PAVEMENT TECHNOLOGY INC.

24144 DETROIT ROAD
WESTLAKE, OHIO 44145
(440) 892-1895
(800) 333-6309
FAX (440) 892-0953

Asphalt Recycling & Preventive Maintenance Specialists

January 9, 2023

Ms. Deidre Bain
Procurement Agent
Procurement Department
The City of Plantation
400 NW 73rd Avenue
Plantation, FL 33317

RE: Asphalt Rejuvenating Project – ITB #072-22

Dear Ms. Bain,

Enclosed is our submission for the referenced Invitation to Bid. Should we be determined low bidder, we would like to provide our financial statement upon your request at that time, if this is suitable to you.

Thank you for your time and consideration. We look forward to our continued working relationship with The City of Plantation.

Sincerely,

Debbie Cancelliere

Debbie Cancelliere
Contracts Administrator
dcancelliere@pavetechinc.com

enclosures

NON-COLLUSION CERTIFICATION

TO BE RETURNED WITH BID

By signing and submitting this bid, the BIDDER certifies that this bid is made independently and free from collusion.

BIDDER shall disclose below, to their best knowledge, any City of Plantation officer or employee, or any relative of any such officer or employee as defined in Section 112.3135(1) (c), Florida Statutes (2014), who is an officer of director or, or has a material interest in, the BIDDER's business, who is in a position to influence this procurement. Any City of Plantation officer or employee who has any input into the writing of specifications or requirements, solicitation of offers, decision to award, evaluation of offers, or any other activity pertinent to this procurement is presumed, for purposes hereof, to be in a position to indirectly own any of the total assets or capital stock of any business entity owned or operated by the BIDDER, or if they otherwise stand to personally gain if the contract is awarded to this BIDDER.

Failure to submit this executed statement as part of the bid shall make the bid nonresponsive and not eligible for award consideration. In the event the BIDDER does not indicate any names, the CITY shall interpret this to mean that the BIDDER has indicated that no such relationships exist. Failure of a BIDDER to disclose any relationship described herein shall be reason for termination of bid or award, whichever is applicable, with no time to cure.

NAME	RELATIONSHIP
N/A	N/A

Witnesses:

Typed name: Susan Durante

Typed name: Debbie Cancelliere

BIDDER:

By: Colin Durante

Name: Colin Durante

Title: President

NON-COLLUSION CERTIFICATION

NOTARY BLOCK FOR AN INDIVIDUAL

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of personal acknowledging*), who is personally known to me or who has produced _____(*type of identification*) as identification.

My commission expires: _____

NOTARY PUBLIC

NOTARY BLOCK FOR A CORPORATION

STATE OF Ohio

COUNTY OF Cuyahoga

The foregoing instrument was acknowledged before me by means of ☑ physical presence or □ online notarization, this 1/9/23 (*date*) by Colin Durante, President (*name of officer or agent, title of officer or agent*), of Pavement Technology, Inc. (*name of corporation acknowledging*), an Ohio (*state or place of incorporation*) corporation, on behalf of the corporation. He/she is personally known to me or who has produced _____ (*type of identification*) as identification.

My commission expires: Elizabeth Mielcusny

NOTARY PUBLIC

Elizabeth Mielcusny
Notary Public, State of Ohio
My Commission Expires: February 27, 2025

NOTARY BLOCK FOR A LIMITED LIABILITY COMPANY:

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of member, manager, officer, or agent, title of member, manager, officer or agent*), of _____(*name of company acknowledging*), a _____(*state or place of formation*) limited liability company, on behalf of the company, who is personally known to me or who has produced _____(type of identification) as identification.

My commission expires:

_____

NOTARY PUBLIC

QUALIFICATION STATEMENT

Fill in Form

The undersigned certifies under oath the truth and correctness of all statements and of all answers to questions made hereinafter (Attach additional sheets with appropriate reference, if necessary). You must respond to all questions. **FAILURE TO DISCLOSE OR PROVIDE THE REQUESTED INFORMATION BELOW MAY RESULT IN THE BIDDER'S BID BEING DEEMED NON-RESPONSIVE AND THE BIDDER AS NOT QUALIFIED FOR AWARD.**

SUBMITTED TO: City of Plantation

ADDRESS: 400 NW 73rd Avenue
Plantation, FL 33317

SUBMITTED BY: Pavement Technology, Inc.

NAME: Colin Durante

ADDRESS: 24144 Detroit Road, Westlake, OH 44145

TELEPHONE NO.: 440-892-1895

FAX NO.: 440-892-0953

EMAIL ADDRESS: dcancelliere@pavetechinc.com

1. State the true, exact, correct and complete name of the partnership, corporation, trade or fictitious name under which you do business and the address of the place of business.

   The correct name of the BIDDER is: Pavement Technology, Inc.

   The address of the principal place of business is: 24144 Detroit Road, Westlake, OH 44145

   The business is a (Sole Proprietorship) _____ (Partnership) _____ (Corporation) ✓

2. If BIDDER is a corporation, answer the following:
   a. Date of Incorporation: 5/30/1972
   b. State of Incorporation: Ohio
   c. President's Name: Colin Durante
   d. Vice President's Name: John Schlegel
   e. Secretary's Name: Susan Durante
   f. Treasurer's Name: Susan Durante
   g. Name and address of Resident Agent: Business Filings Incorporated
      1200 S. Pine Island Rd., Plantation, FL 33324

3. If BIDDER is an individual or a partnership, answer the following:

   a. Date of organization: _____
   b. Name, address and ownership units of all partners: _____
   c. State whether general or limited partnership: _____

QUALIFICATION STATEMENT

4. If BIDDER is other than an individual, corporation or partnership, describe the organization and give the name and address of principals:
Bidder is a corporation.

5. If BIDDER is operating under a fictitious name, submit evidence of compliance with the Florida Fictitious Name Statute. N/A

6. How many years has your organization been in business under its present business name: 50

   a. Under what other former names has your organization operated?
   None.

7. Indicate registration, license numbers or certificate numbers for the business or professions that are the subject of this Proposal. Please attached certificate of competency and/or state registration. Please include the foregoing information for all parties to be assigned to the project.

   State of Florida - Certificate P12308

8. Have you personally inspected the site(s) of the proposed work? (Y) Yes (N)

9. Do you have a complete set of documents, including agenda? (Y) Yes (N) ___

10. Have you ever failed to complete any work awarded to you? If so, state when, where and why?

    No.

11. Within the five (5) years, has any officer of partner of your organization ever been an officer or partner of another organization when it failed to complete a contract? If so, explain fully.

    No.

12. State the names, telephone numbers and last known addresses of three (3) owners, individuals or representatives of owners with the most knowledge of work which you have performed or goods you have provided, and to which you refer (government owners are preferred as references).

    Please see page 29.

13. List the pertinent experience of the key individuals of your organization (continue on insert sheet, if necessary).

    Please see attached Key Individuals' Experience Records.

14. Provide a list of similar projects, which have been completed within the past five (5) years, including project description, owner's names, addresses and phone numbers.

    Please see attached Project Experience List.

15. Provide a list of work currently under contract.

    Please see attached Current Contracts List.

16. On Exhibit A, list all disputes, claims, mediations and litigation in which the bidding entity, a parent entity, an affiliate entity, a predecessor entity or other entities with which you were then associated or affiliated were involved in any contract disputes over the last five (5) years as of the solicitation response due date. If BIDDER is a joint venture, the information provided should encompass the joint venture and each of the entities forming the joint venture. For said claim, identify with particularity the nature of such dispute, the names and addresses of the other parties to such disputes, and whether or how such disputes were resolved, including any mediation, arbitration or litigation involved and dollar awards. [Do not include disputes, claims, mediations and litigation that involve only garnishment, auto negligence, personal injury, or a proof of claim filed by BIDDER]

N/A

17. List all disputes, claims, mediations and litigation between the Owner and any of the responding entity's subcontractors/subconsultants over the last five (5) years as of the solicitation response due date.

N/A

18. Has any governmental entity within the last five (5) years commenced proceedings to discipline any of the officers, partners, or principals of the BIDDER, or sought to revoke a license held by the BIDDER (or its qualifying agent)? If so, please describe in detail the proceedings and how the matter was resolved.

No.

19. Will you sublet any part of this work? If so, give details. (sub-contractor's name, address, phone number and contact)

No.

20. Provide a list of equipment available to be committed to perform the work contemplated under this contract.

Please see attached Equipment List.

21. Please list any objections to the text of the Contract Documents in the area below or on separate sheets of paper attached hereto, if necessary.

N/A

22. Please attach a copy of your latest financial statement.

Fill in Form

QUALIFICATION STATEMENT

NOTARY BLOCK FOR AN INDIVIDUAL

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of personal acknowledging*), who is personally known to me or who has produced _____(*type of identification*) as identification.

My commission expires: _____

NOTARY PUBLIC, STATE OF FLORIDA

NOTARY BLOCK FOR A CORPORATION

STATE OF Ohio

COUNTY OF Cuyahoga

The foregoing instrument was acknowledged before me by means of ☑ physical presence or □ online notarization, this 1/9/23 (*date*) by Colin Durante, President (*name of officer or agent, title of officer or agent*), of Pavement Technology, Inc. (*name of corporation acknowledging*), an Ohio (*state or place of incorporation*) corporation, on behalf of the corporation. He/she is personally known to me or who has produced _____ (*type of identification*) as identification.

My commission expires: Elizabeth Mielcusny

Elizabeth Mielcusny
Notary Public, State of Ohio
My Commission Expires: February 27, 2025

NOTARY PUBLIC, STATE OF ~~FLORIDA~~ Ohio

QUALIFICATION STATEMENT

NOTARY BLOCK FOR A LIMITED LIABILITY COMPANY:

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of member, manager, officer, or agent, title of member, manager, officer or agent*), of _____(*name of company acknowledging*), a _____(*state or place of formation*) limited liability company, on behalf of the company, who is personally known to me or who has produced _____(type of identification) as identification.

My commission expires:

_____

NOTARY PUBLIC, STATE OF FLORIDA

Fill in Form

REFERENCES

*Please provide the names of three (3) **Governmental Agency** contract references. The references must be current or former clients with a similar engagement within the past 3 years.*

NAME: James Layport	POSITION: Project Manager
ENTITY: Charlotte County	
PHONE: 941-575-3672	E -MAIL ADDRESS: james.layport@charlottecountyfl.gov
ADDRESS: 410 Taylor Street Punta Gorda, FL 33950	
PROJECT: 2020 Rejuvenation	
COMPLETION DATE/STATUS: Completed June 25, 2020	

NAME: Austin Potts	POSITION: Project Engineer
ENTITY: Polk County	
PHONE: 865-535-2221	E -MAIL ADDRESS: austinpotts@polk-county.net
ADDRESS: 3000 Sheffield Road Bartow, FL 33830	
PROJECT: 2022 Rejuvenation	
COMPLETION DATE/STATUS: Completed April 27, 2022	

NAME: Howard Elkin	POSITION: Division Manager
ENTITY: City of Orlando	
PHONE: 407-246-2289	E -MAIL ADDRESS: howard.elkin@cityoforlando.net
ADDRESS: 400 S. Orange Avenue Orlando, FL 32801	
PROJECT: 2021 Rejuvenation	
COMPLETION DATE/STATUS: Completed December 7, 2022	

BIDDER'S CERTIFICATION

Fill in Form

TO BE RETURNED WITH BID

WHEN FIRM IS A PARTNERSHIP

IN WITNESS WHEREOF, the BIDDER hereto has executed this Form this_____day of
_____, 20____.

_____
Printed Name of Partnership

_____
Witness

By: _____
Signature of General or Managing Partner

_____
Printed Name of Partner

_____
Witness

_____
Business Address

_____
City/State/Zip

_____
Business Phone Number

_____
State of Registration

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of officer or agent, title of officer or agent*), of _____(*name of corporation acknowledging*), a _____(*state or place of incorporation*) corporation, on behalf of the corporation. He/she is personally known to me or who has produced _____ (*type of identification*) as identification.

My commission expires

_____
NOTARY PUBLIC

Fill in Form

BIDDER'S CERTIFICATION

WHEN BIDDER IS A CORPORATION

IN WITNESS WHEREOF, the BIDDER hereto has executed this Form this 9th day of January, 2023.

Pavement Technology, Inc.
Printed Name of Corporation

Ohio
Printed State of Incorporation

By: _____
Signature of President or other authorized officer

Colin Durante, President
Printed Name of President or other authorized officer

24144 Detroit Road
Address of Corporation

Westlake, OH 44145
City/State/Zip

440-892-1895
Business Phone Number

(CORPORATE SEAL)

ATTEST

By _____
Secretary Susan Durante

STATE OF Ohio

COUNTY OF Cuyahoga

The foregoing instrument was acknowledged before me by means of ☑ physical presence or ☐ online notarization, this 1/9/23 (*date*) by Colin Durante, President (*name of officer or agent, title of officer or agent*), of Pavement Technology, Inc. (*name of corporation acknowledging*), an Ohio (*state or place of incorporation*) corporation, on behalf of the corporation. He/she is personally known to me or who has produced _____ (*type of identification*) as identification.

My commission expires: Elizabeth Mielcusny Notary Public, State of Ohio My Commission Expires: February 27, 2025

_____
NOTARY PUBLIC

Fill in Form

BIDDER'S CERTIFICATION

WHEN FIRM IS A SOLE PROPRIETORSHIP OR OPERATES UNDER A FICTITIOUS OR TRADE NAME

IN WITNESS WHEREOF, the Bidder hereto has executed this Form this_____day of _____, 20____.

_____
Printed Name of Bidder

By: _____
Signature of Owner

_____
Witness

_____
Printed Name of Individual

_____
Witness

_____
Business Address

_____
City/St
ate/Zip

_____
Business Phone Number

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of personal acknowledging*), who is personally known to me or who has produced _____(*type of identification*) as identification.

My commission expires:

_____
NOTARY PUBLIC

Fill in Form

BIDDER'S CERTIFICATION

WHEN BIDDER IS AN INDIVIDUAL

IN WITNESS WHEREOF, the BIDDER hereto has executed this Form this _____day of _____, 20_____.

By: _____
Signature of Individual

_____
Witness

_____
Printed Name of Individual

_____
Witness

_____
Business Address

_____
City/State/Zip

_____
Business Phone Number

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of personal acknowledging*), who is personally known to me or who has produced _____(*type of identification*) as identification.

My Commission Expires:

_____
NOTARY PUBLIC

INSURANCE REQUIREMENTS

Statement

Contractors shall not commence any work until they have obtained and satisfied the city's insurance requirements under written contract with the city and such insurance has been approved by the City of Plantation Risk Management Department. Contractors shall not allow any subcontractor to commence work until all insurance requirements have been so obtained and approved. All insurance policies shall be with insurers qualified and doing business in the State of Florida. All insurance companies shall have a Financial Rating of no less than "A-" and Class X respectively, in the latest edition of A.M. Best Rating Guide. The types and amounts of insurance shall not be less than the amounts specified in this agreement.

Insurance

The required insurance coverage's shall be written in accordance with the hazards and magnitude of the project, but in no circumstances a lesser coverage amount, nor more restrictive than the limits of liability and schedule of hazards described herein.

Contractors shall be responsible to purchase and maintain required insurance policies during the term of the contract agreement. If the Contractor fails to procure and maintain such insurance, the City of Plantation shall have the right, but not the obligation, to purchase and maintain said insurance for and in the name of the Contractor, and the Contractor will pay the premium cost thereof and shall furnish all necessary information to the city in order to make effective and maintain such insurance.

Additional Insured

Certificates of Insurance and insurance policies shall also be endorsed to name the City of Plantation "**Additional Insured**" on the Commercial General Liability with the following or similar endorsements providing equal or broader Additional Insured coverage, such as the basic CG2026 07 04 Additional Insured--Designated Person or Organization endorsement, or the CG2010 10 01 Additional Insured-Owners Lessees, or Contractors endorsement, or the CG2010 07 04 Owners, Lessees or Contractors endorsement, including the additional endorsement of CG2037 10 01-Additional Insured- Owners, Leases have Contractors Operations endorsement. Endorsements shall be required to provide back coverage for the contractors **"Your Work"** as defined in the insurance policy and liability arising out of the products & completed operations hazard.

Commercial General Liability

Contractor will agree to maintain Commercial General Liability at a minimum limit of liability not less than **$1,000,000** Each Occurrence, and **$2,000,000** Annual Aggregate unless the particular contract calls for specific limits of insurance. Coverage shall not contain any endorsement(s) excluding nor limiting Product/Completed Operations, Contractual Liability or Cross Liability. When a self-insured retention (SIR) or deductible exceeds **$25,000**, the City reserves the right, but not the obligation, to review and request a copy of Contractor's most recent annual report or audited financial statement.

Business Automobile Liability

Contractor will agree to maintain Business Automobile Liability at a limit of liability not less than **$1,000,000** Each Occurrence. Coverage shall include liability for Owned, Non-Owned & Hired automobiles. In the event Contractor does not own automobiles, Contractor agrees to maintain coverage for Hired & Non-Owned Auto Liability, which may be satisfied by way of endorsement to the Commercial General Liability policy or separate Business Auto Liability policy.

Workers Compensation & Employers Liability

The Workers Compensation and Employers' Liability insurance shall be in accordance with Florida State Statutes 440.

Umbrella Excess Liability

If required by contract will be no more restricted than the underlying insurance policies.
City of Plantation must be added and endorsed separately as additional insured on umbrella policies.

Professional Liability

If required by contract will be a minimum of 1,000,000.

Waiver of Subrogation

The Contractor will agree that each required policy will contain Waivers of Subrogation in favor the City of Plantation. Should an insurance policy condition **not** permit Contractor to enter into a pre-loss agreement to waive subrogation without an endorsement, then the Contractor will agree to notify the insurer and request the policy be endorsed with a waiver of Transfer of Rights of Recovery against others, or its equivalent. This waiver of subrogation shall not apply to any policy, which includes a condition specifically prohibiting such an endorsement, or voids coverage should contractor enter into such an agreement on a pre-loss basis.

Certificate(s) of Insurance

The Contractor will agree to provide City a Certificate of Insurance evidencing that all coverage's, limits and endorsements required herein are maintained and in full force and effect, and certificates of insurance shall provide a minimum thirty **(30)** days to notify, when available by Contractors insurer. If the Contractor receives a non-renewal or cancellation notice from an insurance carrier affording coverage required herein, or receives notice that coverage no longer complies with the insurance requirements herein, Contractor agrees to notify the City by fax within five **(5)** business days with a copy of the non-renewal or cancellation notice, or written specifics as to which coverage is no longer in compliance. Certificates of Insurance shall be in the form as approved by Insurance Standards Office (ISO) and such certificates shall clearly state all of the coverage's required in this section.

INSURANCE

Commercial General Liability insurance will cover liability bodily injury and property damage. Exposures to be covered are premises, operations, products/completed operations, and contracts. Coverage must be written on an occurrence basis, with the following **examples** of insurance.

Schedule	**Limits**
Commercial General Liability	$1,000,000 Each Occurrence
Blanket Contractual Liability	$2,000,000 Each Occurrence
Independent Contractors	Premises-Operations
Products & Completed Operations	Personal /Advertising Injury
Blanket Contractual Liability	Independent Contractors
Automobile Liability	
Any auto including Hired & Non-owned	$1,000,000 Combined Single Limit
Broad Form Property Damage	$1,000,000 Each Occurrence
Blanket X,C,U Hazards	If required (Included)
Workers' Compensation	Florida 440 Statutory Coverage
Employers Liability	$1,000,000 Each Accident
Disease Policy Limit	$1,000,000

INSURANCE REQUIREMENTS

Bonds:

A surety bond maybe required equal to the value of the job to guarantee the work will be done per the specifications on a timely basis.

Insurance Summary:

A. Violation of the terms of this agreement and its subparts shall constitute a breach of the written contract and so the city at its sole discretion, may cancel the contract and all rights, title and interest of the contractor shall thereupon cease and terminate.

B. The City reserves the right to require or adjust any of the insurance coverage's it deems necessary depending upon the company, the project and the potential hazard exposures.

C. The city requires being named **"Additional Insured"** on all certificates of insurance. Certificates of Insurance can only be endorsed by an insurance agency or insurance company.

D. No work is to be performed pursuant to a mutually agreed upon written contract between the City of Plantation and the Contractor. The city will have the right to amend such contract to conform to City of Plantation guidelines for contract work.

E. The City requires a "thirty (30) day notice of cancellation" on all certificates of insurance.

F. The City requires a "wavier of subrogation" for all Workers Compensation Coverages

THE UNDERSIGNED CONTRACTOR HAS READ All THE FOREGOING REQUIREMENTS AND AGREES TO THE TERMS.

WITNESS Susan Durante, Secretary/Treasurer

CONTRACTOR Colin Durante, President

January 9, 2023
DATE

CITY OF PLANTATION

INSURANCE REQUIREMENTS

SAMPLE

DATE (MM/DD/YYYY): 12/12/2018

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER American Underwriters Miami, FL 33166	CONTACT NAME: Agent Name (A/C, No, Ext): FAX (A/C, No):
INSURED Any-Business 1101 Easy St MIAMI, FL 33131	Agent CONTACT INFORMATION / NAIC # INSURER A : INSURER B : INSURER C : INSURER D : INSURER E :

CERTIFICATE NUMBER: REVISION NUMBER:

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE Per - OCCUR X GEN'L AGGREGATE LIMIT APPLIES PER: POLICY PRO-C JECT LO OTHER:	X	X				EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$ 1,000,000 $ 100,000 $ 5,000 $ 1,000,000 $ 2,000,000 $ 1,000,000
	AUTOMOBILE LIABILITY ANY AUTO ALL OWNED AUTOS SCHEDULED AUTOS HIRED AUTOS NON-OWNED AUTOS		X				COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident)	$ 1,000,000 $ INCLUDED $ INCLUDED $ INCLUDED
	UMBRELLA LIAB X OCCUR CLAIMS- X EXCESS LIAB MADE DED RETENTION $	X	X				EACH OCCURRENCE AGGREGATE	$ $
C	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y / N ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/ MEMBER EXCLUDED? (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below	N / A	X				X PER STATUTE OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	$ 1,000,000 $ 1,000,000 $ 1,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

THE CITY OF PLANTATION SHALL BE LISTED AS CERTIFICATE HOLDER AND ENDORSED AS AN ADDITIONALINSURED FOR LIABILITY. POLICIES SHALL BE ENDORSED TO PROVIDE 30 DAYs WRITTEN NOTICE CANCELLATION TO CERTIFICATE HOLDER.

10 DAYS NOTICE OF CANCELLATION FOR NON-PAYMENT. CONTRACTORS INSURANCE SHALL PROVIDE PRIMARY COVERAGE AND SHALL NOT REQUIRE CONTRIBUTION FROM CERTIFICATE HOLDER. *CONTRACTOR IS RESPONSIBLE FOR ALL DEDUCTIBLES. *FOR WORKERS COMP- WAVIER OF SUBROGATION

INSURANCE REQUIREMENTS

CERTIFICATE HOLDER

City OF Plantation **400 NW 73rd AVENUE** **PLANTATION, FL 33317**	**SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS** AUTHORIZED REPRESENTATIVE - REQUIRED SIGNATURE

DRUG-FREE WORKPLACE

Fill in Form

STATEMENT UNDER SECTION 287.087
FLORIDA STATUES

TO BE RETURNED WITH FIRM

Preference must be given to FIRMS submitting certification with their bid or proposal, certifying they have a drug-free workplace in accordance with the Florida Statutes, Section 287.087. This requirement affects all public entities of the State and became effective January 1, 1991.

Preference shall be given to businesses with drug-free workplace programs. Whenever two or more bids, proposals, or replies that are equal with respect to price, quality and service are received by the State or by any political subdivision for the procurement of commodities or contractual services, a bid, proposal, or reply received from a business that certifies that it has implemented a drug-free workplace program shall be given preference in the award process. Established procedures for processing the bids will be followed if none of the tied vendors have a drug-free workplace program. In order to have a drug-free workplace program, a business shall:

1. Publish a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the workplace and specifying the action that will be taken against employees for violations of such prohibition.

2. Inform employees about the dangers of drug abuse in the workplace, the business's policy of maintaining a drug-free workplace, any available drug counseling, rehabilitation and employee assistance programs, and the penalties that may be imposed upon employees for drug abuse violations.

3. Give each employee engaged in providing the commodities or contractual services that are under bid a copy of the statement specified in subsection (1).

4. In the statement specified in subsection (1), notify the employees that as a condition of working on the commodities or contractual services that are under bid, the employee will abide by the terms of the statement and will notify the employer of any convictions of, or plea of guilty or nolo contendere to, any violations of Chapter 893 or of any controlled substance law of the United States or any state, for a violation occurring in the workplace, no later than five (5) days after such conviction.

5. Impose a sanction on, or require the satisfactory participation in, a drug abuse assistance or rehabilitation program if such is available in the employee's community, by an employee who is so convicted.

6. Make a good faith effort to continue to maintain a drug-free workplace through implementation of the above measures.

As the person authorized to sign this statement, I certify that this company complies with the above requirements.

Colin Durante
Signature

Colin Durante, President
Printed Name

Pavement Technology, Inc.
Firm Name

1/9/2023
Date

BID FORM (REVISED)

Bidding Company's Name: Pavement Technology, Inc.

Address: 24144 Detroit Road, Westlake, OH 44145

Phone: 440-892-1895

Email: dcancelliere@pavetechinc.com

To furnish and deliver all materials and to do and perform all work in accordance with the Contract Documents for the Project entitled:

SOLICITATION NAME: Asphalt Rejuvenation Project – Term Contract
ITB No. 072-22
City of Plantation

TO: City of Plantation
400 NW 73rd Avenue
Plantation, FL 33317

The Undersigned BIDDER proposes and agrees if this bid is accepted, to enter an agreement with the CITY to complete all work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Time indicated in this Bid and in accordance with the Contract Documents.

BIDDER accepts all of the terms and conditions of the Instructions to Bidders, including without limitation. This bid will remain open for ninety (90) days after the day of Bid Opening.

A. BIDDER has examined copies of all the Contract Documents and of the following Addenda: (if any addenda have been issued)

DATE:	ADDENDA NUMBER:
[ ]11/18/22	[1]
[ ]12/14/22	[2]
[ ]12/21/22	[3]

(receipt of all of which is hereby acknowledged) and also copies of the Advertisement or Notice to Contractors and the Instruction to Bidder.

