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STATE OF NEW JERSEY
NEW JERSEY CLEAN AIR COUNCIL
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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IN RE :
What Can Be Learned from Low Cost :
Air Quality Monitors: Best Uses :
and the Current State of Technology :
-----X

Location: New Jersey Department of
Environmental Protection
401 East State Street
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TEL: (609) 989-9199 TOLL FREE: (800) 368-7652
www.renziassociates.com

1 HELD BEFORE:

2

3 TOBY HANNA, P.E.

4 LEONARD BIELORY, M.D.

5 RICHARD OPIEKUN, PH.D.

6 MARIA CONNOLLY

7 HOWARD GEDULDIG, ESQ.

8 JOHN VALERI, JR., ESQ.

9 MICHAEL EGENTON

10 SARA BLUHM

11 JEFF KNAPP

12 PAM MOUNT

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1 MR. OPIEKUN: Good morning, ladies
2 and gentlemen and welcome to the Clean Air
3 Council Public Hearing. My name is Richard
4 Opiekun, and I am the chair this year. Our
5 cochairs for the hearing are Toby Hanna and Len
6 Bielory. We're going to go around the table in a
7 minute and just have everybody introduce
8 themselves and their affiliations so everybody
9 knows who is in the room.

10 I just wanted to go through a little
11 bit of housekeeping, so you know what's going on
12 for the day. First of all, I just ask that, out
13 of respect for our speakers, many of whom have
14 traveled a long way, to please silence your cell
15 phones, put them on mute, turn them off,
16 whatever. If you do need to take a phone call,
17 please step outside and do that, so we're going
18 to ask that we don't have those type of
19 interruptions.

20 Restroom facilities are out those
21 doors and to the left. Ladies and men's room
22 both to the left down the hall. You can't
23 reenter through these doors, so you'll have to
24 enter through the room there. We have a really
25 packed schedule today. The agenda is basically

1 set for us taking a lunch break today at around
2 noon. Lunch will be provided for speakers and
3 council members. For people who are in the
4 audience, there are places along State Street to
5 eat as well as in the DEP cafeteria that you can
6 go and get lunch.

7 We will be taking a 30 minute lunch
8 break at that time. You'll be able to also take
9 a look at the air monitors that are on the side
10 there and kind of touch, feel, see what's
11 available. You'll be able to find out, see the
12 technology first hand, find out what it's all
13 about, so we do encourage you to do that during
14 our break. The format for the hearing is that
15 we're going to have formal presentations by our
16 invited experts throughout the morning and
17 afternoon followed by a discussion.

18 It's designed to engage the council
19 and participants in a dialogue about the issues
20 related to emerging portable technologies as well
21 as Citizen Science and how the two work together.
22 The goal is actually to develop recommendations
23 to Commissioner Martin here at DEP. We are going
24 to have a brief period of time after each
25 presentation for a few questions from members of

1 the council.

2 At the end of the day, where we have
3 an open dialogue, round table discussion, we hope
4 to engage discussion among the presenters as well
5 as council members. There will be a comment
6 period by the public, people who wish to address
7 the council. You will be able to do that later
8 on today after the round table discussion.
9 Please register with Heidi at the front desk,
10 just your name and your affiliation, so we know
11 who to expect and we can also introduce you when
12 the time comes.

13 We'd also like to thank our
14 stenographer, Lauren Etier, for being here. The
15 notes from today will be available on the website
16 some time in August. We also hope to have the
17 report that we're going to develop, based upon
18 today's testimonies, available some time in
19 August. It will be a PDF that will be
20 downloadable, so you will be able to check back
21 at that time. If there are no questions right
22 now, I'd like to introduce our hearing cochair,
23 Toby Hanna, who will go through the agenda and
24 also have people around the table introduce
25 themselves and their affiliations. Thank you.

1 MR. HANNA: Thank you, Rick. Good
2 morning, everyone. Thanks for coming. Why don't
3 we go around the table and do council
4 introductions first. I'll introduce myself
5 again. Toby Hanna. I work for a company called
6 ERM, an environmental consulting firm and I
7 represent the New Jersey Society of Professional
8 Engineers on the Clean Air Council.

9 MR. BIELORY: Len Bielory,
10 physician, allergist, immunologist. I do the
11 pollen counts for the state of New Jersey.
12 Rutgers University, Professor of Medicine
13 Pediatrics and Ophthalmology.

14 MS. CONNOLLY: Maria Connolly, and
15 I'm a planner. Department of Community Affairs
16 designee.

17 MR. GEDULDIG: Howard Geduldig,
18 retired Deputy Attorney General, and I'm a public
19 member on the council.

20 MR. VALERI: Hi. My name is John
21 Valeri. I'm an attorney from Chiesi, Shahinian
22 and Giantomasi.

23 MR. OPIEKUN: You've all heard me.
24 I'm Richard Opiekun. I represent the New Jersey
25 Department of Health.

1 MR. EGENTON: Michael Egenton. I'm
2 the executive vice president of the New Jersey
3 State Chamber of Commerce.

4 MS. BLUHM: Sara Bluhm, vice
5 president of the New Jersey Business and Industry
6 Association representing us on the council.

7 MR. KNAPP: Good morning. Jeff
8 Knapp, New Jersey Business Action Center.

9 MS. MOUNT: Pam Mount. I represent
10 the League of Municipality.

11 MR. HANNA: Did we get everybody?
12 There is a few members missing today, just two or
13 three, but this group is always does a great job
14 pulling together our annual hearing and our
15 recommendations. More importantly, our
16 recommendations to the Commissioner, to the state
17 of New Jersey and happy to do that again this
18 year.

19 This year we picked a topic that is,
20 I guess my perspective on it, is I've been doing,
21 looking at air pollution control problems for
22 27 years. And a constant challenge across those
23 27 years, that I've seen, is our ability to
24 accurately and reliably, and most importantly,
25 affordably measure, monitor air quality. We're

1 able to do it but not cheaply. The outside
2 environment is not a lab in measuring chemistry
3 in ambient air.

4 It's something that has a scientific
5 complexities that lend themselves maybe to the
6 lab techniques but not in the outdoor environment
7 with seasonal changes, and year in, year out,
8 reliability. The advances in technology in the
9 past few years seem to be changing that with
10 lower cost air quality monitors coming on the
11 market.

12 Mostly based with electronic
13 sensors, so we're looking at technology that's
14 developing in so many ways around the world right
15 now in all areas of our lives, and air quality
16 measurement is another one, so in the past couple
17 of years, we've seen some emergence here, and the
18 group of speakers, I think have all been involved
19 in some of these in different ways, as you'll
20 hear.

21 We wanted to bring together a
22 hearing today, this year, on the topic to help
23 understand really where this technology has come
24 from, where it's going, what its potential uses
25 are and its value, what its risks and pitfalls

1 are, how advanced it is, how reliable it is and
2 what we're going to be able to do with it and
3 need to pay attention to around the technology in
4 the coming years, so the speakers that we brought
5 together represent some government agencies that
6 are closely tracking what's happening here,
7 USEPA, South Coast Air Quality Management
8 District, represents some of the projects that
9 are happening around the country that are
10 interesting and new and have been through the
11 selection process for technology, made choices
12 based on their criteria, which we're interested
13 in hearing how they've done those evaluations and
14 what they've seen so far.

15 We also have some of the vendors for
16 equipment presenting today and helping us with
17 their perspectives, what they see the vision for
18 the technology they're developing and the market
19 for it, so that's a little bit of a snapshot of
20 the agenda. We'll talk to each speaker, we'll
21 introduce them as we come through, but that's the
22 intent and the purpose and happy to get this
23 kicked off.

24 We do have a little bit of time
25 before the Commissioner comes in. We thought we

1 might have that, but happy to take any questions
2 on format, structure and otherwise, we can give
3 you a little bit of a free time to see the props
4 in the back. Paul, you want to stand up? Paul
5 Roman from New Jersey DEP. He's the owner, the
6 proud owner of the new low cost sensors. DEP has
7 got -- where is Louis Slim? DEP has how many,
8 not low cost, we'll call them air quality monitor
9 stations?

10 MR. SLIM: We have 33 stations all
11 over the state. We have over 100 monitors of
12 various costs, most of them measuring air quality
13 data that's up for comparison to the national
14 ambient air quality standards.

15 MR. HANNA: So that's the
16 traditional methods that we know are reliable and
17 accurate, just not quite as cost effective as
18 we'd like them to be so we can have more of them.

19 MR. SLIM: Or as mobile.

20 MR. HANNA: We can't park the
21 trailers in the room.

22 MR. SLIM: No, we can't.

23 MR. HANNA: There is a question. Go
24 ahead.

25 UNKNOWN SPEAKER: You noted

1 previously that there would be minutes and the
2 video available I think. How about the
3 presentation slides? Would they be available?

4 MR. HANNA: We're going to publish a
5 public report. The Clean Air Council, on our
6 website, which you can find off the DEP website,
7 you'll see our public report there primarily with
8 recommendations to the Commissioner, to
9 legislature, to the state of New Jersey on this
10 topic, so we don't typically produce, I don't
11 know -- Rick? I don't think we typically post
12 all of the presentations, do we?

13 MR. OPIEKUN: We do not. If we do
14 get permission from our presenters, as far as the
15 Power Point slides, we can look into that and
16 post them as PDFs, but we will check with every
17 presenter beforehand. It's traditionally, the
18 stenographer's report as well the report to the
19 Commissioner.

20 MR. HANNA: There will be a pretty
21 thorough summary of the hearing all the way down
22 to the actual transcript on the website if you're
23 interested.

24 UNKNOWN SPEAKER: Thank you.

25 MR. HANNA: Any other questions?

1 Why don't we take a break. When the Commissioner
2 comes in, we'll grab our seats real quick, take a
3 few minutes to stretch your legs and check the
4 air monitors in the room, talk to Paul and we'll
5 reconvene as soon as the Commissioner is here.
6 Thank you.

7 (Whereupon a break was taken.)

8 MR. HANNA: If everyone could take
9 their seats, please. I understand the
10 Commissioner is on his way down. Commissioner
11 Martin is here, the man who needs no
12 introduction. Come on in. Join us. We're ready
13 for you. We heard you were coming down. Thank
14 you for coming today. This is a great audience
15 for us and very pleased to have you kicking us
16 off as tradition allows.

17 COMMISSIONER MARTIN: Good morning.
18 Nice to see everyone again. This is absolutely
19 one of my favorite groups. I have two or three
20 groups, as you know, I love to spend time with,
21 and this is definitely one of them so thank you
22 again for being here today. First off, thank
23 you, Toby. I appreciate the introduction. I
24 want to thank members of the Clean Air Council
25 for your leadership and for what you do here.

1 I want to thank you for today's
2 hearing. I also want to thank the speakers that
3 are being included here today as well. I wanted
4 to thank EPA, the South Coast Air Quality
5 District, the universities that are here and
6 technology leaders that are in the room as well
7 for all being here and testifying today. As you
8 are the leaders in innovation in your areas, I
9 appreciate the work you do, and I know we'll get
10 some great insight today.

11 I additionally want to thank Rick
12 Opiekun for his leadership today, Sara Bluhm,
13 Toby Hanna, as I just mentioned, as well and
14 Leonard Bielory for your leadership as well in
15 today's hearing. You know, while we're coming
16 into the last nine months of this administration,
17 this will be probably my last hearing with all of
18 you given the schedule of things. I know we're
19 going to have a follow up in the summer based on
20 your report and all the rest of that.

21 So what I wanted to do is spend a
22 couple of minutes talking about some of the
23 things we've achieved together based on the input
24 from all of you in this council over the years,
25 which has certainly changed public policy and

1 shaped the public policy of this organization.
2 Over the past seven years you've advised me on
3 topics, everything from transportation to power
4 plants, interstate transport of air emissions,
5 air toxics, cumulative impact of air pollution,
6 climate change and many other topics that have
7 helped shape this policy.

8 Your leadership and dedication have
9 made Clean Air Council a great partner protecting
10 the air quality in the state of New Jersey. New
11 Jersey has made great strides with clean air, and
12 will continue to do so, and be very committed to
13 air quality in the state of New Jersey. The work
14 that was started by previous administrations, and
15 continued by this administration over the past
16 seven years, has improved air quality immensely,
17 and I'm very proud of the work that we've done
18 over the past seven years.

19 This reflected in the trends of
20 continuous lower air quality improvements in all
21 sectors in the state of New Jersey. New Jersey
22 has some of the lowest power plant emission rates
23 in the country. We're 45th lowest in SO₂, 45th
24 lowest in NO_x emissions and 40th lowest in carbon
25 emissions from our power sector. New Jersey is

1 also ranked fourth in the nation in total
2 installed solar capacity. Our focus is now
3 heavily on the transport issue that continues to
4 impact the state of New Jersey.

5 Over 50 percent of the emissions
6 comes from other state sources that are outside
7 of New Jersey. Since day one of this
8 administration, we identify a clear line to hold
9 with other states and hold them accountable for
10 their emissions. We have done this in several
11 ways including litigation and petitioning the
12 EPA. That led to the precedence setting 126
13 petition to reduce emissions from the Portland
14 Power Plant in Pennsylvania.

15 At the same time, we continue to
16 work with our partners in Pennsylvania to address
17 all air emissions, especially NOx emissions. I'm
18 happy to report that Pennsylvania has not
19 implemented an updated RAC rules and implemented
20 EPA's CSAPR Regs as well. As part of
21 Pennsylvania's updated RAC rules, they have added
22 a new requirement to operate existing air
23 pollution controls that have installed, or
24 curtailed, or not operated over the past three
25 years.

1 DEP will closely track and operate
2 the operation of all pollution control equipment
3 in Pennsylvania and in other states this summer.
4 Our air quality is much cleaner since the
5 measurements began. Your recommendations have
6 been helpful to many of the DEP's air pollution
7 control initiative that have made this happen.
8 In many cases, DEP was able to take your
9 suggestions and turn them into programs that
10 produce great results for air quality.

11 Your recommendation to implement
12 stricter NOx emission limits for peak power
13 plants used by high energy to mandate plants when
14 ozone is the highest, has resulted in the shut
15 down of more than 2000 megawatts of old high NOx
16 emitting turbines. It also has resulted in NOx
17 controls were added to another 500 megawatts of
18 termite in the state of New Jersey. We set an
19 example for other states with air pollution
20 control performance standards, whether it's coal,
21 oil or natural gas.

22 This council has also helped to
23 focus on mobile sources. Based on your
24 suggestions, we implemented the successful
25 electric vehicle work place charging program,

1 grant program. It Pays to Plug In is the name of
2 that program. It's aimed to tackle mobile source
3 pollution. So far, \$850,000 is funded to
4 allocate for 178 level two charging stations.
5 It's my expectation that the grant program will
6 expand in the future as other funding sources
7 become available and we are committed to working
8 with our partner, the BPU, to make that happen.

9 We have also tackled emissions for
10 diesel vehicles by replacing dirty diesel
11 engines. I am pleased to report that DEP
12 continues to be a successful in obtaining grant
13 money to do just that. Just recently, DEP
14 received almost five million dollars from EPA, NJ
15 DOT and the North Jersey Transportation Planning
16 Authority to partner with C Street to repower
17 three of their passenger ferrys that operate in
18 the Atlantic highways.

19 This will replace poorly controlled
20 diesel engines with the newest and cleanest
21 marine engines available. Now, I want to shift
22 gears. I want to focus on the topic of this
23 hearing. What can we learn from low cost air
24 quality monitors? You have put together an
25 impressive agenda with experts from all over the

1 country as well as New Jersey. I'd like, again,
2 to thank the speakers for sharing their expertise
3 with the Clean Air Council and my staff here at
4 the DEP. Air monitoring is the foundation of our
5 air pollution control program.

6 We are proud of our program which is
7 robust and well respected amongst the states for
8 a high quality data. We recognize that with low
9 cost monitored devices available, the public will
10 be more interested in collecting environmental
11 data. I support local air quality monitoring.
12 However, we need to tackle the authority issue of
13 how and if we will use this data. We need to
14 ensure that projects and data have integrity, and
15 that are collected with valid, calibrated
16 equipment according to protocols and
17 scientifically valid methods.

18 I understand the Watershed
19 Ambassador Program made a presentation to the
20 council last month on how to promote community
21 involvement. We're very proud of our program of
22 Watershed Ambassadors. This program is an
23 example of successful public involvement in
24 collecting water and biological samples. It is a
25 model for the council to consider as you prepare

1 your recommendations later this year.

2 In addition, our CIO, Pete Tenabruso
3 gave the council some insights over the
4 challenges associated with accepting and managing
5 large quantities of data and suggestions of other
6 possible options for data repositories. Those
7 are important points to consider as you listen to
8 today's speakers and begin to draft
9 recommendations. We have some experience with
10 community air monitoring in Elizabeth and Newark.

11 I've had the opportunity to hear
12 presentations by students who have performed air
13 monitoring near busy intersections as they
14 perform their exercises. I was impressed by
15 their knowledge and excitement about the project.
16 Even though the students monitoring will not be
17 used for regulatory purposes, it was useful to
18 help grow future scientists and install
19 appreciation for environmental protection. Their
20 enthusiasm was certainly something to respect.

21 As you discuss the specifics of
22 aspects of low cost air quality monitors during
23 your hearing today, I want you to consider the
24 point I mentioned to you a moment ago.
25 Specifically, in order for data to be useful, it

1 needs to be collected with valid measurement
2 devices and according to specific protocols. In
3 addition, the purpose of monitoring can range
4 from educational to data collection that is used
5 to assess a situation or a concern. Please
6 distinguish between the different types of local
7 monitoring, and if and how DEP should be
8 involved.

9 Advise DEP on how to best help the
10 public interpret and understand the data
11 collected from these monitors and how DEP can
12 ensure that locally generated data is accurate.
13 Discuss whether DEP should accept, review and use
14 any of the data. And if so, how might the data
15 be used. Just because someone is collecting data
16 does not mean it is scientific or useful. We do
17 not want to chase phantom problems based upon bad
18 data.

19 Unstructured and unscientific data
20 divert DEP resources from tackling legitimate air
21 quality concerns. I see the value in local
22 monitoring beyond educational purposes, but we
23 need to ensure that data is valid and can be
24 supported and that the work can support DEP's
25 efforts in the long run.

1 In closing, I want to thank you for
2 your service in the past. I want to thank you
3 for your service today. Your dedication and your
4 work with the state has been unparalleled by more
5 of the other environmental organizations I've
6 dealt with. You've been a great team to work
7 with over the years, and I want to thank you.

8 I've enjoyed working with all of you
9 and I'm looking forward to your work and the
10 recommendations that are going to come back to
11 me, I think in the summertime is the game plan
12 right now. So with that, I thank you all and I
13 appreciate all the efforts you're doing and
14 looking forward to the outcomes of today's
15 hearing. Thank you very much.

16 (Applause)

17 MR. HANNA: Thanks very much,
18 Commissioner Bob Martin. That's a great way to
19 kick us off. Andrea, you want to step up?
20 Andrea Polidori is joining us from the West
21 Coast. Welcome to the East Coast.

22 MR. POLIDORI: Thank you.

23 MR. HANNA: I understand, were you
24 part of Rutgers at one point?

25 MR. POLIDORI: Yes, Ph.D. at

1 Rutgers.

2 MR. HANNA: All right. Wonderful.
3 I'll do a quick introduction for you. Andrea is
4 the Atmospheric Measurements Manager at South
5 Coast Air Quality Management District, and the
6 thing I really appreciate the most about him is,
7 if you haven't seen it already, the Air Quality
8 Sensor Performance Evaluation Center or AQ-SPEC.
9 Google that, look it up, if you haven't seen it
10 already. It's something we need badly, and it's
11 very nice to see it coming together so well.

12 I think of it as a consumer reports
13 for the low cost air quality sensors evaluation
14 of reliability and effectiveness, long term too
15 importantly, and Andrea is responsible for
16 running that, the vision to create and conduct
17 comprehensive performance tests of commercially
18 available long cost air quality sensors, so a
19 great way to kick us off I thought, as we were
20 preparing for the hearing, is to have Andrea come
21 up and tell us about his work and orient us
22 around the technical options that we have out
23 there.

24 MR. POLIDORI: Thank you very much
25 for the introduction. So, yes, I've been in

1 California for the past 11 years, but my first
2 five years in the U.S. were here in New
3 Brunswick, so I got my Ph.D., I think you might
4 know, Barbara Turpin. So today, I will tell you
5 about our AQ-SPEC Center, Air Quality Sensor
6 Performance Evaluation Center. And so the center
7 was, we started it back in 2014.

8 And again, it's not a certification
9 center so we do not certify the sensors, but we
10 want to basically, you know, try to communicate
11 with the public how well these sensors that you
12 can find on the market perform and kind of give
13 an indication whether or not they can be used for
14 different purposes. So as you all know, you can
15 find low cost devices for measuring air quality
16 pretty much all over the internet these days.

17 You can go on Amazon and buy the --
18 and I don't know if you can find the -- but you
19 can definitely buy cheaper air quality devices on
20 Amazon, other specialized websites. You can find
21 them anywhere. As the Commissioner was saying,
22 these devices have tremendous potential, both
23 because they are low cost and most of them are
24 easy to use. So if you have a scientist that is
25 interested in monitoring air quality at the

1 neighborhood level, you can buy this device
2 on-line and start playing around with those.

3 We have multiple potential
4 applications. They are not as accurate as
5 reference methods that we use at our monitoring
6 stations, but somehow they can give you an
7 indication of temporal and spatial air quality
8 information in the area you're interested. You
9 can definitely use successfully for fence-line
10 applications and I'll show you a few examples of
11 those fence-line applications later in the
12 presentation.

13 So one of the problems is we started
14 back two, three years ago. We started to get
15 phone calls from citizen scientists that were
16 telling us, I bought this device, I turned it on
17 and somehow the PM level in my back yard went
18 through the roof, so what's going on. So more
19 often than not we found that maybe they were
20 using this device five feet from the diesel truck
21 or very close to their barbecue, so then you have
22 two problems. A, the device is not very
23 accurate.

24 And at the same time, it's used
25 inappropriately, but also we got phone calls and

1 we got approached by citizen scientists that put
2 their own sensor package together themselves and
3 they were actually conducting real science for
4 this. A couple of instances of people leaving
5 down wind over refineries and they were able
6 consistently to track, for example, some of the
7 emissions from the nearby refineries or from
8 nearby facilities. So the main question here
9 becomes, A, how reliable and accurate are they.

10 So can they be used for monitoring
11 the air quality, and if they can, which kind of
12 measurement can you conduct and how reliable are
13 they. So we saw kind of an opportunity here to
14 develop a center to systematically evaluate the
15 performance of both particle and gaseous air
16 quality sensors. So background. The AQ-SPEC
17 sensor was established first in July of 2014.

18 The initial capital investment was
19 about \$600,000. We have maybe three FDEs there
20 that are not included in the estimate, but the
21 main goals of the center were to provide guidance
22 and clarity over this ever evolving sensor
23 technology, try to catalyze the evolution and the
24 use of the sensor technology and especially
25 minimize confusion among the users.

1 In terms of sensor selection
2 criteria, we basically decided to test pretty
3 much everything that is on the market. In terms
4 of technology, the main three technologies for
5 these low cost sensors are optical sensors for
6 the measurements of particulate matter.
7 Electrochemical sensors to metal oxide for
8 measuring gaseous pollutants. Most of them can
9 provide a real or near real-time information.

10 Some of these sensors that you see
11 in the picture, can provide air quality
12 information at the one minute level, sometimes
13 even lower than that, and we are mainly targeting
14 criteria pollutants, but also in some cases, air
15 toxics. We did an evaluation of H₂S sensors. We
16 are trying to evaluate the performance of DOC
17 sensors, but those are a little more difficult to
18 test and I will show you why when I describe of
19 some of our laboratory equipment.

20 So this is just, there are two main
21 components in the AQ-SPEC Center. One is the
22 field testing. So every time that we buy a new
23 sensor, we buy three units for each sensor to get
24 some statistical power. Of course the higher the
25 number of sensors that you test, the better the

1 results of your evaluation. So we deployed in
2 the field at one of our monitoring stations and
3 we compared them side by side with, you know, a
4 federal reference or federal equivalent method,
5 so EPA approved methods.

6 So after two months worth of
7 testing, for those sensors that, you know, showed
8 some promise, we read them back in the lab and we
9 do some more detailed testing using laboratory
10 chamber, and later on, I'll show you some of the
11 characteristics of our environmental chamber. So
12 at the end of the evaluation, we are able to
13 basically segregate all these sensors and those
14 that are basically random number generators, and
15 believe it or not, there are many of those and
16 opt to those that basically correlate quite well
17 with the EPA approved methods.

