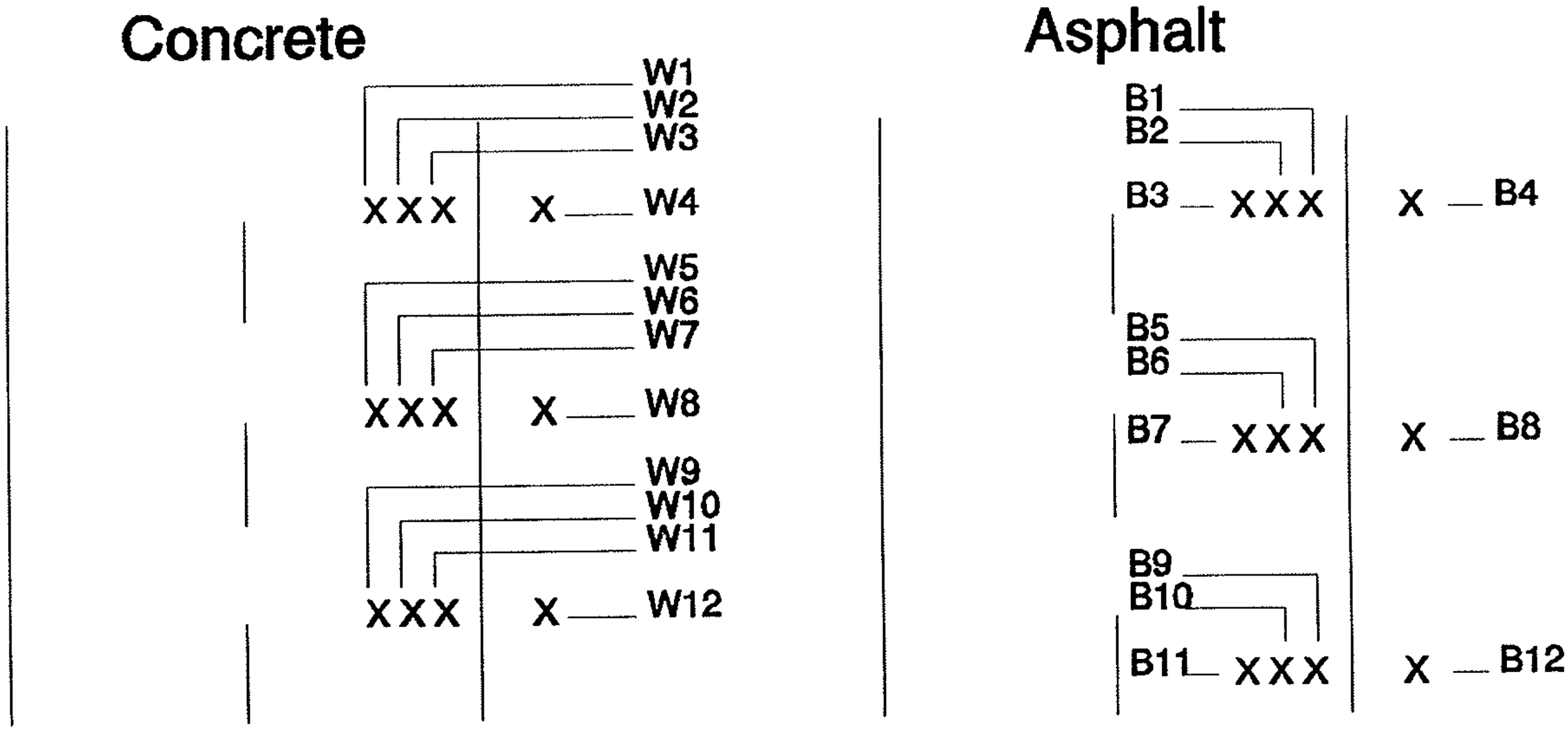
TABLE C

ILLINOIS TCLP TEST RESULTS FOR HOT MIX ASPHALT CORES

Sample Number	7 (Control)	8	9	10	11	12 (Soil)	---
Site Number	B-0	B-1,2,3	B-1,3,9	B-2,6,10	B-3,7,11	B-4,8,12	EMS Heritage Det. Limit
PAH's, μ/L.							
Naphthalene	BDL	0.26	0.26	0.31	0.28	0.76	0.16
Acenaphthylene	BDL	BDL	BDL	BDL	BDL	BDL	0.25
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	0.16
Fluorene	BDL	BDL	BDL	BDL	BDL	BDL	0.019
Phenanthrene	BDL	BDL	BDL	0.30	BDL	BDL	0.16
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	0.021
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	0.021
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.075
Benzo(A)Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	0.013
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	0.041
Benzo(B)Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	0.029
Benzo(K)Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	0.013
Benzo(A)Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.023
Dibenzo(A,H)Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	0.085
Benzo(G,H,I)Perylene	BDL	BDL	BDL	BDL	BDL	BDL	0.14
Indeno(1,2,3-cd)Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.028
Metals, mg/L.							
Barium	2.9	3.7	BDL	3.1	2.6	3.5	2.000
Cadmium	BDL	BDL	BDL	BDL	BDL	BDL	0.020
Chromium	BDL	BDL	BDL	BDL	BDL	BDL	0.050
Lead	BDL	BDL	BDL	BDL	BDL	BDL	0.200
Silver	BDL	BDL	BDL	BDL	BDL	BDL	0.040
Arsenic	BDL	BDL	BDL	BDL	BDL	BDL	0.005
Selenium	BDL	BDL	BDL	BDL	BDL	BDL	0.010
Mercury	BDL	BDL	BDL	BDL	BDL	BDL	0.005

FIGURE A

SAMPLE LOCATIONS ON ILLINOIS ROUTE 4



Sample #1, 5 & 9 are inbetween wheel paths.
Sample #2, 6 & 10 are in the outer wheel paths.
Sample #3, 7 & 11 are ourside the outer wheel paths.
Samples #4, 8 & 12 are soil samples from the shoulder.

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EVALUATION OF RAP FOR USE AS A CLEAN FILL

by: Anthony J. Kriech

January 30, 1991
HRG #4122EM02

12

Background:

