

BITUTECH RAP & PER

**HIGH RAP AND WARM-MIX
ASPHALT SOLUTIONS**





BITUTECH RAP & PER

- **UNIQUE COMPOSITION**
 - 100% NATURAL MIXTURES OF PLANT EXTRACTS
 - ROSINS & ROSIN ESTERS
 - FATTY ACIDS
 - VEGETABLE OILS
 - UNLIKE AROMATICS EXTRACTS AND OILS, *BITUTECH RAP* & *BITUTECH PER* ARE SAFE FROM EXPOSURE, EMISSIONS AND CARRY NO POLLUTION RISK
 - MADE FROM GREEN AND RENEWABLE USA RESOURCES
 - LIQUID PRODUCTS – EASY TO HANDLE AND TRANSPORT



Technology developed by: **Green Asphalt Technologies LLC.**



BITUTECH RAP & PER

- **CHEMISTRY**

- ASPHALTENES AGGLOMERATE OR BUILD UP OVER PAVEMENT LIFE RESULTING IN BINDER HARDENING
- *BITUTECH RAP* BREAKS UP OR SEPARATES THESE GIANT ASPHALTENE DOMAINS WHILE AT THE SAME TIME, SUPPLEMENTING OR REPLENISHING THE LOST MALTHENES PHASE, I.E TRUE REJUVENATION

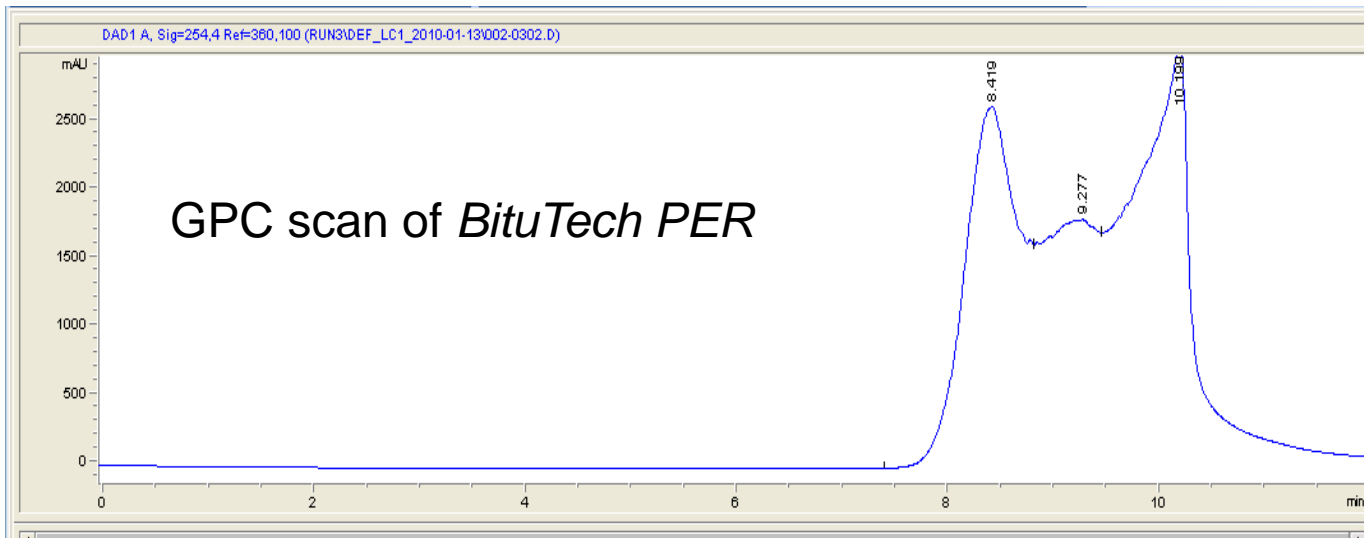
- **HPLC & GPC ANALYSIS OF ASPHALT PLUS *BituTech PER* vs. ASPHALT**

- MIMICS AND SUPPLEMENTS MALTHENES
- UNIQUE & POWERFUL DISPERSANT FOR ASPHALTENES



Technology developed by: **Green Asphalt Technologies LLC.**

BITUTECH PER

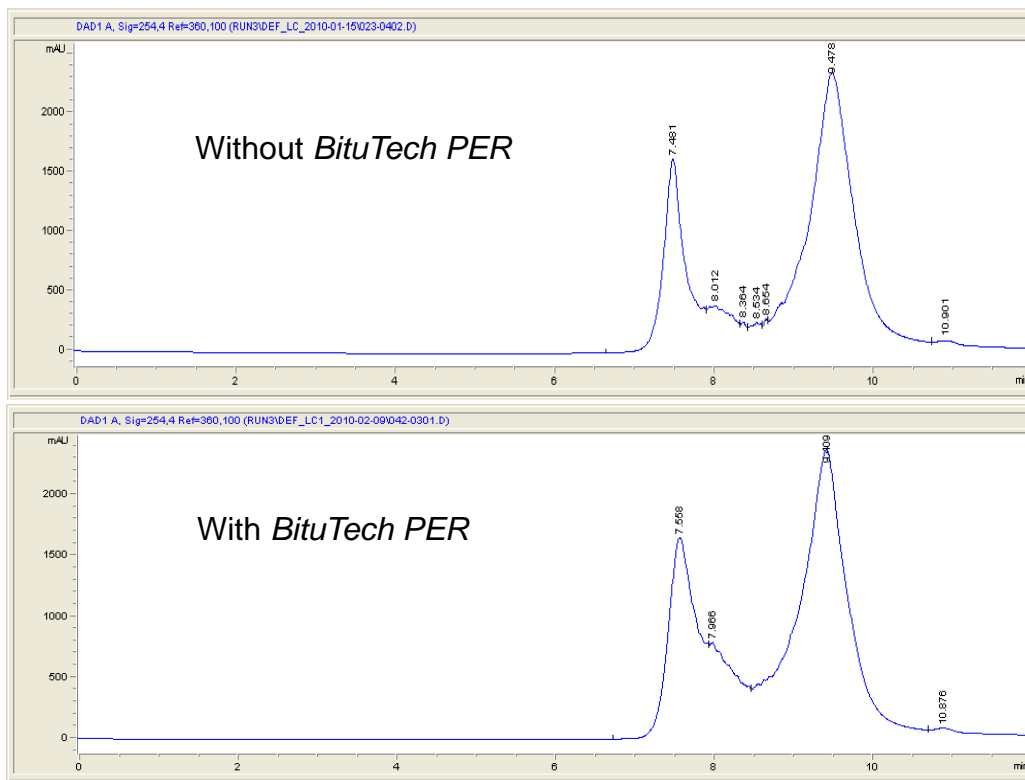


	Mn	Mw
Peak 1	1290	1760
Peak 2	231	269
Peak 3	95.0	99.5



Technology developed by: **Green Asphalt Technologies LLC.**

BITUTECH PER



Valero PG67-22

NO PER	Mn	Mw
Peak 1	7350	1110
Peak 2	160	235
WITH PER	Mn	Mw
Peak 1	5400	8880
Peak 2	180	267