18 So we also have a website, and you
19 know we basically publish reports, testing
20 reports, showing the details of our field and
21 laboratory evaluation, what we have found, so if
22 you are technically inclined, so to speak, you
23 can find all sort of details about our field
24 laboratory testing on the website and if you're
25 interested in maybe reanalyzing our data, we can

1 provide data to you so that you can take a closer
2 look maybe at the data that we have or basically
3 gather through this field laboratory exercise.

4 So the main purpose of the AQ-SPEC
5 is actually trying to bring the three major
6 players together and of course we want to provide
7 the vendors, the manufacturers and potential
8 developers with the information that they need to
9 basically, you know, to fully evaluate the
10 performance of their sensors. We want to tell
11 the community what we found so that if there is
12 either a community group or a scientist, and you
13 know, they can take a look at everything that is
14 available on the market and make an appropriate
15 selection so they can measure air quality using
16 an instrument that works.

17 And of course we also want to
18 communicate the results of our testing to air
19 quality officials because of course you know
20 there is New Jersey DEP, South Coast AQMD, Bay
21 Area AQMD, and several other environmental
22 agencies across the country, trying to basically
23 use these devices to compliment the air quality
24 measurements from their network. So for the
25 field testing we started back in 2014, as I

1 mentioned at the beginning, all of the sensors
2 are tested in triplicates, so we take three units
3 for each sensor model that we evaluate.

4 We deploy it in the field for
5 approximately two months, and generally speaking,
6 if a sensor costs less than \$2,000, we tend to
7 purchase it. If it costs more than that, you
8 lease it, borrow it, steal it, acquire it. So we
9 have two main locations where we do this testing.
10 I would say 95 percent of the testing is done at
11 our Rubidoux station. It's an inland site. It's
12 fully instrumented.

13 We find every sort of federal
14 reference instrument that you can possibly
15 imagine, so we can test for particle, pollutants.
16 We have instruments there and so on and so forth.
17 Then on the top left is our chicken coop so to
18 speak. So we basically employ all of the sensors
19 inside of the enclosure and basically we connect
20 them to either a laptop or to like a central
21 server to download all the data in real-time, and
22 after a period of two months, we basically take a
23 look at how the sensor data compares to the
24 reference instrument data.

25 This is a few pictures of our

1 environmental chamber. It's a custom made
2 chamber. One of the few, I think in the United
3 States that is capable of, you know, doing this
4 type of laboratory testing. We can test for both
5 aerosols or particulate matters and also for
6 different gases. On top of the chamber, I'll try
7 not to be too technical, but just to give you a
8 few details. We have two different particle
9 generation systems. One for generating small
10 particles.

11 Another one for generating larger
12 particles and we have a reference monitor for
13 measuring particle concentration like under the
14 chamber, maybe not in the \$45,000 instrument on
15 the bottom of 2,200 pound chamber, but in terms
16 of technically speaking, that configuration works
17 quite well. We also have, you know, other
18 instruments for measuring the particle size
19 distribution so we can fully categorize the
20 particles that we generate.

21 In terms of gaseous testing, we have
22 basically a stand up gaseous dilution system. So
23 basically, we can re-create different gases at
24 different concentration and we can control
25 exactly the type of gases we inject in the

1 chamber and the concentration of that gas or of
2 those gases. Sometimes, for example, for ozone
3 sensors, it's well known that ozone sensors are
4 also sensitive, some of them at least, to NO₂, so
5 we can play around with different concentration
6 of ozone and NO₂ to see if there is any
7 interferences, and if that sensor is subject to
8 interference issues.

9 In terms of one of the main
10 characteristics of the chamber is that we can
11 vary both the temperature and the relative
12 humidity inside the chamber. So one of the --
13 field testing is that, you know, California, we
14 have two seasons. Warm and warmer, so we cannot
15 really evaluate how a particular sensor works
16 under very cold condition or very high humidity
17 or a combination of both, so the chamber, we are
18 able to basically change and vary the temperature
19 between almost freezing and 50 degrees C and the
20 relative humidity can be varied five and
21 95 percent.

22 We never push it to 95, for obvious
23 issues. We don't want condensation. We don't
24 want to ruin the chamber, but at the moment, we
25 basically do the testing using three combination

1 of three different concentration, so if it is PM,
2 we use a low, medium and high concentration.
3 Three different temperature and three different
4 relative humidity settings so we have this matrix
5 of 27 values that gives a pretty good idea of how
6 the sensor is working in different kind of
7 environmental conditions. So as I said before,
8 we can test for particles, for all pollutants,
9 gases and, you know, we can't test for EOCOS, but
10 we are trying to get that.

11 So this is, you know, the address of
12 our AQ-SPEC website. You can go, you know, you
13 see the address there. You can go there and take
14 a look at our website. I think it's very
15 informative. There's a lot of information about
16 all of the sensors that we have tested. As I
17 said before, there is a link to basically a full
18 report for both, you know, the field and
19 laboratory testing. If you're interested, we can
20 send you the data and there is a small movie
21 there that shows some of the background about the
22 sensor, what we do, our main goals and
23 objectives, how we select the sensors and so on
24 and so forth.

25 I think this is something that the

1 community likes quite a bit, and so under sensors
2 you can basically take a look at all of the
3 particle and gaseous sensors that we have tested
4 so far, and I think at the we have tested about
5 30 different particle and gaseous sensors. And
6 if you click at one of the pictures there, there
7 is another web page that shows you the general
8 description of the sensor, the principal
9 operation, some of the main technical features
10 and sometimes we also have links to You Tube
11 videos, when available, that kind of teaches you
12 how to set it up, how to start measuring air
13 quality and some of the information about that
14 specific sensors.

15 So as I said, you can find reports
16 and documentation about all of the different
17 sensors, but in general, if you're interested in
18 comparing the performance of all of these sensor
19 devices, we have a summary table for both the
20 particle and the gaseous monitors, so this is a
21 summary table for PM sensors, and you can take a
22 look at the picture how it looks, the
23 manufacturer, approximate cost. Actually, there
24 is the type of sensors, if they are optical.

25 Most of the PM sensors are optical,

1 so in this case, it really doesn't make a
2 difference. So there is a column there for the
3 type of pollutant that they measure. Most of
4 them measure PM1, PM 2.5 or PM10. There's an
5 approximate cost, the cost might vary, so if you
6 really are interested in purchasing one of these
7 sensors, you should possibly contact the
8 manufacturer, but as you can tell, for particle
9 sensors, they go anywhere between a few hundred
10 dollars to I think there's one that costs several
11 thousands, but the price is also very variable.

12 So in terms of how we report, you
13 know, the results, we chose this R square, this
14 correlation -- so if the R square is zero, there
15 is zero correlation between the sensor and the
16 reference monitor. And if R square is one, there
17 is perfect correlation between the two. There
18 is, you know, both R Square for the field and for
19 the lab, we report all the laboratory R square
20 results for ambient conditions to do like a side
21 by side comparison and there is a link to the
22 corresponding summary report.

23 And so in general, after about two
24 years and evaluating these sensors, what we saw
25 is that most of them at the middle down time, so

1 impressively enough, you have the Dylos there,
2 and I can't remember the result for that Dylos,
3 there is a \$400 device that only gives you
4 particle count concentration that you can work to
5 get the corresponding particle mass
6 concentration, but I remember that running three
7 of those units for two months, we were able to
8 record about more actually than 99 percent of the
9 data, which is quite impressive for a device that
10 costs only 400 dollars.

11 Most of the PM sensors, the moderate
12 intra model variability, meaning that if you
13 basically operate three different units of the
14 same model, more or less, you get the same type
15 of results from all of those units which is also
16 important. Generally speaking, there is a fairly
17 strong correlation between PM sensors and, you
18 know, EPA reference instruments which is also
19 very encouraging.

20 However, of course, there are a few
21 issues. Sensor calibration is needed in most
22 cases. That is because of course if there is a
23 good correlation, it is possible that the sensor
24 is reading higher or lower than the reference
25 monitor, so it's highly advisable, if you want to

1 use these type of sensors for practical purposes,
2 you want to deploy them in the field, it's always
3 recommended to calibrate the sensors before use.
4 Most of the sensors measure, they do not detect
5 the very small particles.

6 Most of them do not detect particles
7 below 0.5 microns, so if you want to come back
8 for example on roadway emissions and you want to
9 basically capture and figure out the particle,
10 ultra fine particles, very, very small particles.
11 The technology is not quite there yet. Although,
12 I know there are a few vendors that are working
13 to resolve this problem. One of the other issues
14 is that there might be bias in the algorithm that
15 is used to convert particle number to particle
16 mass concentration.

17 So different vendors might develop
18 their own algorithm, and even if they use similar
19 technology, the end result could be quite
20 different. So the gaseous sensors, the results
21 are a little different. Most of them have
22 acceptable little recovery. Now, we're
23 experienced at least, not as good as the recovery
24 for PM sensors. In general, there is a wider
25 intra model variability between different units

1 of the same gaseous sensor model.

2 If you want to measure primary
3 combustive pollutants such as CO, NO, ozone, when
4 measured alone, there is definitely decent
5 correlation between these sensors and the
6 corresponding EPA approved methods. Sometimes,
7 as I mentioned before, for ozone sensors, there
8 is some interference between ozone NO2, so some
9 of these electrochemical sensors are effected by
10 this kind of interference which needs to be taken
11 into account.

12 Other more exotic, so to speak, air
13 pollutants such as SO2, H2S and especially VOCs
14 are more difficult to measure with available
15 sensor technology. So again, we do not endorse
16 any of these instruments but kind of give you an
17 idea of how this technology is progressing.
18 There is an instrument on the top left of the
19 graph. It's actually the only sensorish device.
20 The only portable device that we have found so
21 far that is FEM approved.

22 It's a Federal Equivalent Method so
23 it actually can be used for regulatory purposes.
24 It's \$4,500, but it's portable. You know, you
25 can basically move it from place to place and

1 very easily. And if you can take a look at the
2 correlation that it's one and it's possibly the
3 best performing device that we have encountered
4 so far. On the other hand, if you take a look at
5 one of those devices there, it's about \$10,000.
6 I believe now the price point is a little less.

7 It's about 6,000 possibly, but it
8 includes CO, NO2 ozone, I think they include that
9 PM monitoring as well, but it is higher price
10 doesn't always translate in higher performance
11 and that's something to be aware of. In general,
12 I think, I don't want to say that there is a
13 universal relation between the size of the
14 company and the performance of their sensors, but
15 in our experience, there is companies that
16 definitely, they go all in, they try to
17 commercialize their product right away without
18 properly evaluating the sensors, without properly
19 taking the necessary step to bring it to a point
20 where it's performing well.

21 So we are seeing instances where
22 companies are trying to get into this business
23 and some of them are not into this business
24 anymore after a few months just because, you
25 know, that model is not really working well. On

1 the other hand, there are smaller companies that
2 I think, they are approaching this problem, one
3 step at a time, they work with us or with other
4 organizations or with other community groups to
5 make sure that, you know, they address every
6 single issue that there is with these sensors and
7 I think that model is a lot more successful so
8 they're building their business model one bit at
9 a time and very slowly.

10 So we often are asked, so what is
11 the best sensor, what should I buy, right, so
12 what people, generally speaking, have in mind is
13 what is the sensor, which sensor correlates the
14 best to the EPA reference methods, so for most
15 people, that's the definition of the best
16 performing sensor, and I don't think that's the
17 right question to ask. I think that possibly the
18 question should be reversed, so you should
19 possibly try to identify the type of application
20 that you have in mind, and then select the sensor
21 for that specific application.

22 One of the examples that I always
23 tell people is that if you live down wind of a
24 refinery and you want to know whether or not you
25 can open the window in your bedroom, so if you

1 have, you know, a VOC sensor that tells you,
2 there is no VOC, there is some VOC, there is a
3 lot of VOC, that's the perfect sensor for that
4 type of application, right, so you don't need to
5 get a \$4,000 VOC monitor for that type of
6 application. It's way too much. If it's more
7 accurate, definitely, but it doesn't really
8 address your needs.

9 So there is this graph here that was
10 put together by EPA, back maybe five years ago or
11 so, and so they identified basically the required
12 data quality from the sensors with specific
13 application for each category, so you have for
14 sensors that don't perform very well, that
15 possibly are very cheap. They can still be used
16 for quality personal monitoring, for science
17 education and then all the way up, you have, like
18 the ozone sensor that I was showing you before,
19 that can already be used for legal compliance
20 purposes.

21 You can use it within your network
22 and it can be used for regulatory purposes, but
23 this whole category in the middle that I think is
24 very interesting, there are several interesting
25 applications those sensors can be used for,

1 including characterize spatial variations, and I
2 show you an example of that, but basically if you
3 have only one station in a very wide area and you
4 want to take a look at how the concentration of
5 PM or some other pollutant varies spatially, then
6 you can definitely deploy some of these local
7 sensors and get a better sense of how PM or some
8 other pollutants varies in space and time.

9 One of the other interesting
10 applications is fence-line monitoring. I have a
11 good example of that later on, and you can use it
12 also to address community concerns. For example,
13 local impact on freeways, airports, refineries
14 and other facilities. So in addition to
15 evaluating the performance of these sensors, we
16 also, you know, deploy some of those in the field
17 to specifically address some of the problems, so
18 we run this pilot study back in June, July of
19 2016 and so what you see here to the left is a
20 waste disposal facility in Huntington Beach and
21 down wind of that facility.

22 So on the right hand side of the
23 facility, there is a school. It's really more
24 than 50 feet from the facility, and the school
25 was complaining about emissions of PM coming from

1 the facility, so we worked together with the
2 facility and we installed a network of nine
3 different sensor boxes. I guess I have to find a
4 better name for them, but basically that's what
5 it is. You see there on the right hand side of
6 the central part of this slide, so we built these
7 boxes and each box has a low cost PM monitor.

8 This is an Alphasense. This is
9 manufactured in the UK, and this tells you
10 basically concentration of PM1, PM 2.5 and PM 10,
11 which we are particularly interested in, in this
12 case. There is a GPS and all of the data are
13 streamed to a central server in real-time, so
14 anyway, we installed nine of these devices on
15 light poles around the facilities, and so
16 basically what we do here, we are able to measure
17 the concentration of different PM fractions in
18 real-time.

19 And you know, we are able to tell
20 and confirm that on the southern part of the
21 facility, where you see that big red dot, in the
22 southern part of the facility, they have, the
23 public, a lot of construction builders, they dump
24 their construction material there, so there's a
25 lot of crushing. There's a lot of moving around

1 of old bricks, all kind of construction material,
2 so it makes sense that the PM concentration is
3 very, very much eliminated.

4 So one of the other things -- the
5 project benefits of course, we are able to
6 correlate PM measurements with on site
7 activities, so in this case, as I told you,
8 there's a lot of fugitive emissions in the
9 southern part of the facility, but if we can also
10 correlate PM emissions of course with wind
11 direction with a number of trucks coming in and
12 out of the facility because we have that record.

13 And the facility now is going
14 through a 10 million dollars renovation plan and
15 they're going to enclose some of this, you know,
16 areas where they know already that PM10 levels
17 are the highest, so this is kind of to give them
18 confirmation that their emission plans are
19 working, so one of the other things to consider
20 is when you're basically measuring a one minute
21 data, in 95 locations, you have hundreds of
22 thousands of different points in a very small
23 period of time.

24 So for those of you and us that are
25 used to take a look at, for example, like the one

1 that I showed here, you know, it's okay if you're
2 interested in a very narrow period of time, but
3 generally speaking it's a lot better to use
4 fancier ways of taking a look at data like maps
5 in this case. So this is just an animation that
6 shows you, so it is a quick animation. Just to
7 give you an idea.

8 You can take a look at a whole lot
9 of data in a relatively small period of time, so
10 that gives you an indication of where the highest
11 PM concentrations are. So this is another pilot
12 study that we started a while back and so we
13 deployed 25 low cost PM sensors in the Redlands
14 area. In that area we only have two monitoring
15 stations and inland we notoriously lee have PM
16 2.5 problems.

17 So in order to expand our network
18 and to try to understand the spatial variability
19 of PM 2.5 there, we basically deploy 25 PM
20 sensors so that gives you a better idea of maybe
21 consider moving one of these station where the PM
22 2.5 is higher. We don't always pick the best
23 location for our monitoring stations so all of
24 these sensors are wireless. The only thing you
25 need to do is plug them in and they transmit data

1 to the server right away.

2 We are working with Microsoft
3 actually to extract all of this data so that we
4 can do better data analyzation, data analysis,
5 different mapping, and so as you know, there is a
6 lot that can be done when you have massive amount
7 of information like we have here. So the project
8 goals are test sensor durability and also show
9 the ability to scale up in the future.

10 So if this type of model works for
11 25 local sensors, can we get it up to 100, 200,
12 300, possibly a thousand and one of the things we
13 just won a grant from NASA and we are going to
14 use these type of sensors to validate satellite
15 data that provides PM information. So this is
16 very exciting, this is just the beginning and I
17 think that you know it's a very good pilot study.

18 So this is some other -- we won an
19 EPA grant a couple of years ago, and as I told
20 you before, the sensors for measuring VOCs are
21 not quite accurate but that doesn't mean you
22 cannot use it for specific application in this
23 case. This is a fence-line monitoring
24 application. This is extremely important,
25 especially in the LA area.

1 We have six major refineries in a
2 small, you know, basically facility that has like
3 storage tank, oil pumps and they're located right
4 in the middle of communities. This is not from
5 Los Angeles. But you have a facility with
6 potentially high VOC emissions that is located
7 right next to a community, so what we did, is we
8 put together what we call SPODs. It's just a
9 small sensor device.

10 It is one sensor, detector that
11 measures VOCs, and on top of it there is a 2D
12 anemometer for measuring wind speed and wind
13 direction, so as we go on the next screen, we
14 have built four of them and we deployed them at
15 the fence-line of this small facility where we
16 have identified already that the concentration of
17 VOC are through the roof.

18 Every time that you get a VOC hit,
19 every time the VOC concentration goes up and is
20 high, we are not interested in how high it is.
21 We are interested in the variation from
22 background, so every time the VOC concentration
23 is really high, then we can take a look at the
24 wind direction and wind speed and by means of
25 some inverse social algorithm, we can try to

1 potentially the source of that emission within
2 the facility and by granting some model, we can
3 try to see whether or not there might be an
4 impact in the nearby community.

5 We are also using some optical
6 remote sensing instruments run by a Swedish
7 company actually verify some of the data you can
8 get from the sensors. So this is another quite
9 exciting project. It's basically, you know, it's
10 a STAR grant that we got awarded a STAR grant
11 from the EPA. We got 100 percent of the money,
12 so I'm very happy about that.

13 We won this grant back in 2016,
14 about July and the main goal here is working
15 with, to working with communities to try to
16 educate the community members in the use and
17 operation of low cost sensors, so the educational
18 aspect is also extremely important. There are
19 four specific aims. Develop educational material
20 for communities. We are going to work with teams
21 groups on technology.

22 For this, second bullet, try to
23 evaluate candidate sensors for deployment in six
24 California communities, and the south coast is
25 very equipped for this. We will deploy all of

1 the sensors in six California communities. Our
2 communities are growing. We already have eight
3 to nine, I believe. We will put together this
4 educational package that hopefully will set as a
5 model for other communities that are also
6 interested in this kind of work, so this work is
7 conducting collaboration with UCLA, Sonoma
8 Technology and other air quality agencies in
9 California.

10 In terms of, as you see, we start to
11 basically from there are community members that
12 are purchasing individual sensors, but then they
13 can be used maybe in a small group to create
14 small sensor networks, and the goal really is to
15 develop this wide sensor network that can measure
16 air quality in wide areas throughout the state
17 and throughout the country.

18 I just read this article maybe on
19 March 22nd, so this is a new article like a
20 couple of weeks old and there is a company
21 Weather Underground. Maybe some of you are
22 familiar with it. Weather Underground users, I
23 think have they have 250,000 users, so they are
24 basically private individuals. They own their
25 own meteorological station that they operate in

1 their back yard and they stream the weather data
2 into the Weather Underground platform.

3 So they are basically, they have
4 this massive weather network that is throughout
5 the United States, I believe throughout the world
6 actually and they're able to get, you know,
7 almost neighborhood level weather information.
8 So what they are trying to do and you will not
9 find it in the article, but this is some inside
10 information, I guess, so Weather Underground
11 purchased about, I believe 10,000 PM sensors from
12 a company that shall remain unknown.

13 But basically what they are trying
14 to do, they will give the PM sensors to their top
15 users for free and they will start streaming PM
16 data into their platform with the hope that maybe
17 the remaining 240,000 users will get interested
18 and then maybe purchase one of these sensors, so
19 this is extremely interesting and it has some
20 potential to become, I don't know, the very
21 first, you know, large PM network in the world.

22 So last but not least, again, I
23 guess the journey throughout this presentation
24 went from a single user to the development of
25 large sensor networks. Something to be aware of,

1 you know, most people when they hear, you know,
2 the word low cost, they get super excited, so
3 your project can be relatively low cost if you
4 have one sensor and if you're interested in
5 measuring air quality in the back yard,
6 definitely it is a low cost project, but if you
7 start building up to your network, just as an
8 example, nine sensors.

9 But if you have more than 100
10 sensors, there are huge costs that are associated
11 with the hardware, the maintenance and
12 calibration of the sensors is also a huge factor
13 and you need to be able to know that basically
14 all of your 100 plus sensors are measuring air
15 quality correctly. Sensor connectivity, building
16 your sensor network is not cheap, making sure
17 that all of these sensors connect into a server.

18 The server transmit the data back to
19 where your central location. Data logging and
20 management, data validation and analysis. It
21 takes a lot of manpower to do that. And even
22 visualization and reporting, too, they don't come
23 for free in most cases. So you see what started
24 as a low cost project ended up being a high cost
25 network, so it's something to be aware of,

1 especially for air quality agencies get excited
2 about low cost sensor technology, but at some
3 point you're going to have to face the costs
4 associated with building a network. And with
5 this, I conclude and thank you very much.

6 (Applause)

7 MR. HANNA: Do we have one or two
8 questions from the council?

9 MR. OPIEKUN: From the instruments
10 that you have tested, consumer grade instruments,
11 do they come with adequate documentation on the
12 limitations that users should be aware of?
13 Because you mentioned earlier in your
14 presentation that there are some users that you
15 find out are using instrumentation
16 inappropriately or pushing the boundaries of that
17 equipment, so is there documentation associated
18 with that?

19 MR. POLIDORI: There are some
20 documentation that tells you, possibly the
21 basics, of how to operate the instrument. When
22 it comes to the application, my feeling at least,
23 if you're dealing with like a larger company,
24 maybe you're left on your own. You know, for
25 some of the other smaller companies, Purple Air,

1 I think the advantage of working with the small
2 groups is you can contact them and I found,
3 especially the personal interaction of gathering
4 the information that you need to basically apply
5 the sensors, it's a lot better. It's lot, but
6 generally speaking, it is very variable.

7 MR. BIELORY: So you mentioned
8 earlier that you do not specifically endorse any
9 of these products. Do you do the opposite where
10 if you find problems, do you, and maybe not
11 recommend the product, but at least identify
12 those problems on the website?

13 MR. POLIDORI: Yes, great question.
14 Before I showed you like under in some of the
15 gases, you know, we don't specifically say do not
16 use this product, but in the table when you see
17 \$10,000 of square 0.1, I think that says it all.
18 And in fact, one of the few problems that we have
19 found, you know, one of the only requirements is
20 if you give us your sensors, the program is free.
21 You don't have to pay anything, but the only
22 requirement is whatever we find, we'll publish,
23 so that's kind of an implicit recommendation of
24 what to use and what not to use.

25 MR. BIELORY: One other question.

1 You assess them, how well they work, how long do
2 they last? Meaning, scientifically, the
3 degradation of a product, maintenance, any
4 information that you provide?

5 MR. POLIDORI: Yeah. And that's a
6 huge problem. For example, if you're using a
7 sensor for measuring ozone, it's pretty well
8 known that the sensor head should be replaced
9 every two, three months. Particulate sensors may
10 last longer, and that's a problem. We don't
11 specifically publish that kind of information
12 there because we don't have the testing usually
13 last two months and the chamber is a week worth
14 of measurements.

15 MR. BIELORY: So you do not assess
16 degradation?

17 MR. POLIDORI: We do not.

18 MR. BIELORY: Thank you.

19 (Applause)

20 MR. HANNA: We will have some time,
21 we're going to have a round table at the end of
22 the sessions today and we will be able to, at
23 least the speakers will be able to ask each other
24 some more questions. I have a lot more questions
25 for Andrea. It was great. Thank you. To me, it

1 was worth the cross country flight. Thank you
2 for coming.