B. This bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with any agreements or rules of any group, association, organization or corporation. BIDDER has not directly or indirectly induced or solicited any other BIDDER to submit a false or sham bid; BIDDER has not solicited or induced any person, firm, or a corporation to refrain from bidding; and BIDDER has not sought by collusion to obtain for himself any advantage over any other BIDDER or over CITY.

C. BIDDER shall complete/furnish the work/equipment for the following price. It is the CITY'S intent to award a contract to the lowest, responsive, and responsible BIDDER for Base Bid A or Base Bid B.

BID FORM (REVISED)

TOTAL BASE BID AMOUNT:

BASE BID A

Description	Per SQ YD Cost	Total Cost
Standard Specification – Reclamite Approximately 615,000 square yards annually construction sealing with asphalt-rejuvenating agent furnished and applied.	$ 1.21 SY One dollar & twenty-one cents per sq. yd.	$ 744,150.00

BASE BID B

Description	Per SQ YD Cost	Total Cost
Bid Alternate #1 Approximately 615,000 square yards annually construction sealing with asphalt-rejuvenating agent furnished and applied.	$ 2.49 SY Two dollars & forty-nine cents per sq. yd.	$1,531,350.00

***The City reserves the right to award either Base Bid A or Base Bid B**
***Prices shall remain firm for ninety (90) days.**

Safety Data Sheets enclosed? Yes ✓ No____

Specification Sheets/Brochures? Yes ✓ No____

Communications concerning this Bid shall be addressed to the address of BIDDER indicated below.

The undersigned also agrees as follows:

To do any extra work not covered by the foregoing Schedule of Price which may be ordered by the CITY, and to accept as full compensation therefore, such prices may be agreed upon in writing by the CITY and

the BIDDER SUBMITTED ON 1/9 20 23

SIGNATURE OF BIDDER: Colin Durante

PRINT NAME: Colin Durante

TITLE (if any): President

ADDRESS: 24144 Detroit Road, Westlake, OH 44145
Incorporated under the laws of the State of Florida.

PUBLIC RECORDS

COMPLIANCE UNDER SECTION 119.0701
FLORIDA STATUTES

TO BE RETURNED WITH BID

The CONTRACTOR hereby certifies that it shall comply with public records laws, specifically to:

(a) Keep and maintain public records required by the public agency to perform the service.

(b) Upon request from the public agency's custodian of public records, provide the public agency with a copy of the requested records or allow the records to be inspected or copied within a reasonable time at a cost that does not exceed the cost provided in this chapter or as otherwise provided by law.

(c) Ensure that public records that are exempt or confidential and exempt from public records disclosure requirements are not disclosed except as authorized by law for the duration of the contract term and following completion of the contract if the CONTRACTOR does not transfer the records to the public agency.

(d) Upon completion of the contract, transfer, at no cost, to the public agency all public records in possession of the contractor or keep and maintain public records required by the public agency to perform the service. If the CONTRACTOR transfers all public records to the public agency upon completion of the contract, the CONTRACTOR shall destroy any duplicate public records that are exempt or confidential and exempt from public records disclosure requirements. If the contractor keeps and maintains public records upon completion of the contract, the contractor shall meet all applicable requirements for retaining public records. All records stored electronically must be provided to the public agency, upon request from the public agency's custodian of public records, in a format that is compatible with the information technology systems of the public agency.

IF THE CONTRACTOR HAS QUESTIONS REGARDING THE APPLICATION OF CHAPTER 119, FLORIDA STATUTES, TO THE CONTRACTOR'S DUTY TO PROVIDE PUBLIC RECORDS RELATING TO THIS CONTRACT, CONTACT THE CUSTODIAN OF PUBLIC RECORDS AT 954-797-2237, sslattery@plantation.org, 400 NW 73rd Avenue Plantation, FL 33317

As the person authorized to sign this statement, I certify that this FIRM agrees to comply with the above requirements.

CONTRACTOR: Pavement Technology, Inc.

By (sign): Colin Durante

Colin Durante, President 1/9/23

Print Name: _____

NOTARY BLOCK FOR AN INDIVIDUAL

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of personal acknowledging*), who is personally known to me or who has produced _____(*type of identification*) as identification.

My commission expires: _____

NOTARY PUBLIC

NOTARY BLOCK FOR A CORPORATION

STATE OF Ohio

COUNTY OF Cuyahoga

The foregoing instrument was acknowledged before me by means of ☑ physical presence or □ online notarization, this 1/9/23 (*date*) by Colin Durante, President (*name of officer or agent, title of officer or agent*), of Pavement Technology, Inc. (*name of corporation acknowledging*), an Ohio (*state or place of incorporation*) corporation, on behalf of the corporation. He/she is personally known to me or who has produced _____ (*type of identification*) as identification.

My commission expires: Elizabeth Mielcusny

Elizabeth Mielcusny
Notary Public, State of Ohio
My Commission Expires: February 27, 2025

NOTARY PUBLIC

NOTARY BLOCK FOR A LIMITED LIABILITY COMPANY:

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of member, manager, officer, or agent, title of member, manager, officer or agent*), of _____(*name of company acknowledging*), a _____(*state or place of formation*) limited liability company, on behalf of the company, who is personally known to me or who has produced _____(type of identification) as identification.

My commission expires:

_____

NOTARY PUBLIC

SCRUTINIZED COMPANY CERTIFICATION

Fill in Form

TO BE RETURNED WITH BID

CONTRACTOR Name: Pavement Technology, Inc.
CONTRACTOR FEIN: 34-1108308
CONTRACTOR Authorized Representative Name and Title: Colin Durante, President
Address: 24144 Detroit Road
City: Westlake State: OH Zip: 44145
Phone Number: 440-892-1895
Email Address: dcancelliere@pavetechinc.com

Section 287.135, Florida Statutes, prohibits agencies from contracting with companies for goods or services of any amount that are on the Scrutinized Companies that Boycott Israel List or that are participating in a boycott of Israel; or One million dollars or more if, at the time of bidding, FIRM is on the Scrutinized Companies with Activities in Sudan List or the Scrutinized Companies with Activities in the Iran Petroleum Energy Sector List, or has business operations in Cuba or Syria. The boycott Israel list is created pursuant to 215.4725 and the Sudan and Iran lists are created pursuant to section 215.473, Florida Statutes.

As the person authorized to sign on behalf of CONTRACTOR, I hereby certify that the undersigned company is not participating in a boycott of Israel, on the Scrutinized Companies with Activities in Sudan List or the Scrutinized Companies with Activities in the Iran Petroleum Energy Sector List, or that it does not have business operations in Cuba or Syria. I understand and agree that pursuant to section 287.135, Florida Statutes, the submission of a false certification; or being placed on the Scrutinized Companies that Boycott Israel List, or engaging in a boycott of Israel; or being placed on the Scrutinized Companies with Activities in Sudan List or the Scrutinized Companies with Activities in the Iran Petroleum Energy Sector List; or engaging in business operations in Cuba or Syria will be cause for the CITY to terminate this Agreement at the option of the CITY. In addition, FIRM may be subject to civil penalties, attorney's fees, and/or costs.

The scrutinized company list is maintained by the State Board of Administration and available at http://www.sbafla.com/.

Certified By: Colin Durante,
who is authorized to sign on behalf of the above referenced company.
Authorized Signature Print Name and Title: Colin Durante, President
Date: January 9, 2023

***This form is being provided to comply with Florida Statute 287.135.**

E-VERIFY FORM

CITY OF PLANTATION
E-VERIFY FORM UNDER SECTION 448.095, FLORIDA STATUTES

TO BE RETURNED WITH BID

Project Name: Asphalt Rejuvenation Project

Project No.: ITB No. 072-22

1. Definitions:

"Contractor" means a person or entity that has entered or is attempting to enter into a contract with a public employer to provide labor, supplies, or services to such employer in exchange for salary, wages, or other remuneration. "Contractor" includes, but is not limited to, a vendor or consultant.

"Subcontractor" means a person or entity that provides labor, supplies, or services to or for a contractor or another subcontractor in exchange for salary, wages, or other remuneration.

"E-Verify system" means an Internet-based system operated by the United States Department of Homeland Security that allows participating employers to electronically verify the employment eligibility of newly hired employees.

2. Effective January 1, 2021, Contractors, shall register with and use the E-verify system in order to verify the work authorization status of all newly hired employees. Contractor shall register for and utilize the U.S. Department of Homeland Security's E-Verify System to verify the employment eligibility of:

a) All persons employed by a Contractor to perform employment duties within Florida during the term of the contract; and

b) All persons (including subvendors/subconsultants/subcontractors) assigned by Contractor to perform work pursuant to the contract with the City of Plantation. The Contractor acknowledges and agrees that registration and use of the U.S. Department of Homeland

Security's E-Verify System during the term of the contract is a condition of the contract with the City of Plantation; and

c) Should vendor become the successful Contractor awarded for the above-named project, by entering into the contract, the Contractor shall comply with the provisions of Section 448.095, Fla. Stat., "Employment Eligibility," as amended from time to time. This includes, but is not limited to registration and utilization of the E-Verify System to verify the work authorization status of all newly hired employees. Contractor shall also require all subcontractors to provide an affidavit attesting that the subcontractor does not employ, contract with, or subcontract with, an unauthorized alien. The Contractor shall maintain a copy of such affidavit for the duration of the contract.

3. Contract Termination

a) If the City has a good faith belief that a person or entity with which it is contracting has knowingly violated s. 448.09 (1) Fla. Stat., the contract shall be terminated.

b) If the City has a good faith belief that a subcontractor knowingly violated s. 448.095 (2), but the Contractor otherwise complied with s. 448.095 (2) Fla. Stat., shall promptly notify the Contractor and order the Contractor to immediately terminate the contract with the subcontractor.

c) A contract terminated under subparagraph a) or b) is not a breach of contract and may not be considered as such.

d) Any challenge to termination under this provision must be filed in the Circuit Court no later than 20 calendar days after the date of termination.

e) If the contract is terminated for a violation of the statute by the Contractor, the Contractor may not be awarded a public contract for a period of 1 year after the date of termination.

E-VERIFY FORM

Fill in Form

CONTRACTOR: Pavement Technology, Inc.

By (sign): Colin Durante

Print Name: Colin Durante, President

NOTARY BLOCK FOR AN INDIVIDUAL

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of personal acknowledging*), who is personally known to me or who has produced _____(*type of identification*) as identification.

My commission expires: _____

NOTARY PUBLIC

NOTARY BLOCK FOR A CORPORATION

STATE OF Ohio

COUNTY OF Cuyahoga

The foregoing instrument was acknowledged before me by means of ☑ physical presence or □ online notarization, this 1/9/23 (*date*) by Colin Durante, President (*name of officer or agent, title of officer or agent*), of Pavement Technology, Inc. (*name of corporation acknowledging*), an Ohio (*state or place of incorporation*) corporation, on behalf of the corporation. He/she is personally known to me or who has produced _____ (*type of identification*) as identification.

My commission expires: Elizabeth Mielcusny

Elizabeth Mielcusny
Notary Public, State of Ohio
My Commission Expires: February 27, 2025

NOTARY PUBLIC

NOTARY BLOCK FOR A LIMITED LIABILITY COMPANY:

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of member, manager, officer, or agent, title of member, manager, officer or agent*), of _____(*name of company acknowledging*), a _____(*state or place of formation*) limited liability company, on behalf of the company, who is personally known to me or who has produced _____(type of identification) as identification.

My commission expires:

_____

NOTARY PUBLIC

COOPERATION WITH THE BROWARD COUNTY
OFFICE OF INSPECTOR GENERAL

TO BE RETURNED WITH BID

The Broward County Office of Inspector General ("OIG") has the authority to review and investigate how governmental contracts are performed and how BIDDERS and vendors (herein, "BIDDERS") are paid. To this end, BIDDER agrees to cooperate with the OIG in the event the BIDDER is contacted by the OIG. Such cooperation shall include, answering any questions that may be posed by the OIG, and allowing the OIG to review and copy any of BIDDER's written material, contract documentation, and financial records that may relate to the formulation, execution, and performance of this Contract. The BIDDER acknowledges and agrees that whatever work or effort is expended by BIDDER in interfacing with the OIG is part of the administrative or overhead or base costs of the services provided by the BIDDER to the CITY, and shall never be a basis for claiming extra or additional compensation under this Contract, or for requesting a change order.

The BIDDER's failure to cooperate fully with the OIG as required by the preceding clause shall be a basis for the City claiming the BIDDER is in default, and may, if not timely cured, allow the City to terminate this Contract for cause. Unless the BIDDER is instructed otherwise in a specific written and notarized Order signed by the Broward County Inspector General, BIDDER shall advise CITY, in writing and in the same manner as BIDDER gives the City formal notice under this Contract, each instance, if ever, that the BIDDER is contacted by the OIG, and shall supply the City with information necessary to allow the City to ensure that the BIDDER is fully performing the requirements of this Paragraph.

WITNESSES:

NAME: Susan Durante

NAME: Debbie Cancelliere

BIDDER: Colin Durante

NAME: Colin Durante

TITLE: President

NOTARY BLOCK FOR AN INDIVIDUAL

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of personal acknowledging*), who is personally known to me or who has produced _____(*type of identification*) as identification.

My commission expires: _____

NOTARY PUBLIC

NOTARY BLOCK FOR A CORPORATION

STATE OF Ohio

COUNTY OF Cuyahoga

The foregoing instrument was acknowledged before me by means of ☑ physical presence or □ online notarization, this 1/9/23 (*date*) by Colin Durante, President (*name of officer or agent, title of officer or agent*), of Pavement Technology, Inc. (*name of corporation acknowledging*), an Ohio (*state or place of incorporation*) corporation, on behalf of the corporation. He/she is personally known to me or who has produced _____ (*type of identification*) as identification.

My commission expires: Elizabeth Mielcusny

NOTARY PUBLIC

Elizabeth Mielcusny
Notary Public, State of Ohio
My Commission Expires: February 27, 2025

NOTARY BLOCK FOR A LIMITED LIABILITY COMPANY:

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this _____ (*date*) by _____ (*name of member, manager, officer, or agent, title of member, manager, officer or agent*), of _____(*name of company acknowledging*), a _____(*state or place of formation*) limited liability company, on behalf of the company, who is personally known to me or who has produced _____(type of identification) as identification.

My commission expires:

_____

NOTARY PUBLIC

Bid Checklist and Summary Form

To comply with the City of Plantation's solicitation guidelines, this Bid Checklist Summary Form is **required for all solicitations exceeding $25,000.00 or more.**

This form must be signed and included with the bid submittal in addition to the required bid documents of this solicitation. Failure to do so may result in your bid submittal being considered non-responsive.

Bidder's Name: Pavement Technology, Inc. **Date:** 1/9/23

Base Bid Total: Base Bid A - $744,150.00
Base Bid B - $1,531,350.00

Plantation Local Business pursuant to Section 2-227 of City's Code: Yes ☐ or No ☑

Disadvantaged Business Enterprise: Yes ☐ or No ☑

Submitted Forms:

☑ Non-Collusion Certification Form

☑ General Terms and Conditions Form

☑ Insurance Requirements

☑ Bid Form

☑ References

☐ Federal Funding Requirements - N/A

☑ Drug Free Workplace

☑ Addendums

When bidding on an Alternative Product "or equal," bids must be accompanied with all descriptive information necessary for an evaluation of the proposed material or equipment such as the detailed drawings and specifications, certified operation and test data, and experience records. Failure of any bidder to furnish the data necessary to determine whether the product is equivalent, may be cause for rejection of the specific items(s) to which it pertains.

Are you submitting an equivalent product: Yes ☑ or No ☐

If Yes, please list the equivalent product(s) below:

A.R.A.-1 Ti® Pollution-Remediating Maltene Asphalt Rejuvenator

Signature: Colin Durante

Printed Name: Colin Durante, President

OFFICE OF THE MAYOR
Lynn Stoner
Mayor

PROCUREMENT DEPARTMENT
Charles Spencer, NIGP-CPP
Director

Plantation
the grass is greener

CITY COUNCIL
Erik Anderson, President
Jennifer Andreu, President Pro Tem
Timothy J. Fadgen
Denise Horland
Nick Sortal

ADDENDUM NO. 1

ITB No. 072-22

Asphalt Rejuvenation Project – Term Contract

DATE OF ADDENDUM: November 18, 2022

TO ALL PROSPECTIVE BIDDERS:

The following clarification, changes, additions and/or deletions are hereby made part of the Contract Documents for ITB No. 072-22.

Questions and Answers

Question No. 1 - On page 14, paragraph 2, it states that the initial contract term is two years, with three optional one-year renewal terms, but on page 64, it states that the initial term is for one year, with four optional one-year renewal periods. Can you please tell me which is correct?

Response No. 1 – A two-year initial contract term with renewal options for an additional three one-year terms.

Question No. 2 - Also, page 4, the second paragraph describes elevator work. I know that was just left in by mistake, if you could please confirm?

Response No. 2 – Please disregard that paragraph and refer to the scope beginning on page 14 for a description of work to be performed under this project.

Bids **must** be submitted on or before **January 10, 2023 11:00 A.M**. Bids must be submitted electronically ONLY via the Demand Star website.

https://www.demandstar.com/app/agencies/florida/city-of-plantation-procurement-division/procurement-opportunities/9b6d13fb-3874-4291-9605-81cf63387a40/

All other terms, conditions and specifications remain unchanged for ITB No. 072-22.

Please acknowledge receipt of this Addendum No. 1 by returning it and/or acknowledging it in your bid.

BIDDER'S NAME: Pavement Technology, Inc.

OFFICE OF THE MAYOR
Nick Sortal
Mayor

PROCUREMENT DEPARTMENT
Charles Spencer, NIGP-CPP
Director

Plantation
the grass is greener®

CITY COUNCIL
Jennifer Andreu, President
Timothy J. Fadgen, President Pro Tem
Erik Anderson
Denise Horland
Louis Reinstien

ADDENDUM NO. 2

ITB No. 072-22

Asphalt Rejuvenation Project – Term Contract

DATE OF ADDENDUM: December 14, 2022

TO ALL PROSPECTIVE BIDDERS:

The following clarification, changes, additions and/or deletions are hereby made part of the Contract Documents for ITB No. 072-22.

Questions and Answers

Question No. 1 - The previous contract used by the City was on the South Florida Purchasing Cooperative, will this contract similarly allow for other agencies to piggyback by adding language to that end?

Response No. 1 – The City will allow for other agencies to piggyback by excluding language in the contract that may prohibit it.

Question No. 2 - With the extreme volatility of petroleum-based materials, longer term contracts around the state have added escalation clauses (such as the Producer Price Index or the FDOT Fuel and Bituminous Average Price Index). Would the City of Plantation consider adding such a clause to this contract?

Response No. 2 – Please make the appropriate assumptions for the initial term of the contract. After the initial term, the City will consider the aforementioned escalation clauses.

Bids **must** be submitted on or before **January 10, 2023 11:00 A.M**. Bids must be submitted electronically ONLY via the Demand Star website.

https://www.demandstar.com/app/agencies/florida/city-of-plantation-procurement-division/procurement-opportunities/9b6d13fb-3874-4291-9605-81cf63387a40/

All other terms, conditions and specifications remain unchanged for ITB No. 072-22.

Please acknowledge receipt of this Addendum No. 2 by returning it and/or acknowledging it in your bid.

BIDDER'S NAME: Pavement Technology, Inc.

OFFICE OF THE MAYOR
Nick Sortal
Mayor

PROCUREMENT DEPARTMENT
Charles Spencer, NIGP-CPP
Director

Plantation
the grass is greener

CITY COUNCIL
Jennifer Andreu, President
Timothy J. Fadgen, President Pro Tem
Erik Anderson
Denise Horland
Louis Reinstien

ADDENDUM NO. 3

ITB No. 072-22

Asphalt Rejuvenation Project – Term Contract

DATE OF ADDENDUM: December 21, 2022

TO ALL PROSPECTIVE BIDDERS:

The following clarification, changes, additions and/or deletions are hereby made part of the Contract Documents for ITB No. 072-22.

Changes

Please see the attached revised bid form.

Questions and Answers

Question No. 1 - On page 53, the checklist lists "Federal Funding Requirements" as a submitted form, but that won't apply, correct?

Response No. 1 – Please disregard this checklist item as it does not apply.

Question No. 2 - If we are submitting a price for the standard spec product, Reclamite®, and we are also providing pricing for an alternate product, then would the Grand Total be those two totals added together, or would the Grand Total be the total amount for the standard spec product?

Response No. 2 – Please see the attached revised bid form.

Question No. 3 - In regard to the Base Bid Total on page 53: Is this the total for the standard spec product plus the total for the alternate product, added together, or if it would be the total for the standard spec product, only?

Response No. 3 – Please provide two different totals and make a clear distinction between the standard and alternate bid price.

Bids **must** be submitted on or before **January 10, 2023 11:00 A.M.** Bids must be submitted electronically ONLY via the Demand Star website.

https://www.demandstar.com/app/agencies/florida/city-of-plantation-procurement-division/procurement-opportunities/9b6d13fb-3874-4291-9605-81cf63387a40/

All other terms, conditions and specifications remain unchanged for ITB No. 072-22.

Please acknowledge receipt of this Addendum No. 3 by returning it and/or acknowledging it in your bid.

BIDDER'S NAME: Pavement Technology, Inc.

Reclamite®
Product Submittals

D & D EMULSIONS INC.

Quality Products and Dependable Service Since 1981

Licensed Manufacturer
Tricor Refining, LLC
Producers of Golden Bear® Preservation Products

CERTIFICATE OF COMPLIANCE

TO WHOM IT MAY CONCERN

PRODUCT: RECLAMITE®

IT IS HEREBY CERTIFIED THAT THE ABOVE PRODUCT DESIGNATED HEREON CONFORMS TO THE APPLICABLE SPECIFICATIONS FOR THE PRODUCT SO INDICATED, AND THAT PAVEMENT TECHNOLOGY, INCORPORATED HAS BEEN AN AUTHORIZED APPLICATOR FOR D & D EMULSIONS, INC., AN AUTHORIZED LICENSED MANUFACTURER FOR TRICOR REFINING, LLC.

Date: March 28, 2022

Approved by: Pres.
Title: President

TRICOR REFINING, LLC
Producers of GOLDEN BEAR PRESERVATION PRODUCTS

1134 Manor St. - Oildale, CA 93308 / P.O. Box 5877 - Bakersfield, CA 93388
Phone 661.393.7110 – Fax 661.393.1601

RECLAMITE® Asphalt Rejuvenating Agent

Specifications:

Tests	Test Method ASTM	Test Method AASHTO	Requirements Min.	Requirements Max.
Tests on Emulsion:				
Viscosity @ 25°C, SFS	D-244	T-59	15	40
Residue, % w[1]	D-244 (mod)	T-59 (mod)	60	65
Miscibility Test[2]	D-244 (mod)	T-59 (mod)	No Coagulation	
Sieve Test, % w[3]	D-244 (Mod)	T-59 (mod)	—	0.1
Particle Charge Test	D-244	T-59	Positive	
Percent Light Transmittance[4]	GB	GB	—	30
Cement Mixing	D-244			2.0
Tests on Residue from Distillation				
Flash Point, COC, °C	D-92	T-48	196	—
Viscosity @ 60°C, cSt	D-445	—	100	200
Asphaltenes, %w	D-2006-70	—		0.75
Maltene Distribution Ratio $\frac{PC + A_1}{S + A_2}$[5]	D-2006-70	—	0.3	0.6
PC/S Ratio[5]	D-2006-70	—	0.5	—
Saturate hydrocarbons, S[5]	D-2006-70	—	21	28

[1] ASTM D-244 Evaporation Test for percent of residue is made by heating 50 gram sample to 149°C (300°F) until foaming ceases, then cool immediately and calculate results.
[2] Test procedure identical with ASTM D-244 60 except that .02 Normal Calcium Chloride solution shall be used in place of distilled water..
[3] Test procedure identical with ASTM D-244 60 except that distilled water shall be used in place of two percent sodium oleate solution.
[4] Test procedure is attached.
[5] Chemical composition by ASTM Method D-2006-70:
PC = Polar Compounds, A_1 = First Acidaffins.
A_2 = Second Acidaffins, S = Saturated Hydrocarbons.

Note: For gal/ton conversion use 242 gal/ton.

Note: Data presented are typical. Slight variation may occur from lot to lot.