BituTech PER SMOOTHES THE SMALL PEAKS BETWEEN THE MALTHENES AND ASPHALTENE PEAKS



Technology developed by: **Green Asphalt Technologies LLC.**



BITUTECH RAP & PER

- **DIFFERENCE vs. AROMATIC OILS**
 - SAFE / GREEN vs. AROMATIC OILS
 - NOT COATING BLACK ROCK BUT CO-MINGLING RAP BINDER TO EXTRACT AND UTILIZE THE INHERENT BINDER STIFFNESS, I.E VALUE GAINED OR RECOVERED
 - TREATMENT OF AGED RAP BINDER I.E PG80-10 WITH 0.75% *BITUTECH RAP* WILL REJUVENATE THE AGED BINDER AND GENERATE ~PG64-22, RECOVERING ORIGINAL BINDER FLEXIBILITY



Technology developed by: **Green Asphalt Technologies LLC.**



BITUTECH RAP & PER

- **MIX PERFORMANCE & PG GRADING**
 - ENHANCED RAP BINDER CO-MINGLING
 - IMPROVE m-VALUE IN BASE AND MODIFIED BINDERS
 - EXTENDS LOW TEMPERATURE PG
 - RTFOT COMPLIANT – NO VOLATILES
 - YIELDS TRUE WARM-MIX, NO FUMES OR SMOKE
 - ANTI-AGING ADDITIVE FOR ASPHALT BINDER
 - QUICKLY FORMS HOMOGENEOUS AND STABLE BLENDS
 - SBS/GTR DISPERSANT
 - PUMPABLE AT LOW TEMPERATURES, FLOWABLE AT 34 °F



Technology developed by: **Green Asphalt Technologies LLC.**



USES OF *BITUTECH RAP*

- HIGH (40%+) & ULTRA HIGH (100%) RAP MIXES
- HIGH USAGE (10%) OF ASPHALT SHINGLES (RAS)
- USE IN COMBINATION MIXTURES OF RAP AND RAS
- FLUX COATS "BLACK ROCK" WHILE *BITUTECH RAP* CO-MINGLES WITH RAP AND VIRGIN BINDERS
- MORE EFFECTIVE THAN FLUX
- SAFER TO USE THAN AROMATIC OILS FOR RECOVERY OF RAP AND RAS
- POLYMER COMPATIBILIZER FOR PMA PRODUCTION



USES FOR *BITUTECH RAP* & *BITUTECH PER*

- LOW TEMPERATURE PERFORMANCE ADDITIVE FOR PMA
- GRADE CHANGE ADDITIVE (EG. PG67-22 ⇌ PG58-28)
- VISCOSITY MODIFIER TO FACILITATE HIGH AGGREGATE LOADING
- EMULSIFICATION AID FOR HARD BINDER (~ZERO PEN)
- REJUVENATE FOG SEALS, CHIP SEALS, SLURRY SEALS
- YIELDS FULL WARM MIX BENEFIT
- EFFECTIVELY REPLACES AROMATIC OILS
 - USED IN FLORIDA SINCE 2008



Technology developed by: **Green Asphalt Technologies LLC.**



PROPERTIES OF *BITUTECH RAP*

PROPERTY	TYPICAL RANGE
VISCOSITY @ 60 °C, (cps)	< 100
FLASH POINT, °F (COC)	> 425
SPECIFIC GRAVITY, kg/L	0.92 – 0.95
TOTAL ACID NUMBER, mg KOH/g	40 to 75
MOISTURE CONTENT	< 0.75%
APPEARANCE	CLEAR, DARK AMBER COLORED FLOWABLE LIQUID



Technology developed by: **Green Asphalt Technologies LLC.**



PROPERTIES OF *BITUTECH PER*

PROPERTY	TYPICAL RANGE
VISCOSITY @ 60 °C, (cps)	< 150
FLASH POINT, °F (COC)	> 415
SPECIFIC GRAVITY, kg/L	0.92 – 0.95
TOTAL ACID NUMBER, mg KOH/g	40 to 120
MOISTURE CONTENT	< 1.0 %
APPEARANCE	CLEAR, DARK AMBER COLORED FLOWABLE LIQUID



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BITUTECH RAP OR PER **IN ASPHALT BINDER**

1. BASE BINDER PG 67-22	PG 68.1–23.5
RTFO VOLATILES, (%)	-0.27
2. BASE + 2% <i>BITUTECH RAP OR PER</i>	PG 65.3–28.4
RTFO VOLATILES, (%)	-0.22
3. BASE + 4% <i>BITUTECH RAP OR PER</i>	PG 62.0–29.9
RTFO VOLATILES, (%)	-0.30