3 Leslie, come on up. Thank you.

4 Leslie Cronkhite is US EPA lead for the Next Gen
5 and Compliance team. Leslie has been with US EPA
6 for 18 years. Has experience in regulatory and
7 voluntary based programs spanning most of the
8 environmental statutes. She has collaborated
9 with stakeholders for meaningful environmental
10 results on issues related to drinking water,
11 underground injection, clean water, wetlands and
12 chemical safety. Welcome, Leslie.

13 MS. CRONKHITE: Thank you. Thank
14 you very much. I'm really pleased to be here
15 today, very excited to be in New Jersey. It's
16 the longest amount of time, from last night to
17 now, that I've ever been in the state, so it's
18 very interesting. Architecture is super,
19 friendly people, so thank you for having me. My
20 presentation is going to be from the perspective
21 of the EPA as a regulatory agency.

22 Policy issues associated with
23 sensors and I really appreciate Andrea's
24 presentation which explained very nicely a lot of
25 the technical issues, so I think my presentation

1 will be shorter but yours was very effective and
2 great and helpful for me, too, so it's nice to
3 see you. So the working definition of advanced
4 monitoring. We have a team of EPA people that
5 works across all the EPA media offices looking at
6 use of advanced monitoring and we're considering
7 that to be any type of monitoring that is newly
8 on the market, but that is not yet a part of a
9 standard method or considered a federal reference
10 method.

11 So today I'm just going to focus on
12 sensors, the type of monitors that Andrea
13 addressed and that you guys are asking about. We
14 believe that sensors will create a paradigm shift
15 in environmental monitoring. We think that
16 because they're more portable, they're less
17 expensive and they're easier to use and they're
18 cheaper, citizens will start to use them in GOs,
19 facilities, researchers and it will move from the
20 current technology to new technology.

21 And this will change having the EPA
22 regulators or the state regulators being the ones
23 that typically dictate environmental monitoring
24 to everybody conducting, lots of people
25 conducting monitoring and having environmental

1 data out there that is not controlled by the
2 regulators or qualified by the regulators and so
3 this slide just shows two different comparisons,
4 current technology and the new technology. So we
5 already addressed the first one. Typically, the
6 traditional methods of monitoring big footprint
7 and require dedicated power. They may require
8 expertise to use that monitoring technology.

9 There are often delays for lab
10 analysis, and that analysis is typically
11 associated with the quality assurance
12 requirement. It's usually collected by either
13 government or regulated facility or researchers,
14 and then the data that's generated is stored by
15 government agencies and then published on their
16 websites. The new technology has a smaller
17 footprint, is more mobile, battery powered or
18 solar powered.

19 Perhaps easier to use, depending on
20 the performance capability and the intended use
21 which Andrea spoke to. There is no, the
22 information frequently comes as real-time because
23 there's no laboratory wait, but then there's also
24 not the standard quality assurance protocols
25 associated with that information can be

1 collected, as I mentioned, by communities and GOs
2 and facilities, researchers or citizen, and then
3 the data is shared and accessed through non
4 governmental sites.

5 So I think that we believe there's a
6 lot of promise in sensor technology for
7 environmental programs. Primarily, because it
8 makes the invisible, visible, and once the
9 pollution is visible, will tend to be reduced
10 through mechanisms listed here. Either it
11 attributes to the more effective regulatory
12 monitoring by regulated communities or
13 government.

14 It can enhance the ability of a
15 facility to prevent, reduce and treat pollution
16 if they can use the sensors, as Andrea pointed
17 out, to target areas that may be -- that may show
18 where the high sources are. If the data can be
19 collated and merged and then published and given
20 access to the public, it will enhance the
21 public's ability to make personal behavior
22 decisions to avoid hot spots.

23 There's a public accountability
24 issue if the public sees the data they will hold
25 facilities more accountable and that will drive

1 improved performance. We also think sensors
2 could be used to improve effective permits and
3 inspections and then under pending all that is
4 the idea that the sensors are generating
5 real-time data which is very powerful. So the
6 opportunity as regulators for EPA and for states
7 is to transform environmental programs.

8 First, by using sensor data to
9 supplement the gold standard or the federal
10 reference methods, monitors with richer data on
11 air and water quality. So the data that gets
12 generated by sensors, no matter what the source,
13 if it's merged and useable, it can fill in all
14 the spatial gaps for the standard monitors, and
15 the new devices can be powerful tools for
16 screening or assessment of sources and their
17 impacts.

18 So I wanted to step away from the
19 slide for a minute and just tell you about a
20 couple of projects I recently heard about in
21 Baltimore. The city is starting three research
22 projects using sensors. They're going to outfit
23 volunteer citizens, about 50 of them, with their
24 own personal monitoring devices and have them
25 wear them throughout their regular daily

1 activities, and through the data collection, on
2 those sensors, they'll be able to see what the
3 effects are on peoples exposure as they walk
4 amongst traffic and also they're going to be
5 looking at the effects of exposure to people from
6 changing energy sources.

7 It's a really interesting use of
8 sensors. They'll be using that information to
9 help inform their public health policies. So the
10 other opportunity is just having that rich body
11 of data from many different sources can give a
12 vast body of environmental information that can
13 be used by everyone. However, there are some
14 challenges that the regulators are already
15 starting to face.

16 First of all, the pace of the
17 technology is moving so quickly, that it's
18 difficult for the EPA and states to stay on top
19 of what's out there, how the devices perform and
20 what they can be used for. Citizens and
21 communities are using the new technology, but the
22 results, the meaning of the results are unclear
23 because we don't know the quality of the devices.

24 So if we get a call from a citizen
25 asking about a higher reading, it's hard for us

1 to really respond to that if we don't know what
2 the device is really capable of giving in terms
3 of this performance. So this could lead to false
4 positives which could suck up a lot of time for a
5 facility or for an environmental agency to try to
6 reconcile what people are seeing with what the
7 device is actually able to read, or false
8 negatives could be a problem as well.

9 So some people may have a false
10 sense of security thinking there's nothing there
11 because the device isn't sensitive enough or
12 isn't able to perform in the condition they used
13 it and it didn't detect something that really was
14 there. So we have our Office of Research and
15 Development at EPA does in depth studies similar
16 to what South Coast does. They do very, very
17 thorough looks at devices.

18 However, we're limited in how much
19 we can do. We have found, as Andrea said, that
20 some of the results indicate that manufacturer
21 claims are not always confirmed through those
22 studies. I think I already addressed number
23 three. So another issue that we see is trying to
24 speak to data that comes in one minute, five
25 minute or 15 minute increments for instance when

1 the health standard is based on long term
2 exposure.

3 It's hard to explain to somebody
4 what the meaning of that short term data is. And
5 another challenge is our EPA's approval methods
6 for using or coming up with the standard that we
7 think is useable in our rules and our permits and
8 in our enforcement. So we are looking at trying
9 to make that process a little bit more
10 streamlined so that we can incorporate some of
11 this new technology into our compliance programs.

12 There may be a need for us to expand
13 on data systems to collect the data, display the
14 data and then publish it back out to people.
15 We've got some different groups that are working
16 on that issue, and then finally, learning how to
17 extract useful information from larger datasets,
18 and we're thinking in terms of statistical tools,
19 that may be able to pull lower quality data
20 together and make something out of it.

21 So these are challenges that we're
22 trying to address because we see the opportunity
23 and the sensors for EPA to be able to use these,
24 in EPA and states, to be able to use these in
25 rules and in inspections and enforcement and

1 compliance programs. We wanted to address the
2 challenges, so we met with the E-Enterprise for
3 the environment council, which if you're not
4 familiar with the E-Enterprise, it's a business
5 strategy that was started in 2014.

6 It has states and EPA working
7 closely together to identify problems and
8 solutions across the environmental enterprise
9 rather than as federal and state, so the
10 E-Enterprise Leadership Council consists of 10
11 EPA senior executives and 10 state commissioners
12 and they looked at this issue and agreed that
13 states are struggling with some of these
14 challenges as much as the EPA is and possibly
15 more, and so they asked us to form a team of EPA
16 and state folks to address five objectives.

17 One is to explore potential, a
18 potential for an independent third party
19 certification program. A second objective is to
20 form a network of EPA and state scientists and
21 engineers who can help inform each other and
22 share information. The third is to address a
23 question of how you communicate the results of
24 short term monitoring data that are based on long
25 term exposure.

1 And the fourth one is to develop
2 data standards so that data can easily be merged
3 and shared. And the fifth one is to consider
4 whether or not our methods approval processes can
5 be streamlined using the lean process. So I'll
6 talk about those very briefly. Why are we
7 looking for a third party certification? So this
8 is our first need that is -- trying to address
9 some of these issues that Andrea brought up.

10 Technology is advancing at a rapid
11 pace. The environmental sensors market right now
12 for 2014 was estimated to be 13.2 billion dollars
13 and it's expected to increase to 19 billion by
14 2019. Some of the high tech companies like
15 Google and other data mining companies are
16 getting involved and environmental monitoring,
17 and so we feel that there needs to be an
18 independent body that can do some of the work to
19 certify the quality of the devices.

20 Because, as we mentioned, some of
21 the untested sensor technologies is strained,
22 government resources is also strained facilities
23 that have to speak to some of the results. So
24 the team that looked at the options for a third
25 party certification project looked at

1 certification versus evaluation and verification.
2 And the difference is that evaluation and
3 verification looks at the performance of a device
4 against what the manufacturers say.

5 Whereas, the certification looks at
6 predefined standards that all devices are tested
7 against, so a certification body might be similar
8 to underwriter laboratories which when you buy an
9 electronic device with a UL stamp on it shows
10 that the device has been tested against safety
11 standards and has passed, so we're thinking of
12 something similar to that. The folks who are
13 working on this at existing certification
14 programs, and they're also considering looking at
15 creating new program and partnering with other
16 federal agencies and with the private sector.

17 While we think that the government
18 may need to fund initially getting the program
19 started, we intend for this type of program to be
20 self sustaining. So for the second objective,
21 establishing a network amongst the states and
22 EPA's engineers, the idea behind this is we have
23 a group of people who are interested as part of
24 their regular job, scan across city and
25 environmental enterprise, what is the interest in

1 sensor monitors and then find devices and use the
2 market that may meet their need and then do a
3 screen on the information that is readily
4 available.

5 So this would be manufacturing
6 information that we would gather, possibly digest
7 and then put into a clearinghouse to be shared
8 among network members. The network is focused on
9 EPA and state regulators and would probably be a
10 temporary body until a third party certification
11 were established. The type of information the
12 standard network would gather is not a substitute
13 for the in depth testing that our Office of
14 Research and Development does or that South Coast
15 does.

16 But it would just provide easy
17 access to the information that is out there and
18 also in cases where we know of states that have
19 done some testing, we would like to be able to
20 share those experiences as well. We're piloting
21 the networks, so right now we have 25 members.
22 We just kicked it off last week, and once we
23 figure out the processes and how it's going to
24 work, we'll be expanding it across the country.

25 So objective three is the team is

1 working on that question of how you do comparison
2 of one minute data to help the standards.
3 They've developed a mock up that looks at sort of
4 presenting the data in terms of high, medium and
5 low. So if you have a reading of ozone for
6 instance that is 25 PPM, what do you make of that
7 as a citizen. Is that like off the charts? Is
8 that barely detectable? And so just to give
9 people a sense of scale, this team is sort of
10 stalled at this point.

11 They'd like to make some
12 visualization tools and develop those statistical
13 tools that I talked about before that would allow
14 merging data and then making sense of it and
15 possibly making it useful, even if it's not the
16 highest quality, but we're kind of waiting for
17 resources in the budget to be handed out and when
18 we figure that out, they'll be able to pick back
19 up on their work.

20 The fourth objective is to create
21 data standards and this is a very techy IT,
22 slough through the mud kind of work, but the
23 leads explains it using more every day
24 experiences. When we are turning in our taxes
25 electronically through Turbo Tax or H and R Block

1 or your accountant system, we're able to do that
2 because there are data standards that they're all
3 complying with, so it defines how the data should
4 be formatted.

5 And therefore, people who comply
6 with the standards, they can send the data to the
7 IRS. And the same is true with banking. We do
8 electronic banking. There are standards that
9 have been developed with the data and that allows
10 us to do business trans actions electronically,
11 so the same idea for sensor monitoring data.

12 This is an effort to define, are we
13 going to report a certain concentration of PPM or
14 PPB, and having sort of data quality information
15 of when the last time the device was calibrated,
16 et cetera. Having these standards will allow us
17 to use the numerous and diverse entities and
18 leverage all that monitoring that is being done.
19 There is ongoing work in the private sector to
20 make use of sensor data, and our team has been
21 reaching out to the people that we know of that
22 are already doing that work so that we can be
23 sure to merge or duplicate their efforts.

24 And then the final team is working
25 on leaning the methods approval process, so

1 monitoring methods for regulatory permitting and
2 compliance purposes have to be approved by EPA
3 and state environmental agencies. And so in
4 order for us to try to make sure that that's
5 working, those processes to approve methods are
6 efficient and flexible, we're going through a
7 lean process.

8 We've identified five monitoring
9 approval programs in the EPA, and so far we have
10 completed a lean exercise for the Clean Water Act
11 monitoring approval and there should be a report
12 of that coming out in a couple of months. I want
13 to end with talking about the benefits of this
14 work. I have some of them listed here. We see a
15 lot of benefits across the Enterprise. We think
16 it's good for industry. It's good for
17 communities, and it's good for good government to
18 have the third party certification, to have data
19 standards, to have a framework for communicating
20 results.

21 So all the work that we're doing has
22 benefits that could be far reaching. And first
23 of all, as I've mentioned, we will reduce time
24 spent on false negatives or false positives.
25 Having some of the standards in place and being

1 able to use sensors in a robust way consistent
2 with environmental programs allows for more
3 important decisions, i.e., the work being done in
4 Baltimore. It will enable communities to
5 formulate more meaningful plans.

6 It will, we believe, could stimulate
7 markets to develop new technologies to improve
8 their advanced monitoring devices if we have
9 performance standards that we're saying for a
10 particular use, this is the standard you need to
11 meet. It gives manufacturers a target.

12 And finally, and maybe most
13 importantly, if the data can be high quality
14 merged and shared, it could empower individuals
15 to make personal behavior decision such as
16 avoiding hot spots, so we are -- about the
17 possibility of moving forward with sensors and
18 starting to incorporate it more into EPA and the
19 state programs. And here is my contact
20 information. I'll be happy to take questions.

21 (Applause)

22 MR. BIELORY: Two questions. One,
23 have any of these formal monitors used by your
24 states or private parties been approved under any
25 of these programs under air, water? So, you

1 know, to the extent they need to be approved or
2 methods need to be approved, has that been done
3 in any particular state?

4 MS. CRONKHITE: Yes. I think one
5 has the 2B Technologies ozone monitor I think.
6 I'm not sure, but I believe that one has been
7 approved, but we have not been able -- because
8 there hasn't been an ability to approve a lot of
9 them yet, we haven't -- that's why we haven't
10 been able to incorporate them into rules.

11 MR. BIELORY: And that's used both
12 the state government and or private parties?

13 MS. CRONKHITE: So the states
14 typically rely on federal reference methods.
15 There may be some states that develop their own
16 methods processes, but I think typically they
17 rely on what EPA comes up with.

18 MR. BIELORY: And does EPA enforce
19 relying upon private party, but private party air
20 monitoring for enforcement actions?

21 MS. CRONKHITE: We're not relying on
22 private party results, but we have been
23 incorporating sensor monitoring into some of our
24 settlement agreements.

25 MR. HANNA: Leslie, I was interested

1 to get your thoughts, maybe pros, cons on the
2 10,000 sensor deployment that Weather Underground
3 was planning that Andrea told us about.

4 MS. CRONKHITE: Well, I think it's
5 very exciting. I think that the real potential
6 of sensors is the democratization of
7 environmental monitoring. I think it has
8 fantastic potential to sort of revolutionize
9 environmental monitoring and having people be
10 more interested and more involved in their
11 environmental quality. I guess a question that
12 came up to me, when I heard him talking about
13 that, was again the quality of the sensors, the
14 ability of the people using them to ensure that
15 they're calibrated properly and that they're used
16 properly, and then finally, what the conditions
17 are, as this gentleman asks, what the conditions,
18 the performance is over time, so those are sort
19 of the questions that came up to me, but I think
20 it sounds very exciting.

21 MR. OPIEKUN: At some point does EPA
22 envision publically collected data flowing
23 directly to EPA, or do you envision the use of
24 something like partnering with the exchange
25 network? Since I know that every state has a

1 node on the exchange network, do you envision
2 some sort of pass through system where it would
3 go to state government first before going to a
4 federal repository? Is there any thoughts on
5 that?

6 MS. CRONKHITE: Yeah. Actually we
7 have a project, another project under
8 E-Enterprise with states and the EPA, looking at
9 how to collect sensor data from different
10 sources, and we do not intend to do is have a
11 central depository that EPA mans or we don't
12 expect the states would be able to do that, or
13 EPA, because it's a huge amount of data that
14 would be coming and expensive, and maybe not
15 really where we should be spending our resources.

16 Instead, what this group is looking
17 at is having a central, I think they're calling
18 it a catalogue of the data that's available, so
19 if you've collected sensor data, and you want to
20 share it, you would register with this catalogue
21 and give a little bit of detail what the data is,
22 you hit that catalogue, which we would intend to
23 maintain, and the catalogue would send you to the
24 owner of the data and you could retrieve it in
25 that way.

1 MR. HANNA: Thank you, Leslie.

2 (Applause)

3 MR. HANNA: So we've heard from a
4 couple representatives from government agencies
5 and we're going to move to a few presentations of
6 owners of projects, so Holger Eisl is the
7 research associate professor at Queens College,
8 and Dr. Eisl is currently principal investigator
9 of the New York City Community Air Survey in a
10 joint project with New York City Department of
11 Health and Mental Hygiene. He oversees all
12 activities related to the collection of ambient
13 air monitoring data, lab analyses and data
14 validation procedures for the New York City
15 Community Air Survey. And under his direction,
16 works on new and innovative air monitoring
17 instruments to perform field testing of
18 environmental monitoring services.

19 MR. EISL: Thank you. I want to
20 thank Chairman Opiekun and council members for
21 the invitation to have the opportunity to
22 testify, so what I was asked to sort of give a
23 presentation or an overview of our work in New
24 York, so I'm a faculty at the Barry Commoner
25 Center for Health and the Environment so we are

1 doing research on environmental issues and also
2 on environmental health related problems. What I
3 plan to do is, again, give you an overview of the
4 program.

5 The NYCCAS program, if I have time,
6 I'll also briefly address a new program that
7 we're doing deploying network of real-time
8 instruments for PM 2.5 in New York City and we
9 also plan to do, start a Citizen Science project
10 at the Commoner Center with funding from the New
11 York City Department of Health. I show this
12 slide simply here to indicate being exposed to
13 air pollution is unhealthy, causes serious
14 problems, and that's the reason actually the city
15 of New York decided to do a detailed study.

16 The seriousness of the problem is
17 actually documented on this slide where the World
18 Health Organization estimates that in the world
19 seven million people die every year because of
20 exposure to air pollution. 3.7 million die
21 because of exposure to outdoor air pollution.
22 And another study published indicates that
23 ambient exposure to PM is the ninth leading risk
24 factor for all diseases in the world.

25 When it comes to New York City, the

1 health department estimates every year 2,000
2 people die prematurely because of exposure to PM
3 2.5. In addition to that, you have issues with
4 hospitalizations and emergency room visits, so
5 hospitalizations, we have roughly 1500 in New
6 York City and 4,800 emergency room visits which
7 also overloads at times the hospitals. Now, the
8 start or the reason that NYCCAS was created came
9 out of the PlanYC which was basically, the idea
10 came from former Mayor Bloomberg, and the plan was
11 launched in 2007 and it's sort of the plan that
12 creates a vision for the City of New York, how it
13 should look like by 2030.

14 In fact, based on the fact that the
15 population will increase and the plan asks for
16 improvements on water problems, solid waste issue
17 and climate issues and of course also problems
18 with air quality in New York City. Now, the key
19 sources in New York City for air pollution is
20 traffic and emissions from buildings. These are
21 the key sources. We don't have too many problems
22 with manufacturing. We have some critical point
23 sources, transfer stations and also some power
24 plants.

25 Now, at the time in 2007 when the

1 plan came out, the city didn't have the tools to
2 sort of understand the spatial variability from
3 neighborhood to neighborhood in New York City, so
4 the mayor's office charged the Department of
5 Health to design the study and the Health
6 Department approached us and we basically -- the
7 NYCCAS program. The critical goals, we have four
8 objectives for NYCCAS, so we want to assess the
9 year round variation of the multiple pollutants
10 across New York City neighborhoods.

11 And we want to identify potentially
12 additional sources that contribute to the urban
13 air pollution within these different
14 neighborhoods, the data being used to inform the
15 public and the government to potentially develop
16 strategies to reduce air pollution, and as a
17 byproduct, we create dataset off high quality
18 spatial data of air pollution for etiological
19 studies and health surveillance programs.

20 So the NYCCAS program started in
21 2007. In the first year, we developed the
22 program, designed the program and we also
23 developed an instrument that can do the work
24 because there was nothing existing at that time,
25 so monitoring began in the winter of 2008 through

1 2009. Initially, we had 150 sites and over time,
2 we reduced the sites for two reasons. First of
3 all budgetary constraints with the Department of
4 Health.

5 Remember, 2008, 2009 was the time of
6 the economic crisis, so there was some pressure
7 on the Health Department to save money so they
8 cut back on the budget, but we also, we are also
9 combining the monitoring data with the latest
10 regression model and realize there was some
11 redundancy in the monitoring sites which we could
12 eliminate and still have a robust model. What we
13 are doing actually is totally different than what
14 we have discussed so far.

15 We are not doing real-time data. We
16 are doing integrated sediment. Why do we that?
17 Because when it comes to health outcome, long
18 term exposure is a significant problem, so the
19 Health Department was more interested really in
20 sort of seasonal averages and annual averages,
21 and so it can be seen what we are doing, we are
22 sampling at each location four times a year,
23 during each season, and the samples placed at the
24 monitoring site for two weeks and collect the
25 data and we have also reference sites.

1 One in each of the five boroughs
2 where we continue to sample and target pollutants
3 are PM 2.5, the gaseous pollutant of the Oxide of
4 Nitrogen, ozone and Sulfide Oxide. Now, the
5 monitoring data are integrated into a land use
6 regression model which allows you basically to
7 take the pattern from the monitoring site with
8 the surrounding land use to forecast pollution
9 levels in the area where you don't take the
10 measurements, so here it shows you basically how
11 it compares on the maps on the right side.

12 It's basically the monitoring sites
13 from DEC, from regulatory agencies, a total of 27
14 sites. The majority of them are -- 17 focused on
15 one pollutant as PM 2.5. There are three sites
16 in New York City, two in the Bronx. The Bronx,
17 one at a school and one at Queens College where
18 they target all the same pollutants that we are
19 targeting. These are regulatory monitors and
20 they're real-time instruments. On the left side
21 are the monitoring sites from the NYCCAS program.

22 There are a total of 150 sites
23 listed there. It is difficult to see what we are
24 monitoring at 75 sites. There are also some
25 sites in what's called the Environmental Justice

1 Zone where they target certain low income and
2 economic and disadvantaged sites where we often
3 do some, so I won't go into details but you can
4 imagine, in a city of 8.5 million, the Health
5 Department says, now monitor and tell us what the
6 spatial variability is. It's not an easy task,
7 so we developed a model to tell us what the
8 critical locations, where we should place
9 monitors.

10 So we used a model and that helped
11 us sort of identify 120 locations where we did
12 some monitoring, but the models are never perfect
13 so we had what we call purposeful sites where we
14 use expert opinions, some missing here, some
15 missing there, so there was some gaps for example
16 on the model. We also had to go, at least one
17 monitored site for each community district and
18 some other areas of concern.

19 For example, we had one monitoring
20 site next to the World Trade Center. We also
21 targeted some schools where we wanted to have the
22 monitoring sites. Now, at that time there was no
23 instrument available so it took us a year to
24 develop that instrument. It's basically, we are
25 sort of collecting samples for the gaseous

1 pollutants using -- basically, this is the
2 housing units for the ozone. This is for noxious
3 SO2 in the middle.

4 There is a sensor where we collect
5 data on the relative humidity and temperature.
6 It is important in the lab analysis for coming up
7 with the results for the gaseous pollutants. The
8 PM 2.5, with a Harvard impactor which is
9 connected to a pump that is connected to a smart
10 controller which sort of collects samples on PM
11 2.5. We did extensive testing over the years, so
12 this is in the Bronx.