Evaluation of Seal Coat Runway 16-34 Lajes Field, Azores

by
J. E. Pickett

Geotechnical Laboratory
U.S. Army Engineer Waterways Experiment Station
P.O. Box 631
Vicksburg, Mississipi

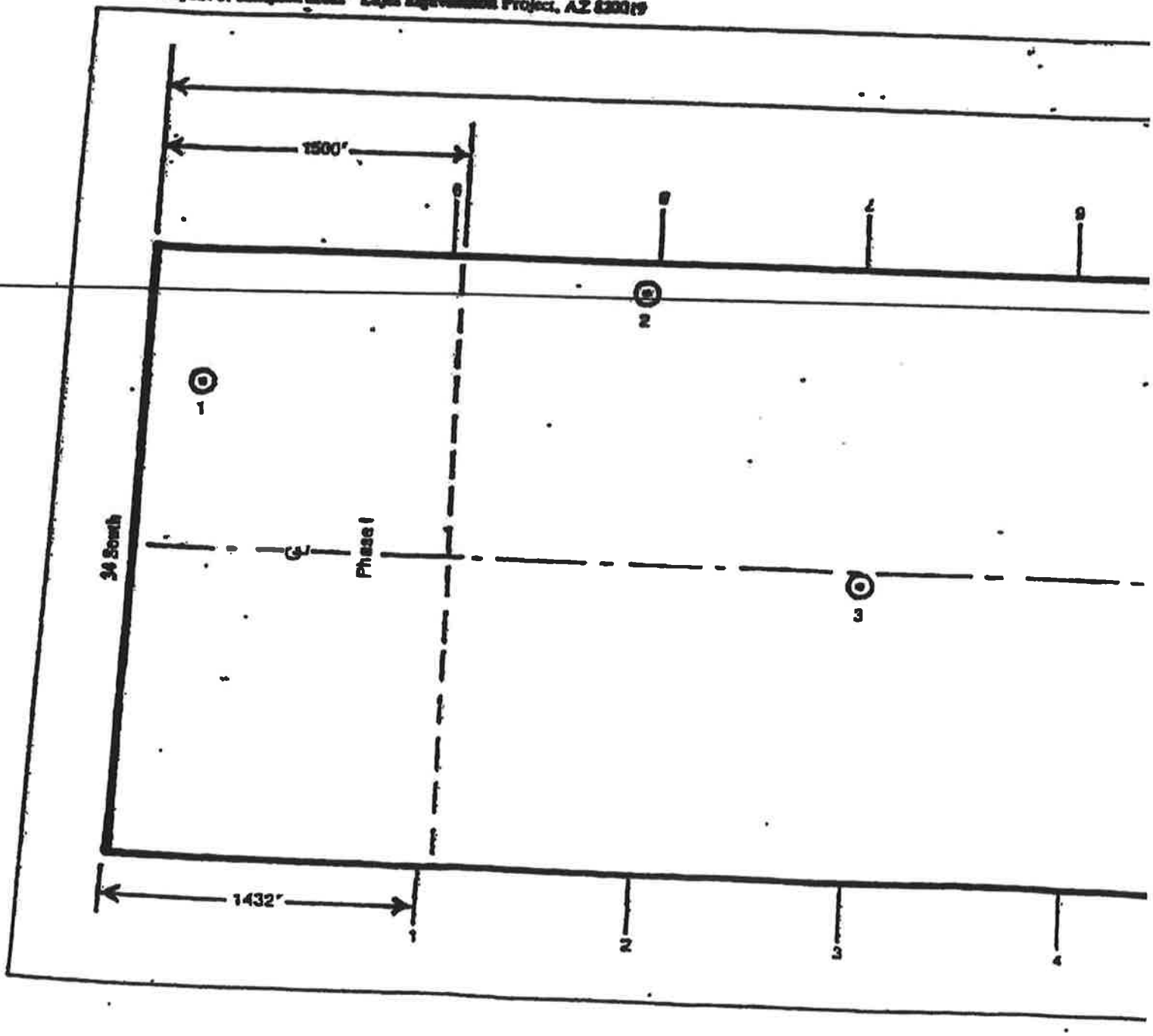
March 1983

1. In February 1983, the Pavement Systems Division, Geotechnical Laboratory, U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, was requested by the 1605th Air Base Wing (MAC), Lajes Field, Azores, to provide technical assistance and construction inspection of the rejuvenator project on Runway 16–34, which included sampling and laboratory testing. Treatment of the runway was performed 10–15 March. An excess of Reclamit remaining from projects in 1979 and 1983 w used to treat some parking aprons and taxiwa

2. Messrs. Jack E. Pickett and James E Schoenberger traveled to Lajes Field on 28 February 1983 to take samples before and after treatment and to observe the rejuvenato application.

3. The 10,864–ft runway was divided in sections and treated in three phases. This was

Incl 1 Layout of sampled areas, Lajes Rejuvenation Project, AZ 8300[illegible]



done so the runway could remain open to traffic during treatment. Before treatment, one set of three 6–in. cores were taken at each of eight locations, selected at random throughout the runway, two sets from Phase I and three sets each from Phases II and III. Core locations are shown on Incl 1. After treatment, three additional cores were taken at each location within 2 to 4 ft of the original core locations and in the same construction lane.

The samples were processed by sawing 3/ of material from the upper surface. The asphalt was extracted from this 3/8–in.–t sample and recovered; untreated samples processed at the field laboratory at Lajes. recovered asphalt and treated samples wer returned to WES for processing and penet tion and viscosity testing. Results of these laboratory tests are summarized in Table I. Test results indicate the rejuvenation of

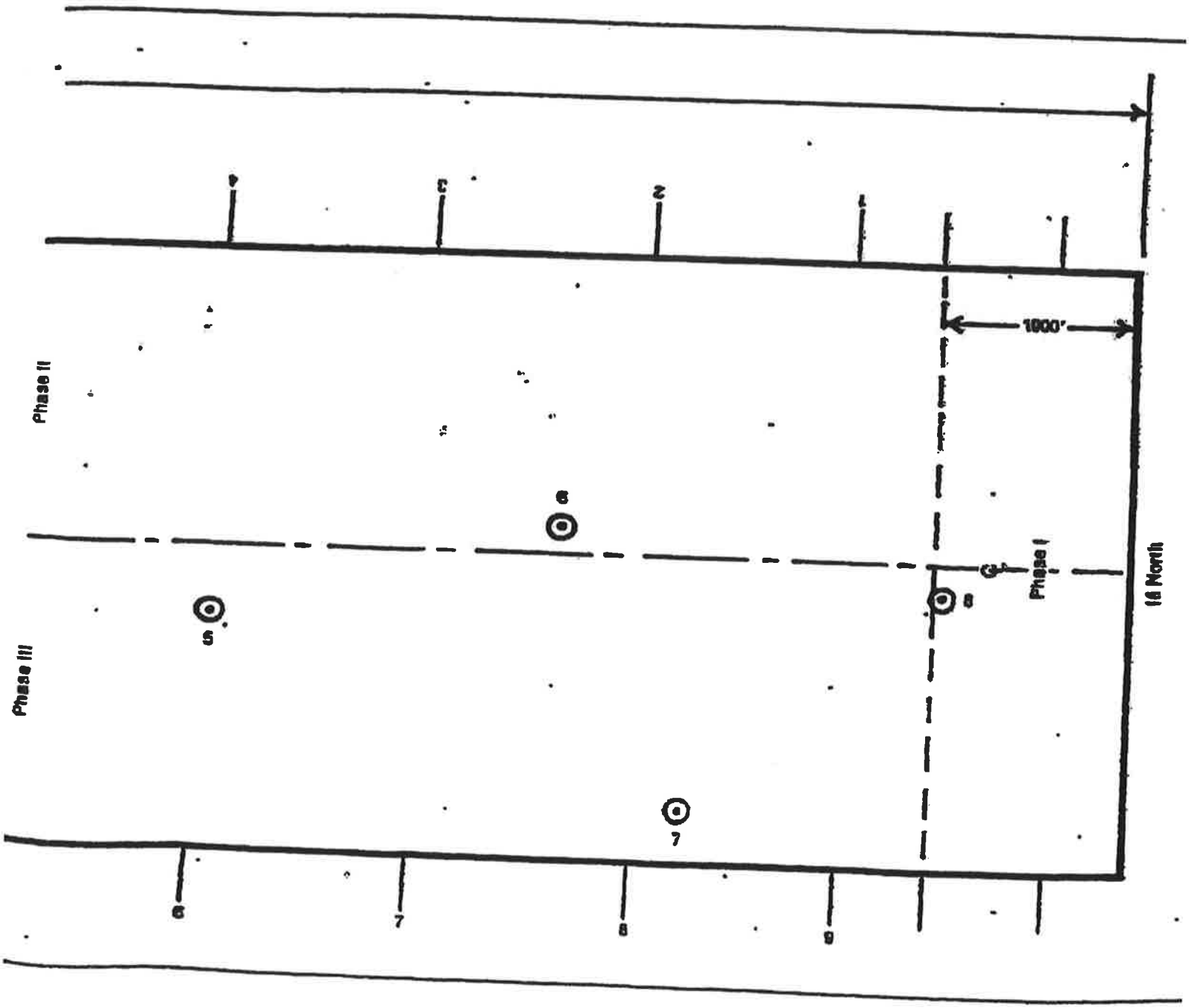


Table I

Lajes Rejuvenator, 1983

Sample Number	Station From South End R/W & C	Penetration 77°F (25°C) 100 g, 5 sec 0.1 mm		Absolute Viscosity 140°F (60°C) 300.0 mm Hg Vacuum, Poises	
		Untreated	Treated	Untreated	Treated
1	2+43, 83.7 ft W	11.00	20.00	401, 351	65, 420
2	23+55, 134.9 ft W	11.00	23.00	449, 520	62, 011
3	34+34, 5.1 ft E	13.00	31.00	242, 293	32, 860
4	52+07, 51.3 ft W	9.00	27.00	1, 852, 362	43, 497
5	64+36, 32.4 ft E	4.00	17.00	2, 774, 367	177, 941
6	80+67, 14.6 ft W	9.00	22.00	863, 971	62, 736
7	86+86, 121.4 ft E	6.00	34.00	1, 263, 880	23, 444
8	99+17, 17 ft E	6.00	29.00	1, 318, 687	41, 392
Average Change (%)		8.63 Penetration	25.38 194.00 Increase	1, 145, 804 Viscosity	63, 663 94.40 Decrease

Runway 16–34 was satisfactory. The penetration test shows an increase of approximately 194 percent and the viscosity test shows a decrease of approximately 94 percent. The specification requires the average penetration to be increased by 20 percent and the average viscosity to be decreased by 40 percent.

4. The contractor for the project was Mr. Colin M. Durante, Pavement Technology, Inc., 11260 Beret Road, Cleveland, Ohio 44102. He elected to use Reclamite, a proprietary material manufactured by the Golden Bear Division of Witco Chemical Corporation, Bakersfield, California, as a rejuvenator. Reclamite is a resin-based emulsion that leaves an oily residue and is applied with a bituminous distributor. The Reclamite material was mixed at the job site in a two to one ratio with water, two parts Reclamite to one part water. The Reclamite mixture at ambient temperature (60–70°F) was sprayed onto the runway pavement by using a 1140 gal bituminous distributor equipped with a 10-ft spray bar. Application rates were varied intentionally to avoid excess rejuvenator in areas, such as recently patched areas, and areas with rubber build-up. Areas outside regular traffic were sprayed heavier, which would not bother air traffic, in case of excess rejuvenator on the surface. Dates of treatment and application rates (gal/yd²) are shown in Table II. The remainder of the material was used to spray various taxiways and parking aprons.

Table II

Phase I	
Center 100-ft-wide area	0.053 gal/sq yd
All other areas	0.061 gal/sq yd
Phase II	
From center line runway out 50 ft	0.055 gal/sq yd
All other areas	0.066 gal/sq yd
Phase III	
From center line runway out 50 ft	0.058 gal/sq yd
All other areas	0.074 gal/sq yd

Jack E. Pickett
Materials Engineering Technician
Pavement Systems Division
Geotechnical Laboratory

Construction seal.

Reclamite was used as a construction seal. For comparison, the lower left area was not treated.

Penetration values of asphalt extracted from cores (New Mexico Highway Department).

Core	Depth	Value
Reclamite treated (2 years)		
1	Top ½"	52
2	Top ½"	48
3	Top ½"	40
Untreated		
4	Top ½"	17
5	Top ½"	23
6	Top ½"	22

Reclamite was used as a construction seal on the dry areas of the pavement. Untreated areas are still wet from water penetrating the surface.

Penetration values of asphalt extracted from cores (Douglas Street, Kern County, Calif.).

Depth	Reclamite treated 6 mos.	30 mos.
Top ½"	37	26
Untreated		
Top ½"	18	13

Reclamite was used as a construction seal on the dry areas of the pavement.

Penetration values of asphalt on cores taken at intervals over period of time (Day Street, Kern County, Calif.).

Depth	Reclamite treated 2 mos.	18 mos.	36 mos.
Top ½"	82	48	40
Untreated			
Top ½"	23	19	16

Report: 15-1229

January 8, 2016

Customer: Pavement Technology, Inc. - Colin Durante, John Schlegel

Project: Charleston County, South Carolina - 2015 Reclamite Application

Samples Submitted: Sixteen core samples (8 untreated and 8 treated with RECLAMITE®) identified as:

Forest Trail, Hulsey Boulevard, Patterson Avenue, South Rhett Avenue, Shadowmoss Parkway, Algon Quin Road, Queen Street, Wingo Way

Requested Testing:

Determine the Dynamic Shear Rheological properties at 60°C of the recovered asphalt binder from the top 3/8-inch layer of each core. These properties include viscosity, phase angle, complex, elastic, and viscous moduli.

Summary of Testing:

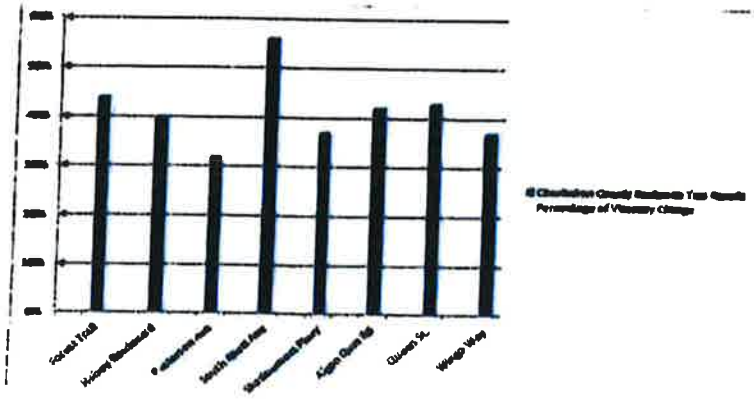
The top 3/8-inch of each core was removed for testing. The asphalt was extracted and recovered as prescribed by California Test Method 365. Viscosity and phase angle, as well as, complex, elastic, and viscous moduli were determined on the recovered asphalt binder using Dynamic Shear Rheology as prescribed by AASHTO T315. Test results are reported by Table 1.

Sample Identification	Viscosity 60°C, Poise	Phase Angle, °	MODULUS, 60°C, Pa		
			Complex	Elastic	Viscous
Forest Trail					
Untreated	110430	57.8	110730	59855	93463
Treated	61394	68.9	61566	22166	57427
	44% decrease				
Hulsey Boulevard					
Untreated	96417	65.8	96672	39719	88198
Treated	57459	69.1	57681	20972	53881
	40% decrease				
Patterson Avenue					
Untreated	108930	65.5	109220	45355	99359
Treated	74816	67.5	74911	28497	68646
	32% decrease				
South Rhett Avenue					
Untreated	87271	66.9	87501	34382	80498
Treated	38897	70.8	38999	12787	36748
	55% decrease				
Shadowmoss Parkway					
Untreated	85824	67.5	86034	37873	88729
Treated	53725	69.6	53892	23267	48586
	37% decrease				
Algon Quin Road					
Untreated	102180	64.7	102370	43770	92539
Treated	58971	68.4	59126	21781	54968
	42% decrease				
Queen Street					
Untreated	55747	59.9	55867	33013	49477
Treated	32020	70.2	32158	17667	29874
	42% decrease				
Wingo Way					
Untreated	68464	68.2	68624	22522	56786
Treated	37862	70.1	37962	18947	32896
	57% decrease				

Charleston County, South Carolina

Reclamite Application 2015

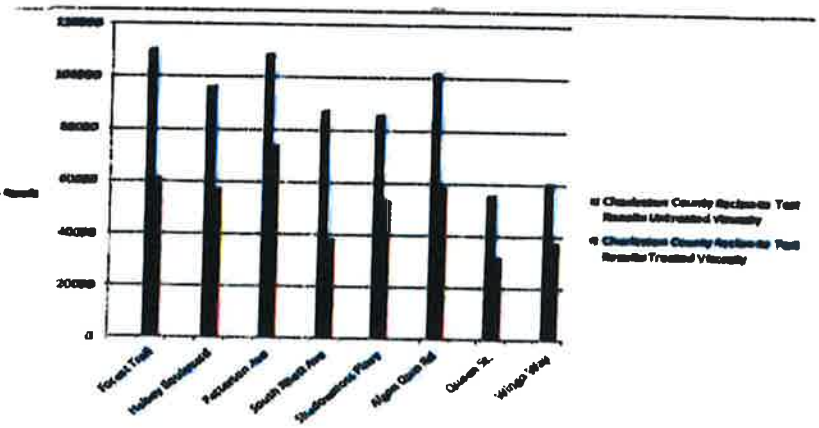
Change in Viscosity Results



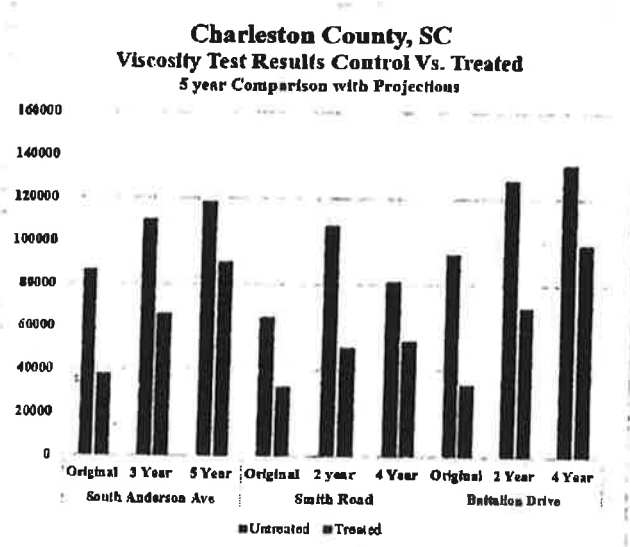
Charleston County, South Carolina

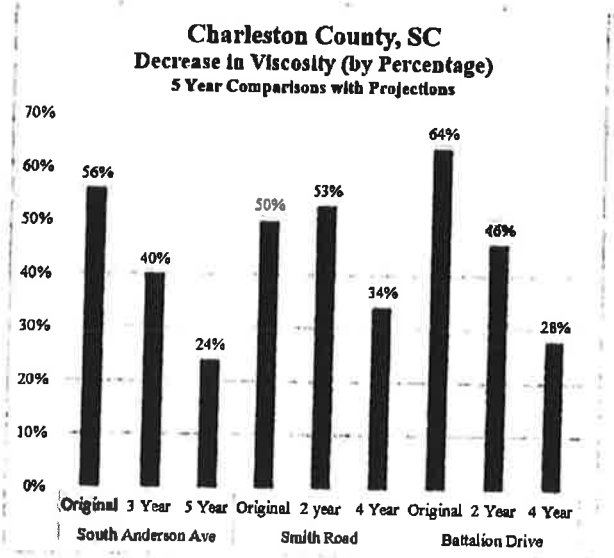
Reclamite Application 2015

Viscosity Test Results Control vs. Treated



Sample Identification	Viscosity 60° C, Poises		
	Original	3 Year	5 Year
South Anderson Avenue			
Untreated	86177	109950	118490
Treated	38220	66424	90198
Percentage Decrease	56%	40%	24%
	Original	2 Year	4 Year
Smith Road			
Untreated	64993	107220	81289
Treated	32426	50643	53746
Percentage Decrease	50%	53%	34%
	Original	2 Year	4 Year
Battalion Drive			
Untreated	94533	128750	136340
Treated	33743	69437	98896
Percentage Decrease	64%	46%	28%





Reclamite®
Safety Data Sheets

TRICOR

SAFETY DATA SHEET

1. Identification

Product identifier	**RECLAMITE® EMULSION**
Other means of identification	None.
Recommended use	Asphalt Rejuvenator
Recommended restrictions	Must be diluted with water following manufacturer's recommendations.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer:	Tricor Refining, LLC.
Address:	P.O. Box 5877 Bakersfield, CA 93388
24-hour Telephone Number:	(661) 393-7110
CHEMTREC:	1-800-424-9300 (North America) 1-703-527-3887 (International)

2. Hazard(s) identification

Physical hazards	Not classified.
Health hazards	Not classified.
Environmental hazards	Not classified.
OSHA defined hazards	Not classified.

Label elements

Hazard symbol	None.
Signal word	None.
Hazard statement	Not available.
Precautionary statement	
Prevention	Not available.
Response	Not available.
Storage	Not available.
Disposal	Not available.
Hazard(s) not otherwise classified (HNOC)	None known.
Supplemental information	Not applicable.

3. Composition/information on ingredients

Mixtures

Chemical name	Common name and synonyms	CAS number	%
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY NAPHTHENIC		64742-52-5	<=40
Extracts (petroleum), Heavy Naphthenic Distillate Solvent		64742-11-6	<=40
WATER		7732-18-5	<=40
PROPRIETARY INGREDIENTS		N/A	< 5

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Rinse with water. Get medical attention if irritation develops and persists.

Ingestion	Rinse mouth. Do not induce vomiting without advice from poison control center. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.
Most important symptoms/effects, acute and delayed	Direct contact with eyes may cause temporary irritation.
Indication of immediate medical attention and special treatment needed	Treat symptomatically.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Dry chemicals. Carbon dioxide (CO2).
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Cool containers exposed to heat with water spray and remove container, if no risk is involved. Move containers from fire area if you can do so without risk.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep upwind. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Extinguish all flames in the vicinity. Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Absorb in vermiculite, dry sand or earth and place into containers. Prevent entry into waterways, sewer, basements or confined areas. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use.
Environmental precautions	Contact local authorities in case of spillage to drain/aquatic environment. Prevent further leakage or spillage if safe to do so. Do not contaminate water. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Avoid prolonged or repeated contact with skin. Avoid prolonged exposure. Use only in well-ventilated areas.
Conditions for safe storage, including any incompatibilities	Keep away from heat and sources of ignition. Store in original tightly closed container.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY NAPHTHENIC (CAS 64742-52-5)	PEL	5 mg/m3	Mist.

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
Extracts (petroleum), Heavy Naphthenic Distillate Solvent (CAS 64742-11-6)	PEL	5 mg/m3	Mist.

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY NAPHTHENIC (CAS 64742-52-5)	TWA	5 mg/m3	Inhalable fraction.

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value	Form
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY NAPHTHENIC (CAS 64742-52-5)	Ceiling	1800 mg/m3	
	STEL	10 mg/m3	Mist.
	TWA	350 mg/m3	
Extracts (petroleum), Heavy Naphthenic Distillate Solvent (CAS 64742-11-6)	STEL	10 mg/m3	Mist.
	TWA	5 mg/m3	Mist.

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls Provide adequate ventilation, including appropriate local extraction, to ensure that the defined occupational exposure limit is not exceeded.

Individual protection measures, such as personal protective equipment

Eye/face protection Wear safety glasses with side shields (or goggles).

Skin protection

Hand protection Chemical resistant gloves are recommended. If contact with forearms is likely wear gauntlet style gloves.

Other Wear appropriate chemical resistant clothing.

Respiratory protection When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Liquid.

Form Liquid.

Color Not available.

Odor Not available.

Odor threshold Not available.

pH Not available.

Melting point/freezing point Not available.

Initial boiling point and boiling range > 212 °F (> 100 °C) IBP

Flash point	> 413.6 °F (> 212.0 °C)
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	Not available.
Solubility(ies)	
Solubility (water)	Readily Dispersible
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	500 °F (260 °C)
Decomposition temperature	Not available.
Viscosity	Not available.
Other information	
Specific gravity	0.92 - 1.04

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Prolonged inhalation may be harmful.
Skin contact	Frequent or prolonged contact may defat and dry the skin, leading to discomfort and dermatitis
Eye contact	Direct contact with eyes may cause temporary irritation.
Ingestion	Expected to be a low ingestion hazard.
Symptoms related to the physical, chemical and toxicological characteristics	Not available.

Information on toxicological effects

Acute toxicity	Not classified.
Skin corrosion/irritation	Prolonged skin contact may cause temporary irritation.
Serious eye damage/eye irritation	Not classified.
Respiratory or skin sensitization	
Respiratory sensitization	Not classified.
Skin sensitization	Not classified.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity

IARC Monographs. Overall Evaluation of Carcinogenicity

DISTILLATES (PETROLEUM), HYDROTREATED HEAVY NAPHTHENIC (CAS 64742-52-5) 3 Not classifiable as to carcinogenicity to humans.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1052)

Not regulated.

US. National Toxicology Program (NTP) Report on Carcinogens

Not listed.

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not classified.
Chronic effects	Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity	The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.
Persistence and degradability	No data is available on the degradability of this product.
Bioaccumulative potential	No data available.
Mobility in soil	No data available.
Other adverse effects	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions	Contract with a disposal operator licensed by the Law on Disposal and Cleaning. Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not discharge into drains, water courses or onto the ground. Dispose in accordance with all applicable regulations.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.
Waste from residues / unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not available.

15. Regulatory information

US federal regulations All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1052)

Not regulated.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical No

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations WARNING: This product contains a chemical known to the State of California to cause cancer.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 08-19-2021

Revision date 10-27-2021

Version # 02

NFPA ratings Health: 2
Flammability: 1
Instability: 0

Disclaimer The information provided in this Safety Data Sheet is correct to the best of our knowledge information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Revision information

Hazard(s) identification: Response
Hazard(s) identification: Prevention
Hazard(s) identification: Disposal
Hazard(s) identification: Storage
Hazard(s) identification: Hazard statement
Hazard(s) identification: GHS Symbols
Hazard(s) identification: GHS Signal Words
Composition/information on ingredients: Composition comments
Composition/information on ingredients: Component information
Physical & Chemical Properties: Multiple Properties
Toxicological information: Carcinogenicity
HazReg Data: North America
GHS: Classification

A.R.A.-1Ti®
Product Submittals

A.R.A.-1 Ti® Pollution-Remediating Maltene Asphalt Rejuvenator

Pavement Technology, Inc.

December 2022

Hewlett-Packard Company

Pavement Technology, Inc.

24144 Detroit Rd.
Westlake, Ohio 44145
Phone: 800-333-6309

A.R.A.-1 Ti® Pollution-Remediating Maltene Asphalt Rejuvenator

Following five years of successful laboratory and field testing, Pavement Technology, Inc. (PTI) is delighted to announce the commercialization of our suite of state-of-the-art pollution-reducing, super-hydrophilic, and UV protective photocatalytic pavement solutions. The product stock represents PTI's next evolution of premium pavement preservation materials enhanced with photo-reactive titanium dioxide (TiO_2). **A.R.A.-1 Ti®** is our celebrated maltene asphalt rejuvenator[1], with five decades of proven pavement preservation accomplishment, strengthened with the environmental and ecological properties of TiO_2.

As a natural decomposition accelerant, TiO_2 is a multifaceted photo-responsive material[2] rapidly gaining increased scientific and commercial interest for near-roadway microenvironments (MEs) as it advances a host of positive environmental benefits, including:

- **Depolluting** near-pavement air (or water) cleaning applications, where TiO_2 reacted surfaces oxidize a variety of pollutants and contaminants such as those emitted by vehicles, especially NO_x and VOCs, reducing ozone pollution and mitigating acid rain formation
- **"Cool Pavements"** where TiO_2 treated surfaces provide a solar-reflective top boundary, which lessens pavement heat absorption and related radiative forcing (RF) by materially reducing the convective re-release of UV radiation that leads to the undesired heat island effects in our cities while extending the life-cycle assessment of pavements by slowing-down pavement oxidation[3]
- **Super-Hydrophilic** surfaces, which provide a rapid water-desorbing pavement to reduce saturation and prevent water intrusion damage. Super-hydrophilic pavements are also self-cleaning to remove

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[1] See Maltene Replacement Technology (MRT) discussion Section 3.7, Page 32.