The IAPA (Illinois Asphalt Pavement Association) has asked Heritage Research Group to evaluate six RAP (Reclaimed Asphalt Pavements) for their potential use as a clean fill. In certain situations the RAP, which is produced by milling an old pavement is unsuitable for recycling and could be used on site for clean fill. The goal of this testing program is to determine if the RAP contains materials which may make it environmentally unsuitable for clean fill.

Site Locations:

Six RAP samples were selected based on achieving a wide geographical cross section of the state of Illinois. This would ensure that different aggregates, as well as asphalt sources, were included in the study. The sample location can be found in Figure A with a sample description and code in Table A.

Sample Log-in and Preparation:

Samples were received directly from IDOT (Illinois Department of Transportation) personnel via UPS, along with a Sample Identification Form. This information includes date sampled, location, project, type of material, how it was removed and person obtaining the sample. This information is summarized in the sample identification Table A. The 50 lb. samples were split using a Gilson splitter to obtain smaller representative samples for further testing.

Sample Analysis:

The sample analysis was performed in two parts. The first is physical testing of the RAP for typical properties. This includes asphalt content, gradation (aggregate sizing) and Abson Recovery to look at the physical properties of the recovered asphalt cement, which is removed from the aggregate. These tests were performed by Heritage Research personnel using appropriate ASTM (American Society of Testing Materials) and AASHTO (American Association of State Highway and Transportation Officials) procedures. Heritage Research is inspected by AMRL (AASHTO Materials Reference Laboratories), a division of the National Bureau of Standards for procedures and laboratory equipment for these tests. Heritage Research also participates in a round robin of laboratories conducted by AMRL for these procedures on a regular basis. The results of the physical tests are enclosed in Table B.

