UNIVERSITY OF HOUSTON
ORAL HISTORY OF HOUSTON PROJECT

Interview with: Dr. Stephen Linder
Interviewed by: Carla Curtis
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Transcribed by: Suzanne Mascola

CC: This is an interview with Dr. Stephen Linder. He is the Taskforce Coordinator on the Mayor's Taskforce of Health Effects of Air Pollution, at the University of Texas School of Public Health. It is 2 p.m. on July 25. Dr. Linder, could you please tell us what your title at the University is?

SL: I am currently the Interim Director of the Institute for Health Policy at the School of Public Health and the responsibilities within that organization are that we provide decision support for policy makers; that is, doing analytical background studies and _____the scientific literature and so on to be able to assist them in choosing among alternatives or in framing alternatives or in sorting out options. We also do some analysis of sample surveys and the behavioral risk factor survey for the State of Texas. Again, analysis focusing on assistance to decision makers in varying capacities, both public and private. We are also involved in a number of collaboratives to develop health indicators and in some randomized field experiments of some new interventions to deal with behavioral health issues. But those kinds of studies come and go, and our basic mission is to integrate research and disseminate the findings of research. So, it is distinctive from what other centers in the school and in the Health Science Center do which is primarily to generate new research based on grant and contract funding that involves new investigations and primary data gathering. Most of our focus is on what is already

known, bringing it together, translating it into terms that decision makers can use and getting it out to the people who need it.

CC: And so, do you have any specific areas of study that you focus on?

SL: They varied from education – we did a study earlier this year of the impact of education on health and health on education, and the most recent study - why we are here – is for the mayor on arranging some priorities among pollutants in order for him to be able to plan better and to allocate his resources to the highest risks. What we can do, because we are an institute, is to draw on faculty from across the University and put together working groups of faculty. Usually the working groups are relatively informal and the faculty come together to focus on a particular problem issue or issue that we are addressing.

In the case of the taskforce, the Mayor's Taskforce for the Health Effects of Air Pollution, it was a bit more formalized because the charge came through the president of Health Science Center to the Institute through the dean of the school. It started, I think, in January of 2005 with the Texas Commission on Environmental Quality releasing a report about elevated levels of benzene and butadiene in some east Houston neighborhoods, and they were tracking these elevated levels and they were of concern to TCEQ. They have a watch list of pollutants and benzene and butadiene are still of concern to them. They still are finding elevated levels. But in any event, this report, staff report that was done in January of 2005 based on 2004 data showed elevated levels. And in the meantime, the Houston Chronicle, through Dina Cappiello, had been doing a fairly extensive study that included personal monitoring in some east Houston neighborhoods.

CC: You are referring to the special, "In Harm's Way?"

SL: "In Harm's Way," yes. The five-part series. That followed within about one month of the TCEQ report and it was, I think, a watershed event in terms of peoples' awareness and the reaction that the public had generally to those kinds of reports because they focused not just on ozone which is our day-to-day conversation . . . we get ozone levels published in the newspaper and we hear about it with the weather report and we have an alert system based on colors about how bad the ozone is going to be on a particular day and we take measures – staying inside, making sure we are in air-conditioned spaces and so on for ozone, so our attention has been focused I think, deservedly so, on ozone. For the past 4 or 5 years, we were found to be out of compliance by the federal government through the EPA for the ozone, the federal ozone standard and there are financial consequences largely in terms of highway funds and some other federal transfers to not being in compliance and we faced those consequences. And so, refinements were made in the state implementation plan to see that we would make the ozone standard by 2010. In the meantime, the TCEQ study in January of 2005 focused on hazardous air pollutants for which federal standards did not exist – they are not the same kinds of standards that govern ozone levels in large urban areas. And the follow-up by the Houston Chronicle also pointed out a number of chemicals that were toxic that were in the air and that could have manifest health effects on the population over and above what ozone did. And so, it was a look at a whole other area of hazardous air pollutants that had been identified in the Clean Air Act as of concern and that EPA periodically released studies on the levels of these hazardous air pollutants in cities but there was no federal standard as there was for ozone and a number of other pollutants for which there are national air quality standards. And if you exceed those standards for a

given period of time, then there are financial consequences; clearly regulatory kinds of measures in place for those substances like nitrogen oxides and the sulfur oxides and lead and ozone and, now, particulate matter.

CC: There are now standards for particulate matter?

