By Tori Tragis

When spring shatters the lock winter has held on Alaska's frozen white land, the hillsides soften into green and the ground becomes springy underfoot. The rivers flow again, the puddles dwindle and fade — and then comes the dust. Billowing, suffocating piles of it, massive blooms of tawny grit and ricocheting pebbles. The thick air blinds drivers, chokes pedestrians and cascades into homes, dust settling onto every surface and into every crevice — on countertops, in computers and down into the lungs.

During the summer, dust inundates Eagle — the Native village and the city, twin communities in eastern Alaska, near the Canadian border. The road leading into Eagle, the road that connects the small city with the village, the byroads and side roads, all are unpaved. There's been talk of paving at least the primary paths off and on over the years, but the community consensus has generally been against it.

"It gives Eagle part of its feel, having dirt roads," says Ann Millard, the local school's recently retired principal. "The tourist industry is important to us, although it's not really active [right now]. Having paved streets is at the opposite end of the spectrum."

The problem was worse when the large tour buses came regularly into town, but Millard says many Eagle people accepted that as the price to be paid for providing a frontier feel that would attract tourists. And, she points out, the sprawling, silty Yukon and its buffeting winds come with an all-natural deluge of dust.

Still, dust is a problem. It hangs in the air and gets tracked into people's homes. It aggravates the asthma of some of the kids in Millard's school. It coats the community garden and clings to salmon drying on racks. So about 10 years ago, the Alaska Department of Transportation and Public Facilities offered to try a dust suppressant, or palliative, on Eagle's roads. But the product DOT wanted to try uses a proprietary formula, which means its contents are secret.

"That's what makes people nervous," Millard says. "After it was applied we noticed we were getting a rainbow sheen on the road. I saw a sign up at the post office, something about 'Brought to you by the state government: Rainbows on our rain puddles.'"

The secrecy bothers Gary, Ann Millard's husband. He moved to Eagle from his hometown of Fairbanks 17 years ago so he could live somewhere that wasn't so big, so … city. "I went to the public testimony when the DOT guy was coming in before they applied it. I'm not a big fan of government agencies telling us, 'Oh, it's ok.' […]They won't tell us what is going to happen for those that are ingesting it. They say it's all organic. Well, that's all fine and dandy, but oil is organic and you don't drink it."

The Millards agree something should be done to control dust, but absent solid information

about what is in the chemical palliatives, they lean toward using water to regularly dampen the streets. They are careful to note that while some in their community agree with them, others do not. Bruce Atkinson, who lives up the road between Eagle and Eagle Village, just upstream, deplores the dust and welcomes even a chemical solution, anything that's more efficient and cost-effective than watering the roads twice a day, which crews had been doing during the tour bus heyday.

"Just a regular vehicle doing 15 mph kicks up tremendous dust," Atkinson says. "A big huge cloud of dust goes up in the yard and carries everything into the house. Sometimes I will run the garden hose but that only lasts a couple hours when it's hot. It's terrible."

Calcium chloride is an alternative to water and chemicals, and is commonly used (though not in Eagle). It's also commonly the focus of complaints that it leaves a salty taste on subsistence foods like berries and drying fish so many villages still rely on spraying water on unpaved roads. It works, but only for a while. On a hot, dry day, it could evaporate within a few hours, so the roads have to be continually sprayed.

"Water is labor intensive, and things are tight," says Andy Journey. He's the water plant operator and utilities director for the city of St. Mary's, in Southwestern Alaska. His situation highlights the scarcity of a number of resources — money, labor, equipment — that is common in rural communities.

"We need to take one of our operators away from one of our other projects," Journey explains. "We have a flatbed with a thousand-gallon tank on it but it sits on a lowboy that will only fit on a dump truck, and you need an operator's license for that. We'd normally haul it with our flatbed but our trash truck is broken so we're using the flatbed as the trash truck."

Journey is the only one with an operator's license, so he drives the dump truck with the water tank on it. On hot, sunny summer days, he'll be out there every day for two to three hours, spraying water that will keep the dust down for just three or four hours.

"Watering roads is a daily chore. A dust palliative would last two to three months and get us into the fall rains, and [then] it wouldn't matter."

"Watering roads is a daily chore," he says. "A dust palliative — we could put it on in three, four days and it would last two to three months and get us into the fall rains, and [then] it wouldn't matter."

Journey says the village tested four types of palliatives in 2012. One worked especially well, but he notes ruefully that it was the most expensive of the group, and there were problems with applying it, so he's still trying to figure out his options. He has to factor in the exorbitant cost of barging in whatever he does decide on, and while there's talk of one of the regional Native corporations developing a palliative from used cooking oil that could be produced regionally, it's not a viable candidate in the near future.

In the meantime, he maintains the streets as best he can. "It's an ongoing battle. We have to do our roads no matter what."