The environmental testing involved testing for PCB's (Polychlorinated Biphenyls) on the samples before leachate testing. Identical samples were also prepared for TCLP (Toxic

Characteristic Leachability Procedure) for each RAP source. Samples were crushed to correspond to the size requirements of the test. Samples were hand carried to EMS Heritage Laboratories by Heritage Research personnel. Following the TCLP test the leachate was tested for semivolatile organics, Polynuclear Aromatic Hydrocarbons by HPLC and metals by Atomic Absorption.

Background information on EMS Heritage Laboratory qualification to run these tests are listed in Appendix A for your information.

Test procedures were in accordance with EPA procedures and are as follows.

	Method/Procedure
PCB Extraction Procedure	SW846-3550
PCB Analysis	SW846-8080
TCLP Procedure	SW846-1311
Semivolatiles GC/MS	SW846-3510
PAH's	SW846-8310
Metals	SW846-3010

A summary report of the results is listed in Table C. A complete listing of the results from EMS/Heritage is included in Appendix B.

Comments:

1. Physical testing indicates that these RAP samples are typical in gradation, asphalt content and asphalt residue properties to other RAP materials tested by Heritage Research Group.

2. PCB's were tested on the RAP samples, not on the leachate after TCLP. The results were then measured on a weight basis in mg/Kg. or parts per million. There is not a currently known method for testing on leachate. From these results it appears that no PCB's were found at the detection limits listed in any sample.

3. TCLP leachate did not contain any of the standard semivolatile compounds normally tested for by the EPA at the detection limits listed. It should be noted that semivolatiles are listed in μg/liter, which is parts per billion.

4. The polynuclear aromatic hydrocarbon show up in only trace levels. Naphthalene, the most volatile PAH is still under a half a part per billion, which is well within any guidelines tested for this material. Benzo (A) pyrene, a known carcinogen which is often used as a marker compound for PAH's, was not found in any sample at the detection limits reported.

5. Metals were also tested and found to have measurable values in three samples. Barium is present in all three samples, but 200-300 times below maximum concentration of contaminants for TCLP under RCRA (Resource Conservation Recovery Act) for hazardous materials by characteristics (see Table D for guidelines). Barium was also below national drinking water standards for this metal. For metals it is one hundred fold below Table D guidelines. Chrome and lead are also below the Table D guidelines for hazardous by characteristic. The leachate on Site #2 would, however, not meet drinking water standards. It is important to point out that Site #1 meets all guidelines, whereas Site #2 had low, but measurable levels of lead, chrome, and barium. Both of these were taken from the same project, but at different locations. This could indicate that contamination of the surface was a possible cause for having a low, but measurable level. Barium could be from a lube additive and be from crankcase drippings. The same is true for chrome, a wear metal. Lead could also be from crankcase oil and leaded gasoline.

   Background samples from soils along the roadside have been studied in the literature. It is not unusual to find much higher levels of lead than encountered in this sample due to the use of leaded fuel in the past.

Conclusions:

After a thorough investigation of these samples it can be ascertained that all of these samples meet current guidelines for TCLP maximum concentration for the contaminants by characteristic. Due to asphalt non-volatile viscoelastic properties this is not surprising. The migration of metals and organics are impaired greatly by the matrix of asphalt and aggregate. It is contaminants which may be spread on the road surface later through spills or accidents, which could change these characteristics. The results on this representative group of RAP samples would suggest that RAP should not be a concern for clean fill.