SL: There are old standards for particulate matter and they are reconsidering the particulate matter standards. They are under review currently and we are likely to get more stringent particulate matter standards. And if we get more stringent standards for particulate matter than we currently have, Houston will be out of compliance for particulate matter as well as ozone.

In any event, by the beginning of March, the mayor was beginning to discuss in public the problem of air pollution based on the Houston Chronicle study and on the TCEQ report focusing on east Houston around the Ship Channel, around the east 610 loop, around the concentration of petrochemical firms within the city limits because the city couldn't control much beyond the city limits and there was a fair amount of transfer going on from outside the city- the eastern Harris County blowing in to the city. TCEQ had a cooperative arrangement with the city and that was beginning to change. The city wanted more aggressive enforcement. They wanted to begin citing plans for violations and they wanted to be on the forefront of negotiating resolutions without taking them to court but trying to get reductions, trying to get repairs for those 188 hazardous air pollutants that had been named in the Clean Air Act because the firms that operate in east Houston have to be permitted if they emit one of probably 500 chemical substances. Of the 188, the permits then track the emissions of the 188 that are named in the Clean Air Act in a way that you can check to see whether a firm is emitting a particular hazardous

air pollutant and if so, how much it is emitting a year or how much it is permitted to emit a year. And then, you can compare that to what is being monitored for on these monitoring sites and make a determination as to whether or not the permits are capturing all the chemicals that are being emitted in the air. The thing about these chemicals is that they are also emitted by mobile sources and not just stationary sources. So, it wasn't just a concern with the petrochemical plants but there were other sources for these chemicals: area sources - things like filling stations and dry cleaners; and mobile sources – cars, trucks, buses on highways, and east Houston had its share of vehicle miles being traveled between I-10, 610, 225, 45, 59. You had lots of traffic in the east end, some of it surrounding the Ship Channel and the industrialized areas in east Houston and some of it just involving highway travel. So, in any event, it was a fairly complex picture and by coincidence, Mayor White had a conversation with James Willerson, at least as it has been told to me, asking for help – what could the Health Science Center, the UT Health Science Center do to assist the City and establish some priority among all of these 188 chemicals? And, in tum, James Willerson came to my dean, Guy Parcel, who brought me in and we decided that the best way to bring together the scientific knowledge was to form a task force and to have it extend throughout the Medical Center and down to specialists at other campuses. And so, we made tentative lists of possible candidate for the scientific group based on reputation and our concern for having certain areas covered by the expertise we would bring in. And we also wanted representation from the leading institutions. And so, we selected a cancer epidemiologist from M.D. Anderson.

CC: Who would that be?

SL: Melissa Bondi from M.D. Anderson; from Baylor College of Medicine, we got a pediatrician who has done extensive work in asthma and from UTMB, we got a toxicologist, Jonathan Ward, who is a specialist in butadiene which is one of the key chemicals of concern. From the school, we tapped George Delclose, also a physician who has done some work in asthma and respiratory diseases off an Occupational origin. Tom Stalk, who is a chemist and industrial hygienist who has done extensive work and, in fact, was one of the key scientists in the Dina Cappiello studies and has done personal monitoring studies where residents actually wear a badge that detects their immediate exposure to certain chemicals. Ken Sexton, was the scientific director, director of the taskforce – an environmental scientist with 10 years experience as an administrator at the Environmental Protection Agency. And so, he knew what the study needed to look like and what the constraints were and what all the caveats were for this kind of study. We also had Matt Frazier who is a chemical engineer from Rice who had been involved in a number of taskforces earlier on. This wasn't the first task force that had been charged to look into this or the first organized group of experts but it was the first with this kind of charge and the charge was to come up with a priority ranking of what the health risks were. And it wasn't then a matter simply of reviewing the research or of calling for more research, it was a matter of going through the particular chemicals that were included on the list of 188 and determining both from EPA modeling and from ambient concentrations that had been measured which chemicals represented the biggest threats to residents.

CC: Who identified the actual chemicals?

SL: It was a fairly protracted process. Eventually, the taskforce members all agreed on the ranking of all the chemicals but we went through a process of establishing what health effect thresholds we would set for a given concentration of the chemical and EPA has a number of health effect thresholds published for chemicals that are carcinogens or that are thought to cause cancer. There is a health risk value of both which you can then begin to compute what the cancer risk is. And below that threshold, it is assumed that the cancer risk is less than 1 in one million.

CC: And so, the standard used was 1 to one million?