[2] *Polymers, Light and the Science of TiO2*, DuPont™ Ti-Pure® Titanium Dioxide, DowDuPont, www.dow-dupont.com.

[3] Gopalakrishnan K, et al.

contaminants (e.g., mold) and staining and are indicated for inclement weather-related safety (rain displacing; ice inhibiting) improvements for roads[4]

Lead by **A.R.A.-1 Ti®**, our suite of pollution-remediating solutions creates a perpetual air-purifying roadway microenvironment (ME) that can mitigate the effects of Urban Heat islands and contribute to an agency's compliance with the Clean Air Act (CAA) and the U.S. EPA's stringent National Ambient Air Quality Standard (NAAQS).

The Texas A&M Transportation Institute (TTI) is PTI's research partner for our TiO_2 enhanced products and all applications include standard verification testing perfected by TTI for pollution-reduction efficiency, Urban Heat Island (UHI) mitigation and water displacement effectiveness.

TTI standard photocatalytic property testing includes:

- **Titanium Dioxide Penetration and Load:** XRF (fluorescent X-ray) analysis
- **Nitrogen Oxide Removal:** Japanese Industrial Standard (JIS) TR Z 0018 *Photocatalytic Materials – Air Purification Test Procedure* (as adapted to ASTM)
- **UHI Mitigation:** U.S. Green Building Council USGBC), LEED V4 Heat Island Reduction (HIR) via Solar Reflectance Index (SRI) - ASTM E1980 - 11 *Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces*
- **Hydrophilic Properties:** ASTM D7334 - 08(2013) *Standard Practice for Surface Wettability of Coatings, Substrates and Pigments by Advancing Contact Angle Measurement*

The verification testing results can be used for preparation for environmental grants and programs, including the Federal Highway Administration's Congestion Mitigation and Air Quality Improvement Program (CMAQ) as provided under the CAA and administered by the Federal Highway Administration (FHWA) with matching funds of 80% to 100%; [5] and the Federal Transit Administration's Urbanized Area Formula Program Grants (UAFPG), which match fund up to 80% for "technical transportation-related studies" and up to 90% for capital investment in "associated transit improvements" attributable to compliance with the CAA.[6] Other eligible sources include the Voluntary Airport Low Emissions Program (VALE) through the Federal Aviation Administration (FAA) and the FAA's Aviation Research Grants Program (FAA-12-01).

Contact: Michael Durante
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[4] Arainpour F and Farzaneh M, On Hydrophobic and Icephobic Properties of TiO2-Doped Silicon Rubber Coatings, Department of Applied Sciences, Universite du Quebec, *International Journal of Theoretical and Applied Nanotechnology*, 2012.

[5] U.S. Department of Transportation, Federal Highway Administration: Congestion Mitigation and Air Quality Improvement Program (CMAQ) (U.S.C. 149 / FAST Act Section 1114), www.fhwa.dot.gov.

[6] U.S. Department of Transportation, Federal Transit Administration: Urbanized Area Formula Program Grants (49 U.S.C. Chapter 53, Sections 5307 and 5340 / FAST Act Sections 3004, 3016), www.transit.dot.gov.

A.R.A.-1 Ti® Pollution-Remediating Maltene Asphalt Rejuvenator

- Maltene Asphalt Rejuvenating Agent
- Enhanced with Photocatalytic Grade Titanium Dioxide (TiO_2)
- Captures and Removes up to 60% of Toxic Airborne Vehicular Emissions
- Replenishes Exact Molecular Components Lost to Manufacturing and In-Service Oxidation
- Restores and Improves Pavement Density and Durability
- Creates a UV Protected Pavement that meets USGBC LEED for Urban Heat Island Mitigation
- Presents a 'Quick Drying' Super-Hydrophilic Surface
- Reduces Water Intrusion Damage
- Extends Pavement Life Cycle by as much as Twofold
- Self-Cleaning; Anti Mold; and Anti-Microbial
- Promotes Safer Inclement Weather Pavements

Urban Scaling for the Benefits of Pollution Remediation, Heat Island Reduction and Pavement Preservation with Durable Photocatalytic Pavements

Research Support

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Table of Contents

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List of Drawings and Figures

List of Tables

List of Acronyms

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ABD	Atmospheric Boundary Layer
AMTIC	Ambient Monitoring Technology Information Center
APEX	Air Pollutants Exposure Model
APWA	American Public Works Association
ARA	Asphalt Rejuvenating Agent
ASR	Alkali-Silica Reaction
ASTM	American Society for Testing and Materials
BTU	British Thermal Units
°C	Celsius
CAA	Clean Air Act 1990 (amended)
CAFE	Corporate Average Fuel Economy
CAP	Criteria Air Pollutant
CIR	Center for Infrastructure Renewal
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CO_2e	Carbon Dioxide Equivalent
CsT	Centistokes
D&D	D&D Emulsions, Inc.
ECF	Electrochemical Energy Field
EPA	U.S. Environmental Protection Agency
ENV	Envision Framework for Sustainable and Resilient Infrastructure
EV	Electric Vehicle
°F	Fahrenheit
FAST	Fixing America's Surface Transportation Act
FHWA	Federal Highway Administration
FRM	Federal Reference Method
GSY	Gallons Per Square Yard
GHG	Greenhouse Gas
GWP	Global Warming Potential
H_2O	Water
HAP	Hazardous Air Pollutant
HIR	Heat Island Reduction
HIRP	Heat Island Reduction Program
HNO_3	Nitrate Salt
HUD	U.S. Department of Housing and Urban Development
ICV	Internal Combustion Vehicle
IRI	International Roughness Index
ISI	Institute for Sustainable Infrastructure
JIS	Japanese Industrial Standard
LCA	Life Cycle Assessment
LEED	Leadership in Energy and Environmental Design
LF	Lineal Feet
M^2	Meters Squared
ME	Microenvironment
MJ	Megajoule
MM	Millimeter
MOT	Maintenance of Traffic
MPG	Miles Per Gallon
MPO	Metropolitan Planning Organization
MRT	Maltene Replacement Technology
MSRP	Manufacturer's Suggested Retail Price
NAAQS	National Ambient Air Quality Standards
NEI	National Emissions Inventory
NREL	National Renewable Energy Laboratory
NAWQA	National Water-Quality Assessment Program
NVFEL	National Vehicle and Fuel Emissions Laboratory
NEV	New Energy Vehicle
NM	Nanometers
NNE	Nitrite-Nitrate Exchange Indexing
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_3	Nitrate
NO_x	Nitrogen Oxides
O_3	Ozone
OGFC	Open Graded Friction Course
OTIC	Ohio Turnpike and Infrastructure Commission
P	Poise
PCC	Portland Cement Concrete
$PM_{2.5}$	Particulate Matter <2.5 µm (micron)
PPB	Parts Per Billion
PPM	Parts Per Million
PPMC	PPM Consultants, Inc.
PSH	Photoinduced Superhydrophilicity State
PTI	Pavement Technology, Inc.
PCO	Photocatalytic Oxidation
Redox	Oxidation-Reduction
RF	Radiative Forcing
ROI	Return on Investment
SCAQMD	South Coast Air Quality Management District
SCM	State, County, and Municipal
SCR	Selective Catalytic Reduction
SCRP	Sustainable Communities Regional Planning Grant
So_x	Sulfur Oxides
Sq/Yd	Square Yard(s)
SR	Solar Reflectivity
SRI	Solar Reflectance Index
TTI	Texas A&M Transportation Institute
TiO_2	Titanium Dioxide
IUC	University of Illinois Urbana-Champaign
UAFPG	Urbanized Area Formula Program Grant
UHI	Urban Heat Island effect
USD	U.S. Dollars
USGBC	U.S. Green Building Council
UV	Ultraviolet Light
VALE	Voluntary Airport Low Emissions Program
VOC	Volatile Organic Compound
W	Weight of Residue
WCA	Water Contact Angle
WHO	World Health Organization
XRF	X-ray Fluorescence

1 SUMMARY AND TESTING

The background, methods, application and testing for PTI's photocatalytic pavement solutions for pollution removal, pavement lifecycle extension and urban heat management are described herein.

PTI is into its fifth decade serving government agencies and was an early advocate for asphalt rejuvenation nanoscience using Maltene Replacement Technology (MRT) [7] to extend the life cycle assessment (LCA) of asphalt pavements. Thousands of agencies (SCMs) have employed MRT for many decades as part of their roadway planning and maintenance protocols to reduce costs and lower their community's carbon footprint. Pavement preservation solutions enhanced with the trifecta of photocatalytic properties, from depollution to heat-reducing and life cycle extending, are a natural advancement in environmental and sustainability solutions from PTI.

These next generation products are proving valuable to SCMs and other transportation infrastructure authorities, such as airports, seeking to manage compliance with the Clean Air Act (CAA), the National Ambient Air Quality Standards (NAAQS) for airborne pollution inventory minimums, and Urban Heat Island effect (UHI).

The near-road microenvironment (ME) is a significant area of policy and practice concern for modern urban planners, regulators, and sustainability managers. Emissions from cars and trucks are a major source of greenhouse gases (GHGs) and the primary source for anthropogenic airborne toxins, such as nitrogen oxides (NO_x) and volatile organic compounds (VOCs), that form the nucleus of unhealthy photochemical smog.

The combined action of urbanization (change in land use) and sharp increase in vehicular emissions intensifies both the build-up of GHGs in the air we breathe and the impact of heat sinks. The circular impacts from air pollution and UHI amplify related economic stresses on communities. In turn, GHG inventories accumulate, exaggerating linked atopic and other human disease.[8]

National Emissions Inventory (NEI) Data [9] indicate motor vehicles operating on roadways emit on average 60% of ozone pollution (O_3), principally NO_x in the United States. In more densely populated areas, vehicle-based emissions inventory trend closer to 75%, while total vehicle emissions in rapidly growing metropolitan areas have skyrocketed over 80% since 1990.[10]

In addition to poorer air quality and the escalating health burden, mobile-sourced pollution is contributing to the "western impacts", including rising sea levels and warmer climates. For example, intensified El Niño effects are resulting in exaggerated precipitation and incidence of flooding in the Southeastern United States and droughts in the West.

NO_x is the primary component of O_3 or "urban smog". It is a class of gaseous pollutants generated during high temperature processes of internal combustion engines and consists of nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is considered among the most dangerous air pollutants impacting human health and the environment and is one of six Criteria Air Pollutants (CAPs) as defined under the NAAQS.

Photocatalytic oxidation (PCO) of NO_x using topical spray materials containing **titanium dioxide (TiO_2)** for roadway applications is a novel, yet proven technology for mitigating urban smog. It has been researched and tested broadly,

[7] Pavement Technology, Inc., www.pavetechinc.com/got-maltenes/.

[8] Swamy G, et al., *Urban Heat Island (UHI) Influence on Secondary Pollutant Formation in a Tropical Humid Environment*, www.PubMed.gov.

[9] U.S. Environmental Protection Agency (EPA): National Emissions Inventory (NEI), www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei.

[10] Boston University: Database of Road Transportation Emissions and *The New York Times*, October 2019.

especially in Europe. While the success rate for PCO efficiency of TiO_2 solutions has been consistently encouraging,[11] [12] prevailing techniques for both the development and application of TiO_2 compounds have proven not durable or economical.

That now has changed.

In 2017 (and 2018), PTI applied the first field tests for *durable* TiO_2 solutions in Greenville (SC) and Orlando (FL). The technological breakthrough combined proven surface penetrating pavement preservation compounds, long utilized by conservation minded SCMs, fortified with photocatalyst grade TiO_2, to impregnate pavements with the natural pollution-reducing and heat reflecting material. The PTI technique provides both a method for sustainable TiO_2 delivery into pavement wearing-course depth and at cost-effective "retrofit" economics. The practice promotes an efficient and scalable application for solar-based, direct capture technology for O_3 precursors in the near-road environment.

Titanium is an amazing material. It is as strong as steel, yet a fraction of its weight and much more durable. TiO_2 is a natural mineral whose atypical chemical properties have led to a diverse range of commercial and industrial uses from whitening additives in paints to food coloring, candy coatings, toothpaste, and reflective sunscreens, etc.

Or as surface 'wetting' (i.e., hydrophilic) and anti-fogging agents and as photo-reactive chemical catalysts.[13]

With a half century of experience introducing nanotechnologies to pavements, PTI's photocatalytic solutions are designed to deeply penetrate pavement surfaces to deliver nanoparticle, photocatalyst TiO_2 into depth at optimal load for sustained PCO and UHI mitigation. The product stock can be applied to almost any asphalt or concrete substrate using PTI's advanced application apparatus and at a fraction of the costs to more archival means to clean air, reduce heat build and extend infrastructure life cycle.

Based on the Greenville and Orlando successes **(Table 1.1)**, [14] more refined applications of these new solutions have been deployed in the field as pilot projects in Austin (TX), Charlotte County (FL), Greater (Cary) Raleigh (NC), Bartow (FL) [FDOT test], Akron (Summit County) (OH) and at Orlando International Airport (MCO).

Recently, Cincinnati (OH) and Raleigh (NC) placed the first ever public bid and RFP for these materials. They will be used on the first photocatalytic pavement related project to receive LEED in St. Petersburgh (FL) and piloted at the Kennedy Space Center by NASA later in summer 2020.

1.2 Field Testing – Vehicular Pollution Removal

The Texas A&M Transportation Institute (TTI) has tested field cores from the pilot sites using standardized photocatalytic materials testing protocols for PCO. [15] TTI testing indicates consistently strong NO_x reduction at all sites tested and over multiple years on the oldest sites **(Tables 1.1-1.4)**.

[11] Dios J, et al., *Decontamination through Photocatalytic TiO_2 Additions – Past, Present and Future,* International Conference on Emerging Trends in Engineering and Technology (ICETET), London 2014.

[12] Gopalakrishnan K, et al., *Climate Change, Energy, Sustainability, and Pavements*, Springer, 2014.

[13] Gopalakrishnan K, et al., *Climate Change, Energy, Sustainability, and Pavements*, Springer, 2014.

[14] Zollinger DG and Joshaghani A, *Laboratory Investigation of the Effect of TiO2 Topical Treatments on Concrete and Asphalt Samples*, Texas A&M Transportation Institute, September 2018.

[15] Japanese Industrial Standard (JIS) TR Z 0018 *Photocatalytic Materials – Air Purification Test Procedure*.

Table 1.1 Multi-year NO_x Reduction Testing – Orlando (FL) and Greenville (SC)

A.R.A.-1 Ti®

Site	NO Reduction Efficiency (%)				
0.04 – 0.05 gsy Light TiO_2	Control Sample	Y1 Sample A	Y2 Sample A	Y1 Sample B	Y2 Sample B
Orlando (FL)	NEGL	28%	33%	34%	30%
Greenville (SC)	NEGL	38%	35%	43%	38%

Source: Texas A&M Transportation Institute (TTI)

Table 1.2 NO_x Reduction – Orlando International Airport and Charlotte County (FL)

Site	NO Reduction Efficiency (%)				
0.08 gsy > TiO_2	Control Sample	A.R.A.-1 Ti® Sample A	A.R.A.-1 Ti® Sample B	Litho1000Ti® Sample A	Litho1000Ti® Sample B
Orlando International	NEGL	45%	43%	53%	57%
Charlotte Co. (FL)	NEGL			42%	46%

		Ti-introCME™ Concrete Sample A	Ti-introCME™ Concrete Sample B	Ti-introCME™ Asphalt Sample A	Ti-introCME™ Asphalt Sample B
Charlotte Co. (FL)	NEGL	48%	47%	49%	50%

Source: Texas A&M Transportation Institute (TTI)

Table 1.3 NO_x Reduction – Greater Raleigh [Cary] (NC)

Site	NO Reduction Efficiency (%)				
A.R.A.-1 Ti®	Control Sample	0.08 gsy Sample A	0.08 gsy Sample B	0.07 gsy Sample A	0.07 gsy Sample B
Cary, NC	NEGL	46%	45%	42%	44%

Source: Texas A&M Transportation Institute (TTI)

Table 1.4 NO_x Reduction – TTI Test at the Center for Infrastructure Renewal (CIR)

Compound	NO Reduction Efficiency (%)					
Application Rate	Control Sample	0.05 gsy	0.06 gsy	0.08 gsy	0.10 gsy	0.12 gsy
A.R.A.-1 Ti®	NEGL	53%	57%	61%	53%	48%
Ti-introCME™	NEGL	48%	52%	55%	58%	53%

Application Rate		0.04 gsy	0.06 gsy	0.10 gsy
Litho1000 Ti®	NEGL	46%	55%	48%

Source: Texas A&M Transportation Institute (TTI)

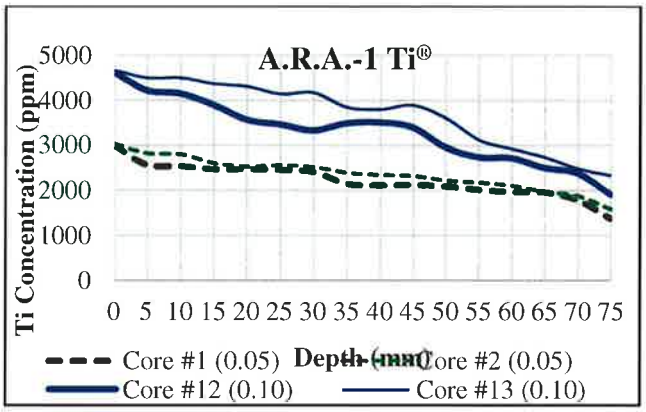
Texas A&M also has tested the pilot sites for TiO_2 penetration (durability) and load optimization (PCO efficiency) through 'wearing-course' depth (0 to 6 mm) [16] using x-ray fluorescence analysis **(Figure 1.1)**.[17] [18]

Due, in large part, to previously proven penetrant technology, PTI test sites consistently indicate deep penetration of the photocatalyst material at efficient PCO concentrations (> 2000 ppm) as deep as 50 mm (2 inches) or 8x AASHTO wearing-course depth.

The high TiO_2 presence at wearing-course depth is why the NO_x reduction figures are consistently strong. Penetration and reliable load optimization of the TiO_2 is the key to the significant technological advancement with Pavement Technology's photocatalytic pavement solutions. This was achieved by combining two proven nanotechnologies – known pavement preservation penetrating agents (e.g., MRT) and photocatalysis using photoreactive grade nanoparticle titanium dioxide.

Road-level NO_x capture and sequestration or "NO_x Capture" has been the principal advantage of PTI's photocatalytic pavement solutions, with a product stock including **A.R.A.-1 Ti®** for asphalt surface courses, **Litho1000$^{Ti®}$** for concrete surface courses, **JOINTBOND$^{Ti®}$** (longitudinal joints) and **Ti-introCME®** (all substrates), which cover most or all transportation infrastructures and needs.

Figure 1.1 TiO_2 Penetration – Orlando International Airport



Source: Texas A&M Transportation Institute (TTI)

[16] The American Association of State Highway and Transportation Officials (AASHTO) sets pavement wearing course depth at 0.25 inches.

[17] Zollinger DG and Joshaghani A, September 2018.

[18] Zollinger DG and Joshaghani A, Follow-up, May 2019.

1.3 Acid Rain Mitigation with TiO_2 Treated Roads

Atmospheric deposition of nitrogen is a major source of nitrate found in watersheds and is addressed by various water-quality legislation. Specifically, because almost all of the sources of nitrogen contaminations are point sources, this form of pollution is best controlled by directly reducing nitrogen oxide emissions.

Commonly, these point sources are located outside of the political boundaries of watersheds that inherit this atmospheric deposited nitrogen and, therefore, may not be controlled through SCM regulations nor governance. Recent amendments to the CAA have mandated reductions to NO_x, including from mobile sources, as they are a critical factor in managing nitrogen levels impacting lakes, reservoirs, rivers, and other estuarial expanses.

Vehicular emissions are the second largest source of nitrogen builds in watersheds, after agricultural sources, and can contribute as much as 40% [19] of nitrate levels in dense urban settings.

The U.S. Geological Survey (USGS) recommends direct reduction strategies for mobile-sourced NO_x be employed to reduce such water contaminations. So, photocatalytic pavements provide a preferred strategy for acid rain mitigation and direct reduction of watershed nitrogen builds.

Table 1.5 Solar Reflectance – (a) Orlando International Airport and (b) Charlotte County (FL)

Compound / Substrate	Solar Reflectance Index Values (SRI)					
Application Rate (a)	Control Sample	Control Sample	0.10 gsy	0.10 gsy	0.08 gsy	0.08 gsy
A.R.A.-1 Ti® / Asphalt	9	8	40	39		
Litho1000 Ti® / Concrete	24	24			38	38
Application Rate (b)	Control Sample	0.03 gsy	0.06 gsy			
Ti-introCME™ / Asphalt	11	30	34			
Ti-introCME™ / Concrete	20	37	42			
Litho1000 Ti® / Concrete	25	41	46			

Source: Texas A&M Transportation Institute (TTI)

[19] U.S. Geological Survey's National Water-Quality Assessment Program (NAWQA), www.usgs.com.

1.4 Field Testing - Cool Pavements with TiO_2

In 2019, TTI added testing for solar reflectance (UHI mitigation effectiveness), showing PTI test sites consistently exceed the threshold for **U.S. Green Building Council LEED** for heat island reduction **(Table 1.5)**.[20] [21]

At Orlando International Airport, PTI solutions turned an almost perfectly absorptive asphalt parking ramp (FedEx terminal) with a **Solar Reflectance Index (SRI)** of 9 (out of 100) into a 39-40 or 40% more reflective than LEED requirements and **> 4x as heat energy displacing** as original, untreated asphalt.

As a heat mitigator, photocatalytic grade TiO_2 simultaneously absorbs solar radiation away from the pavement substrate and efficiently redirects the energy back into the atmosphere, thereby protecting the pavement from oxidative deterioration (LCA extension) and eliminating excess pavement emissivity (especially in asphalts), creating a so-called – **"cool pavement"** which greatly helps reduce UHI.[22]

1.5 Field Testing – Super-Hydrophilic Pavements

TiO_2-bearing pavements exhibit a **Photoinduced Superhydrophilicity State** (PSH) when exposed to UV radiation, which enables water to disperse and desorb across a TiO2-treated surface much more efficiently. [23] [24] This **greatly reduces water intrusion risk** to pavements and critical for longitudinal joints.

PSH pavements also promote significant **highway safety** improvement implications including reduced hydroplaning, less windshield visibility impairment, and possibly ice formation mitigation. It also is why TiO_2 treated surfaces are mechanically "self-cleaning" and both anti-mold and antimicrobial. [25]

[20] Zollinger DG and Joshaghani A, *Solar Reflectance Analysis of TiO2 Penetrant Treatments on Concrete and Asphalt Samples*, Texas A&M Transportation Institute, August 2019.

[21] U.S. Green Building Council USGBC), LEED V4 Heat Island Reduction (HIR) via Solar Reflectance Index (SRI) ≥ 50% 29, www.usgbc.org.

[22] EPA, *Reducing Urban Heat Islands: Compendium of Strategies, Urban Heat Island Basics*, www.epa.org.

[23] Mechanism of Photoinduced Superhydrophilicity on the Photocatalyst Surface, *The Journal of Physical Chemistry*, American Chemistry Society, 2005, Masato T, et al.

[24] Vassilia Z, *Hydrophilic TiO2 Surface Without Photocatalytic Activation*, Lawrence Berkeley National Laboratory, University of California at Berkeley.

[25] Kubacka A, Suarez Diez M, et al., Understanding the Antimicrobial Mechanism of TiO2- based Nanocomposite Films in a Pathogenic Bacterium, *Nature Journal*, 2014.

For example, the PTI test site at Orlando International exhibited significant mold removal within the first few months on the previously mentioned FedEx ramp treated with **A.R.A.-1 Ti®**.

Light energized TiO_2 strongly attracts water, which is naturally polarized, where the water molecules are split by the activated surface, resulting in vastly improved disposal of H_2O as it is transformed into thin films across the surface, not allowing droplets (and ponding) to form **(Drawing 1.2)**.

Drawing 1.2 Super-Hydrophilic Surfaces Can Rapidly Displace Water

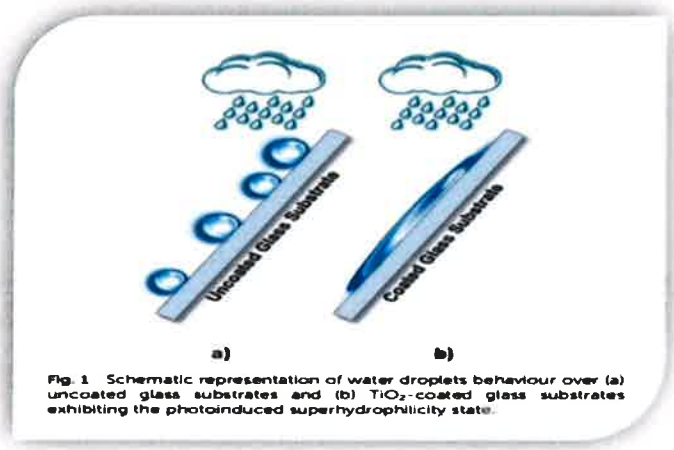


Fig. 1 Schematic representation of water droplets behaviour over (a) uncoated glass substrates and (b) TiO_2-coated glass substrates exhibiting the photoinduced superhydrophilicity state.

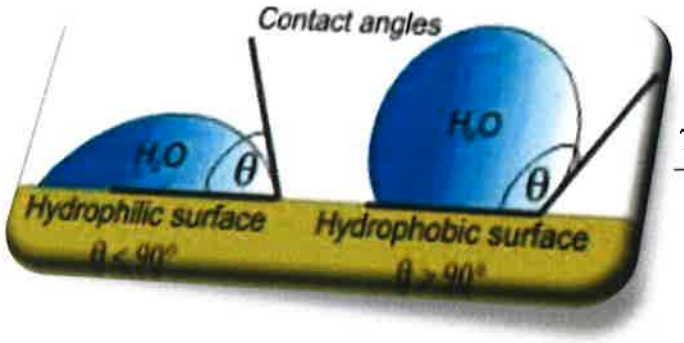
Source: Universidade do Porto (Portugal)

This PSH or **"quick drying"** transition of a photocatalytic pavement surface can be observed by measuring water contact angle (WCA) before and after UV illumination,[26] where a TiO_2-bearing surface presents a **contact angle** considerably **lower** when irradiated. This **accelerates the dispersion** of water across the surface by as much as **5x** a non TiO_2-bearing or "inactive" surface.[27] [28]

As with NO_x reduction, the "fully hydroxylated" TiO_2-bearing pavement [29] during photocatalysis causes powerful oxidants to combine with the adsorbed water molecules (e.g., rain) to form new hydrogen bonding with the H_2O clusters. This forces the distribution of these bonds within the water droplets to decrease, resulting in a **reduction** of **surface tension** between the water and the photoreactive TiO_2 surface.[30] [31]

A WCA of less than 90 degrees is considered "hydrophilic" and will increasingly (with lower contact angle) speed-up the displacement of water **(Drawing 1.3)**.