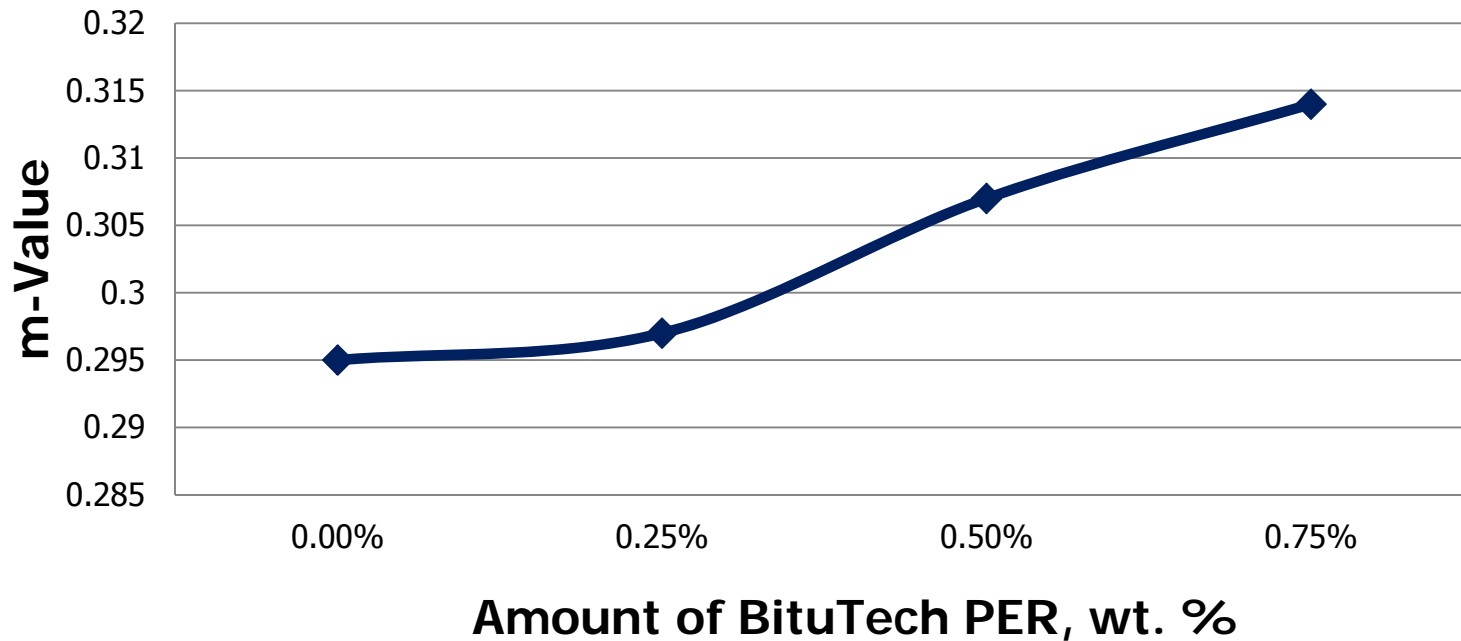
RESULTS: USE OF *BITUTECH RAP OR PER* EXTENDS LOW TEMPERATURE PG RANGE



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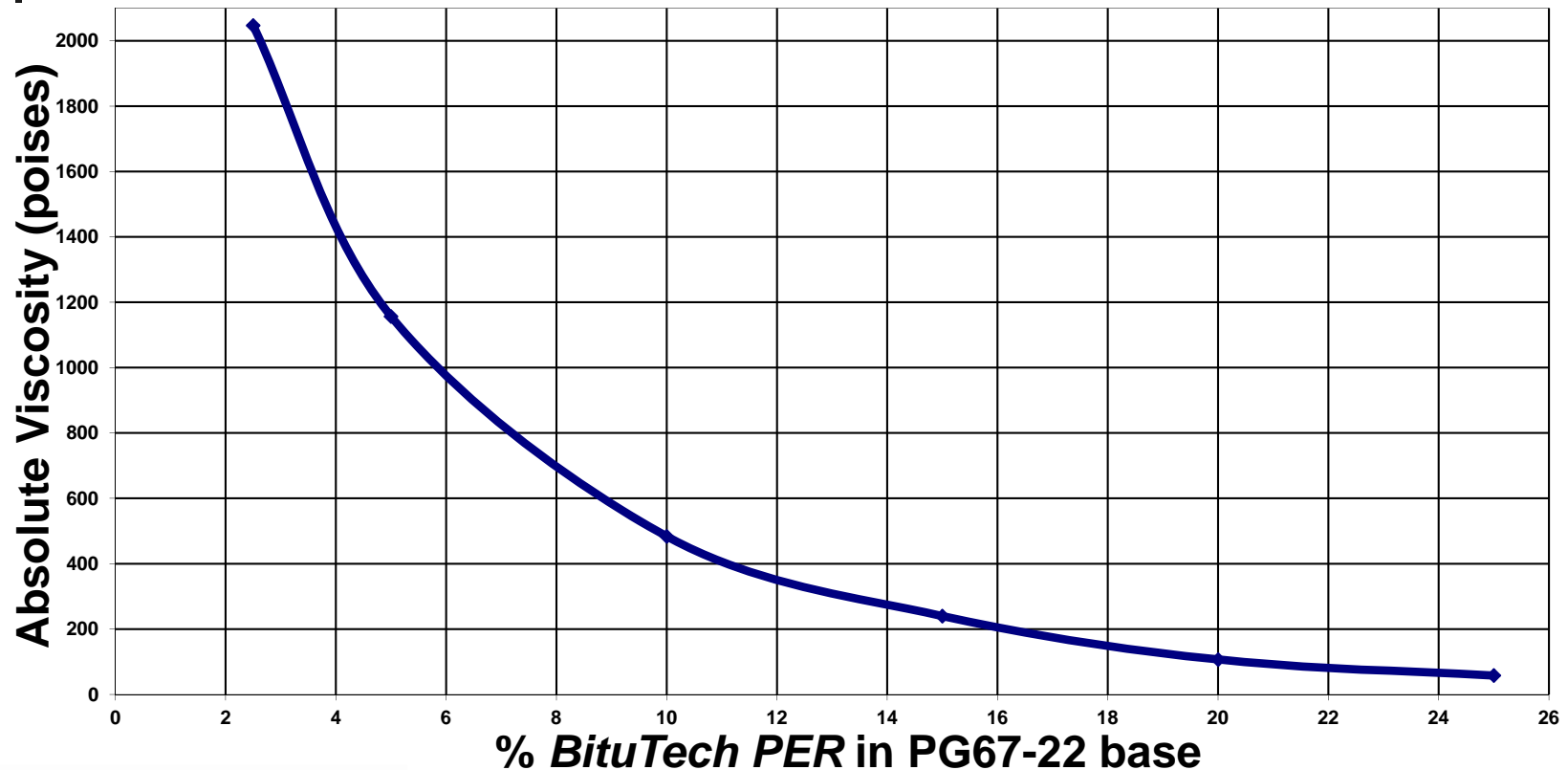
IMPACT OF *BITUTECH PER* ON m-Value of Base Binders

Impact of BituTech PER on m-Value
(3000 vis binder with low m-Value)



Technology developed by: Green Asphalt Technologies LLC.