Keeping it together

A gravel or dirt road is made up of two primary materials: rock or gravel (aggregate) and a binding agent, something that keeps the aggregate together. Dust is part of that binding material. Lose the dust and you lose what holds the road together. If you don't pay to keep the dust on the ground using some kind of mitigation strategy — water, chemical or something else — you'll have to pay a lot more when too much

PAY DIRT

Finding a way to keep the dirt down low could turn a tidy profit. More than a dozen companies in the U.S. produce dust palliatives, products that minimize the amount of dust coming up off dirt roads. They all promise to keep the air above your dirt road or runway crystal clear. Some companies' websites even have the pictures to prove it, but there's the gritty rub: the proof is largely visual. Engineers don't have standardized tests to determine how well a palliative works, nor do the palliative-producing companies themselves.

Enter Dave Barnes and company at the Alaska University Transportation Center. Barnes got pulled into the dust game sideways. He's really a water kind of engineer, but AUTC's director persuaded him that since water and dust both move, they're not all that different. Five years on, the unflappably genial Barnes still seems a little mystified that he has become UAF's top dust guy, but he's even more mystified by dust itself, so he keeps studying it.

As Barnes and his team started developing DUST-M for field research (see accompanying story), they realized they needed a companion lab test to corroborate their outdoor measurements. Surprisingly, no such test existed. So, starting with the bare bones of an idea from fellow researchers, they raided building supply centers for PVC pipes, sandpaper and funnels. They rounded up a toothbrush, a ski wax brush and a plastic tub. Graduate student Wilhelm Muench hunkered down in the machine shop and created a device that lets undergraduate students like Cody Klingman and Logan Little release precise amounts of aggregate (basically dirt and rocks) into the upright PVC pipe at exactly the right time. As the dust drops, it's measured with the only off-the-shelf technical product they used, a laser that measures how much dust is in the air in a small space.

"It's hillbilly science," Barnes says wryly of his team's invention, "but the repeatability is amazing to me."

dust is lost and the road surface needs to be repaired or replaced.

A typical gravel road or runway in Alaska lasts four to eight years if it's not treated for dust control. Put down a palliative, and its life span improves to eight to 12 years before the surface material needs to be replaced. If you're in an area that doesn't have gravel available, which includes much of rural Alaska, you have to barge it in. Take the surface material needed to repair the airport at Manley, which has access to gravel. It costs an average of $50 per cubic yard. Double or even quadruple that for a remote site with no local gravel, and now you're looking at an average of $150 per cubic yard. If the Manley runway gets no dust suppression, it would need a new surface three times over the course of 16 years (year 1, year 8, year 16) in a best-case scenario, costing DOT about $700,000. Use a palliative, which costs far less than buying and laying surface material, and that number drops to $617,000, in part because you only need to put down a new surface twice, in year 1 and year 16. Considering there are 870 acres of runway and 4,600 acres of unpaved roads the state is responsible for in the northern region alone, the savings on dust-treated roads are significant. That doesn't include the miles of roads that villages are responsible for, villages whose budgets are even more constrained than the state's.

Journey isn't worried about using chemicals on his community's roads. He's talked with other villages in his area, and says they are satisfied with the results. "All the technical product descriptions have been tested by some federal chemical labs and have been proven to be safe," he says. "I've seen the lethal doses, and [our application rates are] so far under it."

Instead, he says, it's a question of road safety and quality of life. If one of the big rigs from the local gravel pit go more than 15 mph, he says, you can see hardly anything. The village posts signs asking drivers to stay under 20 mph, and that helps, but only if everyone keeps a light foot on the gas pedal.

Concerns about safety and visibility on the roads are voiced throughout rural Alaska. Seldovia, on the Kenai Peninsula, uses calcium chloride on some of its roads, but it isn't applied everywhere, and in lean funding years, it sometimes isn't applied at all.

"There are times there's so much dust you can't see someone until you're on top of them and you might hit them," says Michael Opheimer, the environmental coordinator for Seldovia Village Tribe. "You sometimes have to stop because you can't see in front of you."

No room to breathe

Air thick enough to see is thick enough to choke on. In a dust-laden community, breathing can be a labor of life for some people, especially the young, the elderly and anyone with lung or heart problems.

Dust contains tiny particles, or particulate matter, called PM_{10}. PM_{10} is less than the width of a human hair and can be seen only with an electron microscope. (PM_{10} also contains $PM_{2.5}$, an even finer measurement associated with smoke from burning wood or coal.) When PM_{10} is inhaled, it gets into the lung tissues, where it can cause breathing and heart problems.