Drawing 1.3 Hydrophilic vs Hydrophobic Contact Angles



Source: London South Bank University

For example, in highway design, an open graded friction course (OGFC) is designed specifically to **physically reduce** water contact angle as **surface roughness** has a strong effect on wettability.

[26] ASTM D7334 - 08(2013) *Standard Practice for Surface Wettability of Coatings, Substrates and Pigments by Advancing Contact Angle Measurement*.

[27] Research Institute of Toto Ltd., Tokyo, Japan, 1995.

[28] Banerjee S, et al., *Self-Cleaning Applications of TiO_2 by Photo-Induced Hydrophilicity and Photocatalysis*, 2015.

[29] Hydroxylation is a chemical process that introduces a hydroxyl group (-OH) into an organic compound and is the first step in oxidative degradation.

[30] Transparent Superhydrophobic/Superhydrophilic TiO_2-based Coatings for Self-Cleaning and Anti-fogging, *Journal of Materials Chemistry*, Royal Society of Chemistry, 2012.

[31] Masato T, Sakamoto K, et al., *Mechanism of Photoinduced Superhydrophilicity on the TiO_2 for Photocatalytic Surface*, Department of Chemistry, Graduate School of Engineering, Osaka Prefecture University, February 2005.

A photocatalytic pavement will be even more efficient at producing a hydrophilic outcome through its high electro-chemical energy transformation of water molecules as described, providing a measurable upgrade to the water desorbing efficiency of any pavement substrate.

PTI tested **A.R.A.-1 Ti®** on an OGFC in Bartow (FL) for the Florida Department of Transportation (FDOT) in 2019. As indicated in **(Table 1.6)**, the TiO_2 enhanced test section observed a material decline in WCA from 81-82 degrees to 50-51 degrees for a nearly 40% improvement in water displacement capability.

Table 1.6 Water Contact Angle – FDOT OGFC Test Bartow (FL)

Site	Water Contact Angle°				
A.R.A.-1 Ti®	Control Sample	TiO2 1 Visible Light	TiO2 1 UV Light	TiO2 2 Visible Light	TiO2 2 UV Light
FDOT Test	81°	82°	51°	81°	50°

Source: Texas A&M Transportation Institute (TTI)

In the Charlotte County (FL) trials, PTI tested both **Litho1000$^{Ti®}$** and **Ti-introCME®** across test sections for skid resistance (friction) under the standard testing protocol [32] which was executed by International Cybernetics **(Table 1.7)**. The primary purpose for which was to determine skid resistance safety when applying TiO_2 enhanced products to high speed thoroughfares. But what also was observed was clear indications of the instantaneous hydrophilic *effect* the TiO_2 imparted to the surface of the pavement.

[32] ASTM E247 / E274M-15 *Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire.*

Table 1.7 TiO_2 Impact on Skid Resistance and Hydrophilic Implications

Litho1000 Ti®

Location / Rate gsy	Pre-Application	Post 20 Minutes	Post 24 Hours
Indian Trail WB / 0.03	43	41	44
Indian Trail WB / 0.06	43	47	50

Ti-introCME®

Location / Rate gsy	Pre-Application	Post 20 Minutes	Post 24 Hours
Alicante Drive EB / 0.03	58	61	61
Alicante Drive WB / 0.06	59	64	64
Indian Trail WB / 0.03	42	43	45
Indian Trail WB / 0.06	42	51	51

Source: International Cybernetics, Charlotte County (FL) March 2019

As exhibited, the surfaces treated with both **Litho1000$^{Ti®}$** and **Ti-introCME®** showed that friction was not adversely impacted in any of the tests and that in all six tests, skid resistance improved meaningfully. That friction results improved immediately (tested after just 20 minutes following application) and continued was insightful as it indicates the clear presence of the TiO_2 and a PSH.

To some, this may appear to be a startling outcome, especially considering the rather small amount of water used in the standardized friction test. But it is direct evidence of improved hydrophilic tendency of a road impregnated with photocatalyst grade TiO_2. While more expanded research is concurrent, under actual inclement weather conditions, one should expect the improved (relative) skid resistance for a TiO_2-bearing pavement to be even greater, hence the safety improvements realizable.

PTI's photocatalytic pavement solutions provide the Public Works profession the first method for sustainable TiO_2 delivery into pavement wearing-course depth and at cost-effective "retrofit" economics. The technique promotes an efficient, durable, and scalable application for solar-based, **"NO_x Capture"** technology for the systematic removal of O_3 precursors, UHI mitigation, pavement infrastructure LCA extension, and improved roadway safety in the critical near-road environment.

PERFORMANCE SPECIFICATION

2 Pollution-Remediating Polymerized Maltene Asphalt Rejuvenator

2.1 Description: TiO_2 Enhanced Asphalt Rejuvenating Agent

The work specified in this section shall consist of furnishing all labor, material, and equipment necessary to perform all operations for the application of a penetrating polymerized asphalt rejuvenating agent to asphaltic concrete surface courses. The asphalt binder rejuvenation shall be affected through the petroleum Maltene Replacement Technology method. In addition, and with the same penetrating carrier liquid, apply photocatalytic-grade titanium dioxide (TiO_2) to create a pollution reducing pavement microenvironment. The rejuvenation of surface courses shall be by spray application of a polymerized maltene based cationic rejuvenating agent composed of petroleum oils and resins emulsified with water and containing photocatalytic titanium dioxide in a minimum parts per million at a minimum depth as hereafter specified.

All work shall be in accordance with the specifications, the applicable drawings, and subject to the terms and conditions of this contract.

Figure 2.1 A.R.A.-1 Ti® Application

Source: Pavement Technology, Inc.; Cary, NC 2019

2.2 Materials and Performance: TiO_2 Enhanced Asphalt Rejuvenating Agent

The TiO_2 Enhanced Asphalt Rejuvenating Agent shall be a cationic emulsion composed of a petroleum resin oil base uniformly emulsified with water. Each bidder must submit a bid with a certified statement from the TiO_2 enhanced asphalt rejuvenating agent manufacturer showing that the asphalt rejuvenating emulsion conforms to the required physical and chemical requirements.

Table 2.1 Test of Emulsion and on Residue

	Test Methods		Requirements	
	ASTM	AASHTO	Min	Max
Tests on Emulsion				
Viscosity @ 25°C, SFS	**D-244**	**T-59**	**15**	**40**
Residue, %W[1]	**D-244(Mod.)**	**T-59(Mod)**	**60**	**65**
Miscibility Test[2]	**D-244(Mod.)**	**T-59(Mod)**	**No Coagulation**	
Sieve Test, %W[3]	**D-244(Mod.)**	**T-59(Mod)**		**0.1**
Particle Charge Test	**D-244**	**T-59**	**Positive**	
Percent Light Transmittance[4]				**80**
Tests on Residue from Distillation:				
Flash Point, COC, °C	**D-92**	**T-48**	**196**	
Viscosity @ 60°C, cSt	**D-445**	**-**	**100**	**200**
Asphaltenes, %w	**D-2006-70**	**-**		**1.00**
Maltene Dist. Ratio[5]	**D-2006-70**	**-**	**0.3**	**0.6**
PC/S Ratio[5]	**D-2006-70**	**-**	**0.5**	
Saturated Hydrocarbons, S[5]	**D-2006-70**	**-**	**21**	**28**

[1] ASTM D-244 Modified Evaporation Test for percent of residue is made by heating 50-gram sample to 149°C (300°F) until foaming ceases, then cool immediately and calculate results.

[2] Test procedure identical with ASTM D-244-60 except that .02 Normal Calcium Chloride solution shall be used in place of distilled water.

[3] Test procedure identical with ASTM D-244 except that distilled water shall be used in place of two percent sodium oleate solution.

[4] Procedure for Determining Percent Light Transmittance on Asphalt Rejuvenating Agent:

a. Scope: This procedure covers the determination of percent light transmittance of the asphalt rejuvenating agent.

b. Apparatus:

1. Container may be glass, plastic or metal having a capacity of 6,000 ml.
2. Graduated cylinder, 1,000 ml, or greater
3. Light transmittance measuring apparatus, such as Bausch and Lomb or Lumberton spectrophotometer
4. Graduated pipette having 1 ml capacity to 0.01 ml accuracy
5. Suction bulb for use with pipette
6. Test tubes compatible with spectrophotometer, 3/4" X 6, Bausch and Lomb, Catalog No. 33-17- 81, (B&L)

c. Calibration of spectrophotometer:

1. Calibrate spectrophotometer as follows:
   a. Set wavelength at 580 mu,

b. Allow spectrophotometer to warm-up thirty minutes,
c. Zero percent light transmittance (%LT) scale,
d. Rinse test tube three times with tap water and fill to top of circle marking on B&L test tube or approximately 2/3 full,
e. Place tube in spectrophotometer and set %LT scale at 100, and,
f. Repeat steps (c) (e) two times or until no further adjustments necessary.

d. Procedure:

1. Shake, stir or otherwise thoroughly mix emulsion to be tested. Place sample of emulsion in beaker and allow to stand one minute.
2. Place 2,000 ml tap water in container.
3. Suck 1.00 ml emulsion into pipette using suction bulb. Wipe off outside of pipette.
4. Using suction bulb, blow emulsion into container.
5. Rinse pipette by sucking in diluted emulsion solution and blowing out.
6. Clean pipette with soap or solvent and water. Rinse with acetone.
7. Stir diluted emulsion thoroughly.
8. Rinse out tube to be used with the diluted emulsion three times and fill to top of circle.
9. Calibrate spectrophotometer.
10. Place diluted emulsion sample tube in spectrophotometer, cover and read %LT to nearest tenth.
11. Repeat steps 9 and 10 until three identical consecutive readings are achieved.
12. The elapsed time between addition of emulsion to dilution of water and final %LT reading should not exceed 5 minutes.

[5] Chemical Composition by ASTM Method D-2006-70 -- (Free) Maltene Distribution Ratio (MDR) can be defined as:

$$\frac{PC + A_1}{S + A_2}$$

Where:

PC = Polar Compounds A_1 = First Acidaffins
A_2 = Second Acidaffins S = Saturated Hydrocarbons

2.3 Maltene Replacement ("Rejuvenation") Test

The TiO_2 Enhanced Asphalt Rejuvenating Agent shall have the capability to penetrate the asphalt pavement surface and shall be absorbed and incorporated into the asphalt binder. Verification that said incorporation of the TiO_2 Enhanced Asphalt Rejuvenating Agent into the asphalt binder has been effected shall be by the petroleum maltene fraction replacement method and analysis of the chemical properties of said asphalt binder therein i.e., viscosity shall be reduced by said method.

For pavements less than two-years old and receiving the original application of TiO_2 Enhanced Asphalt Rejuvenating Agent, the viscosity shall be reduced by a minimum of twenty (20%) percent as determined by the dynamic shear rheometer (DSR) method for asphalt testing in accord with AASHTO T315-05. For treatments of pavements older than two-years and/or after an initial treatment with a petroleum maltene asphalt rejuvenator, the viscosity shall be reduced by petroleum maltene replacement method a minimum of thirty percent (30%) in accord with same. This analysis shall apply to extracted asphalt binder, taken from cores extracted fifteen to thirty days following application, in the upper 3/8" of pavement. The treated areas shall be densified or resistant in depth to the intrusion of air and water.

The TiO_2 Enhanced Asphalt Rejuvenating Agent shall have a record of at least two years of satisfactory service as a TiO_2 enhanced petroleum maltene based emulsion asphalt rejuvenating agent and in-depth densifier. Satisfactory service shall be based on the capability of the material to decrease the viscosity of the asphalt binder by the petroleum maltene replacement method and provide an in-depth seal. A.R.A.-1 Ti®, a Pavement Technology, Inc. product manufactured by D&D Emulsions, Inc., Mansfield, Ohio, is a product of know quality and accepted performance.

The bidder must submit with his bid the manufacturer's certification that the material proposed for use is in compliance with the specification requirements. The bidder must submit with his bid previous use documentation and test data conclusively demonstrating that; the TiO_2 Enhanced Asphalt Rejuvenating Agent has been used successfully for a period of two years by government agencies such as state, county and municipal governments or "SCMs", etc.; and that the enhanced rejuvenating agent has been proven to perform, as heretofore required, through field testing by government agencies as to the required change in asphalt binder rheology and photocatalytic properties as hereinafter detailed. Testing data shall be submitted indicating such product performance on a sufficient number of projects to insure product consistency. In addition, field testing data shall be submitted to indicate said product performance over a minimum testing period of two years to insure reasonable sustainability.

The Engineer may require that untreated and treated core samples, a minimum of four inches in diameter, be removed by the Contractor at locations indicated by the Engineer. The treated core sample shall be taken in the same lane in close proximity to each untreated sample. A minimum of one untreated and treated core sample shall be taken for each pavement group or one per 50,000 square yards of treated pavement in each pavement group.

2.4 Photocatalytic Properties Testing

2.4.1 TiO_2 Penetration Test: The TiO_2 Enhanced Asphalt Rejuvenating Agent shall have a non-destructive analytical procedure applied to determine the percent of Titanium Dioxide nanoparticles present in each two-millimeter (2mm) layer of the field core sample matrix for a minimum depth of six millimeters (6mm) from the top of the treated sample core. The method of measurement shall be by fluorescent X-ray emitted from the surface when excited by a principal X-ray source that is exceptional for the given element. A hand-held XRF analyzer is acceptable for this testing.

The minimum required concentration of Titanium Dioxide nanoparticles per each two-millimeter (2mm) section up to the minimum depth of 6mm shall average 2000 parts per million (ppm).

2.4.2 NO_2 Reduction Effectiveness: The TiO_2 Enhanced Asphalt Rejuvenating Agent shall be verified for the effectiveness of the air pollution remediation of the Titanium Dioxide nanoparticle portion by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4") in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

2.4.3 NO_2 Reduction Test: A photo reactor test chamber shall be employed that allow for the evaluation of the efficient photocatalytic reduction of introduced NO_x gas of a known and controlled concentration within the chambers volume. The chamber light source shall be a UV lamp having a wavelength of 375 nanometers. The interior chamber environment shall be at 77°F with a constant humidity of 55% ±5%. The test total duration shall be five hours. The analysis test system shall be based on a Japanese Industrial Standard (JIS) TR Z0018 "Photocatalytic Materials-Air purification test procedure". NO removal

efficiency shall be measured using a Model 42i Chemiluminescence NO-NO_2-NO_x Analyzer (Thermo Fisher Scientific Inc.).

The minimum NO reduction following the heretofore outlined test procedure evaluating field core samples shall average 25% for all cores tested.

2.4.4 Solar Reflectance Effectiveness: Verification of the effectiveness of the solar reflectivity the Titanium Dioxide nano-particle portion of the TiO_2 Enhanced Asphalt Rejuvenating Agent shall be by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4") in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

2.4.5 Solar Reflectance Test(s): Solar reflectivity shall be determined by measuring the treated core samples for a Solar Reflectance Index (SRI) value. SRI is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100. The relevant standards for measuring solar reflectance are:

Table 2.2 Test of Solar Reflectance

Value	Test Method
Solar Reflectance	**ASTM C1549 – Standard Test Method for Determination of Solar Reflectance**
Solar Reflectance Index	**ASTM E 1980 – Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces**

Based on these standards, the SRI is a measure of the relative steady-state temperature of a surface with respect to a standard white surface (SRI=100) and a standard black surface (SRI=0) under standard solar and ambient conditions.

Under normal ambient conditions, the steady-state temperature for the black and white reference surfaces is 355.61 kelvin (K) or 180°F and 317.76 K (110°F), respectively.
A Solar Reflectance Index (SRI) can be defined as:

$$SRI = \frac{T_b - T_s}{T_b - T_w}$$

Where:

- Steady-state Surface Temperature (Ts)—the temperature of the surface, in K, under the standard solar conditions. The surface temperature Ts (°C)=Ts (K)-273
- Reference Black Surface Temperature (Tb)—the steady-state temperature of a black surface with a solar reflectance of 0.05 and infrared emittance of 0.9, under the standard solar and ambient conditions
- Reference White Surface Temperature (Tw)—the steady-state temperature of a white surface with a solar reflectance of 0.80 and infrared emittance of 0.9, under the standard solar and ambient conditions
- Sky Temperature (Tsky)—the temperature of a black body that would radiate the same power in the thermal infrared spectrum (5 to 40 nm) toward the earth as does the sky

The minimum SRI value following the heretofore outlined test procedure(s) evaluating field core samples shall average 29 (or 0.29) for all cores tested, which meet the minimum standard (≥50% 29 SRI) for the U.S. Green Building Council (USGBC) hardscape threshold for Leadership in Energy and Environmental Design (LEED) credit or the minimum standard for the American Public Works Association (APWA) / Institute for Sustainable Infrastructure (ISI) Envision Superior (≥60% 29 SRI) level of achievement credit.

2.4.6 Hydrophilic Improvement: Verification of the improvement in hydrophilic property of the Titanium Dioxide nano-particle portion of the TiO_2 Enhanced Asphalt Rejuvenating Agent shall be by laboratory analysis of core samples extracted from the treated pavement as directed and required by the Engineer. The cores shall be a minimum of four inches (4") in diameter and in pairs at each location directed by the Engineer. The cores shall be tested by an accredited laboratory or university with the equipment and capability to perform the following test procedures.

2.4.7 Wettability Test: Hydrophilic improvement shall be determined by measuring the treated core samples for Water Contact Angle (WCA). WCA is a common measurement of a constructed surface's ability to improve wettability or the ability of water to develop a stronger boundary (less resistance) with the surface as shown by a decline in water contact angle. A WCA of $> 90^0$ is considered hydrophobic or high resistance while a WCA $<90^0$ is considered hydrophilic or low resistance. The relevant standard for measuring WCA is:

Table 2.3 Test of Water Contact Angle

Value	Test Method
Water Contact Angle	**ASTM D7334 - 08(2013) Standard Practice for Surface Wettability of Coatings, Substrates and Pigments by Advancing Contact Angle Measurement**

The minimum WCA reduction following the heretofore outlined test procedure evaluating field core samples shall average 20% for all cores tested.

2.5 Equipment

2.5.1 Distributor: The distributor for spreading the emulsion shall be self-propelled and shall have pneumatic tires. The distributor shall be designed and equipped to distribute the asphalt rejuvenating agent uniformly on variable widths of surface at readily determined and controlled rates from 0.04 to 0.10 gallons per square yard of surface, and with an allowable variation from any specified rate not to exceed 5% of the specified rate.

Distributor equipment shall include full circulation spray bars, pump tachometer, volume measuring device and a hand hose attachment suitable for application of the emulsion manually to cover areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the emulsion within the tank.

The rate of application shall be controlled by an onboard computer control system designed to control the selected application rate uniformly and consistently in gallons per square yard regardless of the forward speed of the distributor truck.

A check of distributor equipment as well as application rate accuracy and uniformity of distribution shall be made when directed by the Engineer.

2.5.2 Aggregate Cover Truck: The truck used for cover aggregate application shall be equipped with a spreader that allows the aggregate to be uniformly distributed onto the pavement. The spreader shall be able to apply 1/2 pound to 3 pounds of cover aggregate per square yard in a single pass. The spreader shall be adjustable so as not to broadcast cover aggregate onto driveways or to lawns.

The cover aggregate to be used shall be free flowing, without any leaves, dirt, stones, etc. Any wet aggregate shall be rejected from the job site.

Any equipment that is not maintained in full working order, or is proven inadequate to obtain the results prescribed, shall be repaired, or replaced at the direction of the Engineer.

2.5.3 Calibration: Distributor- prior to construction, calibrate the distributor in accordance with ASTM D2995-99 in the presence of the Engineer. The distributor shall be moving forward at the proper application speed at the time the spray bar is opened. If at any time a nozzle becomes clogged or not spraying a proper pattern, the operation shall be immediately halted until repairs are made.

2.6 Construction

2.6.1 Layout: The Contractor will be responsible for the lay out of the roadway and project planning and sequencing to meet traffic control requirements prior to paving.

2.6.2 Weather and Seasonal Limitations: The TiO_2 Enhanced Asphalt Rejuvenating Agent shall not be applied to a wet surface or when rain is occurring, or the threat of rain is present immediately before placement. The surface treatment shall not be applied when the temperature is less than 40° in the shade. When applying emulsions, the temperature of the surface shall be a minimum of 45°F, and no more than 150°F.

If unexpected rain occurs prior to material penetration and cover aggregate application, the agent shall be reapplied at no cost to the agency. Further, the contractor's traffic control and project monitoring shall continue until the application has penetrated, area has been sanded and the resultant surface is acceptable to the Engineer for vehicular travel.

2.6.3 Preparation of Surface: The contractor will be responsible for blowing or sweeping the road immediately ahead of the application operation to make sure the road is free of standing water, dirt, loose aggregate, and other debris. The surface shall be clean and dry prior to the application.

2.6.4 Application of TiO_2 Enhanced Asphalt Rejuvenating Agent: The TiO_2 Enhanced Asphalt Rejuvenating Agent shall be applied by a distributor truck at the temperature recommended by the manufacturer and at the pressure required for the proper distribution. The emulsion shall be so applied that uniform distribution is obtained at all points of the areas to be treated. Distribution shall be commenced with a running start to ensure full rate of spread over the entire area to be treated. Areas inadvertently missed shall receive additional treatment as may be required by hand sprayer application.

2.6.5 Material Placement of TiO_2 Enhanced Asphalt Rejuvenating Agent: Application of TiO_2 Enhanced Asphalt Rejuvenating Agent shall be on one-half width of the pavement at a time. When the second half of the surface is treated, the distributor nozzle nearest the center of the road shall overlap the previous application by at least one-half the width of the nozzle spray. In any event the centerline construction joint of the pavement shall be treated in both application passes of the distributor truck.

Before spreading, the TiO_2 Enhanced Asphalt Rejuvenating Agent shall be blended with water at the rate of two parts rejuvenating agent to one-part water, by volume or as specified by the manufacturer. The combined mixture of asphalt rejuvenating agent and water shall be spread at the rate of 0.04 to 0.10 gallons per square yard, or as approved by the Engineer following field testing.

Where more than one application is to be made, succeeding applications shall be made as soon as penetration of the preceding application has been completed and the Engineer grants approval for additional applications. Grades or super elevations of surfaces that may cause excessive runoff, in the opinion of the Engineer, shall have the required amounts applied in two or more applications as directed.

The Contractor shall furnish a quality inspection report showing the source, manufacturer, and the date shipped, for each load of TiO_2 Enhanced Asphalt Rejuvenating Agent. When directed by the Engineer, the Contractor shall take representative samples of material for testing.

2.6.6 Test Strip for Application Rate: Prior to start of the project, the contractor shall perform test strip applications as directed by the engineer. Test strips shall be performed for each pavement group of similar age and type within the project area.

The test strips shall be applied at a minimum width of 6 feet and for a length of 50 feet. A total of three test strips shall be applied at application rates of 0.04, 0.08 and 0.10 gallons per square yard, respectively. The time, in minutes, for essentially complete absorption of the asphalt rejuvenating emulsion shall be recorded for each test strip. The optimal rate to be used in a given area shall be that rate essentially absorbed within 20 minutes.

In the event that all three of the standard test rates are absorbed completely within the 20-minute timeframe, then the Contractor and the Engineer shall agree on a fourth test strip application rate.

Upon completion of the test strips for each pavement group, the Engineer will determine the final application rate to be applied to each pavement group.

2.6.7 Cover Aggregate Application: After the TiO_2 Enhanced Asphalt Rejuvenating Agent emulsion has penetrated, and when recommended by the Contractor and approved by the Engineer, a coating of dry cover aggregate shall be applied to the surface in sufficient amount to protect the traveling public as required.

All cover aggregate used during the treatment must be removed no later than 24 hours after treatment of a roadway. This shall be accomplished by a combination of hand and mechanical sweeping. All turnouts, cul-de-sacs, etc. must be cleaned of any material to the satisfaction of the Engineer. Street sweeping will be included in the price bid per square yard for asphalt rejuvenating emulsion.

If, after the cover aggregate is swept and in the opinion of the Engineer a hazardous condition exists on the roadway, the contractor must apply additional cover aggregate and sweep same no later than 24 hours following reapplication. No additional compensation will be allowed for reapplication and removal of materials.

2.6.8 Handling of TiO_2 Enhanced Asphalt Rejuvenating Agent: Contents in tank cars or storage tanks shall be circulated at least 45 minutes before withdrawing any material for application. The distributor truck will be cleaned of all of its asphalt materials and washed out to the extent that no discoloration of the emulsion may be perceptible. Cleanliness of the spreading equipment shall be subject to the approval of the Engineer.

2.6.9 Street Sweeping: The Contractor shall be responsible for sweeping and cleaning the streets after treatment. All cover aggregate used during the treatment must be removed no later than 24 hours after treatment of the street. This shall be accomplished by a combination of hand and mechanical sweeping. All turnouts, cul-de-sacs, etc. must be cleaned of any material to the satisfaction of the Engineer.

If, after cover aggregate is swept and in the opinion of the Engineer a hazardous condition exists on the roadway, the contractor must apply additional cover aggregate and sweep same no later than 24 hours following reapplication. No additional compensation will be allowed for reapplication and removal of cover aggregate.

2.6.10 Resident Notification: The contractor shall distribute by hand, a typed notice to all residences and businesses on the street to be treated. The notice will be delivered no more than 24 hours prior to the treatment of the road. The notice will have a local phone number that residents may call to ask questions. The notice shall be of the door hanger type, which secures to the door handle of each dwelling. Unsecured notices will not be allowed. The contractor shall also place the notice on the windshield of any parked cars on the street. Hand distribution of this notice will be considered incidental to the contract.