13 We also placed multiple of these
14 units and make sure they compare well and they're
15 also -- they are precise and tweak the units over
16 a year period and eventually produce a total of
17 90 units in the New York City program. We set up
18 a laboratory at Queens College where we basically
19 prepare the units for deployment and we have fill
20 data sheets. We develop all the protocols, and
21 once the units are coming back after two weeks,
22 they get basically processed.

23 The filters get harvested, data gets
24 downloaded and so that is why we need the
25 laboratory facility. Basically, we have field

1 teams. Basically, typically on a Tuesday the
2 field teams go out and deploy the units. We are
3 going to deploy units in the middle of the night
4 because of traffic concerns. Typically, it takes
5 us, for a team, four to five hours to deploy 10
6 to 12 units. We have two teams going out doing
7 this work and typically on a Wednesday then,
8 teams go out again overnight and retrieving the
9 units from the previous session.

10 We modified a vehicle, we modified
11 the vehicle here. There is the compartment where
12 all the instruments are located and in the lower
13 compartment we have foldable scaffold which we
14 need to -- we are setting up at each lamp post to
15 reach a height of 10 to 12 feet to deploy the
16 unit. That shows you basically once we initially
17 defined where we go, we preinstalled mounting
18 plates, which allow for rapid deployment and
19 retrieval and here on the right side you see one
20 of our staff members being on that scaffold and
21 he's deploying or retrieving one of the units.

22 That's the way it looks when you
23 zoom in. It's actually in Manhattan. That's the
24 way the unit looks. Once it's deployed, it's
25 locked to the mounting plate. The unit itself is

1 locked and that's what it looks like from the
2 sidewalk. You don't even recognize. However, it
3 was a big issue when we set up the study. You
4 can imagine, since September 11th, there are
5 changes to New York City and an open unit looks
6 like a bomb basically, so we had to talk to the
7 Homeland Security and NYPD, to get all special
8 permits.

9 Vehicles have special lights, so
10 normally I use students to go out so they have
11 sort of necessary documentation because if they
12 get stopped by police, over the years now they
13 know us, so that's a logistical challenge. So
14 once the samples come back, they basically
15 harvested them and there are all types of
16 different lab methods are being used to extract
17 and come up with the results.

18 Now, when we decided to study to
19 outsource all of the lab work because of quality
20 assurance, quality control issues, so we are
21 using the same laboratory EPA is using. We use
22 research lab in Arizona, so that shows you. This
23 slide shows you the sampling activity over the
24 last, 2009 to 2016, so far -- 13,000 samples. We
25 have the majority of samples for PM 2.5 and NOx

1 because we only focus, when it comes to ozone, we
2 only sample the summertime and SO₂, we sample in
3 the winter time.

4 So it's critical for the data is
5 that we look at precision and comparability, so
6 whenever we deploy instruments at certain sites,
7 normally two sites, so two units on one lamp post
8 and we also co-locate at all times DEC reference
9 sites, so basically this shows you sort of a
10 correlation of co-located NYCCAS units on the
11 top. These are the co-located NYCCAS units at
12 point 95. These ones are compared the data with
13 DEC of .88.

14 These are some results that shows
15 you here, basically the maps from 2009 and 2015
16 for the five year results. It shows you what we
17 have a decline in New York City by 16 percent.
18 Here is the map on NO₂. What you have to
19 remember is we have 75 sites and a strong model
20 and be able to determine the spatial variability
21 of the whole city. That's interesting in the
22 discussion where you guys are talking about
23 thousands of monitors and discussion will be what
24 models should play an important role.

25 This is simply a map of SO₂. So

1 because of our activities and our findings, there
2 were a number of sort of actions taken by city
3 council. One of the important ones was the
4 phasing out of number six for boilers in high
5 rise buildings, and that had a significant impact
6 in New York City to reduce SO2 levels. We are
7 also setting up a network of real-time models.
8 We use PR 1500 which is used typically for
9 indoors and sort of create an environment for
10 this instrument to also be able to monitor
11 outdoors, and here we have deployed so far five
12 units in New York City.

13 We plan to have deployed 12 units by
14 basically August of this year. Now, we got
15 funding from the Health Department for two year
16 program of Citizen Science. We will hire
17 basically a post op position and then basically
18 work corporation with the DOH on the Citizen
19 Science project. What's unique and interesting
20 will be to use some of these new devices within
21 an environment where we have a pretty good
22 understanding of the spatial variability.

23 I wouldn't call it a gold standard,
24 but a pretty good standard to compare what we get
25 from Citizen Science. So let me stop here. I

1 only want to show it's not my work. It's really
2 work of a huge group outside consultants, health
3 department and of course our group at Queens
4 College is doing this work. Thank you.

5 (Applause)

6 MR. HANNA: Questions from the
7 council? Holger, I think you got to it at the
8 end, but the use of 2007 technology passive non
9 real-time, now you're supplementing that one with
10 established network with electronic sensors.
11 Where do you see those choices? Do you think if
12 we roll the clock forward, how would you do this
13 project differently with today's technology?

14 MR. EISL: I think we still would do
15 it the same way, but what helps us now, in the
16 Citizen Science project what we will do, we will
17 probably select a high traffic zone ora marine
18 transfer station, and basically let -- we
19 probably add additional NYCCAS units there and
20 also sort of have monitoring with Citizen Science
21 instruments, and then having additional NYCCAS
22 units, we can later see what the NYCCAS model
23 predicts, do we actually represent with the
24 model.

25 Also what we suddenly measure with

1 Citizen Science or the additional NYCCAS models.
2 That tells us how accurate our models. We are
3 very confident, but the question is, when you
4 look at hot spots, do we really capture that with
5 the NYCCAS program, and if it turns out with help
6 from Citizen Science instrumentation, maybe we
7 are missing a hot spot, we may tweak the system,
8 add additional sites and modify the model to make
9 it even stronger. So we won't use the actual
10 numbers from Citizen Science, but it helps to
11 scan it and see whether we are missing something.

12 MR. HANNA: A screening tool.

13 MR. EISL: A screening tool.

14 MR. HANNA: Thank you very much.

15 Continuing with our discussion about ongoing
16 projects, Anna Scott, who is currently a Ph.D.
17 student at Johns Hopkins is joining us to talk to
18 us more about the Baltimore project that Leslie
19 highlighted briefly for us, and Anna, you stand
20 between us and lunch so we'll keep you on
21 schedule. No pressure.

22 MS. SCOTT: Thanks, everyone. I'll
23 try and be a little brief. Before I start I was
24 kind of curious. Could I get a raise of hands of
25 how many people here have an air quality and a

1 meteorology background? Okay. That's like five
2 people. How many people have a regulatory
3 background or work for a state? A couple.
4 That's more. Maybe 10.

5 And then how many people are with
6 health sort of exposure stuff, public health?
7 Great. That was like four. And how many people
8 are here in their capacity as interested citizens
9 or other? Two people. People are playing hooky
10 like me. I'm going to talk today about project
11 that we're working on in Baltimore, and one of
12 the projects that Leslie identified.

13 This project is called Baltimore
14 Open Air, and this is more of DIY I guess Citizen
15 Science version of a lot of the monitor research
16 activities that are taking place at John Hopkins.
17 This project is really a community driven and
18 partially funded project to monitor air quality
19 using open source, off the shelf technologies and
20 using this to develop a network of air quality
21 monitors, and then the software network
22 infrastructure around those to be able to read
23 and use that data.

24 Our project has a couple of goals,
25 and these are in no particular order, but we're

1 hoping to first we've got to design and build the
2 monitors themselves. We have a shoe string
3 budget. I think we got about \$40,000 from the
4 EPA and we supplemented that with a couple
5 thousand dollars from funding. We got some
6 matching funds from the Institute at Hopkins, so
7 we have to basically design our own stuff from
8 scratch. Everyone like me is working on this as
9 a volunteer, so we have free mental labor, not so
10 free other stuff.

11 So the engineering challenges are to
12 design and build the monitors and put that data
13 on the internet and manage it. We hope to use
14 this to do some science and specifically to do
15 some of the stuff they've done in New York, to
16 quantify the spatial variability within our city
17 and air quality, and that's something that's been
18 identified of interest to our partners and in the
19 city and additionally, this is not last.

20 This is in conjunction with all
21 these activities, we hope to work with citizen
22 scientists and community groups and environmental
23 justice organizations to build and deploy the
24 network, so we can make sure that really everyone
25 is a part of this and can learn, not just about

1 maybe what the sensors are saying but learn some
2 of the difficulties that are inherent in doing
3 some of the monitoring because I think that can
4 sort of improve the relationship is I think I
5 hear from a lot of state regulatory agencies,
6 we're really worried, we're really worried about
7 this data quality and the social justice and
8 environmental groups, they take it that a little
9 bit of the wrong way.

10 A lot of people I met in these
11 environmental groups don't necessarily have a
12 science background. They haven't spent a decade
13 of their life dealing with lab equipment, and I
14 feel like getting people on board with some of
15 those challenges, for me, it's a little cathartic
16 emotionally, but I think that can sort of help
17 get everyone on the same page. So I guess
18 getting on board with this project does require
19 getting on board with this new monitoring
20 paradigm.

21 But I think Leslie touched on it a
22 little bit. First on our project we are going
23 to, number one, prioritize understanding spatial
24 variability. It's really critical for us to
25 understand, not necessarily the absolute level,

1 but to say things like this neighborhood is more
2 or less, you know, polluted than another
3 neighborhood and maybe not be able to tell you
4 the PPM level, but to be able to identify where
5 those hot spots.

6 Second, rather than thinking about
7 point source accuracy or live report accuracy,
8 we're thinking about the accuracies of the
9 overall network, sort of the idea that maybe one
10 sensor isn't going to be as precise as we might
11 like, those of us who do have that science or
12 monitoring or measurement background, but when
13 you think about what is the network as a whole
14 saying.

15 So how are we going to do this.
16 Step one is we still do have to ensure the
17 reliability of our sensors. We have a couple of
18 strategies to do this, and I'm happy to talk more
19 if people have good ideas. And Andrea was
20 talking about some of the measurements that they
21 took, STAQMD, and I think you guys were treating
22 these -- at least what I heard from you guys,
23 that you were treating these like consumer
24 products, off the shelf products.

25 That is not our approach. We've

1 gone through the documentation. We think it's
2 okay, it's boring, and I think you have to be an
3 engineer to be able to read it because I think it
4 was written by engineers, so we've gone through
5 this documentation, and we're like, okay, great,
6 our sensors are going to be cross sensitive to
7 four or five other species, let's measure those,
8 let's do some sort of analysis, let's figure out
9 the sensitivity and we'll correct our raw data to
10 get a final estimated air quality product.

11 The second strategy, which is
12 something that we've tested out before with some
13 of the monitoring that I've done and we've done a
14 lot in Baltimore at looking at understanding
15 temperature variability within the city. It's to
16 ensure the network reliability. One by
17 clustering monitors so we can quantify the
18 variability of the sensor to sensor or monitor
19 the monitor variability.

20 And then second would be co-locating
21 reference networks, which in this case would be
22 the state run networks with the reference, the
23 federal reference standard equipment. I guess I
24 should note here for this presentation, as a
25 group that is building our own devices, I draw a

1 distinction between a sensor and a monitor.

2 So for us, the sensor is really just
3 the device physically interacting with the air
4 pollutants to give out some sort of electronic
5 signal and for us to monitor the entire product
6 that we've put together because we're building
7 our own we can make that distinction. I totally
8 understand that a lot of people aren't in that
9 position. So here we get to the details. Like I
10 said, we don't have a whole ton of money for
11 this. But we're planning on building about 300
12 of these things.

13 The first cost is for our circuit
14 boards, our solar panels, our batteries, our
15 boxes, our screws, I think we have like one screw
16 zip tied, et cetera part, I guess. If you're
17 interested in air quality monitoring, that's the
18 et cetera part. That costs us about \$120. That
19 includes our assembly labor. Then we get to the
20 sensors, so the sensors that we're going to use
21 for this, we've been testing out the ones from
22 SPEC.

23 We have actually had -- these do not
24 do so well on Andrea's measurement test, but we
25 think in part that was the case because they have

1 significant cross correlation with some of these
2 other species and we think we can improve the
3 measurements we get by taking those into account.
4 Secondly, we have been terribly not impressed by
5 some of the circuit boards that come with these,
6 so we think the sensors are working okay, but
7 already we got five of our -- like the company's
8 microprocessors and we've had to like, we had a
9 clock that wasn't working correctly, like the
10 clock was drifting.

11 We had another circuit that we had
12 to re-solder ourselves, so I think this is
13 something to keep in mind is that the performance
14 of the sensors is maybe slightly different than
15 the performance of the microprocessors and
16 everything that is processing the data, and I
17 think that is something to keep in mind,
18 especially for these newer companies that
19 probably started us out with expertise in sensing
20 and not necessarily all of the low cost
21 electronics, so these are sensors.

22 Once we get that data, we will pipe
23 this up to a database on the Cloud. We have
24 proposed to be using an Amazon web service
25 product. These products have tiered pricing.

1 They call it infinitely scalable which means if
2 you have a lot of data, you can still use their
3 products. For us we're on the free tier and it
4 would take us a lot to be able to get up to where
5 we would be paying anything more than a couple
6 hundred dollars a year.

7 We're going to be sending them data
8 in what we call semi real-time, so that means
9 that we are solar powered so we can only afford
10 to transmit data, we think once a day and maybe
11 more than that depending on the sun exposure, so
12 we'll be able to use the Amazon web service
13 products to manage our data, log the location.
14 DynamoDB is what's called a no sequel database.

15 It's a non relational database that
16 you can put data into and it's like widely used
17 in the industry which is why we picked it. There
18 is also a web service that's an IOT platform
19 which manages individual sensors and will connect
20 the sensor data that you send to the Cloud or to
21 the internet and pipe that up DynamoDB. There is
22 another service that we're also planning, I
23 haven't mentioned, which works with cell phone
24 connectivity.

25 It's called Tulio. I think it was

1 recently filed by Amazon, but that's a service.
2 This is like a technology if you're interested in
3 and you think you won't have wireless
4 connectivity, but you might have cell service,
5 that's a product, not me personally, but some
6 members of our team have had experience and then
7 the last part is to visualize this and make the
8 data available to everyone. For this we're using
9 products that's been an open source platform
10 that's been developed in particular with the
11 hyperlogical community. That's called Tethys
12 platform. I haven't had experience with it.

13 Some of our colleagues are using it
14 and we're combining this website building with
15 some of our projects in order to save money. So
16 we're really just going to start at phases of our
17 project. This is kind of like the first data
18 that's coming off one of our first monitors.
19 It's just sitting outside of my house. This is
20 not corrected for cross sensitivity on the top is
21 NO2.

22 On the bottom is ozone and you can
23 see they're really, really -- because these are
24 current are exactly the same. When we ran this
25 through our regression model this morning, this

1 is pretty new data, we found that the sensitivity
2 that the manufacturer was reporting to these
3 additional, they also did temperature and
4 humidity, as well as the other gases, were pretty
5 spot on, so far we're pleased to see that that
6 seems to be matching what the manufacturers is
7 advertising.

8 We have a number of partners on this
9 project that I need to thank. Johns Hopkins,
10 which is like this behemoth university. We're
11 involved with four schools at Hopkins, a number
12 of professors and there's been all sorts of
13 people who haven't worked theoretically on this
14 grant, but give us advice so it's been really
15 great. We've got a number of non profit
16 partners.

17 Over on the left I'm showing
18 pictures from some of our workshops, and I think
19 most notably, by using this sort of open source
20 technology, we've been able to leverage support
21 from the maker space community, and if you're not
22 familiar with maker spaces or the maker movement,
23 it's a movement of people who use -- they do
24 electronic building for fun, sort of the way some
25 people like to build cabinets.

1 Some people like to build weather
2 stations and they've been a really great resource
3 and a great way to engage people that wouldn't
4 necessarily be interested in the environment per
5 se. This is us, a lot of this is me. These are
6 photos on my phone. This is our first monitor.
7 I took that last night. This is kind of the
8 level that we're at right now. We are building
9 things. We're engaging people, and we're excited
10 to start rolling this, ramping this up and
11 rolling this out later in the summer. So with
12 that, I think I can let everyone go to lunch
13 early, but I'm happy to take questions and feel
14 free to contact me.

15 (Applause)

16 MR. HANNA: That was a great
17 perspective, Anna. Thank you. Very grass roots.
18 What's the duration, or what's the expected time
19 to see results?

20 MS. SCOTT: Well, to see results, I
21 think there is two results we're going to see.
22 One is the proof of concept, like can we do this
23 and that will be something that will be
24 abundantly clear in the next couple of months, I
25 would say by August. If these things aren't out,

1 that would be a bad sign. I think that we're
2 planning to get data later on in the summer that
3 we can use to then make statements about spatial
4 variability. I think the EPA Smart City Air
5 Challenge, which funded half of this project, is
6 a one to two year project. We would be excited
7 to maybe see if we could extend it beyond that,
8 but we would need funding to do that.

9 MR. HANNA: So we're talking about
10 2017, '18, '19, in that time frame, we'll be
11 getting subsequent information?

12 MS. SCOTT: Yeah.

13 MR. HANNA: Are you planning to send
14 Andrea a couple of your monitors?

15 MS. SCOTT: Yeah. I don't know if
16 you did but your colleague said that you guys
17 would be happy to test them out, so putting you
18 on the spot. We are really trying to do this in
19 an open source sort of fashion so we're going to
20 have all of our data. It didn't make it yet.
21 We're sharing code and we're sharing our circuit
22 code design, and all that is going to be
23 available on our Get Hub website.

24 Get Hub is a code sharing platform,
25 if you're not familiar with it, but apparently

1 you can share circuit board designs. But working
2 with, if anyone, since we're like resource
3 limited, we're really happy to work with anyone
4 and test in any laboratory. We're really excited
5 to, I don't know. We're doing this for fun.
6 This is something that's exciting. I feel like
7 I'm in parks and recreation. One of the
8 questions, how can you do some of these low cost
9 monitoring things.

10 We have student at Hopkins who will
11 work for free. We offer to pay them and they
12 turn it down. You guys in New Jersey, I'm sure
13 these Princeton students down the road, or
14 Rutgers students, if you can make contact with
15 some of these people, I think they're excited
16 young people who are really excited to engage.
17 I'm happy to put you guys in touch, too. We've
18 got plenty of students from the area.

19 MR. HANNA: Any other questions for
20 Anna? Thank you.

21 (Applause)

22 MR. HANNA: So as Rich mentioned at
23 the top of the session today, lunch is provided
24 for the speakers and the council here. Others,
25 DEP has a pretty well stocked cafeteria down in

1 the hall. If you go straight across the lobby,
2 you'll find it. There's some local restaurants.
3 There are slimmer pickings than there used to be,
4 but we can certainly get you references for that.
5 We're going to break for a half hour and
6 reconvene at 12:40.

7 (Whereupon a break was taken.)

8 MR. HANNA: We're going to
9 reconvene. Because we want a full room, when our
10 former Clean Air Council colleague, Dr. Rob
11 Laumbach, comes back up to talk to us. Rob just
12 left the Clean Air Council last year.

13 MR. LAUMBACH: Yes.

14 MR. HANNA: We're glad to have him
15 back, so we invited him back in. Rob is an MD
16 and associate professor in the Department of
17 Environmental and Occupational Health in the
18 Rutgers School of Public Health. As I mentioned,
19 he's been on the council with us doing air
20 quality issues in New Jersey and around the world
21 for how many years?

22 MR. LAUMBACH: Too many to count.

23 MR. HANNA: Let me introduce Rob,
24 and appreciate you joining us, Rob. Thanks.

25 MR. LAUMBACH: Thank you very much.

1 So as Toby mentioned, I'm at Rutgers University.
2 I've been doing air quality research, really
3 focusing on health outcomes, trying to make
4 linkages to create exposure to air pollution and
5 health and focusing a lot on clinical type
6 studies with individuals, so I don't know that I
7 have that much more to add in general about some
8 of the capabilities and the challenges of using
9 low cost monitors.

10 But I have a little bit of
11 experience, both observing communities here in
12 New Jersey who are engaged in some Citizen
13 Science and also low cost sensor monitoring
14 studies and then also a small study that we
15 started to dabble in this area ourselves, and
16 we've been particularly interested, both at my
17 group in Rutgers as well as in the community, in
18 traffic related air pollution and how people move
19 through environments where there's near roadway
20 environments say for example where there is more
21 or less traffic related air pollution.

22 And then in particular, we've been
23 looking at in vehicle exposures, so peoples
24 exposures, traffic air pollution in cars which
25 comes from primarily surrounding vehicles and the

1 general on road -- environment, so I want to talk
2 a little bit about those experiences and try to
3 give a little perspective. I think one take home
4 message. It's not really as easy as it looks to
5 do any of these studies. I think any of us who
6 have done them, can acknowledge that.

7 But especially for I think community
8 members, who may not, again, have the technical
9 knowledge and background that we have, the
10 ability to analyze and interpret data. I think
11 the context is really important. We've talked a
12 little bit about the technical specifications for
13 monitors, and a little bit about also the data
14 management and the challenges involved with that
15 and the interpretation and site design.

16 So we did a little study using the
17 CairPol CairClip monitor which was, I'm not sure
18 if it was back there, but it was on the screen a
19 couple times already which measures nitrogen
20 dioxide and also ozone and other oxidant gases
21 and we did a survey of employees at Rutgers, so
22 our Rutgers community, 18,000 surveys sent out,
23 got about 5,000 back and about 2,500 people
24 agreed to be contacted for future studies.

25 So we want to characterize in some

1 way future studies the exposure that employees
2 have at Rutgers located in the center of New
3 Jersey, as they commute all the way up to
4 Scranton, Pennsylvania all the way down to the
5 state of Delaware and we can do that that with
6 modeling. As Holger mentioned, the models can be
7 very valuable with this, but inside a vehicle,
8 there's a lot of factors involved in terms of
9 what's happening at the microenvironmental level,
10 windows open, windows closed, the modal of the
11 vehicle, filtration, et cetera.

12 So we had, in a pilot study, 16
13 Rutgers faculty and staff volunteer to wear these
14 CairClip monitors and do it for a week of regular
15 commuting and do some daily time activity logs
16 during that week and also wear GPS monitors along
17 with the air monitor. So we used the CairClip
18 monitor. The EPA, the Citizen Science tool kit
19 and obviously verified by AQ-SPEC found that
20 really high precision, or certainly correlation
21 with a reference with the Rutgers monitor, as
22 well as between monitors, between two monitors,
23 intermodal and measure nitrous oxide, as well as
24 ozone, but we presume inside a vehicle where
25 ozone is quenched, even during the summer by

1 nitrogen oxide that are in high concentration on
2 the roadway that we're measuring NO₂.

3 But again, this is one of those
4 technical questions in terms of what the context
5 is, what we're measuring, what it means, so we
6 did this, they're pretty small. They weigh a
7 little less than 50 grams. They're about seven
8 or eight centimeters long, about three
9 centimeters in diameter, little cylinders.
10 People wear them on lanyards. Here's some of the
11 real-time results mapped with, sort of like a
12 heat map, just single commutes here just to give
13 you some idea, and you can see that again the
14 star is our campus, that there is different
15 levels and the levels, the scale is hard to see,
16 but the darkest circles, the darkest circles
17 there are 50 to 100 part per billion.

18 We did that all over Staten Island
19 and so on. We made more congestion, levels are
20 higher and indicating we're not just measuring
21 ambient ozone either, we're measuring NO₂ and
22 some other oxygenated gases there, so I think
23 that illustrates, like we talked about already,
24 the capabilities of those monitors. If you can
25 deploy them widely, you can get information about

1 exposures that people are having in the real
2 world environments that wouldn't be available
3 otherwise, and I'm not going to go through this
4 again.

5 I think these are all things that we
6 mentioned earlier about the capabilities of these
7 monitors, what we can do with them, and the
8 things that enables in terms of doing local scale
9 and personal monitoring, crowd sourcing the data.
10 I think those are all very valuable, but in some
11 ways, I think it's also been touched on that
12 these instruments are too easy to use in the
13 sense that you just turn it on and you're
14 collecting data.

15 And some of them have real-time
16 displays like the CairPol CairClip that we use,
17 so then there's an issue of people are looking at
18 the display and now they're getting really
19 real-time data and maybe not that much context to
20 what that means. As was mentioned, when we look
21 at short term exposures, it's really hard to
22 apply those values to standards that may be based
23 on as little as an hour for NO₂, which is not
24 necessarily a health based standard, but up to
25 either eight hours, 24 hours or annual standards.

1 So what does this number mean when I leave my
2 house and the ozone level is over the 75 part per
3 billion, should I do something.