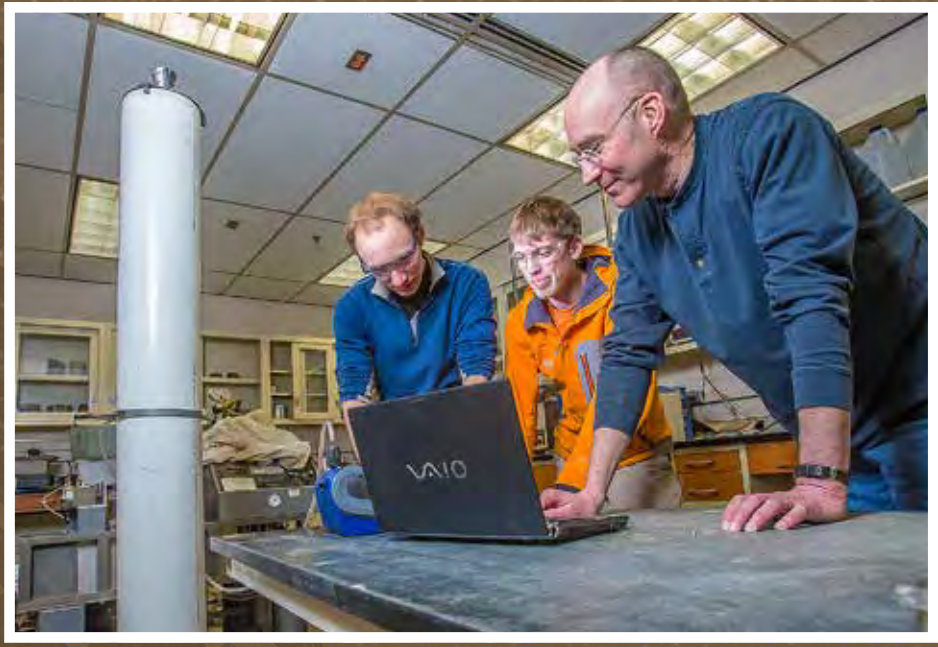
Naturally occurring asbestos can also be a problem in some places in Alaska, according to state toxicologist Ali Hamade. Exposure to asbestos can, he says, lead to serious health problems like asbestosis and lung cancer. Efforts to control dust are, he says, critically important, especially on heavily trafficked roads where children play.

Fifty rural Alaska communities responded to a 2010 rural dust survey conducted by the state Department of Environmental Conservation. All of them reported that dust caused coughing and irritation of the eyes, nose and throat. Dust was considered a factor in aggravating asthma by 84 percent of communities, and 72 percent reported increased problems with chronic bronchitis and chest tightness.*

** The surveys were self-reported by one or more residents in each village, and the respondents were not necessarily medical professionals.*

An in-lab test makes it faster and cheaper for manufacturers to refine a product before heading outside for large-scale testing, and makes it easier to determine what palliatives work best on different surfaces.

The pipe-and-laser design is continually being refined until they get even greater reliability. "If we cannot get the repeatability to a comfortable level," says Barnes, "we stop and come up with new technology."



Working labs are messy, Barnes (right) tells visitors, but are good training grounds for undergraduate researchers like Cody Klingman and Logan Little.

The Seldovia health clinic reports increases in breathing problems and eye injuries from the cloudy air's grit and debris. (Seldovia did not participate in the 2010 DEC survey.) "We're starting to see more and more asthma-related illnesses from them because we're gathering dust from lack of dust abatement," says Opheimer. "It is a concern for us here to keep people from getting more asthmas or bronchial illness."

Seldovia conducted its own survey in summer 2012. At the top of the list of air-quality concerns was dust control — 60 percent wanted to tame the roads. Asthma education ranked fourth (43 percent), echoing the Seldovia health clinic's findings that asthma and other breathing problems were growing. The second and third top concerns, though, had nothing to do with immediate to-dos like watering the roads or holding an asthma-education fair. Instead, they were about measuring, finding out what is in the air and how it got there. Half the survey takers wanted to continue monitoring road dust, and almost the same number of people wanted an air quality emissions inventory.

Dust and verify

Measurement is a basic feature of any study. But how do you measure dust, specifically, dust thrown up on a dirt road by a passing vehicle? How do you measure if something you've put down on a road to suppress dust — a palliative — works? So far, no one has developed an industry-recognized, scientifically legitimate way to do that. Clark Milne, '77, who until this past summer was DOT's regional maintenance engineer for central and northern Alaska, says that engineers have had just one measuring tool.

"Eyeballs."

An engineer on a dust mitigation project observes the amount of dust left hanging in the air by a passing vehicle, lays down a layer of test palliative, has someone drive by again, and guesstimates how well the palliative is working.

It's not an ideal method, Milne admits. "I think you can have a skilled opinion, but it's pretty difficult to say, 'This is too dusty.' There were no technical ways in a repeatable manner to do dust-suppression testing."