2.6.11 Traffic Control: The Contractor shall furnish all necessary traffic control, barricades, signs, and flagmen, to ensure the safety of the traveling public and to all working personnel. Traffic shall not travel on fresh TiO_2 Enhanced Asphalt Rejuvenating Agent until penetration, in the opinion of the Engineer, has become complete and the area is suitable for traffic. The Contractor shall submit an M.O.T plan indicating all facets of traffic control for the project area. The M.O.T. plan must be approved in writing by the Engineer prior to commencing any work. All traffic control shall be in accordance with the DOT Roadway Design Standards (most current edition). Traffic control devices shall be checked daily and periodically throughout the project for compliance; and where adjustments or corrections are needed, prompt revisions shall be made.

2.6.12 Method of Measurement: The TiO_2 Enhanced Asphalt Rejuvenating Agent emulsion shall be paid at the Contract bid unit prices for the actual square yards of pavement treated as field measured. Said payment is compensation in full for all costs of furnishing and applying the material as specified, including cleaning the existing pavement, purchase of cover aggregate, delivery of cover aggregate, all labor, equipment, and materials necessary for the placement of the TiO_2 Enhanced Asphalt Rejuvenating Agent emulsion, sweeping of any loose material after construction and other requirements as specified. Traffic control for maintaining traffic for constructing TiO_2 Enhanced Asphalt Rejuvenating Agent emulsion shall be considered incidental.

Payment for removal of untreated and treated cores shall be paid for as each at the unit price bid for Test Core Removal.

2.6.13 Basis of Payment:

Pay Item	Unit
• TiO_2 Enhanced Asphalt Rejuvenating Agent	Per Sq/Yd
• Field Core Removal*	Each
• Field Core Laboratory Analysis – Viscosity*	Each
• Field Core Laboratory Analysis -Titanium Dioxide Penetration*	Each
• Field Core Laboratory Analysis - Titanium Dioxide NO_2 Reduction*	Each
• Field Core Laboratory Analysis - Titanium Dioxide Solar Reflectance Index (SRI)*	Each
• Field Core Laboratory Analysis - Titanium Dioxide Water Contact Angle (WCA)*	Each
• Mobilization	Per Project

*When required by the Engineer

ADDENDUM

3 BACKGROUND

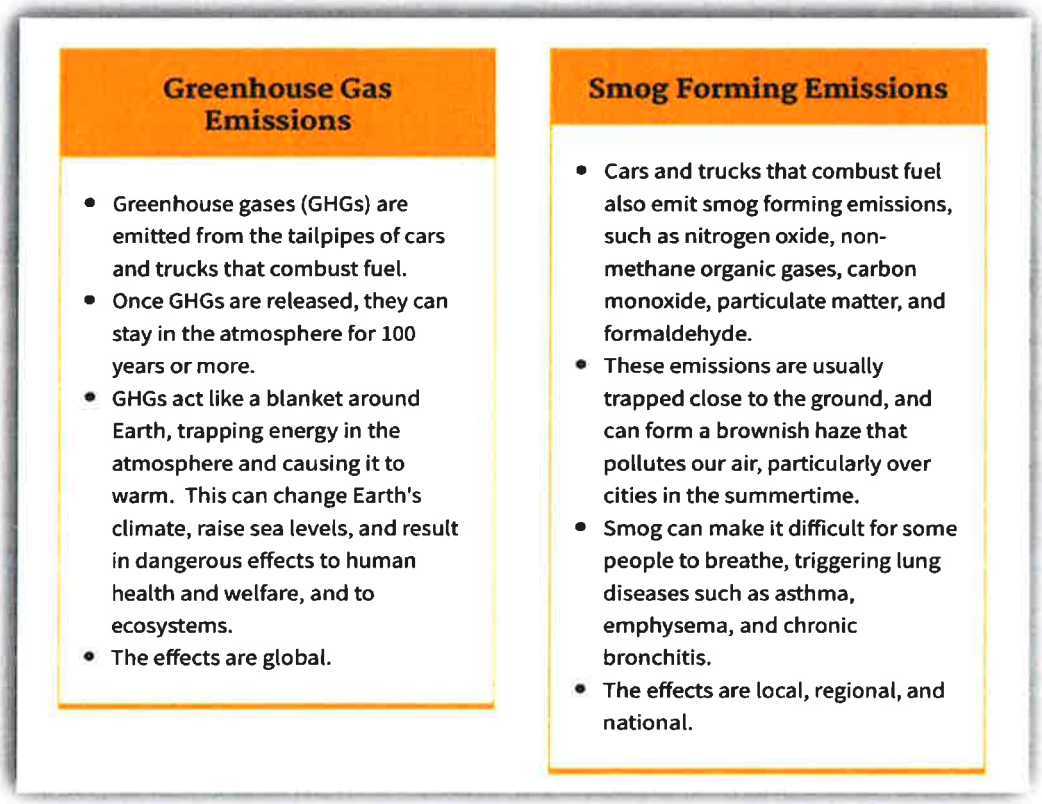
3.1 Mobile Source Pollution and Tropospheric Ozone

Ozone, sometimes referred to as **"smog"**, is a toxic gas that is formed in the atmosphere when three atoms of oxygen combine (i.e., O_3). The chemical structure of ozone is the same wherever it is found; however, as shown **(Figure 3.1)** there are two categories of ozone.

Stratospheric Ozone is found naturally in the Earth's upper atmosphere - 6 to 30 miles above the Earth's surface - where it forms a protective layer that shields us from the sun's harmful ultraviolet rays.[33] This sometimes is referred to as "good ozone".

Ground-Level Ozone is found near ground level, naturally (sometimes called "tropospheric ozone"). It is created by chemical reactions between nitrous oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Emissions from industrial facilities can contribute as much 15% of tropospheric ozone, electric utilities 20% and motor vehicle exhaust contributes 60% or more **(Figure 3.2)**.[34] They are the major sources of noxious gas formations in the air humans breathe ("bad ozone").

Figure 3.1 Greenhouse Gases & Smog Forming Emissions

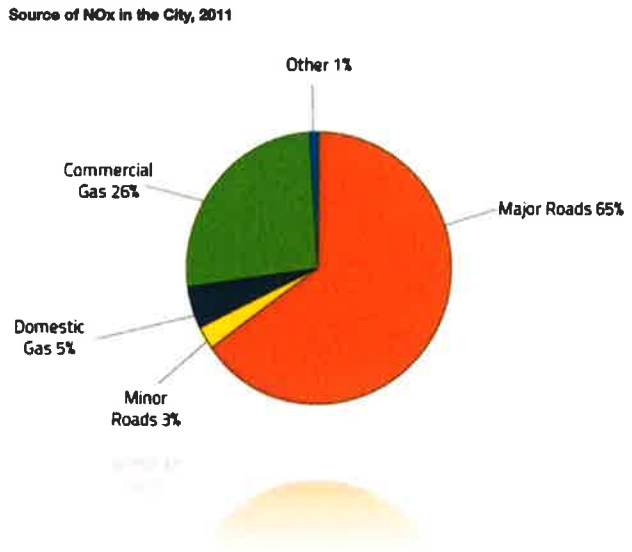


Source: Environmental Protection Agency (EPA) www.epa.gov

[33] Texas Commission on Air Quality, www.tceq.texas.gov.

[34] Environmental Protection Agency (EPA), www.epa.gov.

Figure 3.2 Major City Sources of NO_x



Source: City of London Air Quality Strategy 2011-2015

Climate scientists and healthcare experts have concluded that ground-level pollution or photochemical smog in densely populated, urban environments has developed into a human health crisis.

The World Health Organization's (WHO) most recent survey of 4300+ cities worldwide indicate only 20% of urban populations live in cities that comply with WHO air quality guideline levels for fine particulate matter ($PM_{2.5}$), which includes NO_x as the major contributor.[35] [36]

The poor showing includes American cities, where all of our major urban hubs are near, already at or above WHO limits.[37]

Further, WHO scientists believe the impact of inner-city air pollution on the development of respiratory and atopic disease in childhood, in particular, has reached epidemic proportion.[38] Air pollution may contribute to as many as 9 million premature deaths annually,[39] including 43% of lung diseases and cancer, 25% of heart disease and 24% of strokes.[40]

The American Lung Association has concluded:

"The burden of air pollution is not evenly shared. Poorer people and some racial and ethnic groups are among those who often face higher exposure to pollutants..." [41] owing, in no small part, to their sheer proximity to major point-sources (industry and traffic) for anthropogenic pollution.

3.2 Air Quality and Resident Health

Creation of Hazardous Photochemical Smog Caused by Vehicle Emissions: Detrimental gas emissions, such as NO_x and sulfur oxides (SO_x), are formed during the combustion process from burning fossil fuels. Vehicle emissions introduce one of those oxides – nitrogen dioxide, into the environment, increasing O_3 concentrations. As the ozone concentrates, the percentage of nitrogen undergoing oxidization also increases, resulting in an increasingly higher percentage of NO_2 in the atmosphere, especially in the troposphere to create ground-level pollution harmful to humans and damaging to ecological systems.

Researchers have identified a clear association between these serious environmental, ecological and health dangers with the presence of photochemical smog, acid rain, and rising NO_2 concentrations. The EPA classifies NO_2 as an "extremely hazardous" criteria toxin [42] and has set stringent limits on its ozone inventory under the NAAQS. [43] The ratio of NO_2 to total gas emissions has been rising over the years due to increasing urbanization and associated traffic and

[35] World Health Organization (WHO), *Ambient (Outdoor) Air Quality and Health*, May 2018.

[36] WHO: 10µg/m³ annual mean and 25µg/m³ 24-hour mean for $PM_{2.5}$, www.who.int.

[37] EPA: Air Quality Statistics by City 2017, www.epa.gov.

[38] WHO, *Ambient (Outdoor) Air Quality and Health*

[39] *The Lancet* Commission on Pollution and Health, October 2017.

[40] WHO, Global Health Observatory (GHO) data 2016, www.who.int.

[41] American Lung Association, *Disparities in the Impact of Air Pollution*, www.lung.org.

[42] EPA: List of Extremely Hazardous Substances, www.epa.gov.

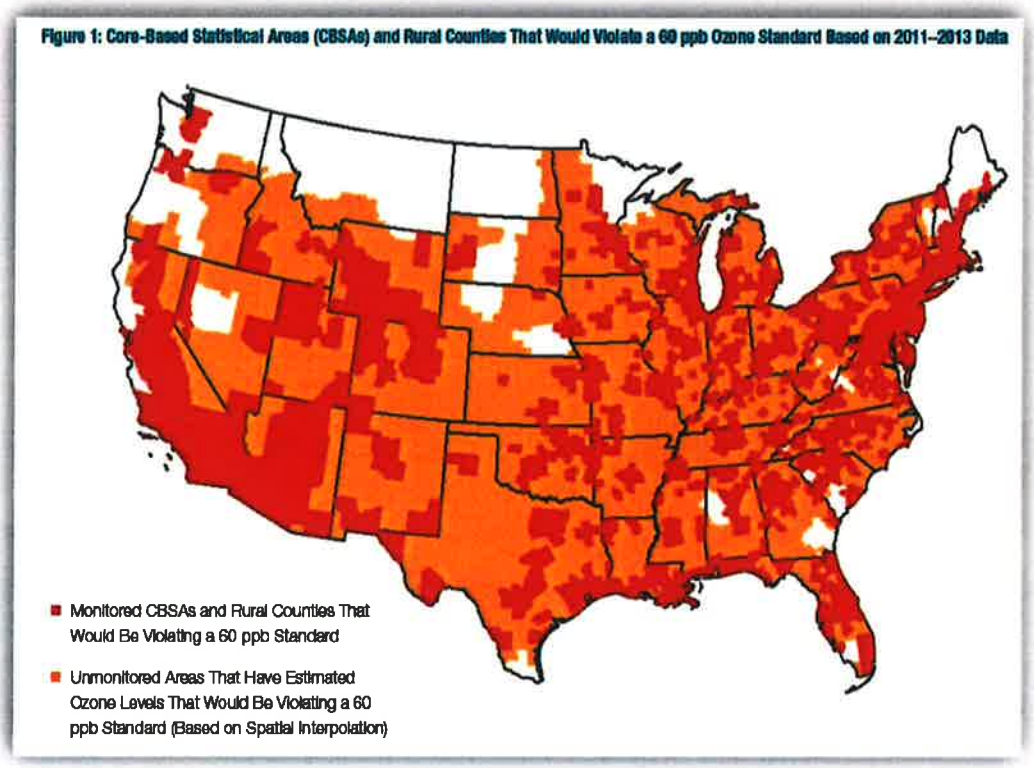
[43] EPA: NAAQS Table, Criteria Air Pollutants, www.epa.gov.

has resulted in a corresponding increase in O_3 ``build-up.[44]

EPA technical data shows that as much as two-thirds of atmospheric NO_2 is emitted from mobile sources.[45] And nearly half of all Americans live within 'maximum exposure' to near-roadway pollution or within 500 meters of high AADT volume roads, according to the most recent U.S. Census.[46]

Airborne nitrous oxides (nitrites) have a half-life ranging 100 to 150 years.[47] The EPA also believes NO_2 concentrations from vehicles and near roadways are appreciably higher than those measured at monitors in the current EPA network. In fact, **near-road concentrations can be 2–3 times higher than measured at nearby area-wide monitors**,[48] making road-level **"breathing zones"** uniquely attractive targets for managing NO_2 contaminations.

Figure 3.3 Ozone Nonattainment at 60 ppb



Source: U.S. Environmental Protection Agency www.epa.gov

[44] Richmond-Bryant J and Owen RC et al., Estimation of On-road NO_2 Concentrations, NO_2/NO_x Ratios, and Related Roadway Gradients from Near-road Monitoring Data, *Air Quality, Atmosphere & Health*, January 2017.

[45] EPA: List of Extremely Hazardous Substances, www.epa.gov.

[46] U.S. Census Blocks 2010, U.S. Census Bureau, www.censes.gov; and U.S. Department of Transportation, Federal Highway Administration (FHWA), Average Annual Daily Traffic Data (AADT), www.fhwa.dot.gov.

[47] EPA, Technical Bulletin: *Nitrogen Oxides (NO_x), Why and How They are Controlled*, November 1999.

[48] EPA: Near Roadway Air Pollution and Health, Frequently Asked Questions EPA-420-F-14-014, www.epa.gov.

EPA estimates [49] **(Figure 3.3)** indicate all major U.S. cities and much of the country's populated areas in general would breach O_3 concentrations at a 60ppb (parts per billion) threshold. The current limit is just 65ppb [50] and most health and environmental experts expect the "nonattainment" limit to be lowered in the near future.

So, agencies need to be both preemptive and proactive. Most do not have adequate strategies in-place, however. [51]

3.3 On-Road Vehicular Emissions

The Good News is that vehicles are getting more efficient. Average new vehicle fuel economy for internal combustion engine (ICV) passenger cars has increased from 13 mpg in 1975 to 25 mpg today,[52] and it's expected to steadily rise to 40 mpg in the coming decade.[53] Many ICV models already exceed 35 mpg. [54]

EPA scientists and engineers at the National Vehicle and Fuel Emissions Laboratory (NVFEL) at the University of Michigan (Ann Arbor) are working closely with our automotive industry ("Detroit") to continue to improve current vehicular technology *in-use* to meet higher MPGs.

The Bad News is that our urban centers and accompanying vehicle ownership are growing far faster than emissions technology can pace.

America alone has seen annual new vehicle registrations nearly triple since 1975,[55] far outpacing gains in fuel efficiency. And while new energy vehicle (NEV) growth has been steady, wide adoption has been greatly limited by steep cost prohibitions, lackluster consumer enthusiasm and other constraints.[56] [57] [58] The electric vehicle (EV) market e.g., appears to be centered exclusively on the super-luxury market, with average MSRPs exceeding 67,000 USD.[59]

The National Renewable Energy Laboratory (NREL) predicts that energy demand would skyrocket by over 60% [60] from current capacity limits if EVs were widely adopted. But where would we get more electricity today, tomorrow, or even fifty years from now to meet such an enormous increase in electricity demand?

By most estimates, we'd need as many as 10 billion solar panels in the United States alone just to handle electric cars, creating substantial financial, logistic and land use issues.[61] And that, of course, assumes the panels will be able to constantly (steadily) produce the electricity we will need, while future technology actually will develop to store it. These are big "ifs".

Reasoned analysis suggests that even if such limitations for renewable energy sources are solved, in part or in whole, estimates for overhauling the country's electric grid and energy infrastructure for ***new energies*** are rounded in the ***tens*** **of trillions** USD.[62] [63] [64] So, alternative energy

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[49] EPA: 2015 (update) NAAQS for Ozone, Ground-level Ozone Pollution, www.epa.gov.

[50] EPA: Fact Sheet - Overview of EPA's Updates to Air Quality Standards for Ground-level Ozone, www.epa.gov.

[51] National Association of Home Builders (NAHB), *Cities Still Miss the Mark on Ozone Standards*, September 2015.

[52] EPA: National Vehicle and Fuel Emissions Laboratory (NVFEL), www.epa.gov.

[53] EPA: Environmental Ratings on the Label, Vehicle Emissions, www.epa.gov.

[54] EPA: Office of Transportation and Air Quality (OTAQ) / National Vehicle and Fuel Emissions Laboratory NVFEL), University of Michigan, www.lsa.umich.edu.

[55] US Department of Transportation, Federal Highway Administration (FHWA), www.fwha.gov.

[56] MIT Sloan School of Management, *The Real Barriers to Electric Vehicle Adoption*, August 2017.

[57] MediaVillage, *Five Reasons Why Electric Car Sales Fail at the Dealer Level*, June 2019.

[58] Forbes, *Prediction: Auto Industry Headed for Financial Pile-up as EV Sales Disappoint*, June 2018.

[59] Edmonds, www.edmonds.com.

[60] National Renewable Energy Laboratory (NREL), www.nrel.gov.

[61] Glenn H and Ost I, www.pick-my-solar.com; Herron D, www.greentransportation.info.

[62] The Republican Study Committee, *A Greedy New Steel*, February 2019.

[63] The University of Texas at Austin Energy Institute.

[64] Stanford University, School of Earth, Energy & Environment.

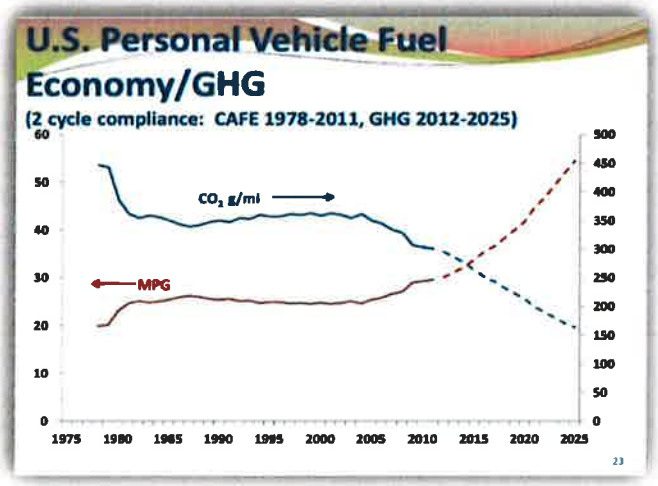
sources are proving more difficult to scale, store or even afford than expected. [65] [66]

For now, GHG emissions from an EV are 50% higher than the improving fuel economy ICVs.[67] So, the need for more commercially practicable solutions today, tomorrow, and perhaps for a lot longer for vehicular emissions management are presenting themselves.

In PTI's on-gong discussions with the Federal Highway Administration's (FHWA) Environment, Air Quality, and Realty Team (which oversees CMAQ), improvements in existing transportation systems remain the highest priority and are consistent with the EPA's NVFEL view.

Any technology which promotes reduced CO_2e from vehicles, including photocatalytic roads, is viewed as a *de facto* improvement or acceleration in vehicular MPG efficiency towards meeting Corporate Average Fuel Economy (CAFE) standards **(Figure 3.4)**.

Figure 3.4 Vehicle MPG vs CO_2e



Source: EPA: National Vehicle and Fuel Emission Laboratory

The global trend to reduce pollution and energy consumption is a most critical cause, but poses unquestionable challenges (as highlighted), as numerous as they are complex for governments and industry. How we adapt products, services, and governance to play a scalable role in reducing pollution and energy consumption and our associated carbon footprint is key. These questions are becoming more urgent as legislative and environmental guidelines drive us towards more efficient energy usage, including and especially for on-road concentrations.[68]

In considering the response and beyond the immense economic costs, one must also consider consumer expectations. While most consumers are aware of the balance between the cost and environmental benefits of reduced energy consumption, many may be reluctant to accept energy-reducing products that compromise other criteria e.g., product or behavior choice or even aesthetics.

3.4 Surface Chemistries & Catalytic Pollution Removal Systems

The photocatalytic effect of TiO_2 applied to pavements and other structures can remove pollutants from the air, so that so-called **"photocatalytic pavements"** can be installed for two primary applications - air pollutant removal and heat management. And critically - without significant cost nor change to transportation infrastructure or effect on consumer choice or behavior.

Several approaches utilizing photocatalysis have been studied as methods for successfully counteracting noxious emissions.

[65] Finkler T and Hannon K, *Renewable Energy: Status and Struggles*, Stanford University.

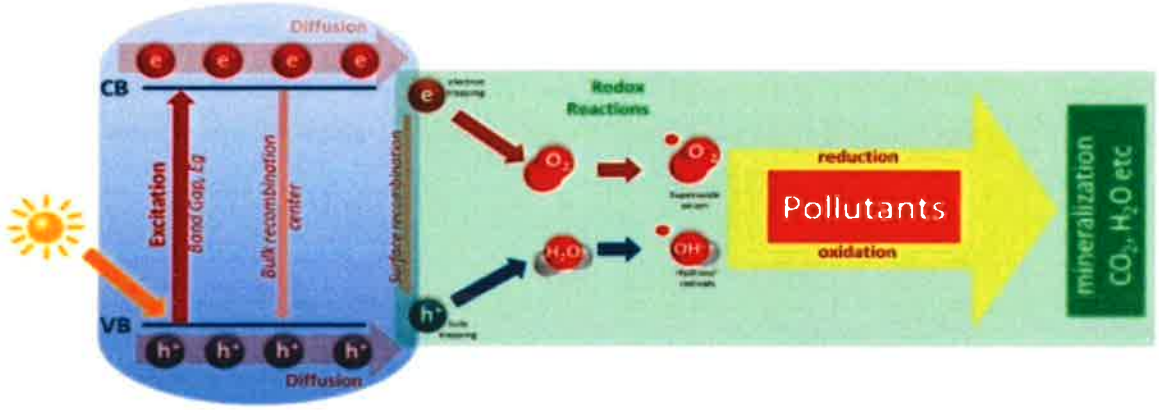
[66] The Wharton School, University of Pennsylvania, *Can the World Run on Renewable Energy?*, April 2015.

[67] Tsinghua University, *Applied Energy* (Journal), May 2018.

[68] U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA): Corporate Average Fuel Economy (CAFE) standards, www.nhtsa.gov.

Photocatalysis or PCO is the acceleration of a photoreaction in the presence of a semiconductor. When the catalyst is activated by ultraviolet (UV) light with wavelengths less than 380nm, hydroxyl radicals and superoxide are created via band gap excitation,[69] [70] forming an electrochemical energy field (ECF) **(Drawing 3.5)**.

Drawing 3.5 TiO_2 Based Photocatalysis – Band Gap Excitation



Source: Journal of Materiomics

The ECF naturally and efficiently decomposes transient molecules traveling near or through the field, including primary O_3 precursors such as NO_x and VOCs as discussed. So, commercial photocatalyst grade TiO_2 <1μm (micron) is widely used as a photocatalyst material for several reasons, including as an effective pollution remediate:

- TiO_2 fulfills the requirements for **effective photo-activity** under the solar irradiance levels experienced on Earth
- Photoreactive TiO_2 is chemically **inert**; physically **stable**; **non-toxic**; **non-exhaustive**; **economical**; and widely (commercially) **available**
- TiO_2 has **strong oxidizing strength**, in particular at the ambient conditions near the Earth surface given that TiO_2's wide band gap (minimum energy required to excite and mobilize electrons) [71] in the solid state enables it to be very efficient in the UV range of the light spectrum
- TiO_2 also promotes **super-hydrophilic** (i.e., water-desorbing) as well as **solar-reflectivity** (SR) advantages to building materials

TiO_2 hence promotes numerous advantages useful to science and engineering including de-polluting; self-cleaning; light-remitting; and heat reducing properties.

3.5 Solar Reflective Properties of TiO_2

The growth in urbanization and changing land use coupled with ever rising vehicular emissions intensifies the UHI effects in cities.

The heat-build exaggerates heat-related stresses such as O_3 levels and accompanying disease in humans. And though UHI intensity depends on many factors including wind speed, direction, and solar flux, the thermodynamic properties of surface materials can greatly exaggerate the temperature profiles at the local scale.

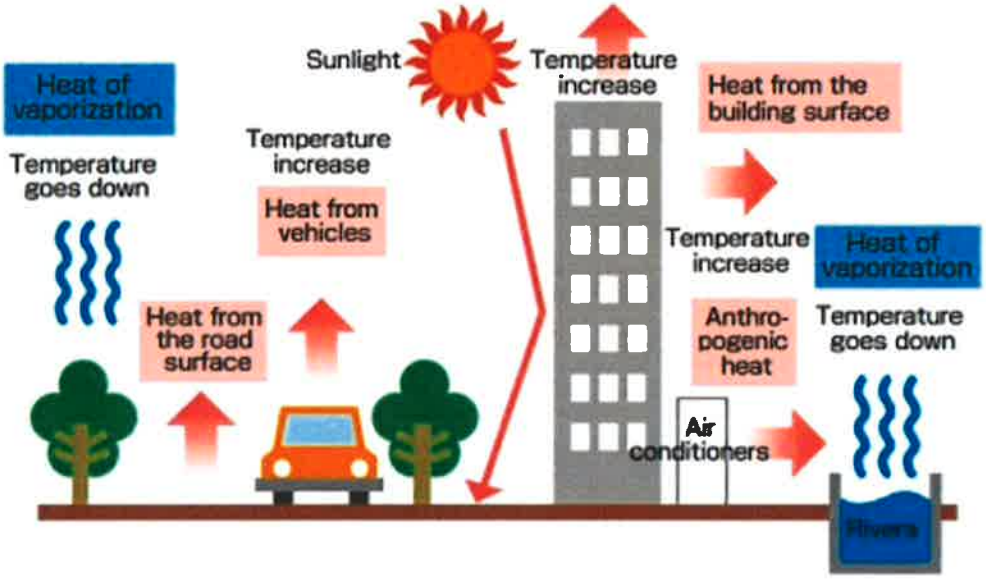
[69] Zollinger DG and Joshaghani A, *Laboratory Investigation of the Effect of TiO2*, September 2018.