SL: Actually, no. First we drew on primarily EPA sources but also on California EPA sources of what those health values would be. The majority of those 188 chemicals caused cancer but a number of them have serious respiratory effects and we were interested primarily in their inhalation. So, no oral dose, no water, no toxic waste dump kinds of areas. Our concern was ambient air so it is outdoor as opposed to indoor, and it was inhalation. So, it was the breathing that was the concern to us – the breathing of these chemicals. And so, the research had been collected both in California and at the EPA that established some threshold of harm. For the chemicals that don't cause cancer, they established a threshold where they don't think there will be any harm from the chemical at that level of exposure. And so, the chemicals are all treated based on what their concentration is in the air. And so, we establish a threshold below which we think there will be a negligible effect and above which we think there will be some health effect, and the presumption we made following EPA or Cal EPA was that the effect was largely linear. So, the higher the concentration, the greater the effect. And we were at pains to follow protocols that had been established by either EPA or California EPA on

how we determined what the health risks were for these chemicals. So, for example, for the chemicals that were carcinogens, we established a threshold concentration for a **1** in one million cancer risk, then for **1** in 100,000 cancer risk, then for **1** in 10,000 cancer risk. And we considered then which chemicals exceeded those thresholds so that we could categorize them based on whether or not they represented a definite risk at that highest level, a probable risk at the middle level or a possible risk at the lower level. And then there were a number of chemicals that either weren't monitored or were unlikely to cause any sort of health effect at the concentration that they appeared in the greater Houston area and some chemicals that just weren't here at all like coke oven emissions. We don't have any coke ovens. And so, we are able to categorize those as being unlikely. And then, there were over 100 – I think the number was 118 – chemicals that remained uncertain because we could not say that there was no health effect but we could not establish which of those 3 risk categories the chemical actually belonged in. So, we took the ambient concentration data from the monitors from all around the area and there are 20 monitors that measure these hazardous air pollutants. There are many more when you consider ozone, many more ozone monitors than there are hazardous air pollutant monitors, but the hazardous air pollutant monitors, there are 20 of them and they monitor 49 of the 188 so we can get a subset . . .

CC: sites where the monitors are located?

SL: TCEQ had, in the past. The City has now renegotiated its contract with TCEQ so it has some leverage about where it locates the monitors and the city is anticipating getting a mobile monitoring unit that parallels TCEQ which also has a mobile monitoring unit. They are basically a mobile laboratory so they can drive anywhere there is road and

situate the monitor where they choose and where they think there are serious problems. So, we had monitoring data that we obtained from EPA and we decided to use annual average concentrations because we were looking for long-term exposures as opposed to short-term acute exposures because, again, for carcinogens, you are talking about a long-term exposure and for a lot of the respiratory effects, we wanted to establish how high the long-term exposures were so we used annual averages.

For the ambient data, the monitoring data, we concentrated on the year 2004 because that was the most complete ofthe years that we had between say 2002 and 2005, the most complete year was 2004 and the study that TCEQ had released in January 2005 was based on 2004 data. And so, we wanted to have some comparability to what TCEQ had done and its last report was doing 2004 data. About 6 months later, TCEQ released an annual report on the state of the greater Houston area and they focused on 2004 data so we wanted to do that as well. But the big break for us was that in March of this year, EPA released its national scale air toxics assessment. Now, the last one was done for 1996 and it was released in 2002 and there is a lag between when the assessment is done and when it is released principally because the data have to be validated and it takes a long time because the states and the localities that submit pollution and emission data can revise the figures that they submit and they can reestimate some of the way they estimate, for example, mobile emissions. Those things can be changing so that in 2006, we got the report based on 1999 data and so the 1999 data from the national scale air toxic assessment became available to us in March of this year. And what that did was it took . . . instead of taking monitoring data, it took emissions data which is measures of where the chemicals are being emitted not only from all of the permits, the permitted entities which

are usually larger scale entities. You've got to be on the order of 10 tons or so to be a permitted entity – took those entities and also estimated on road and off road mobile sources and also estimated area sources like from filling stations and from dry cleaners. And so, they have a national emissions inventory and from this inventory then, they can develop an estimate of what the concentrations are of various chemicals in the air. What they have to do then is combine it with local meteorologic conditions and with estimates of how the chemicals are being dispersed and the extent to which they are subject to rapid decay or to expansion and recombination with other chemicals and so on. And so, they have a complex computer model that generates estimates. The nice thing for us was not only being able to compare it to the 2004 monitoring data but also to get estimates at the level of census tracks because they generated from the modeling a single annual average concentration for 177 of the 188 at the level of census tracks. So, not only then did we go beyond the 49 monitored chemicals but we were able to fill in a lot of the chemicals that weren't monitored to see how we were doing and we were able to consider differences from census track to census track in terms of, for example, cancer risk for benzene or for butadiene or for some of the leading suspects in the area. So, the report then was, in part, an effort to rank order the chemicals based on their average concentrations, taking into account their relative health risks or their toxicity. And so, the highest ranked chemicals tended to be the ones who had the combination of high concentration or relatively high concentration and relatively high toxicity.