4 And I think also, users, again,
5 needing to have some appreciation for statistical
6 values about precision and accuracies and about
7 planning and hypothesis testing and what the
8 questions are that they're trying to answer and
9 then it was mentioned, I think also, that the
10 true cost of these monitors may be much more than
11 low cost. To some extent due to degradation or
12 deterioration. For example, the CairClip CairPol
13 model, they say it lasts for a year because it
14 has a metal oxide sensor, and it costs 1100
15 dollars for each one.

16 So in long term, that may not be
17 very low cost. And I think what I found working
18 with communities who have been interested in
19 using low cost sensors and other methods to
20 measure exposure on the finer scale in their
21 neighborhoods and a lot of those have been around
22 traffic related air pollution, there is a lot of
23 potential for frustration and then ultimately
24 distrust, if things aren't done right,
25 essentially.

1 Meaning, that if their expectations
2 aren't met, I think that's the most important
3 thing is that we have limitations to the
4 technology and that people who are using the
5 technology, whether they're scientists or whether
6 they're regulators, or whether they're people in
7 the community need to know about those
8 limitations at the outset and need to know how
9 the information that can be obtained can be used
10 and the diversity or the spectrum of different
11 ways that it can be used ranging from, as
12 Commissioner Martin said, at the outset, from
13 education, from making air pollution visible in a
14 way through to regulatory compliance.

15 Somewhere along the way the kind of
16 things I'm interested in, and people in the
17 community, including individuals who have health
18 conditions might be interested in, which is,
19 whether or not there's an association between
20 some measurement of the environmental quality and
21 some health outcome, so I think that the most
22 important question, I think it's already been
23 touched on, is to start off with defining very
24 clearly what the question is that's being asked
25 and that's obviously related to what the ultimate

1 purpose of the monitoring.

2 And that will lead to designing an
3 appropriate measurement campaign or study and
4 that will lead hopefully ultimately to gathering
5 this information that can then be used by
6 communities or regulators or scientists for
7 whatever purpose that they set out to accomplish.
8 I think that some people at the EPA I think, I
9 think it might have been Ron Williams at a recent
10 meeting at NIAHS, I think this is probably close
11 to a quote at least, said that instead of trying
12 to get communities to give us data, we could use
13 that our approach maybe should be to learn how to
14 use the data that communities give us.

15 And I think that was touched on a
16 little bit by Anna about how perhaps with crowd
17 sourcing and other ways, there is innovate ways
18 of using data that might not be as accurate and
19 precise as we would like as scientists or
20 regulators. So again, different purposes. I
21 think we've gone through this quite a bit
22 already. So here's a little bit of data. Again,
23 we're just dabbling with this ourselves.

24 So one off the first things we did
25 was take these monitors and test them against

1 some test atmospheres and we don't have a
2 sophisticated set up as SPEC AQ or AQ-SPEC, but
3 we have a chamber, an exposure chamber, which
4 Andrea may remember from his days around the EOC
5 where we can do an exposure or create an
6 atmosphere that is diluted diesel exhaust, so
7 this is our monitor, a couple of monitors in
8 orange and the gray there relative to the
9 reference monitor in blue.

10 And actually, this is probably not a
11 very fair test against the reference monitor
12 because the reference monitor, you see that
13 jagged blue line for the first hour or so, that
14 took a while to stabilize. But after that, it
15 was a little bit better, but the two monitors
16 against each other, if you look at, you can see
17 they pretty much traced each other and then the R
18 square for that is greater than point 99, but
19 then relative to the reference monitor, the
20 regression line there indicates about a
21 20 percent bias to the positive side.

22 And again, I think it worked a
23 little bit better at the higher concentrations
24 there because the reference monitor had
25 stabilized by that time. That's just the same

1 data. So I think, you know, again, it's managing
2 expectations that's the most important. I think
3 AQ-SPEC is dealing with community groups because
4 in the end then, I think if you don't manage
5 expectations, there is no way for people to be
6 satisfied in the end.

7 I think that involves though setting
8 up the limitations initially very clearly. They
9 might be disappointed initially, but at least
10 they're not going to go through a process of
11 potentially of collecting, doing it themselves
12 huge amounts of data and then in the end come
13 away with nothing or helping regulators or
14 helping scientists to collect huge amounts of
15 data and then in the end not get the answer that
16 they were hoping for.

17 And also I think defining roles, and
18 again, I think that as a scientist and or
19 regulator, academic science or a regulatory
20 scientist, it's really important to educate and
21 help people get that background that they need to
22 make decisions and be involved in decisions about
23 doing community based science with low cost
24 sensors. So here is one last thing here. So
25 again, a little bit of our data, again, very

1 informal so to say than we did recently.

2 Here we co-located seven different
3 monitors, and you can see even though they really
4 well correlated, even between monitors, there's
5 bias of about probably 20, 30 percent, but this
6 is data on one of our subjects in this little
7 study who took the monitor home in the evening
8 from the university. It was home in their
9 apartment and then commuting in the morning. Can
10 anyone give an interpretation of what's happening
11 here?

12 MR. BIELORY: Turning on the oven?

13 MR. LAUMBACH: Yeah. So this is a
14 community where relatively low levels, and we
15 found actually overall that the levels of NO₂
16 that we measured, presumably NO₂, during the car
17 ride was a bit lower than we thought. Maybe up
18 to 50 to 100 PPB at times, but in general, 20part
19 per billion. This is someone commuting on the
20 turnpike, so she gets home in her apartment and
21 then turning on the stove and a nice little decay
22 and then limited ventilation in her home.

23 And we're not sure what the sources
24 are, talk to the subject a little bit and back
25 when she leaves and goes commuting, it's low

1 again. I think the point is even if it's not
2 quantitative, it's an example of useful relative
3 information that in this case could inform an
4 individual or could inform people in a study.
5 And I think your husband worked at Johns Hopkins
6 using samplers, area samplers, in peoples
7 kitchens of showing levels of well over 100 PPB
8 on a continuous long term basis on the average
9 which may be a point obviously in terms of health
10 impacts like asthma.

11 So again, I think depending on what
12 the use is and depending on what the question is,
13 you can get an answer. You want to make sure the
14 answer actually answers the question that you set
15 out to. So I think my recommendations would be,
16 I think I'm not sure at this point where the
17 department is going in terms of, you know,
18 supporting community science.

19 I know there's been several projects
20 that have been done, as Commissioner Martin
21 mentioned, educational type projects, the EPA has
22 done that the Citizen Science air monitoring
23 project in the ironbound. Again, an example of
24 similar to Holger's study more sophisticated
25 equipment set up to be mobile, so not so much on

1 the -- not so much the grass roots Citizen
2 Science approaches to using low cost sensors.

3 But the extent to which the DEP can
4 get engaged early and provide resources and to
5 help people that are interested in doing this to
6 help them to establish what their purposes are
7 and what the right questions might be and then
8 how to answer those questions I think could be
9 extremely valuable in providing technical
10 assistance along the way.

11 And then finally, when the data is
12 collected, to help with analysis and
13 interpretation because in another study that
14 we've done, we had 37 children in the ironbound
15 where not low cost sensors, but microthermometers
16 that cost 6,000 dollars each but wear them up to
17 30 days each and collected up to a million data
18 points and we spent the last year trying to
19 unravel that and get that together in terms of
20 cleaning up that data.

21 Again, a relatively sophisticated
22 instrument but still having issues when kids
23 between the ages of nine and 14 are wearing them
24 on a daily basis. So again, I think there's
25 technical issues. There's issues with use,

1 there's issues with data interpretation, but it
2 all starts with asking the right questions.

3 (Applause)

4 MR. HANNA: Thank you, Rob.

5 Questions for Rob? On your last point, Rob, I
6 just have to ask, to think about the agency
7 supporting the results, the analysis, the QA and
8 helping with that or your challenge with 30
9 something students, what happens when we get the
10 scale of I'll go back to the Weather Underground
11 employing 10,000 units and directly uploading to
12 their Cloud, to their database, what goes through
13 your mind when you think about that?

14 MR. LAUMBACH: Well, I think that's
15 big data scientists are the ones that need to
16 deal with that I guess, and that I'm not a big
17 data sort of person and I'm not sure if anyone
18 else here is and can have a comment on that?

19 MR. HANNA: That's a fine answer.
20 That's my answer too, Bob. Anything else? Pam.

21 MS. MOUNT: I think all this is
22 great, so still when you say, well, you have to
23 communicate some kind of clear expectation of
24 what might come of this project or whatever and
25 what kind of clear expectation did you give

1 anyone when you were working on this stuff?
2 Because obviously you're not going to do anything
3 about it. You're not going to stop cars from
4 driving. There's sort of a gap there.

5 MR. LAUMBACH: Yeah. So this little
6 project was not a community based project in the
7 sense of community driven project. It was like a
8 pilot project. Part of it was to see if people
9 would wear these monitors and how they would work
10 and so on. So we've limited peoples expectations
11 initially and that we cautioned them that the
12 monitors were not to be used for, not to over
13 interpret the data relative to any health
14 outcomes or whatnot.

15 MS. MOUNT: What would you suggest
16 that if you were going to do a community thing,
17 what would the outcome be to convince somebody to
18 do this stuff or what or whatever?

19 MR. LAUMBACH: Well, in our study,
20 commuters at Rutgers, many of them, we had six or
21 700 written in comments about like commuters
22 killing me, and we're interested in not just air
23 pollution, but also stress and how stress and air
24 pollution may interact. I didn't really get to
25 mention it. I think what's really exciting about

1 this new technology, it's not only new
2 environmental sensors, but physiological sensors,
3 new sensors that can stress; new sensors that can
4 measure things or develop things like an exhaled
5 breath, combining those things together can give
6 people interesting and informative general
7 information about associations between health and
8 exposure.

9 But also personally, as other
10 speakers I think mentioned, personal information
11 about whether I'm sensitive as an asthmatic to
12 ozone, a certain level of exposure, that might be
13 achievable some time in the future. I don't have
14 a year.

15 MS. MOUNT: Thank you.

16 (Applause)

17 MR. HANNA: So maybe the next couple
18 of speakers will have some help for us on the big
19 data side of this, too, but I'll introduce
20 Michael Heimbinder who is the founder and
21 executive director of Habitat Map. He's a
22 community organizer, educator and information
23 designer. And Habitat Map is a non profit
24 environmental health justice organization whose
25 goal it is to raise awareness about the impact

1 the environment has on human health. Want to
2 come on up, Michael. Thank you.

3 MR. HEIMBINDER: Thanks for inviting
4 me to testify today. So as Toby said, my name is
5 Michael Heimbinder. I'm the founding executive
6 director of Habitat Map. We're a Brooklyn based
7 environmental justice non profit, and the primary
8 thing we do is we work with schools and community
9 based organizations to grade planning and
10 advocacy maps. One of the community mapping
11 platforms we operate is called Air Casting. Air
12 Casting is a platform for recording, mapping and
13 sharing health and environmental data.

14 This is a platform diagram that
15 shows you a bit about how it all works. At the
16 top you've got the Air Beam, your air quality
17 sensor. We've sold over 1500 Air Beams to date.
18 It's an instrument we developed for measuring
19 fine particulate matter or -- 2.5. It's low
20 cost. It costs 249 dollars and it's open source.
21 Meaning, all the codes for the firmware and all
22 the schematics are available on-line, again,
23 through Get Hub.

24 The Air Beam connects to an Android
25 app called Air Casting, which is free, available

1 through the Google play store where the
2 measurements from the instrument are mapped and
3 graphed in real-time and passed to our web server
4 at Air Casting Dot Org where the data is crowd
5 sourced, brought together, averaged, displayed as
6 a heat map. Below that you've got LED wearables,
7 so we've got wearable items that light up in
8 correspondence to the sensor measurements.

9 And the reason we did this is
10 because this isn't just a scientific project for
11 researchers, but it's also for communities and
12 for educators and for young people, so it's a
13 great way to get people involved and engaged
14 instead of looking at their screen, they can
15 actually light up their vest or hold something up
16 that lights up.

17 And it says at the bottom there, it
18 says individual community and government change.
19 These are some screen shots from inside the Air
20 Casting app. On the far left you've got the
21 sensor's dashboard, and this example we're
22 reporting Carbon Oxide particulate matter,
23 breathing rate, heart rate, activity level. And
24 so each of those tiles represents a measurement
25 coming in real-time.

1 Next to that you've got the
2 measurements over time. It's just a simple
3 graph. Next to that you've got your sessions
4 map, so it looks like a line of many colors.
5 It's actually a line consisting of many colored
6 dots, and those dots are laid down one per
7 second, and they correspond with the intensity of
8 the measurements.

9 So in this case, red is highest,
10 green is lowest and yellow and orange are in
11 between. And then on the far right you've got
12 the Crowd Map. You've got your individual
13 measurements from the session, as you're going
14 along taking measurements, and then you can see
15 underneath that, here is your session route and
16 underneath that is the Crowd Map. So those are
17 all the measurements taken over all time that
18 have been averaged together and displayed as
19 colored blocks.

20 It looks the same when you go
21 on-line, just a bigger screen. You're able to
22 put more things on the screen at once. This is
23 an E cycling from Brooklyn over into downtown
24 Manhattan, and you can see, let me see if I can
25 shoot a laser. I got one spike here which

1 corresponds to this spike here, and that's me
2 behind a dirty diesel van going over a roadway
3 that's recently been ripped up to be repaved.

4 And so it's not as long in duration,
5 and the peak is not as high as this next with one
6 which is the confluence of sources from the FDR
7 Drive, subways entering and exiting because they
8 travel over the Manhattan bridge. And every time
9 they enter the tunnel, they eject particles and
10 then also the traffic backing up going back ways
11 in the Manhattan bridge. So you can really start
12 to see these patterns again and again, you'll see
13 this background concentration and then you
14 encounter a source, background concentration you
15 encounter a source.

16 So you see that again and again when
17 you're recording mobile data. This is actually
18 sound levels. This is a very clean example. We
19 record sound levels because every phone has a
20 microphone and it's also the number one complaint
21 in the New York City 341 hotline. And so here's
22 Prospect Park, a big park in Brooklyn, you get
23 more green block. A neighborhood right here,
24 Park Slope, you get more yellow.

25 Come down to the Oswego Canal where

1 you've got residents mixing in with commercial
2 and industrial and you get more of these orange
3 blocks. This is the Air Casting family. These
4 are some of the instruments that connected in the
5 Air Casting platform. I mentioned the air
6 beaming instrument that we created, but there's
7 lots of different instruments that connected with
8 Air Casting platform. I want to show a few of
9 those.

10 This is something called the
11 Terrier. It was made by a gentleman named Nick
12 Vasong who some you may know. At the time he was
13 working for a company called Multitude which then
14 got bought by Q-Sense. They developed this
15 instrument which measures NO, CO and CO2 and then
16 they plugged them into the Air Casting platform
17 to be able to provide some real-time feedback for
18 the people that are using it, and they pull their
19 data out the other side. So here, the Air
20 Casting platform had a utility for them because
21 they could focus on making their instrument, and
22 they could focus on what was really important for
23 them which was taking the data out and doing
24 third party analytics on it.

25 So the Air Casting solved a problem

1 for them in the sense that they didn't need to
2 create a platform for visualizing and storing the
3 data. This is a Zephyr Bio harness. So like I
4 said, it doesn't just take air quality
5 measurements. It takes physiological
6 measurements as well. This is a commercial
7 product from a company. It costs about 500
8 dollars, and it does come in the parameters I
9 mentioned earlier, such as activity level, heart
10 rate, R to R.

11 This was a device that's
12 commercially available that had something called
13 a software development kit that we use to patch
14 their measurements into our system so we are have
15 instruments that people create to intentionally
16 patch into Air Casting. We have instruments that
17 are already available on the market and you can
18 adapt and then we have things like the Air Beam
19 that we created ourselves.

20 Comparing the Air Beam to this
21 instrument, this is the instrument that Holger is
22 using now with the now with New York City
23 Community Air Survey. It costs 5,000 dollars and
24 weighs two and-a-half pounds. The Air Beam costs
25 250 dollars, so one 20th the price and one fifth

1 the weight at half a pound. It's not as accurate
2 and doesn't have as big of a range as the Thermo
3 Scientific BR1500, but it compares comparably
4 well.

5 So this is an example of how these
6 instruments are coming down in price and
7 disrupting these types of instruments. This is
8 not an -- instrument, but it's another portable
9 that wasn't that portable and wasn't that
10 accurate, so something like the Air Beam can
11 actually compare to it in terms of performance.
12 This is Air Casting Luminescence. We've created
13 a number of different wearables and this is one
14 we most recently created called a Light Beam and
15 we don't sell it, but it's a DIY project, you can
16 do it yourself project, you look it up, follow
17 the instructions and build it.

18 And then I want to provide a few
19 examples. So now you got an idea of how the
20 platform works, all the different instruments you
21 can plug in and here is people actually using it
22 for different applications. This was a
23 collaboration between Columbia University's
24 Mailman School of Public Health and WNYC, the NCR
25 affiliate for New York City. And this woman

1 right here is wearing a vest that probably has 10
2 or 15,000 dollars worth of equipment on it.

3 It's measuring physiological
4 parameters and air quality parameters, and what
5 they're doing is biking and breathing. Well, it
6 doesn't come as a big surprise to people in this
7 room that when you're biking, you breathe harder
8 than if you're walking which means you're getting
9 a bigger dose of these air pollutants, and this
10 is something that's been widely studied, and so
11 what they're doing is they're seeing, you can see
12 in the physiologic, does the breathing rate
13 change, what's happening with people's physiology
14 when they're encountering air pollution.

15 And they've got bicyclists doing it
16 because they're obviously exposed. They're
17 riding in traffic, but they've also got good
18 spatial coverage. They're covering a lot of the
19 city. So that's what the folks said Columbia
20 University is doing, Steve Chilrod and Darby
21 Jacki. And so what does it allow them to do,
22 right. They have maybe 10 of these vests.
23 They're very expensive.

24 They were able to enlarge a number
25 of the people who were participating by not

1 putting everybody with this 10,000 vest, but
2 equipping them with 250 dollar Air Beams and 400
3 Terriers which is that other instrument I showed
4 earlier, and then it also solves the problem for
5 them in terms of collecting the data, visualizing
6 it for the participants and be able to pull it
7 out the other end. These are two projects.

8 First one run by the Minnesota
9 Pollution Control Agency and the second one by
10 Auvergne Rhone Alpes which is a regulatory agency
11 in France that does work in and around Bernabe.
12 And what they've done is they've bought over a
13 dozen Air Beams and Android phones and they run
14 workshops where they check out Air Beams and
15 Android phones to every day folks and they go out
16 and they take measurements and it's primary
17 education and outreach oriented.

18 They're not making policy decisions
19 based on this information. They're not make
20 regulatory decisions but they are doing public
21 outreach and they're educating the public and I
22 think, to a certain extent, they're
23 experimenting, like a lot of people in this room
24 are interested in let's start using this
25 technology to see where it leads us to we can

1 evaluate it ourselves.

2 One of the neat things is not only
3 did they buy Air Beams and are checking these
4 things out and running programs, but they've also
5 are coded, so they've taken Air Casting and they
6 set it up on their own servers. When they
7 collect data with the Android device, it doesn't
8 go to our server at Air Casting Dot Org, it goes
9 to their own server and then gets displayed on
10 their own website, so they can own it. Tim might
11 talk about this later. This is Kids Making
12 Sense. It's a curriculum that Sonoma Technology
13 put together that uses the Air Beam. Here is
14 another example.

15 This time it's a private company
16 that says there's some utility for this. We
17 don't have to invent a device that makes air
18 quality measurements. We don't have to create a
19 platform for visualizing it. We can focus on the
20 curriculum, so they've put together a teachers
21 guide and a curriculum that they've been working
22 with schools and kind of opened up a new line of
23 business for themselves.

24 Closer to home, so it's really
25 exciting for us to see folks all around the world

1 literally using the Air Beam, using the Air
2 Casting platform. But of course we also do our
3 own work and run our own programs mostly in New
4 York City and so this is a report that was put
5 out maybe about a half a year ago. It's called
6 Clearing the Air, How Transforming the Commercial
7 Weight Sector Can Address Air Quality Issues in
8 Environmental Justice Communities.

9 So it was put together by an
10 umbrella group called Transform, Don't Trash, and
11 then this report that we're all members of and
12 this report had assistance from New York Lawyers
13 for Public Interest, New York City Environmental
14 Justice Alliance and Align. And what we did is
15 we partnered with New York City Environmental
16 Justice Alliance and we trained folks, mostly
17 young people from community based organizations,
18 EJ organizations in the Bronx and Brooklyn.

19 So those groups were the point in
20 the South Bronx, El Fuente and Williamsburg and
21 East Williamsburg, Clean Up North Brooklyn in
22 Bushwick and Uprose in Sunset Park. And what we
23 did is we had these people stand at truck
24 intensive intersections, intersections that saw a
25 lot of diesel traffic and they counted trucks and

1 they measured air quality at the same time.

2 And what we found, when we compared
3 their measurements with the measurements taken by
4 the closest DEC, Department of Environmental
5 Conservation monitoring site, was that the
6 pollution over a half hour, the maximum half hour
7 concentration was up to seven times higher than
8 it was at the closest DEC site. And we chose to
9 present as seven times higher as a magnitude as
10 opposed to an absolute value because we were
11 conscientious of the fact that, yes, our
12 instrument is not a reference instrument.

13 But if we're off by an order of
14 magnitude and it's only six times, it's still
15 really bad. This is a map we put together, so a
16 lot of the things some of the people have been
17 mentioning that you collect the data but it's not
18 enough. You have to textualize the data and that
19 could be bringing meteorological data, it could
20 be co-locating with reference instruments.

21 In our case, it meant wherever the
22 truck routes and wherever the waiting transfer
23 stations, so you can see the intersections. One
24 showing the six to eight times ambient here as
25 the maximum half hour concentration and four to

1 six times the ambient here. And all the brown is
2 the truck routes, so this is an incredible
3 density of truck routes, probably more dense than
4 anywhere else in the city.

5 And of the dense concentrations is
6 waste transfer stations in the city. So this
7 report was done to buttress the administration's
8 decision, the De Blasio's administration's
9 decision to do garbage zoning in New York City.

10 What that means is that currently if you're a
11 private business in New York City, you can
12 contract with any private carter to come pick up
13 your waste. For instance, in a single block in
14 midtown Manhattan, you have 79 carters servicing
15 a single block, so that means you're getting 100
16 truck trips, maybe over 200 truck trips a week.

17 So if you zone that, that means that
18 those businesses can now only contract with maybe
19 two, three different carters and those carters
20 win that district by not only having the lowest
21 cost but also having the best environmental
22 performance in terms of what trucks they're
23 running and how they operate their waste transfer
24 stations and also workplace safety, so it's a way
25 of raising the bar at the same time that we're

1 reducing truck traffic which means that we're
2 also improving air quality and reducing air
3 pollution.

4 And so the reason I bring this in as
5 a last example. You were talking about earlier
6 that there's a gap, right. We do this research
7 and people say, did you make a policy impact, did
8 you change people's behavior. That's what we're
9 very much hoping is done now, is to say, we've
10 been doing this since 2011 and the platform works
11 very well now. Certainly all these improvements
12 to be made, but we can really go the next step
13 and we can say how can we leverage this data to
14 inform public policy and change behavior.

15 I'll wrap it up there. If you want
16 to e-mail me at Info at Habitat Map Dot Org.
17 We've got our two community mapping platforms.
18 Habitat Map and Air Casting. Our blog is Taking
19 Space Dot Org, and you can find us on Twitter,
20 Twitter Dot Com Slash Habitat Map. Thank you.

21 (Applause)

22 MR. HANNA: Questions?

23 MR. OPIEKUN: I love the concept of
24 wearables. I think it's a great idea to get
25 people involved in that, but has anybody ever

1 looked at the sustainability of that? In other
2 words, when I used to do industrial hygiene work,
3 a worker at a factory site would not be bothered
4 too much by wearing a monitor for a week, but
5 after that, they'd say it's burdensome or it's
6 getting in the way of what I'm trying to do.
7 When it comes to the public, people who are
8 volunteering to do this, have you seen that it's
9 sustainable over a long period of time? Somebody
10 willing to do monitoring for a week, two weeks, a
11 month, or is it something where interest wanes
12 over time?

13 MR. HEIMBINDER: I think it matters
14 what kind of institution you're embedded in and
15 so you could take the example of Fit Bit fitness
16 trackers. There is a lot of data showing that
17 people will use those for a little while and then
18 throw them in their drawer and never used them
19 again. I'm sure that's happened to a lot of Air
20 Beams bought by individuals who are more
21 interested in seeing what the pollution was like
22 in their house or going for a walk with it and
23 didn't really -- it wasn't sticking for them.

24 So what we've seen is that the
25 groups that are using them consistently and over

1 the long term are embedded within community based
2 organizations, schools, regulatory agencies, and
3 so it's not a wearable in the sense that you're
4 right, it's uncomfortable. You have to make sure
5 it has an air stream so that you can't be putting
6 it in your purse or putting it in your pocket,
7 and it's big.