[70] Binas V, et al., Modified TiO_2 Based Photocatalysts for Improved Air and Health Quality, *Journal of Materiomics*, November 2016.

[71] The electronic band structure of solids refers to the energy difference (in electron volts) between the top of the valence band and the bottom of the conduction band in insulators and semiconductors.

In the southeastern U.S. alone, data indicates the "hot season" now lasts one to three weeks longer than 30 years ago, exaggerating UHI. [72] Heat-builds modify the atmospheric boundary layer (ABL), impacting air flow and mixing height (creates stagnant air) in urban environments, further deteriorating local air quality. So, UHI intensity itself, is highly correlated to air pollution levels.[73]

Drawing 3.6 How the Heat Island Effect Occurs



Source: Green Ribbon Toronto

Pollution-induced climate change is a circular problem and comes with other direct and indirect environmental, ecological and health impacts included in the growing phenomena now just universally described as the **Urban Heat Island** effect **(Drawing 3.6)**.

When humans are exposed to extreme or prolonged heat, many of the crippling and even deadly diseases aforementioned are exacerbated. Low-income populations and the elderly are particularly vulnerable. The EPA has estimated that for every 1.5°F rise in temperatures, net demand for electricity used for cooling/heating would increase by as much 5% or more, impacting consumer behavior and even severely limiting their choices between other essentials for living.[74]

Reduced water quality also is a factor from UHI. The extremely high temperatures of pavement structures, especially asphalt, can measurably increase the temperature of stormwater runoff, escalating additional ecological and health concerns as these warmer waters drain into sewers and eventually into lakes, rivers, ponds, and streams etc.

UHI and climate change interact in many critical and circulative ways:

- **Increased Energy Demand**
- **Increased Air Pollution and Gas Emissions**
- **Reduced Human Health and Comfort**
- **Poor Water Quality and Ecology**

[72] Florida State University, Florida Climate Center, www.climatecenter.fsu.edu.

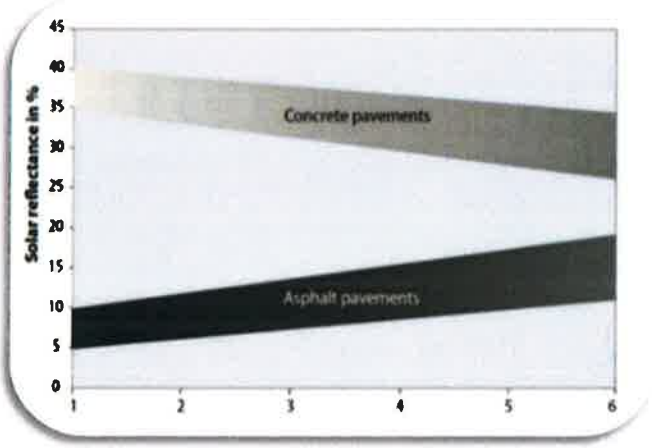
[73] Swamy G, et al., *Urban Heat Island (UHI) Influence on Secondary Pollutant Formation in a Tropical Humid Environment*, www.PubMed.gov.

[74] EPA: Climate Change and Heat Islands, www.epa.gov.

In general, white surfaces will **reflect** as much as 75% of solar energy (strong hiding power) [75] and stay relatively ***cool***, while black surfaces will **absorb** as much as 90% and will get extremely hot, of course.[76]

Research has shown that the impact from improving the solar reflectance of urban infrastructure on UHI can range as high 100 tons CO_2e per lane mile per year of pavement and a global adoption of both cool roofs and pavements could lead to a potential offset of over 40 gigatons CO_2e annually.[77] [78] [79]

Drawing 3.7 Pavement Reflectivity and Time



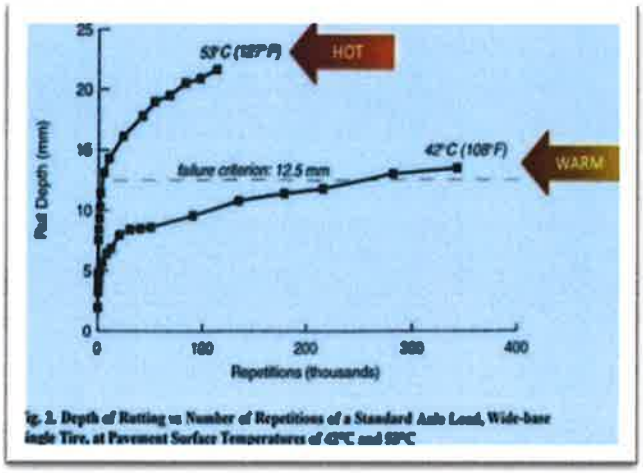
Source: EPA: Heat Island Reduction Program (HIRP)

Asphalt is a particularly good target. New asphalt, according to the EPA Heat Island Reduction Program (HIRP), has an SRI of 5 which slowly rises with age, but remains very heat-absorbing throughout its life cycle **(Drawing 3.7)**.

An SRI of 5 at 72°F would register a surface temperature of the asphalt at 140°F over 8 hours of solar irradiation, according to HIRP testing. And each 10 SRI would reduce the pavement's temperature by 7°F to 10°F.[80]
Conventional paving materials can reach peak summertime temperatures of 150°F [81] or more, transferring excess heat to the air above them and heating stormwater as it runs off the pavement into waterways, effecting watershed ecology.

Pavements in urban centers can be as much as 50% of land cover in major cities.[82] As such, pavements are a critical element in environmental planning and UHI mitigation consideration.

Figure 3.8 Heat Shortens Pavement Life



Source: EPA: Heat Island Reduction Program (HIRP)

Further, asphalt binder begins to photodegrade at 120°F,[83] with exponential damage as the temperature rises. Studies have shown that even modest improvement in asphalt temeperature can

[75] *Polymers, Light and the Science of TiO2*, DuPont™ Ti-Pure® Titanium Dioxide, DowDuPont, www.dow-dupont.com.

[76] BASF SE, www.dispersions-pigments.basf.com.

[77] Zhous a, et al., *Enhanced Solar Reflectance of Thermal Coatings through Inorganic Additives*; City University of Hong Kong; Massachusetts Institute of Technology, Hong Kong / Boston, 2016.

[78] Xu X, et al., *The Impacts of Surface Albedo on Climate and Building Energy Consumption: Review and Comparative and Comparative Analysis*, Transportation Research Board (TRB), 2016.

[79] Qin Y, Urban Canyon Albedo and Its Implication on the Use of Reflective Cool Pavements, *Energy and Buildings*, 2015.

[80] EPA HIRP, *Cool Fixes for Hot Cities*.

[81] EPA HIRP: Using Cool Pavements.

[82] Lawrence Berkeley National Laboratory, Cool Pavements, www.heatisland.lbl.gov.

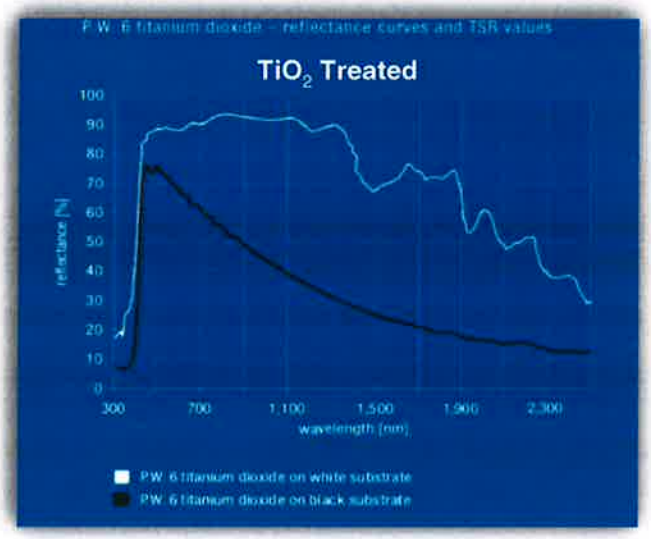
[83] Hossain K and Karakas AS, *Effect of Ultraviolet Aging on Rheological Properties of Asphalt Cement*, Memorial University of Newfoundland and University of Illinois, Urbana-Champaign, June 2018.

materially extend the service life of the asset **(Figure 3.8)**.[84]

Cooler pavements can be created with existing paving technologies including newer approaches such as the use of coatings or spray applied penetrants with SRI reducing materials to create pavements with strong light scattering efficiency.

For example, chemical giant BASF extensively has tested paint pigments for their solar reflectance properties, in large part, to improve weatherability (UV protection). As a result, BASF has developed paint additives, utilizing photocatalyst TiO_2, it markets as **"paint it cool!"** pigments for solar heat management in paints; DuPont similarly.

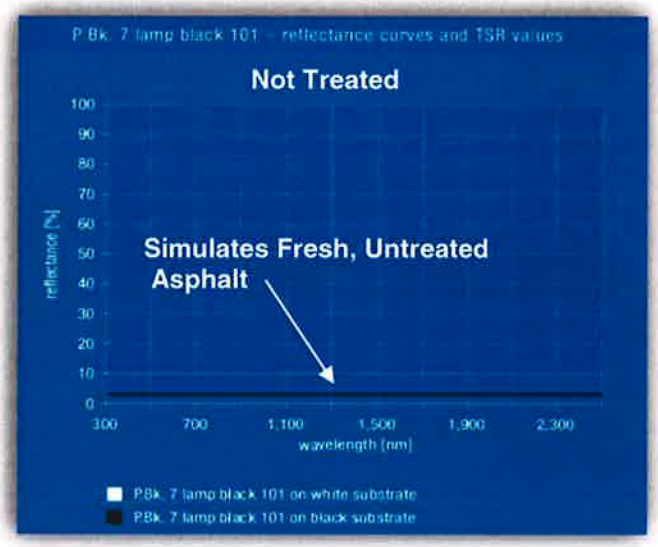
Figure 3.9 Solar Reflectance (%) - Treated



Source: BASF SE

BASF researchers tested TiO_2 presented in both white and black substrates **(Figure 3.9)**. When TIO_2 was added to a white substrate, the surface indicated roughly 90% reflectance from the UVA spectrum (315 to 400 nm in wavelength) all the way past visible light (400 to 700 nm) and even into infrared.

Figure 3.10 Reflectance (%) - Untreated

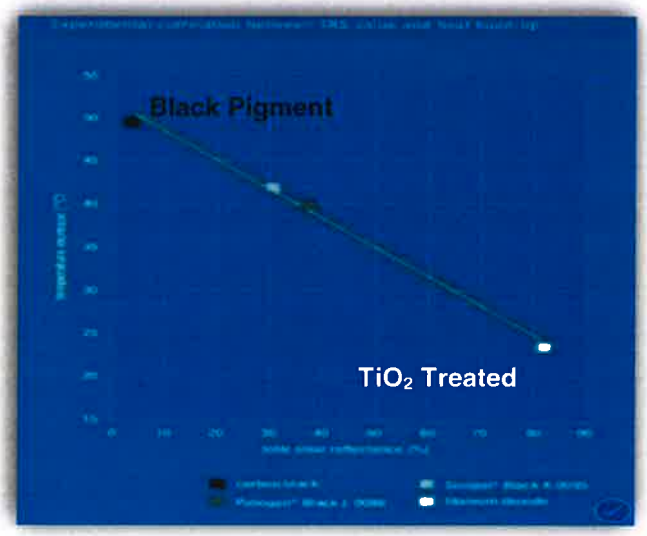


Source: BASF SE

For the control **(Figure 3.10)**, BASF tested black pigment against both color surfaces, which indicated only 5% reflectance, consistent with EPA HIRP testing.

But, the TiO_2 added to the black substrate **(back to Figure 3.9)** showed remarkable results with roughly 75% reflectance in the UVA spectrum or much higher (14x) than the control all the way through the visible spectrum (ranging 60% to 70% reflectance).[85]

Figure 3.11 Heat-Build vs Pigment Color



Source: BASF SE

[84] EPA HIRP: Using Cool Pavements.

[85] BASF SE.

BASF scientists also tested UHI *style* heat build-up against multiple pigments and TiO_2. As indicated **(Figure 3.11)**, the heat-build in black pigment was materially more than the highly reflective TiO_2. The black pigment, with just 5% reflectivity, accumulated more than twice the heat-build of the TiO_2 enhanced pigment.

Over half of the solar energy experienced at the Earth's surface falls within the UV and visible light spectrum.[86] So, these results give one a clear idea of how a TiO_2-bearing pavement would perform to reduce radiative forcing (RF) [87] in the ambient environment.

What can be learned from BASF's testing can be applied to TiO_2-bearing pavements:

Nanoparticle TiO_2 has high light refraction properties,[88] improving a pavement's ability to diffuse thermal loading and to lower emissivity.

Understanding heat management can play a significant role in both ecology and pavement life-cycle assessment, which impacts the evaluation and appraisal for pavements on the environment through materials, construction, use, maintenance, and end-of-life phases.

UHI specifically can play a crucial role in the **use-phase** of pavement LCAs and hence can become a major tool in a community's ability to reduce its carbon footprint without disrupting infrastructure and resident utility.[89]

Yet, cool pavement technologies are not as required (adopted) by agencies as other heat island mitigation strategies (e.g., roofs) and there is no official standard or labeling program to designate cool paving materials in highway construction practices per se. But one can project as much is coming.

Our interviews with the EPA's HIRP staff indicate strong interest in and base knowledge of photocatalytic pavement solutions.

HIRP is especially interested in solutions for asphalts that do not impugn asphalt recyclability (sustainability) as most prevailing UHI mitigation strategies (e.g., "white pavements") and common pavement preservation materials alike risk because they are **adsorbed** and themselves unsustainable.

Photocatalytic pavement solutions for asphalt such as PTI's **A.R.A.-1 Ti®** offer great promise in this regard because the penetrant replaces exact chemicals (true conservation) lost to UHI and the solution is translucent and fully **absorbed** into the substrate. This preserves *full* recyclability of the asphalt while delivering the advantaged solar reflectance properties from the photocatalyst material imbedded.

The American Society for Testing Materials (ASTM) has formed a **'cool construction materials'** subcommittee in recent years to develop standard practices for measuring, rating, and labeling cool construction materials.

The subcommittee also undertook the development of a standard practice for calculating an SRI for horizontal and low-sloped surfaces (like a road), [90] which now can and should be applied to road construction **'best practices'**.

3.6 Pavement Preservation and GHG Mitigation

Asphalt remains the most durable and efficient material for roadway construction, dating back to the Romans and earlier. More than 90% of our roadways are built with asphalt.[91] The manufacturing of asphalts and construction of asphalt roads, however, have a meaningful impact

[86] *Solar Radiation and the Earth's Energy Balance*, EESC Lectures Columbia University, 2007.

[87] Radiative Forcing (RF) or Climate Forcing is the difference between insolation absorbed by the Earth and energy radiated back into space.

[88] DowDuPont, www.dow-dupont.com.

[89] Killingsworth B, et al., Concrete's Role in Reducing Urban Heat Islands, *Concrete Sustainability Report*, July 2014.

[90] ASTM E1980 - 11 *Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.*

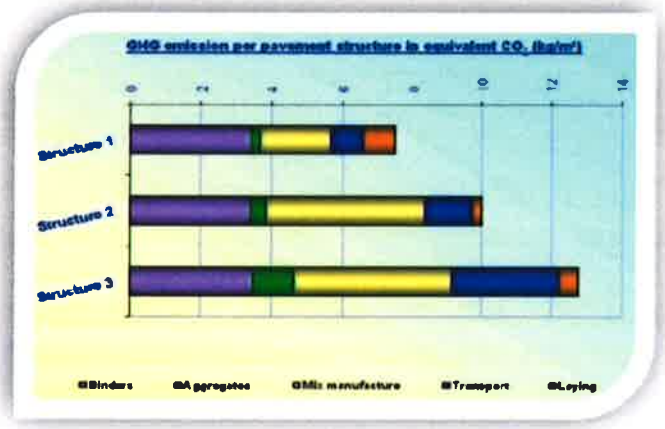
[91] Asphalt Institute, www.asphaltinstitute.org.

on the environment, energy use and GHG emissions.

Pavement reconstruction and most forms of rehabilitation consume significant amounts of energy. From the negative RF in obtaining and processing raw materials, to mixing, transporting, and finally paving (applying), the global warming potential (GWP) of building and maintaining roads is of considerable importance to sustainable urban planning and maintenance **(Figure 3.12)**.

Employing pavement preservation requires significantly less energy than in part or whole rebuild, of course. Fog sealing, which includes molecular replacement strategies such as MRT, uses the least amount of energy per year of extended pavement life at as little as 250 BTU/yd^2-yr (0.4 MJ/m^2-yr).[92]

Figure 3.12 CO_2e Emission by Asphalt Pavement Input



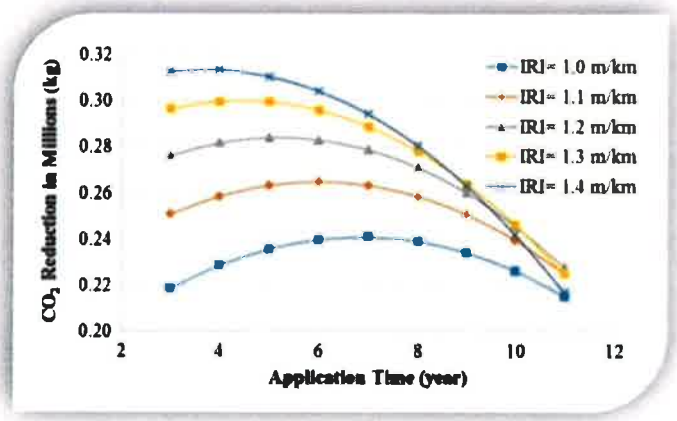
Source: Colas Group SA

Compare that to the energy consumption of a pavement **rebuild** consuming as much as 1.5 million BTUs or 200 MJ/m^2-yr [93] or roughly **500x the CO_2e** of pavement preservation strategies.

Beyond the enormous carbon footprint savings, the significant cost differential for preservation techniques over rebuilds provides returns on investment (ROI) typically exceeding 250%.[94]

One study conducted by Rutgers University [95] compared initial International Roughness Index (IRI), fuel consumption [96] and application year for pavement preservation implementation **(Figure 3.13)**. The results indicated that early pavement preservation can have a materially positive impact on CO_2e reductions.[97]

Figure 3.13 Pavement Preservation Impact on CO_2e Reduction



Source: Rutgers University

The implication for proactive early and recurring pavement preservation strategies clearly support significant GHG mitigation against multiple points of fossil fuel consumption causally related to our critical city infrastructure, including roadways.

3.7 Deterioration of Asphalt Pavements Due to Manufacturing and Environmental Factors

Asphalt pavements are vulnerable to many factors, thermal loading (excess heat) being the

[92] Chehovits J and Galehouse L, *Energy Usage and Greenhouse Gas Emissions of Pavement Preservation Processes for Asphalt Pavements, Transportation Research Board*, 2010.

[93] Chaignon F, *Pavement Preservation: What About Energy and GHG*, Colas Group SA.

[94] For Pavement Preservation (FP^2), www.fp2.org.

[95] Wang H, Al-Saadi I, et al., Quantifying Greenhouse Gas Emission of Asphalt Pavement Preservation at Construction and Use Stages using Life-Cycle Assessment, *International Journal of Sustainable Transportation*, January 2019.

[96] EPA: Motor Vehicle Emission Simulator (MOVES) and other Mobile Source Emission Models, www.epa.gov.

[97] Wang H, Al-Saadi I, et al.

most damaging.[98] As noted, conventional paving materials can reach peak summertime temperatures exceeding 150°F.[99] And asphalt binder begins to photodegrade (oxidizes) at 120°F,[100] with exponential damage as the temperature rises.

Excessive heat required during manufacturing, typically 300°F to 350°F[101] or higher, is especially destructive, which leads to the volatilization or rapid loss of critical molecular components of asphalt binder that are responsible for durability and ductility (plasticity). These are commonly and scientifically referred to as **"maltene fractions"**.

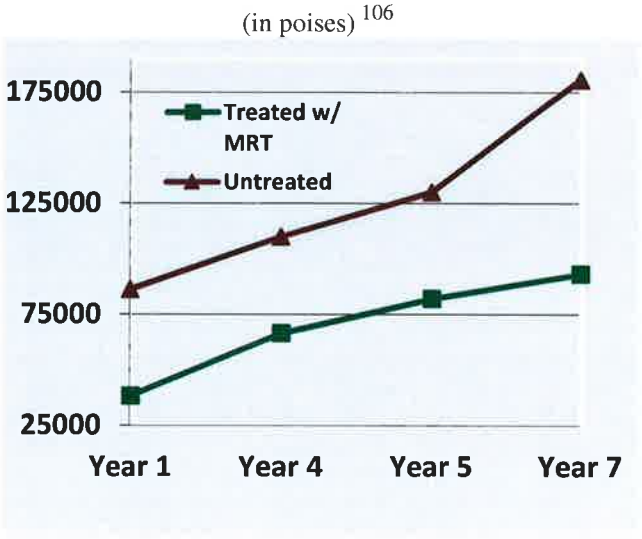
As much as a third of maltene molecular content may be lost during asphalt production,[102] leaving asphalts prematurely aged by the impaired binder. Maltenes are the "media" that enable asphalt binder to impart flexibility, fluidity, and adhesion properties to paved roads. They are largely responsible for the resilience of asphalts to withstand considerable environmental and traffic stresses.

Asphalts with depleted binder chemistry become embrittled, leading to cracking and raveling stress and accelerated repair and rebuild demands.

In-service, heat continues its extortionate role in depleting maltene content in asphalt binder due to the oxidative effect of irradiation (UHI), as asphalts are highly solar energy absorptive.[103] In combination, volatilization and UHI stress are the primary factors responsible for binder-centric failure of asphalt pavements and premature rebuild needs.[104]

A proven remedy for restoring damaged or aged asphalt binder to proper performance properties is to **chemically replace** the maltenes lost during manufacturing and in-service weathering through maltene replacement therapy. MRT, effectively, establishes a molecular **"second curve"** to the LCAs of asphalt pavements.

Figure 3.14 Maltene Rejuvenator Study: Seven Year Oxidation Rate Curves in Charleston County (SC) [105]



Source: Pavement Technology, Inc.; APART

(Figure 3.14) is an abstract from a multi-year study on asphalt pavements in Charleston County (SC) treated with Reclamite®, a petroleum maltene-based rejuvenator.

[98] Alkaissi ZA, Effect of High Temperature and Traffic Loading on Rutting Performance of Flexible Pavement, *Journal of King Saud University- Engineering Sciences*, April 2018.

[99] EPA Heat Island Reduction Program (HIRP): Using Cool Pavements to Reduce Heat Islands, www.epa.gov.

[100] Hossain K and Karakas AS, *Effect of Ultraviolet Aging on Rheological Properties of Asphalt Cement*, Memorial University of Newfoundland and University of Illinois, Urbana-Champaign, June 2018.

[101] Texas Asphalt Pavement Association, www.texasasphalt.org.

[102] U.S. Department of Transportation, Federal Highway Administration, Superpave Asphalt Mixture Design Workshop, Version 8.0, Updated January 2002 www.fhwa.dot.gov.

[103] EPA Heat Island Reduction Program (HIRP), *Cool Fixes for Hot Cities Part 2: Los Angeles*, September 2002.

[104] Lolly R, *Evaluation of Short Term Aging Effect of Hot Mix Asphalt Due to Elevated Temperatures and Extended Aging Time*, Arizona State University, May 2013.

[105] Reclamite® is a trademark of Ergon, Inc.

[106] The poise (symbol P) is the unit of dynamic viscosity (absolute viscosity) in the centimeter-gram-second system of units.

The maltene rejuvenator not only was able to reduce the initial viscosity (improve resilience) of the pavement (by over 50%), it effectively **reset the oxidation curve** for the pavement over the following seven years, dramatically extending the LCA of the pavement.

MRT has been widely tested over the past half century with consistent excellent results. The method employs delivering an emulsified penetrating compound consisting of a near-pure maltene rich petroleum resin, a compatible surfactant, and water directly into the roadway surface.

The surfactant and water help deliver the fresh maltene fractions ratably and deeply into wearing-course depth. The result is a revitalized or "rejuvenated" asphalt binder which can be tested for measurably and sustainably improved rheology, as the Charleston data proves.

MRT has shown, with repeat treatments every three to five years, to extend the life cycle of asphalt pavements by two-fold and at a fraction of the cumulative cost of repaving, reducing reliance on petroleum feedstocks and cutting energy, maintenance and replacement costs.

MRT is the asphalt pavement preservation base found in PTI's **A.R.A.-1 Ti®**.

Combining a proven pavement LCA extending technology with a photocatalytic enhancement has shown great results and synergies beneficial to multiple level CO_2e reductions for pavement infrastructures.

3.8 Road-Level Air Quality Reference Testing

There are key unknown relationships between NO_x, the soluble nitrates (HNO_3) that result from PCO and variant atmospheric conditions.

Capturing and measuring ambient air quality in real-time is very difficult owing to the multitude of meteorological variables, including but not limited to—temperature; air speed; humidity; atmospheric pressure; precipitation; and air composition contamination related to testing area configuration and scale limitations. Roadway "breathing zone" analysis also includes traffic variables, of course.

The EPA sets strict standards for such measurement and guides industry on accepted methods and procedures, including equipment under the **Federal Reference Method (FRM)** and administered by the EPA's **Ambient Monitoring Technology Information Center (AMTIC)**.[107]

Equipment that are "designated" or meet the requirements are prohibitively expensive, with set-ups ranging in the hundreds of thousands USD. And the EPA stated protocol calls for multiple FRM level equipment used in any testing for redundancy and consistency.