CC: Benzene and butadiene have been mentioned quite a bit. Are there any other carcinogens, toxics out there besides those two that have been . . .

SL: The biggest culprit that we were able to identify, where the cancer risk exceeded butadiene and benzene but that there is some controversy surrounding what the appropriate health threshold is was diesel particulate matter. Diesel particulate matter cannot be measured directly. It has to be estimated because it involves a complex combination of chemicals and compounds that are released as carried on the particulates themselves and we estimated it the way California and EPA both estimate diesel particulate matter which was to measure elemental carbon and assume that elemental carbon was a marker for diesel particulate matter but it was a proportion, a small proportion of all the elemental carbon and there were studies done in the Houston area, as it turns out, some by Matt Frazier, a member of the taskforce, that allowed us to partition the elemental carbon that we were able to measure based on the ambient monitoring data to get a good estimate of what the level of diesel particulates were, again using the protocol that had been developed by EPA and supplement it with the health value that California had put on diesel particulate matter. So, we were able . . . they believed that diesel particulate matter is a carcinogen and so they set a health risk threshold for 1 in one million, and they have also extended it up to 1 in 100,000, and so we could compare our computed concentrations of diesel particulate matter against those thresholds and see where we were essentially in violation of California standards. And as it turns out, when it comes to diesel particulate matter, the violations are fairly extensive and fairly large.

CC: Now, diesel particulate matter comes basically from diesel fuel which comes from automobiles, trucks, whatever. Is it used also in industry?

SL: The biggest sources in east Houston were off-road sources and if we considered what the inventory looked like of off-road sources, a lot of it is concentrated in the Ship

Channel area and in the loading and unloading connected with the Port of Houston. A lot of it is also connected with construction. Everything yellow on the side of the road as you drive down the Katy Freeway, all of those large scale, earth moving machines emit diesel particulates. They are all diesel, and the level of diesel particulates are fairly high from those pieces of equipment because they are not regulated. The same thing with large ships. Ships aren't regulated. The diesel particulate matter is fairly serious coming from ships and trains and transportation sources like that. There are special concerns around the airport as well but at least for our purposes, we were attempting to get a handle on where the possible diesel particulate was coming from because the presumption I think is usually that it is all on-road sources and those are only regulated by the federal government, of course. And they have changed the sulfur content of diesel fuel just recently and it is likely to have an effect on the diesel particulate composition but we don't know how much effect it is going to have here because the level of diesel particulate was so high relative to California health standards, we were surprised. That was probably, I think, our biggest surprise, and how many of the chemicals actually exceeded the health values that we had set based on California or EPA.

CC: Would you say the level of chemicals or are you talking about just the benzene, butadiene, the particulates or were there others?

SL: Well, we identified one dozen . . . one of the papers called it the dirty dozen. I sort of liked that. And, again, diesel particulate was the surprise for us. There is another metal that was included that is measured- it is another composite that is also measured in terms of particulates and it was chrome 6. There is a kind of chromium, they call it hexavalent chromium that is especially toxic and there is a way to estimate how much of

the chromium that you measure in a standard particulate measurement can be attributed to chrome 6. And again, we relied on an EPA protocol and we found that there were substantial amounts of chrome 6.

CC: And this first was from . . .

SL: This was from the ambient . . . the primary source was from the National Scale Air Toxics Assessment and I would have to look on the tables to see if we picked it up on the air monitoring as well that it was a health risk because what we did was we compared the estimates from the National Air Toxics Assessment against the estimates we were getting from the ambient monitors. Now, some of the chemicals were not measured by the ambient monitors. Others of the chemicals were measured by both and that was our happiest circumstance, where we had both ambient measures and we had modeled measures, and if they both pointed in the same direction, then it was, you know, convergent validation and they could both point to the same health effect, coming in at roughly the same concentration. And that was true in a number of cases, principally benzene, butadiene and so on. There were other instances where we had only National Scale Assessment values and they weren't monitored at all. And so also, if the National Scale Assessment, if the modeled values were sufficiently high, we included them in our list of 12. And there is a table in there that designates which were monitored and which were measured among the 12.