8 It's still about the size of a hand,
9 so you're absolutely right that I don't think
10 that this is something -- and I think that's one
11 of the reasons why we haven't seen more
12 innovation in this space because there is not a
13 mass consumer market for it, so I think what
14 you're seeing is that the groups that are really
15 using it are the groups that have an agenda and
16 that might be advocacy, that might be outreach,
17 that might be education, but there is something
18 else going on that's driving. It's not just
19 curiosity about one persons individual find.

20 MR. HANNA: Michael, can you give us
21 an idea, and if you did already, forgive me, but
22 the number of subscribers to Air Cast, how many
23 Air Beam units have you sold, how big is the
24 world there?

25 MR. HEIMBINDER: So we've sold about

1 1500 Air Beams and we've got probably over a 150
2 million data points, which seems like a lot, but
3 it's not certainly not even what would be
4 considered big data and that's across all types
5 of -- sound level, air quality and what we see
6 now is we've started setting it up so you can
7 actually do fixed monitoring.

8 Originally the architecture was
9 based on the idea that someone would be wearing
10 it, moving it around. So now we're starting to
11 look towards creating another way of getting data
12 in the platform which is put in this in your
13 house or outside your house and just stream the
14 data 24 hours a day. And what we're seeing is
15 there's a few people who are doing that, not very
16 many, but there are a lot of people who are
17 running projects all around the world.

18 So if you go in and log into Air
19 Casting, every day you'll see anywhere 10 to 30
20 new sessions contributed all around the world and
21 so like anything, it changes over time, so if you
22 look at total downloads for our ap, it's probably
23 10s of thousands, but if you look at people who
24 are actively using it, it's around a thousand, so
25 people are coming on the platform, at the same

1 time people are leaving. It's slowly growing and
2 certainly not astronomical, but incremental over
3 time.

4 MR. BIELORY: The question I have,
5 whenever you have an app or technology, it wears
6 off and the question is, retention you say about
7 1,000 users out of 10,000. Are you saying about
8 a 10 percent retention?

9 MR. HEIMBINDER: I'm saying anybody
10 can download the app even if you don't have an
11 Air Beam, and you can imagine you probably got a
12 lot of apps in your phone. They sit there, you
13 haven't used then. So the thousands are people
14 who are actively using it, like using the app
15 every week at least. Whereas the tens of
16 thousands where the people, historically, since
17 2011 who have downloaded it and used it even
18 once.

19 MR. BIELORY: On an annual basis,
20 you can tell how many downloads you have per year
21 and how many retentions from those few years,
22 usually by e-mail address, you still have data
23 coming in. You can see retention. I'm just
24 curious because as much as kids are into
25 Nintendos and parents are on their iPhones and

1 everything, the retention to an app or to
2 commitment, either you're a scientist or a
3 physician scientist or you're just a peripheral,
4 it's still about 10 percent or less than.

5 MR. HEIMBINDER: I don't know what
6 it would be percentage wise. One of the things
7 we run into being a small non profit is that
8 you're swamped with analytics. We got analytics
9 for our app, we got analytics for our website.
10 You could dig through the data and do more
11 analytics, but we don't have the resources to do
12 that.

13 So all I can say is my observations
14 are anecdotal as opposed to be based on all the
15 analytics that are available that we haven't
16 actually delved into, but again, it's the groups.
17 It's the individuals who are anchored by an
18 institution who continue to participate and it's
19 the people who are dropping out tend to be people
20 who are not part of an institutional effort.

21 MR. BIELORY: Thank you.

22 (Applause)

23 MR. HANNA: We'll keep moving. Jeff
24 Knapp is the president and CEO of Smart Connect
25 Technologies, and Jeff has significant experience

1 with technology companies offering a wide array
2 of integrated hardware and software and services
3 solutions. I think we'll talk about some more
4 about data, big data. Welcome, Jeff. Thank you.

5 MR. KNAPP: Thank you, Toby, and
6 thank you to the council for inviting me to
7 present and testify. Let's see if I can figure
8 this out. We are a bit different than who we've
9 been hearing from, although everybody, virtually
10 everybody has touched to some degree, if not
11 significantly on the importance and the value of
12 actually being able to utilize the data that's
13 generated from these various sensors, these
14 monitors, leveraging the platform and there's
15 been some great discussion and presentation of a
16 lot of alternatives.

17 What we are is a company that is
18 focused entirely on accessing and capturing data
19 and facilitating the presentation and delivery of
20 that data to the Cloud, to analytics platform or
21 to a customer platform and facilitating a
22 dashboard, presentation, if you will, so that the
23 client, the customer, the user can really take
24 advantage and leverage the information that comes
25 from the data.

1 We're completely agnostic as it
2 relates to the hardware. We work with literally
3 any device and that's one of the real
4 differentiators between us and I think some of
5 the other solutions that I'm familiar with. So
6 Smart Connect Technologies was formed to create
7 this platform to leverage the data automation and
8 analytics opportunity, if you will, and
9 requirements that people have in this big data
10 world.

11 We do have a proprietary solution.
12 The software is patent pending. The actual
13 gateway that we offer to interface with the
14 sensors that we work with or the machines or the
15 equipment that is the software in and off the
16 shelf hardware platform. I'm going to go through
17 some of the more sales oriented elements here,
18 but it has been recognized with a number of
19 different awards which really speaks to the value
20 of an application that a customer derives from
21 the data.

22 It always comes back to how are we
23 utilizing the data. We have invested a lot of
24 time and energy in creating a strategic
25 relationship with IBM and integrated with all of

1 their Cloud applications, if you will, Cloudbant,
2 DashDB, the Watson Analytics platform. We
3 present ourselves as an industrial internet of
4 things, IOT technology company. Although we work
5 with virtually any platform, any company.

6 As I said, completely agnostic as it
7 relates to hardware. So as I was saying, we
8 enable connectivity to any device, any platform,
9 any machine. And what's really interesting is it
10 can be an existing sensor a ray of sensors or
11 monitors. It could be existing IP enabled
12 devices or it could be legacy equipment. It
13 could be machines, it could be boilers in a smart
14 building or smart infrastructure environment. It
15 could be HVAC systems.

16 It could be cameras, and it's all
17 able to be aggregated into a single platform, if
18 you will. First a single database, which we will
19 clean the data and normalize the data and prepare
20 it for presentation to the Cloud or to a client
21 application platform. We have a significant
22 relationship with Dell as well, but again, any
23 system works, any hardware platform works, and
24 the value is in the opportunity to make
25 decisions.

1 Obviously, as it relates to air
2 quality in the environment to make decisions
3 regarding utilization, traffic flow, adjustments
4 in population areas, you know, obviously health
5 and wellness related decisions as it relates to
6 larger corporate opportunities, if you will,
7 there's a huge preventive maintenance opportunity
8 in a lot of these areas.

9 And as you can imagine, the
10 opportunity to optimize performance and leverage
11 resources makes a lot of sense. I mentioned the
12 relationships with IBM and with Dell. And what's
13 really interesting, if you look at a lot of the
14 studies, and I'm sure most of you have, the value
15 proposition associated with how the big data
16 marketplace is evolving is truly immense.

17 Clearly, IOT is the next wave of
18 opportunity. We, as an organization, are focused
19 on transportation, manufacturing and smart city,
20 smart infrastructure where air and water quality
21 fit, if you will. And the value impact as
22 quantified by McKinsey is obviously so
23 significant. It's incredible and
24 interoperability is critical as well if you're
25 going to allow municipalities or corporations to

1 really leverage, efficiently leverage input from
2 a whole array of different sensors and different
3 devices and machines effectively.

4 That's where we're focused. We're
5 on that front end of the continuum, if you will,
6 and I'll show you that. And obviously, the
7 differentiator for us is the fact that not only
8 are able to access and capture data from any
9 device or any machine, we can do it much more
10 quickly and for much less cost than traditional
11 solutions, if you will. We don't require any
12 programming, no proprietary driver to access and
13 capture data from the edge, even if it's not an
14 IP enabled device.

15 I'll say fairly unique. I'm not
16 aware of anybody else that does it the way that
17 we do it. So we don't require integration on the
18 frond end. That's a huge cost component when
19 you're trying to capture data from a diverse
20 array of machines or devices or sensors, if you
21 will. If you look at the continuum, if you will,
22 the IOT data access and transfer continuum, we
23 really are focused on the connectivity and
24 management side of the equation which is the
25 front end at the edge, if you will.

1 And then we will hand that data off
2 to an analytic platform, whether it's proprietary
3 platform or Watson Analytics, whatever it might
4 be or we can deliver that directly to a client
5 application. It could be an asset management
6 system. Like IBM's maximal access management
7 system, for example, if you're familiar with it,
8 we can deliver data, integrate it with Maximo, so
9 they can actually monitor.

10 We have gateways on buses that are
11 monitoring all the different sensors on the bus
12 so we can literally help the client predict when
13 maintenance is required and mitigate breakdowns,
14 obviously, enhance customer satisfaction and
15 route performance, if you will, but mitigate
16 break downs, completely virtually eliminate false
17 alarms and proactively schedule maintenance so
18 the deployment of resources is enhanced
19 dramatically and the data is delivered directly
20 to their asset management system, for example,
21 and automatically will create, print and generate
22 a maintenance statement, schedule resources, and
23 it's all automatic, so that's where we are in
24 this continuum, if you will.

25 The other thing that's very

1 interesting is, there's the opportunity to
2 aggregate data from all these different data
3 sources, different machines, different devices,
4 different sensors into a single database. And
5 the user, if you will, the customer, the
6 municipality, whatever the user might be, can
7 actually, you know, manage via the phone or
8 remotely or from a command center or console,
9 whatever it might be, can control the devices, if
10 you will, can control the sensors, can control
11 the machines, can actually turn them on or off,
12 can change the parameters.

13 We'll calibrate, working with a
14 customer, the sensor parameters, if you will, and
15 automatically generate an alert or a message or
16 an e-mail or a text message to whoever the
17 recipients need to be, whether it's executive
18 management or a command center or emergency
19 response, whatever it might be. And if a
20 customer wants to adjust remotely the parameter
21 settings for any of these devices, they can do
22 so.

23 I think this is, I've talked through
24 most of these points. As far as the business
25 model goes, we are as flexible as we can be and

1 work with the client environment. Sometimes
2 software as a service model makes a lot of sense,
3 depending upon the client environment. Sometimes
4 a more traditional license model makes more sense
5 and we are able to work in both of those areas,
6 if you will.

7 I think I've addressed most of these
8 points. I don't want to be redundant. We can
9 also aggregate data from a variety of different
10 sources, so I mentioned we will access and
11 capture data from the various sensors. We can
12 obviously aggregate that with weather station
13 data for example. We can be collecting
14 information on particulates or hydrogen sulfide,
15 whatever you're monitoring, any number of those
16 monitors and aggregate that with weather data, if
17 you will and other it could be data generated
18 from cameras or other surveillance technology and
19 present that to the analytics platform.

20 So again, let's talk a little more
21 specifically about air quality. This is just a
22 visual that talks about collecting the data from
23 the edge, delivering it to the Cloud and
24 ultimately having it reflected in the dashboard
25 view, and we've seen a couple of really exciting

1 dashboard views, some great platforms today
2 already. It's really a very simple limitation.
3 We've deployed a sense of the gateways.

4 We set up our server which is really
5 our software in this off the shelf hardware. We
6 configure the sensors, we calibrate them, we
7 establish the diagnostic codes, correlate them
8 with the parameters for measuring, if you will,
9 the thresholds for messaging and alerts, test it
10 and that's it. From an implementation point of
11 view, it is as simple as it could be.

12 It's really, relatively speaking,
13 not costly at all because, again, no programming,
14 so we don't need technical engineering support on
15 the implementation side. There is no
16 programming, there is no proprietary driver being
17 written. It's all configurable and to actually
18 install a gateway, oftentimes we'll spend half a
19 day, train a customer, electrician, if you will,
20 and then they can actually implement gateways
21 across the organization, or of course we can do
22 it, but the customer doesn't need us to do it.

23 Everything is configurable and very
24 intuitive. So what are some of the real world
25 deployments. You know, the one thing I'll

1 preface this with is ignore the dollar figures
2 because this is pre our software services model.
3 It may or may not be really applicable, and of
4 course every environment is different. We did a
5 project for the EPA actually where we actually
6 outfitted a vehicle with various sensors and they
7 asked us to drive across the country.

8 We spent six weeks going around the
9 country and they were capturing data on air
10 quality and obviously different levels of
11 different substances, if you will, across the
12 country. Southeast, southwest, literally six
13 weeks driving around the United States. And that
14 information is obviously was captured, put into a
15 database and then delivered to an EPA platform.
16 This is an implementation in Australia. In fact,
17 this implementation received an award.

18 This was Department of Environmental
19 Conservation in Australia won an award for the
20 best use of broad banding government by deploying
21 our G pack system which is our smart connect
22 gateway technology and using it for real-time
23 pollution monitoring. What happened was there
24 was a number of constituents in this area of
25 Australia, residents of this area were really

1 upset because there was significant hydrogen
2 sulfide.

3 Obviously, the smell was
4 overwhelming. There had been some
5 reconfiguration of the coast and they were really
6 upset and it became a whole political -- they
7 could not seem, for whatever reason, monitor
8 effectively and persuade the citizenry of exactly
9 what the status was and we instrumented there and
10 they were able to capture information and
11 validate to the citizens that in fact, it was a
12 safe environment and of course they were able to
13 also rationalize some adjustments in some of the
14 seashore, if you will, beach construction, let's
15 call it.

16 We have an implementation in
17 California. This is the California Department of
18 Primarily Health Laboratory. It's actually a
19 Homeland Security facility, and they were having
20 a very difficult time. This is strictly a
21 software implementation. They used their own
22 internal existing sensors and existing hardware
23 and they were having a very difficult time
24 alerting and reacting to changes in the local air
25 environment.

1 There are some oil distilleries and
2 manufacturing facilities is right next to this
3 facility, and they were very sensitive to changes
4 in the air quality, if you will. It was
5 important for them to be able to manage and
6 monitor that, so this facility was able to use
7 our system to monitor both the weather and
8 specific pollutants in the air, if you will, and
9 mold, air traveling mold as well and now they
10 have an opportunity and an ability to issue
11 alerts literally when the wind changes and
12 they're concerned about the air quality over
13 their health facility changing significantly.

14 They issue alerts and they make the
15 adjustments operationally that they need to make
16 whether that's shutting windows, whatever that
17 might be. So there is a limitless number of
18 different applications, any application in any
19 sense. We've actually worked with and tested
20 literally hundreds of sensors and if a client, I
21 don't know that that's the case here, and there
22 is some great alternative, if a client or a
23 municipality wanted us to provide the sensors, we
24 could do that, but we would be looking to some of
25 the folks that are in that space. We are

1 providing a gateway. We're accessing and
2 capturing data and we're agnostic as it relates
3 to everything else. And that's it.

4 (Applause)

5 MR. HANNA: Thank you, Jeff.

6 Questions for Jeff?

7 MR. BIELORY: You're integrated or
8 you're supported by IBM at this point in time?

9 MR. KNAPP: We work with them on
10 various projects. They actually have involved us
11 in some water quality projects in the Atlanta
12 area and in fact invited us to --

13 MR. BIELORY: The reason I'm asking,
14 IBM has purchased Weather Underground, so I was
15 wondering whether you're integrating that
16 information into your system.

17 MR. KNAPP: Yes, we can as any other
18 data source.

19 MR. BIELORY: You haven't yet.

20 MR. KNAPP: We have not, no.

21 MR. BIELORY: I was just curious
22 because of that relationship.

23 MR. KNAPP: But that's simply
24 another source of data. There's nothing unique
25 about that.

1 MR. BIELORY: Okay.

2 MR. KNAPP: Thank you.

3 MR. HANNA: Thanks, Jeff.

4 (Applause)

5 MR. HANNA: Tim, come on up. Tim is
6 senior vice president at Sonoma Technology. Tim
7 directs his knowledge in creativity towards the
8 design and development of innovative information
9 systems such as Air Now, Air Now International
10 and Smog City Two. He's a recognized leader in
11 low cost citizen based air quality monitoring and
12 has led many efforts involving low cost air
13 sensors.

14 MR. DYE: It is a pleasure to be
15 here and to testify in front of everybody. I've
16 got to disclose something because 37 years ago I
17 was actually doing some Citizen Science here in
18 New Jersey because I was a high school student
19 and I grew up here, backyard weather measurements
20 and we crowd source that information with a North
21 Jersey Weather Observers and I think it's really
22 from that start that I got a little passion for
23 making measurements and making personal
24 measurements and taking that responsibility and
25 that really continues today.

1 I work at a company and I have
2 worked at a company since I graduated from Penn
3 State, Sonoma Technology. We are an air quality
4 consulting firm, do a lot of measurements,
5 modeling, various things for industry government
6 and so forth, and what I want to talk about
7 today. I've got lots of information here. So
8 what I want to talk about is a couple of things.

9 One is just where are we at in this
10 path of development and use of sensors, and then
11 I want to talk about five projects that we've
12 done. These are real world projects working for
13 the industry, state and local air quality
14 agencies as well as the education, a couple
15 education projects. And lastly I want to
16 conclude with some lessons that we've learned
17 that you can take away in using this technology.

18 So those are the five studies I'm
19 going to talk about. They're all focused on PM,
20 and with a good reason because those are the
21 sensors that are working reasonably well right
22 now as Andrea talked about this morning. This is
23 our path kind of forward as a big picture. The
24 first issue is how good are these sensors.
25 There's lots of work that's been done by Andrea,

1 EPA, folks in Europe. Some of the sensors are
2 actually working quite well and encouraging.

3 The next question we all need to ask
4 is how useful are these and that's where I want
5 to talk about. We've deployed these on a range
6 of different projects and show you some potential
7 applications of this technology. And then lastly
8 is going to be the question is how sustainable is
9 this, and I'll come back to that at the end of
10 the talk.

11 The first project that we did for
12 the industry and this was for the Electric Power
13 Research Institute. They were interested in
14 looking at this technology and putting to test
15 dust that's blown off of a coal pile near an
16 electric generation facility, so what we did was
17 we deployed reference equipment and then we also
18 in that little teepee there, we deployed a couple
19 of sensors.

20 One was the Air Beam and the other
21 one was the Dylos that sits in the back of the
22 room. We ran this for a two month study and then
23 what we found was these bursts of coal dust that
24 were coming off the pile were very short in
25 duration, only lasting about a minute or

1 two minutes and we were able to detect that with
2 the micro sensors and the reference instrument
3 that we have there which is shown by the blue
4 line provided hourly measurements and that was a
5 BAM 1020 for measuring PM 10.

6 Interestingly enough, it only
7 measures about 52 minutes in the hours and
8 doesn't measure eight minutes, so it actually
9 misses some. When we do a scatter plot, we
10 compare the reference to the sensor over on the
11 left is a non event. It doesn't do that well,
12 but if we just single the data out and just look
13 at the events, these one or two second little
14 bursts, we can see there is some correlation, and
15 the sponsor of this, they said, well, this can be
16 used as an event detector. Maybe we can see if
17 it's low, medium or high.

18 So we're doing a follow on study
19 with them deploying some sensors around the coal
20 pile and all that data streaming in six times a
21 minute and available to be viewed on our web
22 site. The second study was for the Santa Barbara
23 Air Pollution Control District and they were
24 interested in setting up a PM monitoring network
25 at schools in an agricultural community to

1 monitor dust and when dust was kicked up by
2 agricultural activities.

3 So the first phase of the project
4 was to ask the question how reliable are the
5 sensors, so we deployed two sensors. One was the
6 Air Beam and the other was an Alphasense sensor.
7 We put those in those tin cans that are there and
8 then ran that co-located next to a bunch of
9 reference equipment and what we found out was the
10 Air Beam didn't do quite as well for measuring PM
11 10 for mag test, but the Alphasense sensor
12 performed quite well, very good correlation with
13 the reference sensor.

14 And then when we compared one
15 Alphasense to another, saw a very good precision,
16 and that was enough to finish that study and to
17 say, okay, it is possible to then deploy a
18 network of these lower cost sensors in this ag
19 region for monitoring dust as it's kicked up. So
20 that's one study. This is another one, actually
21 that we just completed.

22 It was for the Sacramento
23 Metropolitan Air Quality Management District, and
24 the district has a residential wood burning
25 program where they will voluntary and then also

1 mandate citizens, not to burn during certain
2 nights during the winter, burn their wood stoves
3 or fireplace, and the idea is to reduce PM
4 levels. This study is utilizing sensors to look
5 at the spatial representativeness of wood smoke
6 in that area and what they also wanted to figure
7 out was their communication strategy to all the
8 different communities who speak different
9 languages and bring in information different
10 ways.

11 How effective was that, so we're
12 coupling both low cost sensors, some high cost
13 instruments along with a community survey to try
14 and tease out that information about how
15 effective their communication is. This is
16 showing the set up. They recruited some citizens
17 from the community. That's one of their back
18 yards. It has a little -- Michael showed the Air
19 Beam. The Air Beam sits on top of that white box
20 and it's got a little hood to protect it from
21 rain.

22 That data is then streaming in via
23 cellular about every minute or so to our data
24 center. We also, in all the studies that we've
25 done, and continue to do, we always co-locate

1 sensors next to reference instruments. That
2 provides a really good base and comparison,
3 absolutely critical right now. The technology
4 can't be used solely by itself. With this slide,
5 this is showing the dashboard that we developed
6 and used so we could monitor the data streaming
7 in every minute from the sensors as well as the
8 reference instruments and look down at the bottom
9 and see how things are trending and identify
10 areas that had higher PM or lower PM.

11 So we've set up the whole data
12 system to bring all that information in real
13 real-time. This is kind of a very different
14 study. We purchased about 30 of the Air Beams
15 for our program that I'll talk about in a minute,
16 one of our education programs. Actually, we
17 purchased 50, but we wanted to use 30 to just do
18 an ad hock study with a local community. We
19 decided to give out these sensors to citizens,
20 school kids and some employees and we said, hey,
21 just go out and start measuring, see what you
22 find.

23 There was no objective. What we
24 actually wanted to do is we wanted to collect a
25 bunch of data and to see what are some of the

1 messy things that we're going to find on this
2 data and how are we going to manage this data,
3 and what are the things that we need to start
4 thinking about in terms of managing these data
5 sensors in the future. So I want to share with
6 you a couple of things. This is showing the
7 crowd source map.

8 We ran it over a couple of days, and
9 this is using the platform that Michael talked
10 about, the Air Casting platform and then it's
11 showing you collectively each day, as more and
12 more people are out driving around, walking
13 around, sitting in their house making
14 measurements, all of that information gets crowd
15 source and the map gets filled in. This was one
16 of the interesting things. Someone walked down
17 in the city and we looked at the data and
18 actually went inside. Outside the PM levels were
19 relatively.

20 Once they walked in the coffee shop,
21 PM levels went really high. Once they walked
22 back outside, they went down again, so we started
23 looking at the data and trying to figure out, how
24 are we going to tease out that information
25 because now all of a sudden we're blurring

1 outdoor air and indoor air, so we found some
2 differences in relative humidity and temperature
3 that we could key in on and write some analytics
4 to tease out that information from the data.

5 This was someone walking around and
6 each little blue dot they're making notes. When
7 they made the notes, you could actually look in
8 there and it said wood smoke and one of the
9 things that's kind of interesting is the wood
10 smoke is not spread over the entire city. It's
11 very isolated initially when it's coming out.
12 Now, ultimately, it does disperse. The last
13 program here is Michael talked briefly about it
14 but it's Kids Making Sense.

15 It's purely an educational program.
16 Michael and Sonoma Technology developed it
17 originally. We've taken it and developed a whole
18 curriculum around it. We've given these courses
19 in New York, all parts of California, Taiwan,
20 Thailand and other areas. It's basically we go
21 in and teach kids about particulate matter,
22 pollution, the sources, what to do about it, the
23 health effects and then they take an Air Beam and
24 go out and measure.

25 They break up into teams, say you

1 have five or six or 10 teams, they go out and
2 make measurements. They discover things like
3 this was one group in the New York City subway
4 system and they were wondering why there is high
5 concentrations there, so we did that. The crowd
6 sourcing information. Here is all the materials.
7 There is training materials, there's sensors,
8 there is a website.

9 You can learn more at Kids Making
10 Sense Dot Org. So key challenges that we face.
11 Technology is changing really rapidly. Lots of
12 hardware issues we've had to deal with, but
13 lifetime is unknown of these. We've had things
14 last minutes. We've had an Air Beam that we
15 deployed all winter long in Northern Minnesota
16 outside. It was kind of reckless what we did but
17 it worked all winter. We don't endorse Air Beams
18 or any of the instruments here. I'm just giving
19 you some anecdotal information.