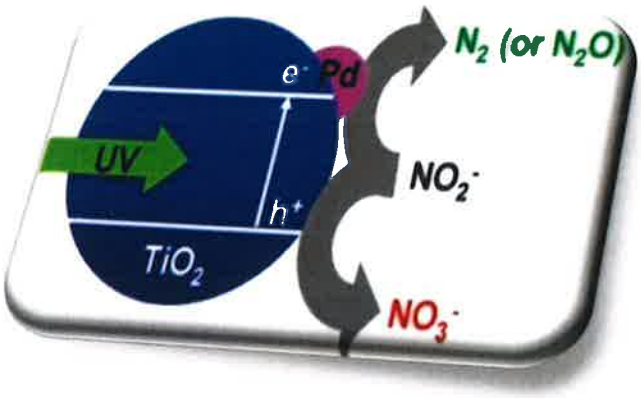
The EPA "reference" requirements are supported by the Agency's computerized simulation (regression) modeling, referred to as the **Air Pollutants Exposure Model (APEX)**.[108] So, the EPA combines advanced field monitoring with very sophisticated data-driven simulation software to predict human exposure risks to anthropogenic pollution.

Additionally, the EPA believes near-road concentrations of pollutants can be 2–3 times higher than measured at nearby area-wide monitors,[109] as previously noted, making "breathing zone" identification critical in estimating human exposure to mobile-sourced criteria toxins such as NO_x.
Conforming to air quality monitoring and human hazard measurement under FRM is logistically difficult and economically infeasible in most circumstances, while non-conforming testing creates an unavoidable data "reference gap".

[107] EPA: Air Quality Methods – Criteria Pollutants, www.epa.gov.
[108] EPA: Human Exposure Modeling – Air Pollutants Exposure Model, www.epa.gov.
[109] EPA: Near Roadway Air Pollution and Health, Frequently Asked Questions, www.epa.gov.

The gap potentially could be mitigated through additional near-field PCO testing to promote correlative significance to non-reference air quality data collected. And this is among the on-going research initiatives with TTI, including potentially advancing future performance specifications for photocatalyst pavements.

Drawing 3.15 Photocatalytic Disproportionation of Nitrite Gas (NO_2) into Nitrate (NO_3)



Source: Royal Society of Chemistry

One approach to promote better field data efficacy is to establish a verifiable NO_x – nitrate exchange rate **("nitrite-nitrate exchange indexing")** in order to ensure more dependable field monitoring of pollution reduction sites using non-conforming sources **(Drawing 3.15)**. [110] [111]

The relationships primarily relate to the efficiency of the NO_x - nitrate exchange rates under varying pollution exposure levels and air masses and movement. The objective of establishing such relationships would be to ascertain how field instrumentation would need to be properly configured in order effectively monitor and characterize the effect of the NO_x - nitrate exchange process under PCO.

The **priori** under such a protocol would be:

- **Step 1: Establish the NO_x - Nitrate Exchange Rates for Fixed NO_x Levels**
- **Step 2: Establish the NO_x - Nitrate Exchange Rates for Variable NO_x Levels**
- **Step 3: Large-Scale Sample Testing to Validate Findings from 1 and 2**

The effectiveness of photocatalytic conversion on treated asphalt and concrete specimens can be tested with respect to a variation of NO_x gas concentration by varying the air flow stream the gas is moving in. And against variant atmospheric conditions.

In the field, NO_x reductions can be measured indirectly based on either quantifying nitrate levels observed directly throughout the testing area or by comparing the **dielectric constant** across the treated surfaces to nitrate levels observed in the laboratory on extracted cores, to determine nitrate evaporation rate and nitrate concentrations in the field.

These testing procedures could provide rapid methods for determining NO_x reduction efficiency against the established NNE, which then could be compared to experimental (non FRM) air quality monitoring for correlations.

Both then would be compared against the established baseline verification [112] to draw an empirical relationship between PCO testing with a high degree of accuracy with those increasingly more developmental at scale. This would be the base pollution capture relationship used to develop a **full-scale econometric model**, to include other traffic and weather variables, for exceptionally reliable ME pollution removal efficiency predictability.

[110] Hassan M and Dylla HL et al., *Durability and Performance of Titanium Dioxide in Photocatalytic Pavements.*

[111] Wang L and Wang Q, Selective Determination of Nitrite/Nitrate Based on Photo-induced Redox Activity of Titanium Dioxide, Journal of Separation Science, August 2018.

[112] Japanese Industrial Standard (JIS) TR Z 0018 *Photocatalytic Materials – Air Purification Test Procedure.*

3.9 The Road of the Future is Ready

In short, human achievement, for all it is great benefits, is overwhelming *Mother Nature's* ability to self-clean our planet. This is not debatable.

Photocatalysis is a natural solution, using the immense energy of the Sun, which helps accelerate inherent, organic mechanisms for managing rising GHG inventories effecting ground-level pollution and exaggerating the impacts of heat islands and climate change.

The technology is available today and it is both scalable and economical.

Real Science. Real Results.

www.SmogEatingRoads.com

A.R.A.-1Ti®
Safety Data Sheets

SAFETY DATA SHEET

1. Identification

Product identifier	**A.R.A. -1 Ti®**
Other means of identification	Not available
Recommended use	Dust control emulsion
Recommended restrictions	Follow the manufacturer's instructions.
Manufacturer/Importer/Supplier/Distributor information	
Manufacturer	
Manufacturer:	D & D Emulsions, Inc.
Address:	270 Park Avenue East P.O. Box 1706 Mansfield, OH 44901
24- Hour Telephone Number:	
CHEMTREC:	1-800-424-9300 (USA and Canada) CCN794154

2. Hazard(s) identification

Physical hazards	Not classified	
Health hazards	Carcinogenicity	Category 1B
Environmental hazards	Not classified	
OSHA defined hazards	Not classified	
Label elements		

Signal word	Danger
Hazard statement	May cause cancer.
Prevention	Obtain special instructions before use. Wear protective gloves/protective clothing/eye protection/face protection. Do not handle until all safety precautions have been read and understood.
Response	IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. Do NOT induce vomiting. IF exposed or concerned: Get medical advice/attention.
Storage	Store in accordance with international regulations. Store locked up.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known
Supplemental information	Not applicable

3. Composition/information on ingredients

Mixtures

Chemical name	Common name and synonyms	CAS number	%
EXTRACTS (PETROLEUM), HEAVY NAPHTHENIC DISTILLATE SOLVENT		64742-11-6	60 - 65
WATER		7732-18-5	35 - 40
PROPRIETARY INGREDIENTS		N/A	<5

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Rinse with water. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. Do not induce vomiting without advise from poison control center. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.

Most important symptoms /effects, acute and delayed	Direct contact with eyes may cause temporary irritation.
Indication of immediate medical attention and special treatment needed	Treat symptomatically.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Dry chemicals. Carbon dioxide (CO2).
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire-fighting equipment/ instructions	Cool containers exposed to heat with water spray and remove container, if no risk is involved.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water sources or onto the ground.

7. Handling and storage

Precautions for safe handling	Avoid prolonged or repeated contact with skin. Avoid prolonged exposure. Use only in well- ventilated areas.
Conditions for safe storage, including any incompatibilities	Keep away from heat and sources of ignition. Store in original tightly closed container. Store away from incompatible materials (see section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CRF 1910.1000)

Components	Type	Value	Form
EXTRACTS (PETROLEUM), HEAVY NAPHTHENIC DISTILLATE SOLVENT (CAS 64742-11-6)	PEL	5 mg/m3	Mist.

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value	Form
EXTRACTS (PETROLEUM), HEAVY NAPHTHENIC DISTILLATE SOLVENT (CAS 64742-11-6)	STEL	10 mg/m3	Mist.
	TWA	5 mg/m3	Mist.

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.
Individual protection measures, such as personal protective equipment	
Eye/face protection	Wear safety glasses with side shields (or goggles).
Hand protection	Wear protective gloves.
Skin protection	
Other	Wear appropriate chemical resistant clothing.
Respiratory protection	Not available
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	Opaque Liquid
Physical state	Liquid
Form	Liquid
Color	Yellow
Odor	Mild Odor
Odor threshold	Not available
pH	4.5 – 7.2
Melting point/freezing point	Not available
Initial boiling point and boiling range	> 212 °F (> 100 °C) estimated
Flash point	Not available
Evaporation rate	< 1
Flammability (solid, gas)	Not available
Upper/lower flammability or explosive limits	
Flammability limit – lower (%)	Not available
Flammability limit - upper (%)	Not available
Explosive limit – lower (%)	Not available
Explosive limit – upper (%)	Not available
Vapor pressure	Not available
Vapor density	Not available
Relative density	1 g/cm3
Solubility (ies)	
Solubility (water)	Readily Dispersible
Partition coefficient (n-octanol/water)	Not available
Auto-ignition temperature	500 °F (260 °C) estimated
Decomposition temperature	Not available
Viscosity	Not available
Other information	
Percent volatile	37.5 % estimated < 2 %
VOC (Weight %)	2.5 % estimated

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.

Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure	
Ingestion	Expected to be a low ingestion hazard.
Inhalation	Prolonged inhalation may be harmful.
Skin contact	No adverse effects due to skin contact are expected.
Eye contact	Direct contact with eyes may cause temporary irritation.
Symptoms related to the physical, chemical and toxicological characteristics	Direct contact with eyes may cause temporary irritation.
Information on toxicological effects	
Acute toxicity	Not available
Skin corrosion/irritation	Prolonged skin contact may cause temporary irritation.
Serious eye damage/eye irritation	Direct contact with eyes may cause temporary irritation.
Respiratory or skin sensitization	
Respiratory sensitization	Not available
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	Contains a substance/a group of substances which may cause cancer. Contains polycyclic aromatic compounds (PACs). Prolonged and/or repeated skin contact with certain PACs has been shown to cause skin cancer. Prolonged and/or repeated exposures by inhalation of certain PACs may also cause cancer of the lung and of other sites of the body.

US. OSHA Specifically Regulated Substances (29 CRF 1910.1001-1050)

Not Listed

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	Not classified
Specific target organ toxicity - repeated exposure	Not classified
Aspiration hazard	Not available
Chronic effects	Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity	The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.
Persistence and degradability	No data is available on the degradability of this product.
Bioaccumulative potential	No data available
Mobility in soil	No data available
Other adverse effects	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.
Waste from residues/unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions)

Contaminated packaging Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not available

15. Regulatory information

US federal regulations All components are on the U.S. EPA TSCA Inventory list.

TSCA Section 12 (b) Export Notification (40 CRF 707, Subpt. D)

Not regulated

CERCLA Hazardous Substance List (40 CRF 302.4)

Not listed

US. OSHA Specifically Regulated Substances (29 CRF 1910.1001-1050)

Not listed

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard – No
Delayed Hazard – Yes
Fire Hazard – No
Pressure Hazard – No
Reactivity Hazard – No

SARA 302 Extremely hazardous substance

Not listed

SARA 311/312 Hazardous chemical No

SARA 313 (TRI reporting)

Not regulated

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) list

Not regulated

Clean Air Act (CAA) Section 112 (r) Accidental Release Prevention (40 CRF 68.130)

Not regulated

Safe Drinking Water Act (SDWA) Not regulated

US state regulations WARNING: This product contains a chemical known to the State of California to cause cancer.

US. Massachusetts RTK – Substance List

EXTRACTS (PETROLEUM), HEAVY NAPHTHENIC DISTILLATE SOLVENT (CAS 64742-11-6)

US. New Jersey Worker and Community Right-to-Know Act

Not regulated

US. Pennsylvania RTK – Hazardous Substances

EXTRACTS (PETROLEUM), HEAVY NAPHTHENIC DISTILLATE SOLVENT (CAS 64742-11-6)

US. Rhode Island RTK

Not regulated

US. California Proposition 65

WARNING: This product contains a chemical known to the State of California to cause cancer.

International Inventories

Country (s) or region	Inventory name	On inventory (yes / no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from this listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 10-31-2014

Version # 01

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Current Contracts

Pavement Technology, Inc.

24144 Detroit Rd.
Westlake, Ohio 44145

Phone: (800) 333-6309 (440) 892-1895
Fax: (440) 892-0953

Current Contracts
Reclamite® Asphalt Rejuvenating Agent

City and Contact	Project Information	Using Reclamite® Since
City of Palm Bay 120 Malabar Road SE Palm Bay, FL 32907 Frank Watanabe P: 321-409-6341 frank.watanabe@palmbayflorida.org	2022 Pavement Preservation 1,886,274 sq. yds. $2,207,276.88	2016
The Villages 1135 Bonita Boulevard The Villages, FL 32162 Daniel Lucin P: 352-753-4022 dan.lucin@districtgov.org	2023 Roadway & Parking Lot Maintenance 278,606 sq. yds. $312,039.00	2016
Brevard County PO Box 1496 Titusville, FL 32780 Susan Jackson P: 321-617-7202 susan.jackson@brevardfl.gov	2023 Rejuvenation 713,367 sq. yds. $833,821.20	2017
City of St. Cloud 1300 Ninth Street St. Cloud, FL 34769 Kevin Felblinger P: 407-957-7283 kfelblinger@stcloud.org	2022 Alternative Paving Methods 371,311 sq. yds. $401,461.45	2022

Polk County 3000 Sheffield Road Bartow, FL 33830 Austin Potts P: 865-535-2221 austinpotts@polk-county.net	2022 Pavement Preservation & Recycling 650,000 sq. yds. $728,000.00	2016
City of Tallahassee 300 South Adams Street, B-27 Tallahassee, FL 32301 Jennifer Magavero P: 850-891-8737 jennifer.magavero@talgov.com	2023 Pavement Preservation 80,094 sq. yds. $97,955.00	2004
City of Port St. Lucie 121 S.W. Port St. Lucie Port St. Lucie, FL 34984 Thomas Salvador P: 772-370-5821 tsalvador@cityofpsl.com	2023 Rejuvenation 452.987 sq. yds. $540,675.00	2002
St. Lucie County 2300 Virginia Ave. 2nd Floor Annex, Rm 229 Ft. Pierce, FL 34982 Shannon Mieras P: 772-462-1813 mierass@stlucieco.org	2022 Roadway Surfacing & Preservation 50,000 sq. yds. $56,500.00	2019

Project Experience List

Pavement Technology, Inc.

24144 Detroit Rd.
Westlake, Ohio 44145

Phone: (800) 333-6309 (440) 892-1895
Fax: (440) 892-0953

Previous Experience Record
Reclamite® Asphalt Rejuvenating Agent

City and Contact	Project Information	Using Reclamite® Since
Charlotte County 410 Taylor Street Punta Gorda, FL 33950 James Layport P: 941-575-3672 james.layport@charlottecountyfl.gov	2020 Rejuvenation 2,036,309 sq. yds. $1,649,410.29 Completed June, 2020	2004
St. Johns County 2740 Industry Center Road St. Augustine, FL 32084 Tommy Mashburn P: 904-209-0184 tmashburn@sjcfl.us	2021 Rejuvenation 380,324 sq. yds. $368,910.40 Completed March, 2022	2003
City of Miami Gardens 1050 NW 163rd Drive Miami Gardens, FL 33169 Tom Ruiz P: 305-622-8032 truiz@miamigardens-fl.gov	2021 Rejuvenation 240,257 sq. yds. $228,244.15 Completed August, 2022	2013
City of Ocala 2100 NE 30th Avenue Ocala, FL 34470 Paul Constable P: 352-351-6772 pconstable@ocalafl.org	2021 Rejuvenation 431,221 sq. yds. $368,037.85 Completed July, 2021	2015

Polk County 3000 Sheffield Road Bartow, FL 33830 Austin Potts P: 865-535-2221 austinpotts@polk-county.net	2022 Rejuvenation 704,679 sq. yds. $618,080.36 Completed April, 2022	2015
City of Orlando 400 S. Orange Ave. Orlando, FL 32801 Howard Elkin P: 407-246-2289 howard.elkin@cityoforlando.net	2021 Rejuvenation 511,575 sq. yds. $470,649.00 Completed December, 2022	2000
City of Palm Bay 120 Malabar Road SE Palm Bay, FL 32907 Frank Watanabe P: 321-409-6341 frank.watanabe@palmbayflorida.org	2021 Pavement Rejuvenation 1,035,815 sq. yds. $1,004,740.94 Completed February, 2022	2016
City of Plantation 400 N.W. 73rd Avenue Plantation, FL 33317 Steve Rodgers P: 954-797-2200 srodgers@plantation.org	2022 Rejuvenation 318,703 sq. yds. $302,169.35 Completed September, 2022	2001

Key Individuals' Experience Records

Pavement Technology, Inc.

24144 Detroit Rd.
Westlake, Ohio 44145

Phone: 800-333-6309 440-892-1895
Fax: 440-892-0953

Experience Outline

President/General Manager – Colin Durante

Construction Operations Education/Training:

Ohio University
Civil Engineering
1960-1964

Registered Professional Surveyor
1973 to present

Employment History:

WVH and Associates
General Civil Design & Survey Supervision
1964-1972

Pavement Technology, Inc.
President/General Manager
1972-Present

Work Experience:

City, County, State, and Military Projects in Pavement Maintenance and Recycling

Professional Affiliations:

American Society of Highway Engineers
American Public Works Association
Northern Ohio Service Directors Association
Street Maintenance & Sanitation Officers of Ohio

Pavement Technology, Inc.

24144 Detroit Rd.
Westlake, Ohio 44145

Phone: 800-333-6309 440-892-1895
Fax: 440-892-0953

Experience Outline

General Superintendent / Vice President – John J. Schlegel

1977 - 1983	General laborer/driver on rejuvenating and recycling projects for Pavement Technology, Inc.
1983 – 1988	General foreman in charge of rejuvenating agent application, crack filling, and other miscellaneous construction work.
1988 – 1991	Construction Manager in charge of all crew scheduling, equipment maintenance, and general construction projects.
1991 – Present	General Superintendent / Vice President in charge of all construction operations.

PAVEMENT TECHNOLOGY INC.

Asphalt Recycling & Preventive Maintenance Specialists

24144 DETROIT ROAD
WESTLAKE, OHIO 44145
(440) 892-1895
(800) 333-6309
FAX (440) 892-0953

Experience Outline

Operations and Fleet Manager – David Clark

1994 – 1995	Studied at Alfred State College, New York – Associate in Automotive Trades – Heavy Equipment, Truck and Diesel
1995 – 1997	Worked at a hazardous waste incineration plant / fork life and OSHA training certificates
1997 – 1999	Foundry work / furnace operator specialized in copper and brass.
1999 – Present	Pavement Technology, Inc., Westlake, Ohio

1999 – 2000	General laborer / driver – rejuvenating agent and crack sealing roadways
2000 – 2004	General supervisor in charge of rejuvenating agent application, crack sealing and other miscellaneous road construction work.
2004 – 2015	Fleet Manager in charge of all repairs and scheduling repairs for all trucks and equipment
2015 – 2017	Operations and Fleet Manager – in charge of scheduling crews and day to day operations.
2017 – Present	ATSSA Certified, OSHA 30 Compliant

PAVEMENT TECHNOLOGY INC.

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FAX (440) 892-0953

Experience Outline

Operations and Fleet Manager – Michael Faustini

2003 – 2018 Fleet Owner/Operator – Faustini Trucking Inc., Tampa, Florida

- Interviewing, hiring/firing of staff, payroll, log audits, DOT, safety maintenance on equipment, purchasing of equipment, packing, loading/unloading, driving, and sales.
- In 2018 the fleet was sold.

2018 – Present Pavement Technology, Inc., Westlake, Ohio

- General laborer/driver – rejuvenating agents and crack sealing roadways
- General supervisor in charge of rejuvenating agent application, crack sealing and other miscellaneous construction work
- Fleet Manager in charge of all repairs and scheduling repairs for all trucks and equipment
- Operations and Fleet Manager – in charge of scheduling and day to day operations.
- ATSSA Flagger Course
- Advanced TTC - Florida Department of Transportation

Pavement Technology, Inc.

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Westlake, Ohio 44145

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Fax: (440) 892-0953

Key Employees

Foremen

Individual's Name	Title	Years & Type of Construction Experience	Education
David Baker II	Supervisor	9 years of specialty construction	
Thomas Donegan III	Assistant Supervisor	5 years of specialty construction	
Charles McNamee, Jr.	Supervisor	20 years of specialty construction	
Norman Sabol	Supervisor	9 years of specialty construction	
Jeffery Mosby	Supervisor	25+ years of specialty construction	

Other (Operations, Laborers, Etc.)

Individual's Name	Title	Years & Type of Construction Experience	Education
Danny Bollin	Driver	3 years of specialty construction	
Tradell Huntington	Driver	10 years of specialty construction	
Tracey Jackson	Driver	7 years of specialty construction	
David Kratky	Driver	25+ years of specialty construction	
Bruce Noble	Driver	8 years of specialty construction	
Kevin Wilson, Jr.	Driver	5 years of specialty construction	
William Wrice, Jr.	Driver	11 years of specialty construction	
Matthew Davis	Driver	9 years of specialty construction	
David Neff	Laborer	2 years of specialty construction	
Eric Parson	Driver	5 years of specialty construction	
Charles Rapp	Driver	10 years of specialty construction	
Jack Shane	Driver	8 years of specialty construction	

Equipment List

SCHEDULE C - LIST OF MAJOR EQUIPMENT AVAILABLE

ITEM	PURCHASE DATE	CONDITION	ACQUIRED VALUE
2018 Dodge Ram 3500 - Supervisor Truck	2018	Excellent	$60,683.00
2019 Empire Cargo Trailer	2019	Excellent	$4,425.00
2014 Kenworth BearCat Distributor Truck (Tanker)	2014	Excellent	$197,558.00
2016 Kenworth T370 Distributor Truck (Tanker)	2016	Excellent	$203,457.00
2015 Kenworth T370 Dump Truck	2015	Excellent	$137,612.00
2017 Peterbilt 348 Dump Truck	2017	Excellent	$130,000.00
2014 Freightliner Johnston Sweeper Truck	2014	Excellent	$227,728.00
2015 Freightliner M2 Sweeper Truck	2015	Excellent	$251,094.00
2016 GMC 2500 Sierra Pickup Truck	2016	Excellent	$33,739.00
2016 GMC 2500 Sierra Pickup Truck	2016	Excellent	$33,739.00
2019 GMC Sierra 1500 Pickup Truck	2019	Excellent	$40,379.00

Florida State Certificate

State of Florida
Department of State

I certify from the records of this office that PAVEMENT TECHNOLOGY, INC. is an Ohio corporation authorized to transact business in the State of Florida, qualified on November 26, 1986.

The document number of this corporation is P12308.

I further certify that said corporation has paid all fees due this office through December 31, 2019, that its most recent annual report/uniform business report was filed on February 21, 2019, and that its status is active.

I further certify that said corporation has not filed a Certificate of Withdrawal.

Given under my hand and the Great Seal of the State of Florida at Tallahassee, the Capital, this the Twenty-first day of February, 2019

Secretary of State

Tracking Number: 1924710495CC

To authenticate this certificate,visit the following site,enter this number, and then follow the instructions displayed.

https://services.sunbiz.org/Filings/CertificateOfStatus/CertificateAuthentication

Certificate of Liability Insurance

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 2/28/2022

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
McGowan & Company, Inc.
20595 Lorain Rd
Fairview Park OH 44126

CONTACT NAME: Frances Lyons
PHONE (A/C, No, Ext): 440.895.4359 **FAX (A/C, No):** 440-333-3214
E-MAIL ADDRESS: flyons@mcgowaninsurance.com

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A : Travelers Property Casualty Co of America	36161
INSURER B : Phoenix Insurance Company	25623
INSURER C :	
INSURER D :	
INSURER E :	
INSURER F :	

INSURED PAVETEC-01
Pavement Technology, Inc
24144 Detroit Rd
Westlake OH 44145

COVERAGES **CERTIFICATE NUMBER:** 2019561021 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY	Y	Y	DTCO324N6425	3/1/2022	3/1/2023	EACH OCCURRENCE	$ 1,000,000
	CLAIMS-MADE X OCCUR						DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 500,000
							MED EXP (Any one person)	$ 5,000
							PERSONAL & ADV INJURY	$ 1,000,000
	GEN'L AGGREGATE LIMIT APPLIES PER:						GENERAL AGGREGATE	$ 2,000,000
	POLICY X PRO-JECT LOC						PRODUCTS - COMP/OP AGG	$ 2,000,000
	OTHER:							$
B	AUTOMOBILE LIABILITY	Y	Y	8108L678293	3/1/2022	3/1/2023	COMBINED SINGLE LIMIT (Ea accident)	$ 1,000,000
	X ANY AUTO						BODILY INJURY (Per person)	$
	OWNED AUTOS ONLY / SCHEDULED AUTOS						BODILY INJURY (Per accident)	$
	X HIRED AUTOS ONLY / X NON-OWNED AUTOS ONLY						PROPERTY DAMAGE (Per accident)	$
								$
A	X UMBRELLA LIAB X OCCUR			CUP2J391570	3/1/2022	3/1/2023	EACH OCCURRENCE	$ 5,000,000
	EXCESS LIAB CLAIMS-MADE						AGGREGATE	$ 5,000,000
	DED X RETENTION $ 10,000							$
A	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y / N	N / A	Y	UB0K349145	3/1/2022	3/1/2023	PER STATUTE / OTH-ER	
	ANYPROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH)						E.L. EACH ACCIDENT	$ 1,000,000
	If yes, describe under DESCRIPTION OF OPERATIONS below						E.L. DISEASE - EA EMPLOYEE	$ 1,000,000
							E.L. DISEASE - POLICY LIMIT	$ 1,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)
Certificate holder is included as an additional insured as required by written contract with respects to the General Liability. Certificate Holder is included as an additional insured as required by written contract. Primary and non-contributory basis applies. It is further agreed that a waiver of subrogation applies in favor of the certificate holder as required by written contract. 10 day notice of cancellation for non-payment and 30 days for all other reasons applies.

CERTIFICATE HOLDER
City of Plantation
400 NW 73rd Avenue
Plantation FL 33317

CANCELLATION
SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Corporate Resolution

Pavement Technology, Inc.

24144 Detroit Rd.
Westlake, Ohio 44145

Phone: 800-333-6309 440-892-1895
Fax: 440-892-0953

CORPORATE RESOLUTION

Pavement Technology, Inc.

I hereby certify that I am the Founder and President of PavementTechnology, Inc., a corporation duly organized and existing under the laws of the State of Ohio; that on this 2nd day of January, 2007, the board of directors of said Corporation authorized and approved the Secretary/Treasurer of said corporation to execute any proposals and contracts for and in behalf of said corporation; that said authority is not contrary to any provision in the articles of incorporation or code of regulations or code of bylaws of said corporation; that said authority has not been rescinded or modified and that Susan J. Durante is the duly elected and acting Secretary/Treasurer of said corporation.

IN WITNESS WHEREOF, I have hereunto subscribed my name on this 2nd day of January, 2007.

Colin M. Durante, President