IMPACT OF *BITUTECH PER* ON BINDER VISCOSITY



Technology developed by: **Green Asphalt Technologies LLC.**

BITUTECH PER **IN ASPHALT BINDER**

	ABSOLUTE VISCOSITY @ 60°C	PEN @ 25°C	SOFTENING POINT
BASE BINDER PG67-22	3300 cps	56	127.7°F
BASE + 2% BITUTECH RAP OR PER	2275 cps	78	123.6°F
BASE + 4% BITUTECH RAP OR PER	1425 cps	108	117.6°F



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Technologies LLC.**

IMPACT OF *BITUTECH PER* ON PENETRATION & SOFTENING PT

	PEN @ 25°C	SOFTENING POINT
ZERO PEN ASPHALT	1	182.4°F
ZERO PEN ASPHALT + 2% BITUTECH RAP OR PER	2	174.2°F
ZERO PEN ASPHALT + 4% BITUTECH RAP OR PER	3	166.5°F



Technology developed by: Green Asphalt Technologies LLC.

VISCOSITY OF RECOVERED RAP BINDER

	PRI DATA REPORTED	
	35% RAP + 5% RAS WITH RA 1000 REFINERY FLUX	35% RAP + 5% RAS + 0.75% <i>BITUTECH RAP</i> ON RAP AND RAS
ABSOLUTE VISCOSITY @ 60°C (140°F), cps	58,338	8,437



Technology developed by: Green Asphalt
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PG DATA ON HIGH RAP RECOVERED BINDER

(Reported by PRI)

PROPERTY	CONTROL USING RA 1000 (REFINERY FLUX)	SAMPLE USING 0.75% <i>BITUTECH</i> RAP ON WEIGHT OF RAP
PG Grade	76-22	70-28
Continuous PG Grade	77.9-26.6	71.6-30.0
RTFO Mass Loss (%)	-0.130	-0.250
m-Value @ -12 °C	0.336	0.387
Stiffness, Mpa @ -12 °C	167	103
m-Value @ -18 °C	0.291	0.322
Stiffness, Mpa @ -18 °C	358	219



Technology developed by: **Green Asphalt Technologies LLC.**



SUPERPAVE HIGH RAP/RAS NCAT / AMS_{LLC} MIX AND DATA

- A. MIX DESIGN: 100 GYRATION SUPERPAVE STRUCTURAL LAYER FOR FDOT TRAFFIC LEVEL "D" WITH OPTIMUM BINDER CONTENT OF 5.2%
- B. MIX CONTAINED 35% RAP / 5% RAS
- C. CONTROL: MARATHON RA 1000 FLUX GRADE
- D. *BITUTECH RAP* MODIFIED TO RA 1000 EQUIVALENT.
- E. MIX TEMP: 285 °F, COMPACTION TEMP: 250 °F



Technology developed by: Green Asphalt
Technologies LLC.

SUPERPAVE HIGH RAP/RAS NCAT / AMS_{LLC} MIX AND DATA

DENSIFICATION DATA:

	<u>Marathon</u>	<u>BituTech RAP</u>
	<u>RA 1000</u>	<u>RA 1000</u>
AIR VOIDS, % (ave. of 6)	4.4	3.5
STD DEVIATION	0.2	0.4
COMPACTABILITY, gyrations	27	21



Technology developed by: Green Asphalt Technologies LLC.



SUPERPAVE HIGH RAP/RAS NCAT / AMS_{LLC} MIX AND DATA

ASPHALT PAVEMENT ANALYZER – RESISTANCE TO
PERMANENT DEFORMATION

AGED 2 HRS @ 147°F / 64°C, HOSE PRESSURE: 100 PSI, 100 LBS VERTICAL LOAD

	<u>Marathon</u> <u>RA 1000</u>	<u>BituTech RAP</u> <u>RA 1000</u>
RUTTING, MM, (ave. of 6)	1.3	1.2
STD DEVIATION	0.3	0.8
RUT DEPTH BELOW 4.5 MM LIMIT AFTER 8000 CYCLES AT REDUCED COMPACTION TEMPERATURE		



Technology developed by: Green Asphalt
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SUPERPAVE HIGH RAP/RAS NCAT / AMS_{LLC} MIX AND DATA

TSR DATA:

	<u>Marathon</u>	<u>BituTech RAP</u>
	<u>RA 1000</u>	<u>RA 1000</u>
CONDITIONED, PSI	142.6	112.7
UNCONDITIONED, PSI	213.5	169.1
TSR	0.67	0.67

NOTE: NO ANTI-STRIP ADDED



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Technologies LLC.



SUPERPAVE HIGH RAP/RAS NCAT / AMS_{LLC} COMMENTS

- A. MIXES SHOW IDENTICAL RUT RESISTANCE & TSR DATA. *BITUTECH RAP* RA 1000 SHOWS SUPERIOR COMPACTION PROPERTIES THAN THE CONTROL
- B. THE *BITUTECH RAP* HAS REJUVENATED AND CO-MINGLED THE AGED BINDER WITH THE VIRGIN BINDER THUS REDUCING CRACKING POTENTIAL
- C. ABSOLUTE STRENGTH IS OVER 100 PSI: ADEQUATE MIX STRENGTH



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SUPERPAVE HIGH RAP/RAS NCAT / AMS_{LLC} COMMENTS

D. RECOMMEND USE TO MEET FDOT REQUIREMENTS
= 0.75% *BITUTECH RAP* ON THE RAP/RAS

TEST OBSERVATIONS:

“DURING THE MIXING PROCESS, EASE OF COATING WAS NOTICED WITH THE RAP/RAS ADDITIVE; THE AGGREGATE SEEMED TO ACHIEVE UNIFORM COATING QUICKER AND EASIER THAN WITH THE CONTROL RA 1000”



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MARSHALL SPECIMEN DATA

PROPERTY	COMPACTED 300 °F 35% RAP + 5% RAS WITHOUT <i>BITUTECH RAP</i>	COMPACTED 270 °F 35% RAP + 5% RAS + 0.75% <i>BITUTECH RAP</i> on RAP AND RAS
Gmm	2.411	2.416
Gmb	2.268	2.271
Va	5.90	6.00
STABILITY	4,575	2,625
TARGET STABILITY	≥ 1,500	≥ 1,500
FLOW	17	14



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MARSHALL SPECIMEN DATA

NOTES

- A. *BITUTECH RAP* IMPARTS FLEXIBILITY TO THE STIFF RAP/RAS MIXTURE
- B. STABILITY: 4,575 VS. 2,625 BUT STILL EXCEEDS THE TARGET STABILITY OF $\geq 1,500$ WHILE REJUVENATING THE RAP
 - LONG TERM FLEXIBILITY VS. STIFFNESS CRACKING
 - ENHANCED LONG TERM TEMPERATURE CYCLING
 - HOMOGENEOUS CO-MINGLING OF AGED RAP/RAS MIXTURE PLUS VIRGIN BINDER



TEXAS DOT APPROVAL

APRIL 2011

***BITUTECH RAP* APPROVED WARM MIX TECHNOLOGY BY TEXAS DOT IN APRIL 2011**

- HAMBURG WHEEL TRACK AND INDIRECT TENSILE STRENGTH TESTS CONDUCTED.
- *BITUTECH RAP* TO BE INCLUDED IN A UNIVERSITY OF TEXAS COMPREHENSIVE EVALUATION OF NEW WARM MIX ASPHALT TECHNOLOGIES.