CC: that the chromium was listed in this index 7?

SL: O.K., here is how this table works. The ACS, here is the number of monitors where these chemicals exceeded the health values in 2004 and it is the annual average so it is not the case that we are just taking extreme values – we take all the measured values

and we computed an average and then we counted how many monitors where the average was above the health risk value and for carcinogens, we are talking in this particulate table about a risk of 1 in 10,000. And so, we had diesel particulate matter, butadiene, and both of those were monitored and they were also modeled. And you can see for diesel particulate matter, there were values that exceeded our health threshold in all 895 census tracks in the greater Houston 10 county area. No one was immune from diesel particulate matter. With 1-3 butadiene, we got it in 9 . . . it was modeled in excessive amounts in 9 census tracks but we picked up excessive amounts in 7 monitors around the area. So, that is one of the chemicals where we got that convergence just like for diesel particulate matter where both the modeled amount and the measured amounts were in excess for our health standards. Chromium 6, here we've got modeled amounts for 433 census tracks that exceeded the health values. There were no values on the monitors that exceeded the health values so benzene, two monitors were picking it up and it was modeled for 66 census tracks.

Ethylene dibromide, it wasn't picked up in the _____ model but it was picked up on 16 monitors in 2004. TCEQ claims that the 2004 data for ethylene dibromide were faulty but these data were evaluated by EPA and they are 2 years old. And so, we are unclear . . . TCE Q is denying that ethylene dibromide is a problem. Their position on chrome 6 is that it is too difficult to measure and there are other things we need to worry about – diesel particulate matter they are not attending to either and they are focusing almost exclusively on 1-3 butadiene and benzene for east Houston.

Acrylonitril came in at 6 census tracks. Acrylene, chlorine, hexamethylene diisocyanate – those are respiratory irritants that can lead to all sorts of, both respiratory

problems and other kinds of health problems. There is a table later in there where we list some of the health effects of these chemicals. You can get a sense of the nasty things that can happen to you as a result of those. Anyway, those are our top 12. Two of those are on the TCEQ watch list and the rest we were recommending that the mayor attend to as being of critical importance.

CC: This is on appendix 8, table 1 on page 51 of the Mayor's Taskforce Study. Chromium 6, of course, made headlines many years ago with PG&E in California, albeit it was ground water so it has been proven to be . . .

SL: Oh, yes. The dose response properties are pretty well known. The difficulty is measuring in an ambient here and separating it from other components of chromium and other kinds of metals. And the way EPA recommends doing it is the way, in effect we do the diesel particulate matter. You have got to assume from your measurement a certain proportion that represents chrome 6 based on the presence of certain kinds of industrial processes. So it will vary the proportion that is chrome 6, varies from area to area. I have forgotten what the chrome 6 proportion was here of the chromium measure but here in the greater Houston area, we have a number of small chromium plating facilities and chromium plating processes release chrome 6 into the air. And so, it is plausible that there is more chrome 6 than people suspect because we do have some industrial processes that generate chrome 6 and emit it into the air. There are also some elements that are released as a consequence of automotive combustion. You get tiny amounts of chrome 6 and car exhaust and so on.

CC: The majority of this is just coming out of industry itself?

SL: The majority ofhexamethylene diisocyanate is probably an industrial source. The majority of acrylene is coming from an industrial source, industrial sources primarily. When it comes to chrome 6, it is a little more difficult to decide . . . you have got to carefully review the profile of industries, you have to see where chrome 6 is related to an industrial process and then you have got to set up your monitor such that you are able to detect chrome 6, and you have got to start measuring chromium more extensively, and chromium is not necessarily one of the standard metals that are measured.

Side 2

CC: Compared to other large cities, are the pollutants more elevated in Houston due to the type of industry we have or were you able to . . .