Milne needed a tool that could give him repeatability, meaning the tool could produce reliable data over and over. If you put your king salmon on a calibrated digital scale and find it's a respectable 40 lbs., and your cousin does a bicep curl with his catch and declares it a family heirloom at 65 lbs., that's not a reliable set of data, because you're using different methods of measurement. (Your cousin probably isn't very reliable, either.)

Not content with making at best an educated guess about

Dust from this road in Bethel will eventually settle on the potatoes growing on the commercial farm that lies alongside.

how well one palliative works compared to another, Milne asked UAF engineers to come up with a tool that could measure road dust while it was being thrown up, or lofted, by a moving vehicle.

The result was DUST-M. (Say it fast, like "dust 'em off.") It's a mobile device that can be placed on the back of an all-terrain vehicle. Behind one of the rear wheels is an intake device that looks like a pingpong paddle, and in the middle of the paddle is a hole with tubing attached to it. As the driver rolls down the road or runway, air and dust get sucked into the tubing, where the amount of dust is measured by an off-the-shelf instrument called a DustTrak. It's a process that can be repeated over and over, and used to compare how much dust is lofted in the air before and after treatment. Instead of eyeballing it, operators can make informed decisions, not informed guesses.

Milne says DUST-M is a critical part in helping engineers identify if a palliative is doing its job. "Without it as a yard stick there's no plausible discussion about your palliatives. It still needs to be finalized — what process can most fairly evaluate dust suppression — but it's better than anything else that I'm aware of in the world."

Industry does not yet recognize DUST-M as a certified measuring device. Sometimes DUST-M gives unexpected and divergent results. Researchers are trying to figure out if unexpected changes in data are because of a design flaw in DUST-M, a mistake in how the palliative was applied, or if it's because, frankly, engineers just don't yet fully understand how palliatives work on different surfaces. Dave Barnes, at UAF's Alaska University Transportation Center, was the lead researcher on the team that developed DUST-M.

"It's not only a matter of taking measurements with DUST-M, but also understanding what our soils are made of to find the right palliative," Barnes says. He gives the example of tests in Eagle and in White Mountain, on the Seward Peninsula in Western Alaska.

There's no escape from the blinding, choking clouds of dust between breakup and snowfall.

A palliative was applied to the Eagle runway at a concentration Barnes and his team thought was appropriate. But the postapplication test showed a level of dust that was among the highest they'd ever measured on a treated runway, which flummoxed the researchers. Their next test site was White Mountain, where the terrain is very different. There they applied the palliative at half the concentration as at Eagle, and Barnes got another surprise. "White Mountain is performing great. We could never figure out why Eagle was flopping so bad for us, but put down less palliative in another place and it does great."

They determined that DUST-M was doing its job, so Barnes looked at the soil makeup in both areas. White Mountain has lots of lightweight dust, or fine particles, mixed in with the aggregate. Eagle has very little. "When we don't have any fines in the soil there's nothing to hold palliative in the soil, so it kind of drains away and doesn't hold parts in place," he says. "When we have a high fraction of fines, those small particles will hold the palliative in the soil and enhance dust retention."

The effort to keep dust in its place is one that requires different strategies and experiments. Some of those strategies and experiments overlap. There's the question of how to measure the amount of dust. Barnes and his colleagues and students at the Alaska University Transportation Center have worked out most of the kinks with DUST-M, and it is nearly ready for others in the field to test it so they can retool it as needed and deploy it industrywide.

"We're starting to get to a point with all these measurements and lab tests," he says, "where we can start putting out some guidance for people to be able to follow to make these palliative applications more successful."

Palliatives are a different conundrum: What works best in each situation and has the least impact on environmental and human health? AUTC can address the first part of the question, but not the second. As long as dust-control companies keep their formulas secret, the safety of chemical measures might not be known for years or even decades. They could wreak health havoc or they could prove harmless.

For most urban dwellers, dust is a nuisance, a housekeeping chore. But for rural Alaska, it's a much bigger problem. There's no escape from the blinding, choking clouds of dust that hang over many villages from breakup to snowfall. When villagers take their trucks or four-wheelers to the store or to visit an elder, they help disintegrate the road and their community's health. It happens slowly, one random rock, one puff of fine particulates at a time.

As state and local resources shrink, Alaska's dirt-road communities need financially sustainable methods to keep the dust on the ground where it belongs. Though there is disagreement about what's best and safest — water? calcium chloride? mystery chemicals? — everyone agrees dust is a problem, but no one has been able to precisely measure it. DUST-M gives communities baseline information so they can start to identify individual solutions.

"Those guys [at AUTC] are involved nationally and internationally," says Milne. "It's pretty exciting that it happened to come out of little ol' Fairbanks, Alaska."

Tori Tragis, '94, '99, is a writer and editor for Marketing and Communications. Instead of looking for moose or berry patches along Alaska's dirt roads, she now stares at dust plumes and wonders how they might best be remedied.