Technology developed by: Green Asphalt Technologies LLC.



TEXAS DOT APPROVAL

APRIL 2011

HAMBURG WHEEL TRACKING DATA:

<u>Criteria</u>	<u>BituTech RAP</u>	<u>TX</u>
# of Passes to 12.5 mm Rut	42,626	10,000
Rut Depth, mm @20,000 Passes	10.053	-

- *BITUTECH RAP* DOSED AT 0.75% ON THE WEIGHT OF THE RAP (35% RAP+5% RAS) IN PG 67-22 BASE ASPHALT.



Technology developed by: Green Asphalt Technologies LLC.



TEXAS DOT APPROVAL

APRIL 2011

INDIRECT TENSILE STRENGTH DATA:

	<u>BituTech RAP</u>	<u>TX Criteria</u>
Dry Tensile Strength (psi):	151.6	85-200

- *BITUTECH RAP* DOSED AT 0.75% ON THE WEIGHT OF THE RAP (35% RAP+5% RAS) IN PG 67-22 BASE.
- RAP/RAS PAVEMENTS WITH IDT>200PSI AN ISSUE IN SOME AREAS IN TX. *BITUTECH RAP* PROVIDES A SOLUTION TO THIS PROBLEM.



Technology developed by: Green Asphalt Technologies LLC.



FLORIDA DOT Trial

OCTOBER 2009

I 95 CONTROL SECTION:
40% RAP (FRACTIONATED)
MIX/COMPACTION: **300 °F**
VOLUME PAVED: 1,000 TONS

I 95 TRIAL SECTION 1:
40% RAP + 0.75% *BITUTECH RAP*
(EQUIVALENT TO USING RA 1000)
MIX/COMPACTION: **270 °F**
VOLUME PAVED: 300 TONS

I 95 TRIAL SECTION 2:
40% RAP + 0.75% *BITUTECH RAP*
(EQUIVALENT TO USING RA 1000)
MIX/COMPACTION: **255 °F**
VOLUME PAVED: 300 TONS



Technology developed by: **Green Asphalt Technologies LLC.**



FLORIDA DOT Trial

OCTOBER 2009

- *BITUTECH RAP* ADDED TO THE NEW BINDER AND INJECTED INTO DOUBLE-BARREL MIX DRUM
- RESULTS:
 1. NO BLUE SMOKE AT MIXING PLANT OR PAVING SITE; A BETTER ENVIRONMENT FOR THE CREW
 2. NO PERFORMANCE ISSUES WITH MOISTURE
 3. IMPROVED COMPACTION, IMPROVED DENSIFICATION, REDUCED RUTTING AND BETTER WORKABILITY WITH *BITUTECH RAP*



Technology developed by: Green Asphalt Technologies LLC.



FLORIDA DOT Trial

OCTOBER 2009

- CHANGED TO *BITUTECH RAP* IN RA GRADES 3 YEARS EARLIER
- CONSISTENT PRODUCTION AND PAVING WITH RA GRADES BASED ON *BITUTECH RAP*
- OVER 1 MILLION TONS OF RAP PAVED IN LAST 2 YEARS
- ZERO COMPLAINTS TO DATE



Technology developed by: Green Asphalt Technologies LLC.



NYCDOT Trial

OCTOBER 2010

NYCDOT HARPER STREET ASPHALT PLANT
20% RAP (FRACTIONATED) + 0.75% *BITUTECH PER*
BITUTECH PER ADDED TO BINDER

MIX TEMPERATURE: 275°F REDUCED TO **250°F**

LITTLE NECK PARKWAY, QUEENS
800 TONS LAID IN 3-4 INCH LIFTS
50°F AMBIENT TEMPERATURE

LAYDOWN & COMPACTION: 260°F REDUCED TO **210°F**

**COMPACTED NORMALLY
NO PAVEMENT DENSITY ISSUES**



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NYCDOT Trial



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NYCDOT Trial



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Technologies LLC.

NYCDOT Trial



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NYCDOT Trial



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NYCDOT Trial



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Technologies LLC.



L.A. County Trial

AUGUST 2010

18% CRUMB RUBBER BLEND APPLIED @ 0.60-0.66 gal/sq. yd.

3/8" PRE-COATED CHIPS APPLIED @ 32-34 gal/sq. yd.

0.75% *BITUTECH PER* / 0.75% *BITUTECH WA1* ON BINDER WT

MIXTURE HEATED AND APPLIED TO PAVEMENT @ **335 °F**

PRECOATED CHIPS WERE SPREAD AND COMPACTED

RESULTS: **NO BLUE SMOKE / LOWER EMISSIONS**

REDUCED BINDER VISCOSITY

APPLICATION @ 400 °F REDUCED TO 335 °F



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BITUTECH RAP Preferred by Recyclers for RAP Rejuvenation

- *BITUTECH RAP* SELECTED AS THE PREFERRED REJUVENATOR FOR 100% RAP RECYCLED MIXES
 - BAGELA USA RECOMMENDS *BITUTECH RAP* TO CUSTOMERS
 - PTIC LISTS *BITUTECH RAP* AS THEIR PREFERRED ADDITIVE IN THEIR SALES LITERATURE
- USER FEEDBACK INDICATES TOUGHER, NON-RAVELING MIX FOR PATCHING
- EASIER HANDLING OF RECYCLED MIXES
- IMPROVED CRACK RESISTANCE



Technology developed by: Green Asphalt
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BITUTECH RAP Preferred by Recyclers for RAP Rejuvenation

- *BITUTECH RAP* HAS BECOME THE PREFERRED ASPHALT REJUVENATOR BY MANY RAP RECYCLERS
 - NEW YORK
 - CONNECTICUT
 - MASSACHUSETTS
 - OHIO
 - MICHIGAN
 - WEST VIRGINIA
 - TEXAS
 - COLORADO
 - MISSISSIPPI
 - INDIANA
 - ILLINOIS
 - WISCONSIN
 - ONTARIO
 - BRITISH COLUMBIA