TABLE A

Site No.	Date Sampled	County	Route/ Sta. No.	Project	Material Type	How Removed	IDOT Personnel Taking Sample
#1	10/08/90	Vermillion	Route #1 1100+06	C-95-143-89	Surface/Binder	Milled	Alex Kedas
#2	10/08/90	Vermillion	Route #1 112+50	C-95-143-89	Surface/Binder	Milled	Alex Kedas
#3	10/11/90	Peoria	IL 88 36+88	FA 646/88171	Surface	Milled	Leroy Williams
#4	10/15/90	Cook	First Avenue	#80451	Surface	Milled	Eddie Pizarro
#5	09/26/90	St. Clair	IL 159 200+00	#96198 FA600	Surface/Binder	Roadtec RX50 Roto-Milled	Allan Guttmann
#6	09/13/90	Jackson	IL 3 IL 151	#98071 FA14	Surface	Cold Milling	Larry Miloshewski

TABLE B

Site Number	#1	#2	#3	#4	#5	#6
County Located	Vermillion	Vermillion	Peoria	Cook	St. Clair	Jackson
Asphalt Content, %	5.2	4.9	4.4	4.4	5.2	3.9
Abson						
Penetration @ 77°F	33	23	26	42	48	35
Viscosity @ 140°F	15614	27040	19225	9121	9017	8335
Gradation						
Passing 2"	100.0	100.0	100.0	100.0	100.0	100.0
Passing 1-1/2"	100.0	100.0	100.0	100.0	100.0	100.0
Passing 1"	100.0	100.0	100.0	100.0	100.0	100.0
Passing 3/4"	100.0	100.0	99.0	98.6	99.8	100.0
Passing 1/2"	98.8	100.0	96.2	92.4	98.7	97.9
Passing 3/8"	95.1	99.3	90.6	85.6	95.2	92.8
Passing #4	76.5	73.5	64.9	56.2	69.5	59.3
Passing #8	60.0	47.5	45.4	37.9	51.4	39.3
Passing #16	47.8	35.3	36.2	30.2	41.9	30.3
Passing #30	37.7	27.6	29.2	25.3	30.8	23.1
Passing #50	24.4	16.6	19.0	18.7	19.7	15.0
Passing #100	12.0	9.2	11.6	7.8	11.6	8.3
Passing #200	6.6	6.4	7.5	7.7	7.4	5.4

TABLE C

STATE OF ILLINOIS TCLP TEST RESULTS

Site Number	#1	#2	#3	#4	#5	#6	Det. Limit
Semi-Volatiles, µg/L.							
1,4 Dichlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	50
2,4 Dinitrotoluene	BDL	BDL	BDL	BDL	BDL	BDL	50
Hexachlorobenzene	BDL	BDL	BDL	BDL	BDL	BDL	50
Hexachlorobutadiene	BDL	BDL	BDL	BDL	BDL	BDL	50
Haxachloroethane	BDL	BDL	BDL	BDL	BDL	BDL	50
Nitrobenzene	BDL	BDL	BDL	BDL	BDL	BDL	250
Pyridine	BDL	BDL	BDL	BDL	BDL	BDL	120
Cresylic Acid	BDL	BDL	BDL	BDL	BDL	BDL	50
2 Methyl Phenol	BDL	BDL	BDL	BDL	BDL	BDL	50
3 Methyl Phenol	BDL	BDL	BDL	BDL	BDL	BDL	50
4 Methyl Phenol	BDL	BDL	BDL	BDL	BDL	BDL	250
Pentachlorophenol	BDL	BDL	BDL	BDL	BDL	BDL	250
2,4,5-Trichlorophenol	BDL	BDL	BDL	BDL	BDL	BDL	50
2,4,6-Trichlorophenol	BDL	BDL	BDL	BDL	BDL	BDL	---
PCB's, mg/Kg.							
PCB Arochlor 1016	BDL	BDL	BDL	BDL	BDL	BDL	1.0
PCB Arochlor 1221	BDL	BDL	BDL	BDL	BDL	BDL	5.0
PCB Arochlor 1232	BDL	BDL	BDL	BDL	BDL	BDL	1.0
PCB Arochlor 1242	BDL	BDL	BDL	BDL	BDL	BDL	1.0
PCB Arochlor 1248	BDL	BDL	BDL	BDL	BDL	BDL	1.0
PCB Arochlor 1254	BDL	BDL	BDL	BDL	BDL	BDL	1.0
PCB Arochlor 1260	BDL	BDL	BDL	BDL	BDL	BDL	1.0
PCB Arochlor 1262	BDL	BDL	BDL	BDL	BDL	BDL	1.0