20 Data logging is an issue as where
21 does this information get stored locally, how do
22 you communicate it. We heard from the previous
23 speaker about how do you communicate that. That
24 become very costly and is still challenging.
25 This is an area that we're really focusing on is

1 data management. How do we get all this data in,
2 quality control it, average it and interpret it
3 and it's an area that we're focusing on, we've
4 developed some software and systems to do this.

5 Andrea touched on this earlier today
6 about the cost. While an individual sensor may
7 be relatively low cost, looking at all the
8 complete operations, over the whole life span of
9 a project, all of a sudden becomes a lot more
10 intensive and more costly. And one of the things
11 that we're starting to pay more attention to is
12 scale. It's one thing to run three sensors of 10
13 or a 100 or a thousand or even 10,000 and we have
14 to start thinking about different paradigms.

15 Normally we think about repairing
16 instruments or equipment. Maybe we need to start
17 thinking about it's partly disposable. If it
18 breaks, you just send them a new one and it's
19 broken. I don't like to think that way, but in
20 order to handle the scale of a thousand or
21 10,000, we have to start to think about things
22 differently. So I think many groups have
23 evaluated this, us, and many, many others and
24 finding that there is some good promise there.

25 There's lots of groups that are

1 starting to do pilot projects to figure out
2 useful is this information and how do you use and
3 when can we not use. That's going to happen for
4 the next three to 10 years or so as we discover
5 new technology. I think one area we need to
6 watch is how sustainable is this. What sort of
7 businesses and organizations in this eco system
8 are established to help provide quality
9 instruments, provide quality data management,
10 provide quality interpretation.

11 Ultimately, that's what's going to
12 make this sustainable over the long term and
13 that's the continuum we're on. That's my
14 information. I'm very passionate about this
15 topic, excited about it. I'd like to talk to you
16 more about it and thank you.

17 (Applause)

18 MR. HANNA: Tim, I'm interested in
19 the evaluation you worked on, the private sector.
20 Any other work that you know of that, or that
21 you've been involved in that's been really on the
22 private sector side? So much of what we've been
23 talking about has been public in the community or
24 the government agencies. Do you have any other
25 examples that you know of?

1 MR. DYE: There is no examples. I'm
2 trying to think right. There are no examples of
3 projects that I have. There have been a number
4 of discussion about that and it's mostly for
5 monitoring what's going on to make better
6 decisions. That's, I think, why everyone is
7 interested in this. What sort of decisions can
8 be made about processes of handling coal, and
9 there's also, without this technology there's
10 actually not an easy way to figure out cause and
11 effect relationships.

12 What on a particular coal pile is
13 causing the dust to be elevated and then where
14 does it really impact. And that association is
15 hard to do. With sensors, now, all of a sudden
16 we have real-time data. There have been similar
17 discussions with some other groups about forest
18 projects and handling forest projects like paper
19 pulp mill and there's lots of particulate matter
20 there and how they might use this information.

21 A lot of it boils down to first
22 doing a pilot project to evaluate the quality of
23 the data in that particular environment because
24 what works in south coast may not necessarily
25 work in environments say in a very tropical area

1 or a really dry area or a cold area, so that's
2 how these are starting a number of discussions.

3 MR. HANNA: That's a way to build
4 the trust around the technology and the
5 reliability around it. I think lightly put, that
6 private sector is concerned about finding more
7 problems with the technology, but the glass half
8 full is that you're going to find solutions
9 easier, too, I think.

10 MR. DYE: Right, yeah.

11 MR. HANNA: That's the point. Okay.
12 Any other questions for Tim? Thank you, Tim.

13 (Applause)

14 (Whereupon a break was taken.)

15 MR. HANNA: Just to remind
16 everybody, Geoff Henshaw is the Chief Technology
17 Officer and founder at Aeroqual, and we have one
18 of your units in the back of the room, Jeff.
19 We've been checking them out all day. It's shown
20 us that we have pretty good air quality in the
21 room today. We haven't spoiled that. Welcome.
22 We'll have you on for 20 minutes or so, and then
23 from there, we're going to break into a round
24 table discussion and you're welcome to stay with
25 us for that. That will go another 40 minutes or

1 so, but give everybody here a little more chance
2 to talk together, but go ahead, Geoff. Take it
3 away. Thank you.

4 MR. HENSHAW: Thank you very much
5 for this opportunity to speak with you. My
6 presentation this afternoon involving the
7 performance and application of low cost
8 instruments for Ozone NO2 and PM. The work with
9 these standards in terms of developing new
10 instrumentation. Just a little bit of
11 background. We've been going for about 10,
12 15 years looking at developing instruments for
13 measurements of air quality, and we've been
14 working for about 10 years now.

15 So I'll start off talking about some
16 of the motivations for low cost instruments in
17 the actual ambient space. I think there is a
18 growing awareness from the public that they're
19 aware of the health impacts of air pollutants.
20 Questions like what am I exposed to, and how do I
21 reduce my exposure, and urban landscapes are very
22 complex and pollutant levels have been shown to
23 vary spatially and temporally.

24 Looking at existing NAMS stations
25 may not adequately portray the air quality

1 situation on the street, and what I mean by that
2 is, you know, within communities and with the
3 people moving about, so I think around people and
4 enabling people to get information around what
5 they are exposed to and along the line, ideas
6 around more data spatially, we develop greater
7 insight into the causes of pollutants and through
8 greater insight we have the potential to develop
9 new mitigation means and hopefully generate
10 (inaudible).

11 Those are some of the motivations
12 for lower cost measurements. This is based on
13 the evolution of the air quality monitoring.
14 Very quickly, existing systems, large stations,
15 they're expensive. We have stack monitoring and
16 then public reporting and the systems which are
17 much more community focused and shorter duration,
18 perhaps rapid response and then leading into
19 ideas around putting into (inaudible) their
20 station and generating more insight that would
21 enable cities to produce more (inaudible) spaces.

22 So that's really the evolution from
23 expensive relatively low density measurements to
24 less expensive and high density measurements. I
25 think it's important to understand what we mean

1 by low cost. When we talk about sensors, these
2 are typically in the range of a few dollars to up
3 to a hundred dollars, and they, you know, produce
4 an output into voltage of power into a pulse in
5 response to an analyte. They're very much a
6 device that needs support. They're not
7 calibrating normally.

8 They don't have any packaging around
9 them, and you need to add all those things to
10 make instruments generate (inaudible) those
11 things already designed into so they're a little
12 bit more expensive. They should be calibrated
13 and output of into parts per million from, data
14 logging or communication system, and encourages
15 enabling them for them to be deployed. And I
16 think what's interesting, and a challenge for
17 manufacturers, is what it's often thought to be
18 synonymous or simple to use, small portable
19 reliable easy to (inaudible) which people are
20 looking and users ahead of low cost to buy.

21 And this could be a challenge, and
22 should be a low cost system. Low cost
23 instruments can actually perform pretty well and
24 I was thinking back looking at the data from 2005
25 where a community group at Houston, an example of

1 their (inaudible). They turn them upside down
2 and stuck them underneath a plastic water shelter
3 with the bottom cut off and a beam to the top.

4 We're interested to see how they
5 performed because they had some questions around
6 the validity of data coming from their monitors
7 in the region. They have deployed these units
8 and located them in a station, ran for a couple
9 of months. (Inaudible) produced over every
10 couple of months. This is the hourly average of
11 the 500 monitors, one of the two monitors
12 operated in Houston.

13 Two time period and then a few
14 minutes later, apply a project or look at the
15 data quality, and this, which is described within
16 the European Union framework for equivalent.
17 They have a copy. It is an instrument, meet
18 criteria associated with potential quality meets
19 the (inaudible) can be considered equivalent.

20 These are one of the cases of --
21 where you determine the frequency between the
22 candidates and the region instruments and listen
23 for (inaudible) and if we use it later on, we can
24 see that it passes at a limit value of 75 PPB.
25 This is indicating a low cost design can produce

1 data of a quality that meets the equivalent
2 requirements for us, so this is an example where
3 there's been a real improvement in the quality
4 data coming from the low cost instruments.

5 Not all sensors are the same, and
6 I'm sure around some of the issues around taking
7 the system and making them work to a wide range
8 of sensors. They often have stability issues
9 around temperature and humidity which needs to be
10 mitigated. But what's interesting is generally,
11 that these facilities are pretty good (inaudible)
12 which is appropriate for deployment and
13 measurements. So it's really a challenge around
14 developing needs to be selective, using these
15 devices and trying to overcome some of the
16 interferences. I'm going to talk a little bit
17 about NO₂ in more detail.

18 One of the things we've been looking
19 at is our ozone is actually pretty selective and
20 we're looking at ways in which that is coming
21 (inaudible) NO₂ electrochemical have very strong
22 deterrent from ozone and NO₂ chemicals measure
23 both ozone NO₂. By ensuring both side by side
24 and using the ozone vapor ozone, we can remove or
25 remove that ozone.

1 And even an example of calibration,
2 calibration data and the chamber where we have
3 offers in orange, the calculated NO2 which is the
4 measurements from chemical from the ozone sensor,
5 and then we can remove it moving them with the
6 ozone and keeping them with the measurement, so
7 it's now following the red line to analyze it.
8 So yeah, we have been developing a new design for
9 measurement of ozone, and this is a unit which
10 we're looking to deployed in larger with high
11 (inaudible).

12 It's using AQY, NO2 which has
13 corrected. Low cost optical PM 2.5 and trying
14 (inaudible). They come factory calibrated and
15 calibrated those instruments. It comes cellular
16 communication and switching the (inaudible) with
17 the data, which then has a data down buy the
18 associates with that. Factory calibration is
19 something that is a significant cost to an
20 overall instrument cost, and it's something
21 that -- and when you start doing of inter
22 calibrations, it's a trade off around if you want
23 to make that calibration.

24 So you think about heading
25 (inaudible) and you would set manufacturers

1 towards whether you're capable of zero and
2 standard deviation and happening up there, the
3 variation between devices means that you are at a
4 higher, higher precision and the cost implication
5 and we are looking at standard deviations and the
6 mentions of devices.

7 Two PPB and the deviations of slope
8 of about .03, so we exceed that, so these are the
9 sort of trade offs that we need to consider as a
10 manufacturer when you're manufacturing pieces and
11 instruments, what we will be able to look at the
12 calibrations that you want to produce. So taking
13 this prototype, we will be able to do two things
14 and we have a 10 units co-located at a station
15 beside near our motorway passes and Auckland, New
16 Zealand and what we're looking to do is take the
17 lab calibration, selectivity and stability during
18 this six months.

19 You can see it's above the station.
20 That's typical of Auckland and so this is the
21 fifth week of data from our ozone NO2 sensors
22 where we are measuring ozone and at the PPB. And
23 you can see you have the unit, the line is in
24 (inaudible) you see very good correlation, you
25 know, to also showing that if we remove the ozone

1 and now tracking you know, so very well. So
2 after a month of data you can still see the
3 beginning of stability and of these conditions.

4 In both, the reference is very well.
5 PM data one week. That continues operating at
6 the same cycle, and variations of a couple of
7 micrograms. That PM 2.5 is a little bit more for
8 PM 10 indicating there is some instruments
9 variations, but it looks to be mostly around this
10 correlation and here is the data for a month.
11 Under these conditions it is starting to be clean
12 and we do see good stability of the zero. So the
13 correlations of that period, again, there is a
14 reference .98 for ozone, point 82 for NO2.

15 And those are 24 hour averages, and
16 in the instruments, ozone 5.99, NO2, point 86.
17 Levels for 2.25 is also a result of what we're
18 measuring so that's close to the resolution of
19 the instrument. That's very high PM 10. Very
20 specific we can take pick up from temperature and
21 humidity. These are plots of the difference
22 between the reference and the instrument.

23 Reaction of either temperature or
24 core humidity and these are correlations, so the
25 instruments are not responding strongly to

1 changes in more humidity over the range of -- as
2 part of this project we've been working with the
3 University of Auckland to see how these devices
4 could be used. And what I want to point out is
5 that this partnership was to deploy these
6 instruments along our streets in Auckland and
7 anterior route commuting straight people going
8 into the city.

9 We put these instruments at various
10 locations along the street on buildings, on the
11 deeds of buildings or on the straight finish of
12 the pole, and we were able to run it for six
13 weeks, and during the time we were also
14 collecting cell phone signals at various
15 locations and the idea was to correlate
16 (inaudible) with individual, individual, they
17 were moving through this area to try and catch
18 the exposure levels of pollution and people using
19 in the street.

20 The data is still being utilized,
21 but I just thought I'd show you some of the
22 information that we're gathering. This is
23 looking at the diurnal variation of the
24 parameters at the various locations. Each photo
25 is a different location. You can see very

1 clearly that there is NO₂ PM at around three in
2 the morning. That is the trend. There is a
3 decrease in ozone at times into at maybe -- in
4 the evening, and just saying we find it little
5 higher levels.

6 I think this is due to a change in
7 traffic and behavior, but also, an increase in
8 emissions from -- in talking to the facilities,
9 so we're still looking at that behavior that we
10 get down our thinking. I just want to pick out
11 one of the slides, so if you look at the blue
12 line, and unit six, the bottom middle photo and
13 that's the side of our bus stop, so we can see
14 that there is little we are actually picking up
15 information within the town. The next step on
16 the project is to deploy 100 node network of
17 these devices in America for 12 months and we
18 have working with a partner including to put in
19 place that project.

20 We're looking to develop automate
21 automatic data validation algorithms. So we have
22 these operating now, and it's around in the basic
23 processing and we're looking at information
24 coming from individual with the characteristics
25 of network as a whole. We need to automate that.

1 The third area is to engage and develop
2 information tools that are useful to federal
3 community, and we're looking to partner in the
4 United States and then we're thinking around
5 commercial release 2018 for this.

6 This is just some tests in the last
7 few days. We're doing a test in an Asian city
8 that has pollutant vehicles and it's the top
9 ozone, the red, blue. The pollutant is the
10 station and we can see that we're now getting a
11 wrap around 18 to 100 PPB. (Inaudible) So we're
12 using this, if you like, trying to understand the
13 best performance of the design test. This is
14 controlling because it's important, as a
15 manufacturer, we don't have any performance
16 standards for the instrument and the emission of
17 outdoor air quality, but it's very important that
18 there are independent studies that are taking
19 devices and evaluating and I wanted to draw your
20 attention to two of those.

21 One I think that I -- AQ-SPEC
22 program, which has been useful information and
23 the other project is the MACPoll project at the
24 JRC in Europe, and this information is available
25 on-line to look upon as well. So in summary, low

1 cost instrument performance for some pollutants
2 shows some pretty high correlation with
3 regulatory monitors, so we have confidence in the
4 data.

5 If the data is of good quality and
6 makes the down stream validation, so there's the
7 hope that we can continue to push the devices and
8 reduce that burden of the validation. We are,
9 you know, in at least some instances, we're
10 pretty good for short term duration of one to
11 three months, but long term duration is all being
12 six months. Part of doing this and surveying the
13 long term behavior of these kinds of devices.
14 And also very high pollutant levels is still being
15 determined from our point of view.

16 The laboratory calibration methods
17 are becoming robust enough to transfer to the
18 field. I think this is a really important
19 activity because it's very difficult to see how
20 you can deploy low cost and the calibration from
21 the facts from the factory is not transferrable
22 to the field meaning that you are really have
23 to -- to feel calibration which is difficult for.

24 And I really want to make a -- the
25 fact that we need to develop performance

1 standards and guidelines to drive acceptance of
2 the new technology, and that it's been talked
3 about but it's quite slow and in the meantime
4 it's really -- evaluations are important and it
5 helps to keep many sectors on keeps us
6 understanding. Thanks very much.

7 I just wanted to acknowledge the
8 people in the Aeroqual research team and the
9 people from the University of Auckland, Professor
10 David Williams and Dr. Jenny Salmond. Thank you
11 very much.

12 (Applause)

13 MR. HANNA: Thank you, Geoff. Are
14 there any questions directly for Geoff? We are
15 going to break into maybe more of a round table
16 discussion. I think, Rick, if it's okay with you
17 maybe we go until quarter after the hour for the
18 round table discussion just to give us 30 to 35
19 minutes for everybody to speak with each other?

20 MR. OPIEKUN: That should be fine.

21 MR. HANNA: I have to apologize. I
22 have to leave right at three o'clock, but I want
23 to extend my personal thanks very much so. Thank
24 you all for being here, and I'll hang out at
25 long as I can. I certainly like to give our

1 speakers the opportunity to ask each other
2 questions. I saw Leslie, maybe when Andrea was
3 speaking or someone, but I'll give you guys a
4 chance, but I'll steal the mike for one more
5 minute.

6 The last slide that Geoff showed
7 talked about longer term reliability, and I heard
8 he expected to doing two month evaluations.
9 Geoff's co-location study was six weeks,
10 mentioned that longer term, six months plus is a
11 concern. Has anybody studied that yet? Do we
12 have any of that information yet out here to
13 really know what it looks like yet?

14 MR. POLIDORI: I don't think there
15 is anything --

16 MR. HENSHAW: We've done a study
17 around endorsements looking over a 12 month
18 period where we were doing 20 instruments around
19 the Auckland region, and we were getting other
20 data over periods of -- but rather nine months
21 and that was of the design which we lose a lot
22 from and have made improvements around, but it's
23 that the opportunity too we're really --

24 MR. HANNA: So my traditional air
25 monitoring whether it's CEM, Continuous Emission

1 Monitoring from point source, as we call that,
2 drift over time and we've got to recalibrate and
3 reset things, is that the alternative? Is that
4 what we're looking for? Is that tipping point
5 where you have to send it back to the lab for the
6 formal calibration? Do we know that yet?

7 MR. HENSHAW: Yes. We have taken --
8 simply to replace. But the unit itself, so
9 replace the sensor itself. That seems to work
10 well. (Inaudible) I think once we can mitigate
11 this issue, wait for it.

12 MR. POLIDORI: So I think that
13 nobody has done anything past six to eight
14 months, which this was a facility I was showing
15 this morning where PM sensors that have been up
16 for eight months, so you know, one of my staff
17 was there, I believe every two weeks, to do some
18 checks with referencing. They drive around
19 basically location to location and actually they
20 were quite stable even after eight months.

21 But I think long term, and again,
22 then, you know, if you have -- then you can do
23 like co-location using traditional techniques.
24 You basically co-locate your sensor with an EPA
25 approved instrument or device, right. But then

1 if you have 500 or more, that model doesn't work
2 anymore, so there have been a few, I think the
3 best way of doing that, and I've seen a couple of
4 examples, is basically using a valuable lead so
5 you have a meteorological data.

6 You have data from air now, so it
7 becomes a data problem, if you're in one area,
8 you have 20 centers in one station, can you use
9 data from those two stations to calibrate the 20
10 sensors and the people try to tackling that
11 problem from the data point of view rather than
12 from co-located at every location.

13 MR. HANNA: I'll stand back and let
14 others ask each other questions. Feel free.

15 MR. HEIMBINDER: I have a question
16 for you, Andrea. How did that particular waste
17 facility get selected for monitoring? And
18 specifically, what were the politics of that?
19 Because I imagine there were a lot of people who
20 would have liked to have something like that
21 happen. And was it connected to any kind of
22 policy initiative or change in the regulations?

23 MR. POLIDORI: So it's nothing
24 glamorous. So the facility has received a lot
25 of complaints from the local community.

1 Specifically, from the school, that is located
2 down wind of the facility, so there's a lawsuit
3 and they received a lot of notices of violation
4 from the South Coast, so there is a way to
5 basically try to help both parties to kind of get
6 the better agreement to get more friendly in the
7 process.

8 Some of them know this is a
9 violation that was used to develop this, and it
10 actually worked quite well. Because now the
11 schools feel it is even more -- to basically
12 check on whether or not deficit is taking
13 measures to improve air quality conditions in the
14 area.

15 MR. HEIMBINDER: You were talking
16 about it might be enclosed. In New York City
17 we're looking for something similar for
18 construction to three facilities. Will there now
19 be -- potentially could this data be used to
20 support regulations that are enclosing these type
21 of facilities, or is that outside the purview of
22 your agency?

23 MR. POLIDORI: At this point, it's
24 just case by case. This is more we're the pilot
25 study, but I think in terms of how it works, that's

1 the first step, so eventually, I think it will
2 lead to that.

3 MS. SCOTT: Robert, I thought the
4 work was really interesting. I see a bit of
5 divide between the groups here in terms of people
6 who are working on personal exposure and the
7 indoor exposure, people who are doing outdoor.
8 So my question is, and you were talking about
9 calibration, a lot of us have been talking about
10 timing measurements to the several reference
11 instruments. What do we do for the indoor
12 measurements or the mixed measurements, indoor
13 outdoor measurements seeing that some of these
14 values are so high. You referenced some of the
15 resources -- and these are crazy high values.

16 MR. LAUMBACH: That is a very good
17 question. Your low cost monitor should be
18 co-located with a reference monitor in the
19 atmosphere where you're having measurements
20 environments. And that particular case there,
21 which I showed, which was in terms of how we
22 co-located our instrument with diesel exhaust
23 atmosphere. That was really not appropriate
24 necessarily to be co-located in a vehicle, so I
25 think that is a -- I'm not sure how to address

1 that. Understanding better what the experiences
2 are, and then understanding what the atmosphere
3 is like, different locations obviously could help
4 to be reassuring about the validity of
5 measurements in these difficult occasions.

6 MR. EISL: I have a question with
7 respect to calibration. When Citizen Science in
8 this technology and they're not associated with
9 groups, they want to do independent work,
10 wouldn't that be a role in the EPA or the DEC in
11 New York, maybe that they sort of take some of
12 the technology to use the calibration and sort of
13 have sort of a lending service or library that
14 people can figure out if they know they are well
15 calibrated and the data?

16 And after they have used the subway
17 in the back and the agency can test the
18 calibration again because not everybody has a
19 high cost regulatory monitor to compare to, so
20 you have to find something for citizens to make
21 sure that that they at least have an instrument
22 that works well.

23 MR. OPIEKUN: The one question I've
24 got, I mean, there is a great level of expertise
25 in this room. You've all worked with either

1 academics. You've worked with community groups,
2 environmental justice groups, but the one thing I
3 didn't hear anybody mention is a community of
4 practice because obviously, you know, if you're
5 working within a region or a municipality, you
6 may have control over what data are collected,
7 how they're collected, how they're stored, how
8 they're interpreted.

9 But as this grows, as this whole
10 movement of community science grows, evolves,
11 goes nationwide, it's inevitable that there will
12 be an interest in groups from one region or one
13 state trying to compare their results with other
14 groups. Is there any thought of kind of
15 spearheading a community of practice where
16 standards for the country are developed, adopted,
17 explored.

18 And you know, obviously you can't
19 force this upon groups or state agencies, but
20 something that's out there is usually something
21 that people could discuss, tweak, and ultimately
22 adopt to make these data more useful, more
23 reliable, so anyone have any insights on that.

24 MR. HENSHAW: Calibrations, and the
25 data, one approach, we've got a paper coming out

1 shortly and one approach that we have taken is to
2 use instruments and take advantage of the -- that
3 is repeatable, not so much around whether they're
4 accurate, whether it's repeatable, and use that
5 text to take measurements and then use those
6 measurements to rank different areas in the city
7 or within a region and then ranking now allows
8 you to identify hot spots, places where the
9 vehicles are higher than other areas in the city,
10 and that can create an argument that may be a
11 problem there.

12 So the instrument is not being used
13 to the instruments that is indicated. You're
14 using an instrument to find where the problems
15 are made, and you're using a ranking system to
16 range that rank that particular area and with
17 that approach gets around a little bit around the
18 calibration.

19 MR. DYE: Regarding your question
20 regarding community practice, I think there's
21 some challenges we face. One is we're early on
22 in kind of the game big picture. Secondly, it's
23 moving pretty quick. Third thing is, this
24 involves a lot of different people, not just the
25 traditional air quality community. We're

1 reaching out. We have big companies, Intel,
2 Google, IBM and others getting involved and so
3 it's a much broader community.

4 EPA has some early efforts with some
5 workshops that they conducted that I think were
6 really successful but they grew too quickly, too
7 big. What I've seen emerge more recently is kind
8 of a regional ad hock meetings that are popping
9 up about whether we can get together and discuss
10 things. I think the E-Enterprise initiative is
11 probably one that's establishing, as Leslie
12 talked earlier, some standards, some data
13 standards, certifications, those types of things.

14 And I'm hoping that one outcome of
15 that is kind of a platform or a community of
16 practice that can form around that because
17 they're developing some standards. So that's
18 probably, you know, a couple of years away from
19 happening, but hopefully it will form around that
20 or maybe something else.