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BAGELA USA IN CONNECTICUT

100% RAP/RAS

2,000 POUNDS (~98%) OF FRACTIONATED AGED RAP

2 QUARTS (0.2%) OF **AROMATIC OIL**

40 POUNDS (~2%) OF RAS

PROCESS: HEATED TO 310 °F IN MIXER DRUM
DISCHARGED AT 290 °F TO 305 °F

RESULTS: **BLUE SMOKE & FUMES, OILY ODOR**
HEALTH OR EMISSIONS QUESTIONS



Technology developed by: Green Asphalt
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BAGELA USA IN CONNECTICUT

100% RAP/RAS

2,000 POUNDS (~98%) OF FRACTIONATED & AGED RAP

2 QUARTS (0.2%) OF *BITUTECH RAP (100% NATURAL)*

40 POUNDS (~2%) OF RAS

PROCESS: HEATED TO 310 °F IN MIXER DRUM

DISCHARGED AT 290 °F TO 305 °F

WARM MIX POTENTIAL NOT EXPLOITED AT THIS TRIAL

RESULTS:

NO BLUE SMOKE OR OILY ODOR

NO HEALTH OR EMISSIONS QUESTIONS

GOOD WORKABILITY & COMPACTION



Technology developed by: Green Asphalt Technologies LLC.



DRUM HEAT SOLUTION FOR HIGH RAP %

- INFRARED (NO DIRECT FLAME) HEATED CONVEYOR
 - RAP/RAS STREAM TURNED OVER ENROUTE TO DRUM
 - *BITUTECH RAP* SPRAYED ONTO THE RAP/RAS STREAM
 - RAP/RAS STREAM CONTROLLED TO 200 - 275°F
 - COST EFFICIENT HEATING
 - LESS WEAR ON AGGREGATE HANDLING SYSTEMS
- INCREASE RAP/RAS STREAMS > 50%
- ACHIEVE SUBSTANTIAL COST SAVINGS UTILIZING HIGH RAP/RAS MIXTURES



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Achieving Greater Warm-Mix Benefits with ***BITUTECH WA1***

- *BITUTECH WA1* – WORKABILITY MODIFIER AND WARM-MIX ADDITIVE
 - IMPROVES FLOW AND SLUMP OF PAVING MIX
 - EXTENDS THE WORK DAY FOR CONTRACTORS
 - MAKES THE MIX EASIER TO HANDLE AND EASIER TO COMPACT AT LOWER TEMPERATURES
 - COMBINED WITH *BITUTECH RAP* OR *BITUTECH PER* FOR MAXIMUM WARM-MIX BENEFITS



Technology developed by: Green Asphalt
Technologies LLC.

Achieving Greater Warm-Mix Benefits with ***BITUTECH WA1***

- *BITUTECH WA1* – WORKABILITY MODIFIER AND WARM-MIX ADDITIVE
 - MORE EFFECTIVE ALTERNATIVE THAN SASOBIT
 - USED WITH *BITUTECH PER* IN GTR CHIP SEALS TO REDUCE EMISSIONS IN CALIFORNIA
 - USED IN WARM-MIX PMA FOR OVER 3 YEARS
 - IMPROVED MIX CHARACTERISTICS
 - POLYMER REDUCTION



Technology developed by: Green Asphalt Technologies LLC.

BITUTECH RAP COST BENEFITS

ABOVE 20% RAP, \$/TON

	40% RAP	50% RAP	60% RAP	70% RAP	80% RAP	90% RAP	100% RAP
BINDER SAVINGS (\$)	\$5.99	\$8.31	\$10.62	\$12.94	\$15.26	\$17.57	\$19.87
AGGREGATE SAVINGS (\$)	\$1.48	\$2.21	\$2.95	\$3.69	\$4.43	\$5.16	\$5.90
FUEL COST SAVINGS (\$) (WARM MIX BENEFIT)	\$1.43	\$1.43	\$1.43	\$1.43	\$1.43	\$1.43	\$1.43
BituTech RAP COST (\$)	\$4.02	\$5.03	\$6.03	\$7.04	\$8.04	\$9.05	\$10.05
TOTAL SAVINGS (\$)	\$3.48	\$4.82	\$6.17	\$7.52	\$8.87	\$10.22	\$11.57



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BITUTECH RAP COST BENEFITS

ABOVE 10% RAP WITH RAS, \$/TON

	10% RAP 5% RAS	20% RAP 5% RAS	30% RAP 5% RAS	40% RAP 5% RAS	50% RAP 5% RAS
BINDER SAVINGS (\$)	\$4.94	\$6.92	\$8.90	\$10.88	\$12.86
AGGREGATE SAVINGS (\$)	\$0.24	\$0.71	\$1.19	\$1.66	\$2.14
FUEL COST SAVINGS (\$) (WARM MIX BENEFIT)	\$1.43	\$1.43	\$1.43	\$1.43	\$1.43
BituTech RAP COST (\$)	\$1.13	\$1.88	\$2.63	\$3.38	\$4.13
TOTAL SAVINGS (\$)	\$4.06	\$5.76	\$7.46	\$9.17	\$10.87