TABLE C

STATE OF ILLINOIS TCLP TEST RESULTS

Site Number	#1	#2	#3	#4	#5	#6	Det. Limit
PAH's, µ/L.							
Naphthalene	0.49	BLD	BDL	0.30	BDL	BDL	0.13
Acenaphthylene	BDL	BDL	BDL	BDL	BDL	BDL	0.20
Acenapthene	0.14	BDL	BDL	BDL	BDL	BDL	0.13
Flourene	BDL	BDL	BDL	BDL	BDL	BDL	0.015
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	0.13
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	0.017
Fluorathene	BDL	BDL	BDL	BDL	BDL	BDL	0.017
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.060
Benzo(A)Anthracene	BDL	BDL	BDL	BDL	0.017	BDL	0.017
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	0.033
Benzo(B)Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	0.023
Benzo(K)Fluoranthene	BDL	BDL	BDL	BDL	0.050	BDL	0.017
Benzo(A)Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.240
Dibenzo(A,H)Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	0.068
Benzo(G,H,I)Perylene	BDL	BDL	BDL	BDL	BDL	BDL	0.110
Indeno(1,2,3-cd)Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.022
Metals, mg/L.							
Barium	BDL	0.40	0.36	0.33	BDL	BDL	0.200
Cadmium	BDL	BDL	BDL	BDL	BDL	BDL	0.200
Chromium	BDL	0.52	BDL	BDL	BDL	BDL	0.050
Lead	BDL	1.80	BDL	BDL	BDL	BDL	0.200
Silver	BDL	BDL	BDL	BDL	BDL	BDL	0.040
Arsenic	BDL	BDL	BDL	BDL	BDL	BDL	0.005
Selenium	BDL	BDL	BDL	BDL	BDL	BDL	0.025
Mercury	BDL	BDL	BDL	BDL	BDL	BDL	0.005