21 MR. OPIEKUN: As I've heard these
22 presentations, I see this as a growing and rather
23 urgent growing need because as more groups get
24 involved with this, you kind of want to stem the
25 tide of bad data, and by following or getting

1 people to follow, the guidance of the community
2 of practice, while you still will have voluminous
3 data potentially coming in to a data warehousing
4 type of facility, there's a better chance that
5 you're going to get good quality useable data.

6 Somebody mentioned here that
7 sometimes the best type of use for some of the
8 instrumentation is just event viewing, trying to
9 see where there is an event versus no, and that's
10 great. I fully understand that there is a great
11 need for that. The fear is that people will take
12 event viewing type data and try to go forward
13 with it. Try to do more with it than you should
14 do with it, and we'd be concerned that that ends
15 up, in a sense, going into that realm of junk
16 science because you're using numbers to tell a
17 story that isn't necessary there. You've got the
18 false positives being developed and just trying
19 to stem that tide with the community pride.

20 MR. KNAPP: I'll just add a thought.
21 This is not specific to air quality or census in
22 particular, but there is an industrial
23 internet -- representation of across
24 internationally, major companies, smaller
25 companies and they actually are doing some good

1 work in terms of creating standards and
2 facilitating standards for connectivity for
3 internet, transfer, if you will, big data
4 exchange and they have work groups in a host of
5 different verticals and with regard to
6 application areas so they're trying to establish
7 the framework for data connectivity and transfer
8 standards.

9 MR. POLIDORI: There is another
10 initiative in the US spear headed by ERG and
11 they're working on data standards, and I think
12 Tim and myself, we have been to a couple of those
13 meetings. And in Europe, there is JRC is also
14 trying to basically build like create standards
15 to the standard that the way the standards are
16 evaluated from an evaluation to a more rigorous
17 application program so there is some effort here
18 and there.

19 I think that possibly the biggest
20 potential is from the E-Enterprise initiative,
21 and so one of the limitations is because I'm part
22 of the certification team and one of the biggest
23 issues that we're encountering is the cost. You
24 know, being able to kind of build the
25 certification progress across the country, it's

1 extremely expensive. You need to be able to do
2 certification protocols. You need to be able
3 to -- everybody needs to fall off certain
4 protocol and tests. Like the one we have is not
5 cheap at all, so I mean, all of these efforts are
6 starting to kind of appear here and there, but
7 they're still not the unified push behind it.

8 MR. VALERI: As the lawyer in the
9 group and the one who represents the industry, I
10 hear everyone about how the technology is moving
11 fast and I'm not sure regulation, slash, the law
12 is moving as fast as the technology is moving.
13 And I suspect one day that this is going to be an
14 area of controversy because people will use the
15 data offensively or defensively, whether its for
16 the attorney general or tort litigation.

17 I'm just curious, for the government
18 folks in the room, or at least those that are
19 affiliated with government entities, but I will
20 put it even broader, has there been discussion or
21 actual regulatory or legislation being used, the
22 legislation being pushed in any of your
23 jurisdictions, regarding the use of these hand
24 held monitors or low cost monitors as we call
25 them? Because I see them being the next area of

1 controversy and conversely an area of defense.

2 My plant is being accused of
3 something, I want to use a monitor, and I can
4 blame it on the next door neighbor. I think
5 that's one of our tasks as part of this council
6 is we have all this great stuff, what do we do
7 with it. Any thoughts? I'm very curious.

8 MS. CRONKHITE: When you say
9 regulations regarding use of sensors, you mean to
10 control the use or restrict peoples use of it?

11 MR. VALERI: Or for the purpose of
12 approving an enforcement for a variety of things.
13 Either one, sort of universal certification or
14 calibration, whatever we want to call it such
15 that it's used in enforcement, it can be,
16 whatever the device or data, it can be relied
17 upon. And then two, more broadly, whether that's
18 something that's been subject to regulation or
19 legislative thought because quite frankly, it
20 will be John Q citizen or John Q company that's
21 going to be using it, so the question becomes
22 whether there's a need for some sort of
23 regulatory construct, so it's used properly and
24 that's what I'm curious about.

25 MR. LAUMBACH: I think the

1 situations have already occurred. In the sense
2 of the templates I can think of related to
3 chemical spills, issues like when the fire
4 department goes out, it does some carbon dioxide
5 monitoring. In the medical legal sort of -- the
6 issues come up though about calibration, you
7 know, and then I guess more experienced tort law
8 than an occasion as an expert in legal medical
9 cases where that's been an issue and then there's
10 debate back and forth about expert opinion on
11 whether or not the calibration of a particular
12 monitor, typically a hand held type monitor, was
13 accurate or not.

14 MR. BIELORY: You set the basis for
15 the next question, the plural of anecdote is
16 anecdotes, not evidence, so when you have a
17 device and we don't have an audible trail that's
18 calibrated, how do you validate it? Now, this is
19 part of the question is who holds the data
20 because if it's government, the government may be
21 under political prejudice to release or not
22 release.

23 In private where there can be self
24 interest as well or do we go to something like
25 the national chronology network, which is a

1 government funded entity that has an advisory
2 scientific council that actually bridges. It
3 holds the data. It has an advisory group, which
4 a pharma, or corporate entity, can participate as
5 well as industry because it has to be an audible
6 trail that's validated.

7 And it cannot be under political or
8 commercial pressures for release or non release.
9 And that's the question I really would love to
10 ask because it's going to be a statement, and I
11 brought this up in our council meeting a while
12 back. And again, I used the sample because I'm a
13 physician. Everybody goes to the internet. I
14 come in with people with self diagnosis. They're
15 allergic to air.

16 And the pleural of anecdote, like I
17 said, is anecdotes, it's not evidence, so we have
18 to say how do we get the anecdotal devices to be
19 evidentiary. And that's, I think where we're
20 going and that has to be one of what I would like
21 to see a recommendation and we have the expert or
22 some experts here listening, if you can give some
23 guidance to the counsel.

24 MR. HEIMBINDER: One thing I would
25 say about it. One thing I would say on that

1 account, which I think has been touched on by
2 several of the presenters today, is that quality
3 assurance and quality control are platform wide
4 or a system wide, so you have a sensor. Once
5 that sensor is integrated into an instrument, if
6 it's integrated in 10 different instruments from
7 10 different manufacturers, they're all going to
8 perform differently.

9 Then you're talking about the firm
10 wear that's running on those devices. Maybe
11 you're doing post processing once it goes into
12 the database, so you basically don't have a
13 measurement. You have a measurement platform or
14 a measurement system. And then beyond that, you
15 have, not just an instrument, you have a network
16 of instruments, and so when you're talking about
17 whether the outcome of this system, which is a
18 series of measurements, is going to hold up
19 under a certain -- hold up in a court of law, can
20 it hold up in the screening tools, can it hold up
21 to make regulatory decisions.

22 I think it becomes very complex
23 because you're talking about quality across the
24 entire platform. So I think what you'll end up
25 with is that you'll have platforms that follow

1 all the protocol that people are starting to
2 develop that people can trust in a court of law
3 and you'll have others that you will say, well,
4 we need to use this. We're looking at what data
5 can be used for and we were looking -- Andrea was
6 showing what the EPA decides different data is
7 useful for. And so I think it's not going to be
8 a clean dance. It's going to be platform
9 specific, instrument specific, and there won't be
10 kind of a clear cut answer.

11 MR. BIELORY: Thank you. Anybody
12 else? I didn't think there would be a clear cut
13 answer, but the point is we have to address the
14 question.

15 MR. EISL: I want to say something.
16 Not only is technology contact points, it's a
17 human contact point. In New York we are using
18 integrated sensors. We are mounting them to 10
19 to 20 feet height. There's a reason why we
20 monitor them 10 to 20 feet height. We want to
21 prevent vandalizing, but more importantly, we
22 want to temporary -- so question of how are we
23 gonna make sure once we get data on the platform,
24 we have to actually measure them.

25 Our friend from Auckland, New

1 Zealand, they place some of the sensors right on
2 the building. We would never do that because
3 there is a building effect which can compromise
4 the data, so you need some guidance, like a tool
5 kit, which helps these people how to use, where
6 to measure, when to measure, all these issues, so
7 it's a technological issue and a human factor.

8 MR. POLIDORI: I think the best we
9 can do at the moment is definitely using these
10 devices for several purposes. In our experience
11 in the South Coast, I'll give an example. We
12 have a program for fence-line monitoring for
13 refineries, and they reuse equipment that cost
14 millions of dollars so there is one band --
15 technology is 1.2 million.

16 Then we use a dial, it's 2 million,
17 so this instrument is very accurate, give you all
18 of the information. So what we try to do is we
19 try to basically compare emission rates from
20 refineries of VOCs, so the best thing we can do
21 right now that this is basically a well known
22 practice for us which is inventory. So we
23 create, for the technical point of view, that all
24 the refineries are emitting between six and 12
25 times more what the initial inventories says.

1 So while we possibly were pushing to
2 make reaction just based on the measurements, it
3 was nearly impossible because every time that you
4 talk to the refineries, the refinery
5 representative, they say it's not -- so you can
6 believe it as much as you want, but there's
7 nothing at the federal level that says this is an
8 improved level for measuring emissions.

9 So under those circumstances, the
10 best step you kind of settle for, we definitely
11 can use the instrumentation for vapors. We find
12 a leading tech and then we can work with the
13 refineries to address the problem, calculate it
14 and move forward from there. So, again, I'm
15 talking about very accurate, very sophisticated
16 type of instrumentation. If you try to
17 extrapolate that type of discussion to sensors,
18 then you can understand that there's basically
19 the same problem, but multiplied by a whole lot.

20 MR. VALERI: Therein lies the
21 problem because I can tell you, and it is clear
22 to me, particularly in urbanized areas where
23 multiple certainly EJE communities, on top of the
24 fact that there is a lot of industry and
25 different types of industry and different owners;

1 that as these devices become more prevalent, less
2 expensive and are accessible, they will be used
3 for the purpose of supporting either litigation
4 or an attempt to enforce and that may be a good
5 thing at this point. It sounds like we're not
6 there yet, but at the end of the day, maybe it's
7 more of a statement or question.

8 It may be good for your agency when
9 you start thinking about that because I think
10 that's going to end up being the next step. And
11 for us, I'm curious as to how we can deal with
12 that because one that happens, most of you folks
13 are going to be going through hours of
14 deposition, going through hours of technology
15 work and I think avoiding some of that at the
16 front end it will be helpful for us, as a
17 council, to make some recommendations.

18 And clearly to the extent that you
19 have folks have any thoughts or additional
20 information to particular schemes that you are
21 thinking, regulation or otherwise, or ability to
22 license people, I'm not saying this is the
23 answer, but it's something I'd be interested in.

24 MR. POLIDORI: The regulations for
25 the South Coast and for the monitoring it will

1 take into account this new technology, so at the
2 local level, I think the effort is already there,
3 but I think it's more of the big area where the
4 regulation, take into account this modern
5 technology. It is more isolated case, more than
6 a federal type of approach.

7 MS. CRONKHITE: I have one more
8 comment to add onto what Andrea said. You know,
9 I mentioned the fact that the EPA methods
10 approval process is very restricted and rigorous,
11 and with that reason that you end up in court, it
12 needs to be defensible ultimately, so you're
13 seeing the sensors, as people have indicated, all
14 day, as screening, targeting, and you would
15 imagine that community groups began to use these
16 more often when it's raised to a regulator that
17 it would trigger action for us to go and do
18 deeper inspections.

19 MR. LAUMBACH: I don't know if it's
20 a useful analogy here or not, but currently, the
21 terms of odor complaints, the state here in New
22 Jersey, I believe the regulation still is that,
23 and the procedure is that people call, the county
24 health inspector typically or somebody at the
25 local health department comes out to where the

1 odor is occurring and they look at the wind
2 direction and they follow it back to a source.

3 So in this case, odor, our noses are
4 pretty sensitive to odor generally, but they're
5 certainly not calibrated and there is some
6 validation that another person coming out, the
7 inspector and verified and going back to the
8 source. I did this before in a prior life as a
9 sanitary and health inspector here in New Jersey
10 a while back, longer than I hope to remember, but
11 it's the same procedure today, I understand.

12 You know, so I think, and again, the
13 state is pretty low in that case. I think it was
14 an 800 dollar fine, but still it's useful
15 information and led to some interventions when I
16 was doing this a while back. So I mean, it might
17 be different uses for different types of data,
18 and it can be used in different ways.

19 MS. SCOTT: If I could maybe comment
20 here. I think your questions raise a very good
21 one for a very short term. But you should be
22 aware that an eight year old girl came to a
23 workshop and had a blast. She had built a
24 weather station, a wirelessly remote like
25 connecting to the Cloud weather station, this

1 stuff is happening.

2 It's going to be very popular and
3 people are going to do it, no matter what the
4 standards and people are doing -- we're doing
5 this for fun and they really enjoy it, so I
6 wonder if there's not a longer term solution that
7 maybe forward thinking. These low cost sensors,
8 they're not super accurate, but they are
9 measuring reactions.

10 And I know if I have a sensor that
11 measures oxidation reactions, that's not
12 something I want happening in my throat, that's
13 not something I want happening in my lungs. But
14 I wondered as a state agency, I know you guys are
15 kind of limited to what the regulations we have
16 now, but I wonder if it's not possible to start
17 thinking forward and working with some of the
18 health folks and saying, look, we have this low
19 cost technology and it doesn't correlate super
20 well with the federal reference standards.

21 But we think it correlates with
22 things that can be indicators or effect peoples
23 exposure, so I wonder if that might not be an
24 alternative route head to toe for the future and
25 get out in front of this technology. It's

1 coming, it's going to be a Tsunami. And to start
2 thinking about alternate approaches to other
3 matrix, if it can't be in terms of these.

4 MR. VALERI: It's one thing to have
5 the matrix. It's another to sue my client for a
6 million dollars because you gave an eight year
7 old kid cancer. I agree with you. I think it is
8 a long term step. I think that's what we need to
9 answer.

10 MS. SCOTT: I would say too, one
11 thing. It is very public, so I think public is
12 certainly going to be something that the total
13 environmental justice people work with.

14 MR. OPIEKUN: To those individuals
15 that work with community groups, have you had
16 people try to find out how the data that they're
17 collecting compares to a health benchmark?
18 Because that's another concern is you've got
19 people that might sample somewhere for an hour
20 and wonder, you know, they see standards out
21 there, there is eight hour standards and 24 hour
22 standards. How does that compare?

23 I know the EPA did a study where
24 they were trying to correlate some
25 instrumentation with standards, but that's also

1 another concern is how do you address that when
2 people really want to know risk. You've done
3 some fence-line monitoring. You've done some
4 quick samples over the course of a day or so.
5 People come to you and say, what is my risk of
6 getting cancer or my child having an adverse
7 birth outcome because of my exposure to this, my
8 hand held device just said that it's 100 parts
9 per million here and the standard is, you know,
10 50, so you know how do you get that messaging
11 across.

12 MR. KNAPP: I think you raised a
13 great point. I wonder if there's not an analogy
14 that may be applicable and that is the database
15 that's been established to help govern the
16 application of pharmacological technology to
17 these various tests that have been introduced,
18 that companies introduce to indicate whether or
19 not, you know, particular individuals will
20 metabolize, particular medications well or not
21 well or be exposed to adverse events, or of the
22 negative effects.

23 So you have the ADG database that
24 Stanford manages that the FDA and the NIA
25 subscribed to and they established levels of

1 evidence for each of these genetic tests, if you
2 will, and if a particular product in that case or
3 the health medical case a particular laboratory
4 test doesn't meet certain levels of evidence,
5 then they can't make certain claims that are
6 legitimate. Maybe there's the same kind of frame
7 work that's going to evolve here so that, you
8 know, it starts with the sensors and then has to
9 evolve and address the larger environment like
10 Michael was describing.

11 MR. BIELORY: I've been doing this
12 for close to a decade, but if we go back about
13 four years ago, we did not have a new SPEC. It
14 was just getting involved in evaluating the
15 sensors and I think all that information has been
16 public, pushed out there and that's put a lot of
17 daylight on some of the things that were sensors
18 out there that people were claiming outrageous
19 things.

20 And now we know those don't work and
21 the broadening community knows those don't work
22 and the continuum, I think now we need to be in
23 the mode of two big things. One is the
24 E-Enterprise initiative, standards, guidelines,
25 formats for exchanging data, putting that

1 together as kind of here is what's needed to
2 produce credible information. The second thing
3 is doing lots of product projects, little ones,
4 big ones and see more and more of that and
5 publish and get it out there so we can figure out
6 what works and what doesn't.

7 And probably after that point, we're
8 going to start to see some more credible data
9 surfacing and some things that could be used for
10 your clients for using against your clients.
11 That's probably four or five years away.

12 MR. BIELORY: As a physician, but
13 here's where things are changing and I think
14 that's not being addressed and what we are trying
15 to assess now is public health. Meaning, when
16 you do a blood test, you get your normal 2.5
17 percent low to calcium curve. However, when you
18 have these devices, it now becomes personalized
19 medicine. How does it effect me as an
20 individual.

21 That is total different ball game,
22 and we're entering that realm as we speak with
23 these devices. Personal monitors going on, so
24 there are individual effects, personalized
25 medicine and what we're addressing here today is

1 public health, but we're entering the personal
2 realm, and again, that's another facet of which
3 we're not going to tackle. This is not the US
4 Senate Health Commission, but nonetheless, the
5 state of New Jersey is interested, and the Clean
6 Air Council is interested in where do we start,
7 how do we see the future, can we set the
8 platform. And I know Toby kind of set the stage
9 at 12. It is 20 minutes after. If anyone has
10 any final statements we would like to take them
11 at this point in time.

12 MS. MOUNT: I would like to comment
13 and appreciate the work that the council has down
14 bringing these folks together and the fact that
15 they came all this way to come and totally
16 relevant to us with this whole process. We try
17 to be down on the ground with this stuff and help
18 through the process. At the DEP, I think we've
19 had a great track record. It's because giving us
20 the kind of information we need and we will sit
21 it out and send it back.

22 MR. BIELORY: We're going to come to
23 a close. I want to thank all the speakers and
24 presenters, but I also want to thank the staff,
25 Miss Hanna, Miss Sills who is hiding in the

1 background who helped put this together. And
2 Bill, you want to come up and make any comments?

3 UNKNOWN SPEAKER: On behalf of the
4 department, I wanted to thank the speakers and
5 thank the council for having another great
6 hearing. A lot of work went into this. Council
7 members, and by staff, Peg, Lewis Lanmark, he's
8 very quiet. And Ruye Azole and Paul Ramon in the
9 back room, all part of Peg's staff who were
10 working behind the scenes, and Heidi of course,
11 in the back room. I think we got William Ferraro
12 back there manning the things and it was really
13 great to get the gentleman from New Zealand.

14 MR. EISL: One more question. If we
15 have additional comments, can we submit them?

16 MR. OPIEKUN: Comments can be
17 submitted to Heidi up until May 5th. I'd also
18 like the notes to reflect, while we did give the
19 opportunity for general public comment period,
20 nobody signed up to give comment, but people have
21 the opportunity.

22 UNKNOWN SPEAKER: I started out 45
23 years ago and air enforcement hasn't changed
24 much. Our main instrument are our eyes and our
25 nose, and I went to smoke school to calibrate my

1 eyes. I was on the stand in Superior Court for
2 two days on the validity of my calibrated eye.
3 It was calibrated. It did win the case, but it
4 came with a lot of procedures and a lot of law
5 and I see the same thing here, a little more
6 sophisticated, but the same kind of things are
7 being used here. Thank you very much.

8 UNKNOWN SPEAKER: Good afternoon.
9 I'm a professor of environmental science at
10 Rutgers and in my projects that I do, I focus
11 mostly on air particles and air quality
12 measurements, and recently, we started doing some
13 projects that actually involve, what we call,
14 consumer grade sensors and we are trying to pick
15 one or two that, in our opinion, perform the
16 best.

17 First of all, I appreciate
18 everybody's presentation. I got a lot of new and
19 interesting information about the sensors that we
20 have not considered. But I just want to say a
21 couple of comments. First of all, by the quality
22 of sensors and their comparisons to standards
23 that I saw being presented. In most cases, I saw
24 that people just presented simple correlation of
25 the square, but it's not just that.

1 I think we have to go a little bit
2 deeper because the sensors could be off by a
3 factor of 10 and they could give a perfect
4 correlation so we have to look at relative and
5 absolute difference between our standard and the
6 -- so to speak. R square could be very
7 deceptive, and also those R squares and those
8 parameters should be broken down by the
9 environment where the sensors were tested or the
10 particle types, if they were tested in a specific
11 chamber.

12 We have seen differences versus dust
13 and then take the same sensors out and you get
14 totally different because of the properties of
15 the particle. Also we talked about sensors,
16 mostly PM 2.5 because these are photometric
17 sensors. That what's what they're able to sense.
18 Very few of them are capable of PM 10 unless you
19 have some more sophisticated mechanisms, but even
20 then, if these automatic sensors, the physics
21 will not allow to measure PM 10 very accurate.

22 PM 2.5 is a more accurate metric.
23 However, in quite a few sensors out there, they
24 present, not just PM 2.5, but they go to try to
25 find the ordinary citizen by giving the -- the

1 EPA has AQY, so does some of the sensors, and
2 they will display the AQY value on the sensor
3 instead -- somebody sees the color green today,
4 that air is good. Orange, not so good. There
5 are sensors that display the AQY for the location
6 where the sensor is in and also they connect to
7 the nearest EPA monitoring station and display
8 those parameters, those measurements side by
9 side.

10 For example, it would say the air
11 outdoors is excellent, you go outside for a jog
12 or walk or the air today is pretty bad, close
13 your doors and windows, stay indoors. I don't
14 know yet how these messages would effect people's
15 behavior, but that's something that could be
16 investigated because you have that \$200 gadget
17 and it tells you open the windows or go outside
18 and don't go outside, you might actually follow
19 that action or be encouraged to do so.

20 If you are hesitating, do I want to
21 go outside. The sensor say, well, the air is
22 good, why don't you go outside. It might effect
23 peoples behavior, so it's not just numerical
24 values that we are -- but also the use -- more
25 value that are geared toward ordinary citizens.

1 Now, also, I want to mention that amount of data
2 is really high, but some of these companies like
3 this air that sensor is being sold from Taiwan,
4 you can buy for 200 dollars being shipped right
5 here to us, or by 2:30 by Amazon. The data
6 automatically uploaded into their website, and if
7 you go there, you can see their measurements
8 worldwide.

9 They can even give you the days, 10
10 worse polluted areas or 10 best areas of air
11 quality, so they gather this massive amount of
12 quality just using this small gadget. And
13 probably the last comment, I want to mention
14 about indoor measurements. Our standard outdoors
15 because we don't have anything indoors, but
16 people use these measurements for indoor
17 measurements, and I think there was some
18 discussion and that's what we should consider.

19 If the sensors they use indoors
20 really depends on where they are placed. If
21 they're in the kitchen and you start frying
22 something, you know what happens, it just shoots
23 through the roof. And again, how people will
24 react after seeing that spike. Oh, my goodness,
25 how am I going to cook forever in my life or I

1 don't care, I don't know. That's also something
2 to be considered and the technology is getting
3 cheaper.

4 There is small gadgets from a
5 company in Germany called Handynus. It is
6 smaller than a box of matches. It attaches
7 directly to your phone and it gives you
8 instantaneous reading and it's just 100 euro's
9 including shipping. I don't know, I have my
10 doubts, but if the kitchen -- if you start frying
11 things, the value needs to go up. Thank you for
12 giving me a couple of minutes.

13 MR. BIELORY: You can submit any
14 comments in writing for us to include. Again, I
15 want to thank the members of the DEP. Mr.
16 Ronald, please stand up so you can be recognized.
17 Miss Roman, Miss Hanna. I want to thank the
18 staff. I appreciate that. Thank you. I want to
19 thank the speakers for coming and thank the
20 council for their time. Have a good day. My
21 motion is to adjourn.

22 (Hearing concluded at 3:29 p.m.)
23
24
25

C E R T I F I C A T E

I, LAUREN ETIER, a Certified Court Reporter, License No. XI 02211, and Notary Public of the State of New Jersey, that the foregoing is a true and accurate transcript of the testimony as taken stenographically by and before me at the time, place and on the date hereinbefore set forth.

I DO FURTHER CERTIFY that I am neither a relative nor employee nor attorney nor counsel of any of the parties to this action, and that I am neither a relative nor employee of such attorney or counsel, and that I am not financially interested in the action.

Lauren M. Etier



Notary Public of the State of New Jersey

My Commission Expires June 14, 2018

Dated: May 1, 2017

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