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BITUTECH RAP COST BENEFITS

<u>You can change the inputs in any of the green-shaded cells to reflect your local costs, binder content or assumptions</u>			X% RAP w/o BituTech RAP	X% RAP w/BituTech RAP	X% RAP w/BituTech RAP	X% RAP / X % RAS w/BituTech RAP	X% RAP / X % RAS w/BituTech RAP
RAP Percentage in the total mix, X		<i>(input % of RAP)</i>	20%	20%	20%	25%	35%
RAS Percentage in the total mix, X		<i>(input % of RAS)</i>	0%	0%	0%	5%	5%
Mix, lbs.			2000.00	2000.00	2000.00	2000.00	2000.00
RAP, lbs./ton of mix @ \$/ton cost of:	\$6.00	<i>(input \$ cost)</i>	400.00	400.00	400.00	500.00	700.00
RAS, lbs./ton @ \$/ton del. cost of:	\$45.00	<i>(input \$ cost)</i>	0.00	0.00	0.00	100.00	100.00
Virgin Mix, lbs.			1600.00	1600.00	1600.00	1400.00	1200.00
Recovered RAP Binder @:	5.20%	<i>(input asphalt % content)</i>	13.52	20.59	20.59	25.74	36.04
Recovered RAS Binder @:	22.00%	<i>(input asphalt % content)</i>	0.00	0.00	0.00	21.78	21.78
Virgin Mix Binder, lbs. @:	6.00%	<i>(input target asphalt %)</i>	106.48	99.41	99.41	72.48	62.18
RAP Binder value, \$ per ton			\$3.72	\$5.66	\$5.66	\$7.08	\$9.91
RAS Binder value, \$ per ton			\$0.00	\$0.00	\$0.00	\$5.99	\$5.99
Required Virgin Binder value, \$ per ton			\$29.28	\$27.34	\$27.34	\$19.93	\$17.10
RAP Aggregate value, \$/ton @ \$/ton:	\$15.00	<i>(input \$ value)</i>	\$2.84	\$2.84	\$2.84	\$3.56	\$4.98
RAS Aggregate value, \$/ton @ \$/ton:	\$15.00	<i>(input \$ value)</i>	\$0.00	\$0.00	\$0.00	\$0.71	\$0.71
Less RAP Processing Cost @ \$/ton:	\$4.00	<i>(input \$ cost)</i>	\$0.80	\$0.80	\$0.80	\$1.20	\$1.60
Calculated net RAP Aggregate Value, @ \$/ton			\$2.04	\$2.04	\$2.04	\$3.07	\$4.09
Additional Binder Savings from Treatment, \$ per ton			\$0.00	\$1.94	\$1.94	\$9.35	\$12.18
New Aggregate Savings, \$ per ton			\$0.00	\$0.00	\$0.00	\$1.02	\$2.04
Fuel Savings; Warm Mix Benefit, \$/ton		<i>(from line #26. see Instruction #9)</i>	\$0.00	\$1.85	\$1.85	\$1.85	\$1.85
Cost of BituTech RAP, 0.75% @ \$/lb.:	\$0.72	<i>(input \$ cost)</i>	<u>\$0.00</u>	<u>\$2.16</u>	<u>\$2.16</u>	<u>\$3.24</u>	<u>\$4.32</u>
Total Savings Over Base 20% RAP, \$ per ton			Base	\$1.63	\$1.63	\$6.43	\$8.60
Fuel savings based on diesel fuel price per gallon of:	\$3.50	<i>(input \$ cost)</i>	for total fuel savings per ton of:			\$1.85	per ton
<i>(Note: Fuel savings are based on saving 2 liters of diesel per ton)</i>							
Asphalt Price Average, \$/ton	\$550.00	<i>(input \$ cost)</i>					
Recovery % of RAP & RAS Binder w/o BituTech RAP	65%	<i>(input assumed % of old binder recovery)</i>					
Recovery % of RAP & RAS Binder with BituTech RAP	99%	<i>(input assumed % of old binder recovery)</i>					
Our test results indicate at least 99% recovery with BituTech RAP							



Technology developed by: **Green Asphalt Technologies LLC.**

Advances in *BITUTECH RAP & PER* Technology

- *BituTech SEF (Self-Emulsifying Concentrate)*
 - Cold-applied use in RAP & RAS Mixes, Cold Mix formulations
 - Enables High RAP & RAS Mixes
 - Pavement Rejuvenation (spray) Agent
 - Green Release Agent for truck beds and bins
- *BituTech PER-H* “Green” high flash performance and viscosity modifier
 - High temperature blending and viscosity reduction



Technology developed by: Green Asphalt Technologies LLC.



Other Products Marketed by Engineered Additives:

- ***BituTech CLX & CLS*** asphalt cross-linkers
 - High sulfur & Low sulfur formulations
 - H₂S Scavenger
 - Non-corrosive
 - Reduced polymer loading
 - Phase Angle improvement
 - SBS & GTR



Technology developed by: **Green Asphalt
Technologies LLC.**



Other Products Marketed by Engineered Additives:

- ***BituTech ADH*** adhesion modifier
 - Improves adhesive and cohesive compound strength
- ***BituTech WA1 & VPW*** warm mix modifiers
 - Performance modifiers
 - Compound viscosity and warm-mix benefits
- ***BituTech BUR*** asphalt oxidation modifier
 - Convert PG 67-22 to BURA, types I-IV at reduced oxidation time & temperature



Technology developed by: Green Asphalt
Technologies LLC.

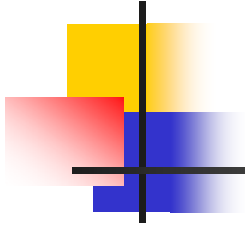


Products Under Development by Green Asphalt Technologies:

- ***BituTech PER Plus*** “Green” performance modifier
 - Low temperature PG improvement plus viscosity reduction
- ***BituTech PLR & PLR-H*** performance modifiers
 - Reduced SBS loading
 - Improve high temperature performance
- ***BituTech HFD*** high flash viscosity cutter
 - High flash & low odor viscosity modifier



Technology developed by: Green Asphalt
Technologies LLC.




























































APPENDIX: PRODUCT PROPERTIES AND APPLICATION MATRIX



Technology developed by: **Green Asphalt
Technologies LLC.**

Engineered Additives Product Properties & Application Matrix




Key:  Applicable  Developmental






































































Industry Applications	BituTech PER	BituTech RAP	BituTech PER-HF	BituTech HFD	BituTech HFM	BituTech SEF	BituTech PER Plus	BituTech BUR	BituTech ADH	BituTech WA1	BituTech VPW	BituTech PLR*	BituTech PLR-H*	BituTech CLX	BituTech CLS
Green Renewable Chemistry															
Asphalt Paving Applications															
Asphalt Roofing Applications															
Agricultural Applications															
Tar Sands Applications															
Transportation & Storage Applications															
Drilling Fluid Applications															
Explosives Formulations															
Release Agent Applications															
Concrete Form Release Applications															
Injection Mold Form Release Applications															
Adhesives Applications															
Polymer Resin Diluent Applications															
Animal Feed Applications															