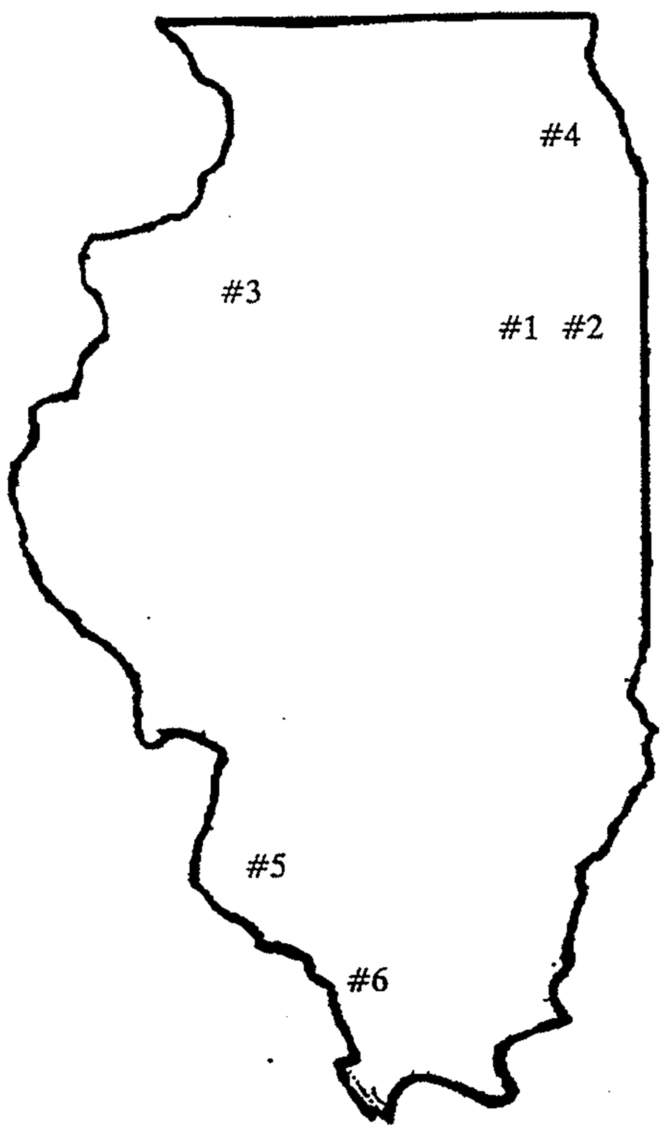
TABLE D

MAXIMUM CONCENTRATION OF CONTAMINANTS FOR THE TOXICITY CHARACTERISTIC (TCLP)

EPA HW NUMBER	CONTAMINANT	CHARACTERISTIC LEVEL (mg/L)
D004	Arsenic	5.0
D005	Barium	100.0
D018	Benzene	0.5
D006	Cadmium	1.0
D019	Carbon Tetrachloride	0.5
D020	Chlordane	0.03
D021	Chlorobenzene	100.0
D022	Chloroform	6.0
D007	Chromium	5.0
D023	0-Cresol	200.0
D024	m-Cresol	200.0
D025	p-Cresol	200.0
D026	Cresol	200.0
D016	2,4-D	10.0
D027	1,4-Dichlorobenzene	7.5
D028	1,2-Dichloroethane	0.5
D029	1,1-Dichloroethylene	0.7
D030	2,4-Dinitrotoluene	0.13
D012	Endrin	0.02
D031	Heptachlor (and its hydroxide)	0.008
D032	Hexachlorobenzene	0.13
D033	Hexachlorobutadiene	0.5
D034	Hexachloroethane	3.0
D008	Lead	5.0
D013	Lindane	0.4
D009	Mercury	0.2
D014	Methoxychlor	10.0
D035	Methyl ethyl ketone	200.0
D036	Nitrobenzene	2.0
D037	Pentachlorophenol	100.0
D038	Pyridine	5.0
D010	Selenium	1.0
D011	Silver	5.0
D039	Tetrachloroethylene	0.7
D015	Toxaphene	0.5
D040	Trichloroethylene	0.5
D041	2,4,5-Trichlorophenol	400.0
D042	2,4,6-Trichlorophenol	2.0
D017	2,4,5-TP(Silvex)	1.0
D043	Vinyl chloride	0.2

FIGURE A

SITE LOCATIONS FOR RAP SAMPLES



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EVALUATION OF HOT MIX ASPHALT FOR LEACHABILITY

by: Anthony J. Kriech

HRG #3959AOM3 (9101)
October 15, 1990

13

INTRODUCTION

A #11 surface mixture was prepared in the laboratory at Heritage Research. This mixture was then tested for TCLP (Toxic Characteristic Leachability Procedure) by EPA SW846-1311 and SW846-351 method. The leachate was then tested for metals, volatiles, semivolatiles, organics, and PAH's (Polynuclear Aromatic Hydrocarbons) to determine what materials, if any, were leachable from a new asphalt mixture.

Materials

The material was an AC-20 asphalt cement from Asphalt Materials Inc. in Indianapolis. The aggregate was a #11 Levy slag, #11 stone and #24 sand from Martin Marietta in Indianapolis. The blend of materials is listed below.

	% by Weight
#11 Slag	23.4
#11 Stone	23.4
#24 Sand	46.7
AC-20	6.5

The mixture met current InDOT (Indiana Department of Transportation) specifications according to InDOT 401.02 specifications.

LEACHATE TESTING

Leachate testing and analyses was performed by Heritage EMS Laboratories of Indianapolis. After the TCLP testing, the leachate was subjected to the following analyses.

Test	Method/Procedure
TCLP	SW846-1311
Semivolatiles GC/MS	SW846-3510
PAH's	SW846-8310
Metals	SW846-3010
Volatiles	SW846-3510

Metal Results

Table A lists the results of metal leachability. The metals selected are those heavy metals normally tested for by the EPA. The results show only chrome had a level above detection limit at 0.1 ppm. This is 50 fold below the level of hazardous by characteristic under RCRA (Resource Conservation Recovery Act). Since the asphalt does not typically contain measurable chrome levels, it is possible that the small level of chrome is coming from the slag aggregate, a by-product of the steel making process.

Volatile Organic Results

Table B lists the volatile organic compounds of concern. The results are in parts per billion and show no measurable compound above detection limits. This procedure uses the zero head space TCLP method.

Semivolatile Organic Results

Table C lists the semivolatile organics after TCLP. Again, the results are in parts per billion and no measurable amounts were found above detection limits.

PAH Organic Results

Table D gives the results of leachable PAH's. These compounds are the highest molecular weight group of organic compounds routinely tested by the EPA. Because of asphalt's high molecular weight, there is a concern that these compounds could be present. The detection limits for these compounds are extremely low allowing measurement well below one part per billion. Only a quarter part per billion of naphthalene was found in the asphalt mix leachate. Naphthalene, the most volatile PAH, is well below any established guideline. Naphthalene is not carcinogenic like some of the other PAH's such as Benzo(A)pyrene carcinogenic, which were not found to be present.

CONCLUSIONS

The leachate testing on the #11 surface indicates very low levels of leachable compounds. These levels are well below any guidelines

TABLE A *Metal Leachates (1311)*		
Parameter	Result, mg/L	Detection Limit mg/L
Barium	BDL	2.000
Cadmium	BDL	0.020
Chromium	0.10	0.010
Lead	BDL	0.200
Silver	BDL	0.040
Arsenic	BDL	0.005
Selenium	BDL	0.005
Mercury	BDL	0.005

TABLE B *Zero Head Space of TCLP Organic (3510)*		
Parameter	Result $\mu g/L$	Detection Limit $\mu g/L$
Benzene	BDL	5
Carbon Tetrachloride	BDL	5
Chlorobenzene	BDL	5
Chloroform	BDL	5
1,2 dichloroehtylene	BDL	5
1,1 dichloroethylene	BDL	5
Methyl Ethyl Ketone	BDL	5
Tetrachloroethylene	BDL	5
Trichloroethylene	BDL	5
Vinyl Chloride	BDL	5

TABLE C *TCLP Semi-Volatile Organics*		
Parameter	Result μg/L	Detection Limit μg/L
1,4-Dichlorobenzene	BDL	12
2,4-Dinitrotoluene	BDL	12
Hexachlorobenzene	BDL	12
Hexachlorobutadine	BDL	12
Hexachloroethane	BDL	12
Nitrobenzene	BDL	12
Pyridine	BDL	60
Cresylic Acid	BDL	30
2-Methyl Phenol	BDL	30
3-Mehtyl Phonel	BDL	30
4-Methyl Phenol	BDL	30
Pentachlorophenol	BDL	60
2,4,5-Trichlorophenol	BDL	30
2,4,6-Trichlorophenol	BDL	30

TABLE D *POLYNUCLEAR AROMATIC HYDROCARBONS BY TCLP*		
Parameter	Result μg/L	Detection Limit μg/L
Naphthalene	0.25	0.096
Acenaphthylene	BDL	0.15
Acenaphthene	BDL	0.194
Fluorene	BDL	0.023
Phenanthrene	BDL	0.033
Anthracene	BDL	0.015
Fluoranthene	BDL	0.037
Pyrene	BDL	0.04
Benz(A)Anthracene	BDL	0.048
Chrysene	BDL	0.017
Benzo(B)Fluoranthene	BDL	0.02
Benzo(K)Fluoranthene	BDL	0.022
Benzo(A)Pyrene	BDL	0.023
Dibenzo(A,H)Anthracene	BDL	0.018
Benzo(G,H,I)Perylene	BDL	0.036
Indeno(1,2,3-CD)Pyrene	BDL	0.021