Technology developed by: **Green Asphalt Technologies LLC.**

Engineered Additives Product & Properties Matrix




Key:  Preferred  Recommended  Developmental


















































Paving Applications	BituTech PER	BituTech RAP	BituTech PER-HF	BituTech HFD	BituTech HFM	BituTech SEF	BituTech PER Plus	BituTech BUR	BituTech ADH	BituTech WA1	BituTech VPW	BituTech PLR*	BituTech PLR-H*	BituTech CLX	BituTech CLS
Green Renewable Chemistry, 100% renewable & safe															
Asphalt Viscosity Reduction, 7-9% to change 3000 vis to 600 vis															
Hot-Mix Viscosity Reduction, e.g. Improve Handling and Workability															
High-flash Viscosity Reduction, 7-9% to change 3000 vis to 600 vis															
Improve Low Temperature Performance, e.g. PG67-22 to PG58-28															
Maintain High Temperature Performance, e.g. PG67-22 to PG64-28															
High RAP & RAS Binder Recovery, e.g. 99+% Recovery															
Tank & Vessel Cleaning, e.g. Dissolve and Recover Asphalt Sediment															
Cold Mix Application, e.g. Activate Old Binder Under Ambient Temps															
Cold Release Application, dilute to 5%-10% concentration in water															
Low Range PG Grade Modifier, e.g. PG67-22 to PG-64-28															
High Range PG Grade Modifier, e.g. PG67-22 to PG70-22															
Improve m Value															
Reduced Polymer Requirement, e.g. up to 50% reduction															
Warm Mix Benefits, e.g. Reduce Energy and Extend Laydown Time															
Improved Mix Work-Ability, e.g. extend laydown time															
Elastic Recovery, Toughness & Tenacity															
Low-(sulfur)-Fume Cross-linking															
Non-corrosive & Free Flowing Cross-linker, e.g. no caking in high humidity															



Technology developed by: **Green Asphalt Technologies LLC.**

Engineered Additives Product & Properties Matrix




Key:  Preferred  Recommended  Developmental















Roofing Applications	BituTech PER	BituTech RAP	BituTech PER-HF	BituTech HFD	BituTech HFM	BituTech SEF	BituTech PER Plus	BituTech BUR	BituTech ADH	BituTech WA1	BituTech VPW	BituTech PLR*	BituTech PLR-H*	BituTech CLX	BituTech CLS
Green Renewable Chemistry, 100% renewable & safe															
Asphalt Viscosity Reduction, 7-9% to change 3000 vis to 600 vis															
High-flash Viscosity Reduction, 7-9% to change 3000 vis to 600 vis															
Reduced Oxidation Time, e.g. 20-30% Faster Batch Cycle Time															
Reduced Oxidation Temperature, e.g. 50 °F lower															
Post Oxidation Pen & S.P. Modifier, e.g. 15 Pen @ 220 to 19 Pen@ 215 with 2%															
Oxidize Harder Base Asphalt, e.g. PG64-22 base vs. shingle flux															
Improve Low Temperature Performance, e.g. reduced risk of cracking															
Suitable for BURA, all Types, e.g. PG67-22 to Type III & IV															
Elastic Recovery, Toughness & Tenacity															
Improved Weathering, e.g. 20-30% Weatherometer Improvement															
Pen & S.P. Modifier, e.g. Changes the Pen & Softening Point Relationship															
Reduced Polymer Requirement, e.g. from 15-50% polymer reduction potential															
Low temperature processing aid, e.g. Improve workability and handling															
Adhesion & Cohesion Promoter, e.g. improves surface adhesion															
Low-(sulfur)-Fume Cross-linking															
Non-corrosive & Free Flowing Cross-linker, e.g. no caking in high humidity															
Tank & Vessel Cleaning, e.g. Dissolve and Recover Asphalt Sediment															



Technology developed by: **Green Asphalt Technologies LLC.**

Engineered Additives Product & Properties Matrix




Key:  Preferred  Recommended  Developmental















Agricultural Applications	BituTech PER	BituTech RAP	BituTech PER-HF	BituTech HFD	BituTech HFM	BituTech SEF	BituTech PER Plus	BituTech BUR	BituTech ADH	BituTech WA1	BituTech VPW	BituTech PLR*	BituTech PLR-H*	BituTech CLX	BituTech CLS
Green Renewable Chemistry, 100% renewable & safe															
Crop Adjuvants, non-polluting and hazard-free															
Pesticide & Fungicide Carrier Fluids, non-polluting and hazard-free															
Fruit Sprays, non-polluting and hazard-free															



Technology developed by: **Green Asphalt Technologies LLC.**

Engineered Additives Product & Properties Matrix

Key:  Preferred  Recommended  Developmental

<u>Tar Sands Applications</u>	BituTech PER	BituTech RAP	BituTech PER-HF	BituTech HFD	BituTech HFM	BituTech SEF	BituTech PER Plus	BituTech BUR	BituTech ADH	BituTech WA1	BituTech VPW	BituTech PLR*	BituTech PLR-H*	BituTech CLX	BituTech CLS
Green Renewable Chemistry, 100% renewable & safe															
Efficient Crude Recovery, e.g. ~98% recovery of tars															
Modify Recovered Sand Burden, e.g. re-use for road paving applications															
Modify Bitumen Characteristics in Syn Crude															
Tank, Vessel & Pipe Cleaning, e.g. Dissolve and Recover Asphalt Sediment															



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Engineered Additives Product & Properties Matrix						Key: Preferred			Recommended			Developmental			
Specialty Applications	BituTech PER	BituTech RAP	BituTech PER-HF	BituTech HFD	BituTech HFM	BituTech SEF	BituTech PER Plus	BituTech BUR	BituTech ADH	BituTech WA1	BituTech VPW	BituTech PLR*	BituTech PLR-H*	BituTech CLX	BituTech CLS
Green Renewable Chemistry, 100% renewable & safe															
Transportation & Storage Applications															
Tank & Vessel Cleaning															
Non-hazardous and non-polluting															
Drilling Fluid Applications															
Drilling Fluid Viscosity Modifier															
Explosives Formulations															
Release Agent Applications															
Release for hot-mix vessels															
Release for tar sands truck beds															
Concrete Form Release Applications															
Injection Mold Form Release Applications															
Adhesives Applications															
Extender Oil - Adhesive Formulations															
Adhesion & Cohesion Promoter															
Polymer Resin Diluent Applications															
Extender Oil - Polymer Formulations															
Animal Feed Applications															
Dust Control															



Technology developed by: **Green Asphalt Technologies LLC.**

Engineered Additives LLC offers its clients and partners unique and cost efficient asphalt modifier and additive choices, many based on recycled or renewable resources, with the formulating support and analysis to effectively utilize those polymers in an asphalt formulation for roofing or paving use.

Green Asphalt Technologies LLC specializes in developing unique and effective products for the modification of asphalt for a variety of applications, including paving and roofing, utilizing recycled and renewable resources and conventional chemistry to create the next generation of asphalt additives, cross-linkers and performance improving modifiers.



Technology developed by: **Green Asphalt Technologies LLC.**

WE THANK YOU!



www.engineeredadditives.com

**GREEN ASPHALT
TECHNOLOGIES, LLC**