SL: There was some surprise that the level of ozone was not higher than it was given our industrial profile and it appears that we are better off in some respects because of our topography than, say, the Los Angeles basin or Denver, and it is really the wind pattern that causes us to get in trouble trapping the ozone over the city. Otherwise, it would be dispersed. And so, for some, in terms of our compliance with federal standards, we are not doing badly. When you consider the hazardous air pollutants, on the other hand, we tend to follow a profile that is not unusual for large urban areas, especially in the traffic corridors and when you combine the large number of vehicle miles traveled in a day in the greater Houston area, with the plant sources then you generate a profile that is not unlike other large urban areas. EPA identified 33 hazardous air pollutants as being common in urban areas. We have about half of those to worry about here. Not all 33 but some portion of the 33. Some are a direct result of industrial sources like 1-3 butadiene. We actually manufacture 1-3 butadiene here and so it is not like it is just a byproduct that

is released into the air- it is a major worry to be able to control fugitive emissions from plants where butadiene is either made or transferred or used on some intermediate processes. So, because butadiene plays a large role here, we have got much more of it to worry over.

CC: Wasn't this developed to make synthetic rubber?

SL: Yes, it is an odd instance where you generate butadiene from a number of places you wouldn't think you would generate butadiene. For example, there is some research that shows that butadiene is released from tires wearing on asphalt and you get some amounts of butadiene that are released just from having cars rolling on tires where butadiene was used in the process of manufacturing the tires. But in Houston, it is different than other urban areas because there are not a lot of places in the country that actually make butadiene and it is difficult to control because it is so volatile than a lot of fugitive emissions – leaky pipes and connections and things where you get butadiene releases and sometimes, the plant managers don't even know. And so, part of the enforcement effort isn't setting up a fine or having some sort of threatening talk, it is saying, 'Hey, we think we found something over here in your 5 acre field of pipes ... there appear to be some that are leaking over here,' and they say, 'Well, thanks a lot.' They go over and they can fix it. And so, it is different in that case.

Having refineries here probably elevates our benzene profile and makes benzene a more serious problem and so I think TCEQ's attending to benzene and 1-3 butadiene responds to the fact that we have got 60% of the refining capacity in the country here and that benzene and butadiene appear to be part of that.

CC: In the permits that are given to these different refineries, I have been told that our standards in Houston or in the state of Texas are different than in other states in the country.

SL: Well, for regulatory purposes, that is, to make sure that all of the chemicals that are specified in the Clean Air Act as reportable are actually reported by firms and they are given permits to release a certain amount that is part of their production process each year and they are held accountable if they release more by accident or something. And they use a level that has been established independently of EPA's health effects levels and by a different process than California developed its health values as well. And they used these ESLs of the effects levels to set permissible emission and they also use them to establish when acute levels, that is, hour to hour measurements are in excess to the point where there ought to be some sort of health alert or some action taken or the likelihood of health effects happen to be substantial.

SL: We haven't done a comparative assessment of the relationship between the health values we used which are EPAs or Cal EPAs, and these ESLs that TCEQ uses. The conventional wisdom is that the ESLs were based in part on occupational exposure data and tend to be far less stringent than the threshold levels that are set based on the protocols the EPA and Cal EPA have for their levels. I don't know enough about that to be able to go into it. We didn't use ESLs in our assessments. We relied exclusively on the health values that were published - either the reference exposure levels, the RELs, or the health risk values which were for the carcinogens that they use what is called a unit risk that sets a threshold for cancer at the level of one million. We relied exclusively on those and just stepped aside from the whole ESL controversy. TCEQ is in the process of

revising how it calculates ESLs and it is being reviewed now, and there is actually a mayor's task force that Matt Frazier is on, that is reviewing ESLs and they are almost ready to report. I expect in the next month or so, there will be a report on ESLs from the mayor's task force on ESL reassessment because the TCEQ opened up the calculation of ESLs to reconsideration and they published recently for review and comment an ESL estimation process and I know the city's air quality staff responded to those. And this task force report will likely do a systematic analysis of those in a way that hasn't been completed before. So, we will have to see.

CC: Has it been noted that there are an elevation of both problems in Houston compared to other cities? Has that ever been done?

SL: That is actually a study being done now by Winnie Hamilton and she is using a fairly complex model being generated out of the University of Houston _____ atmospheric engineering department, there is a large simulator that will generate exposure estimates for a number of chemicals and she is going to use health data and see what the relationship is between exposures and mortality, morbidity outcomes in the Houston area.

CC: Are you talking about the air quality health study that is now starting at U ofH that is going to be monitored in August/September?

SL: I don't know if it is the same study. Who is the PI, do you know?

CC: Rockenglook (sp?).

SL: Oh, no, that is not the same one. So, there are more things going on than we thought.

CC: They are bringing in people from all over the country. He is just one of the

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SL: Baylor. She is in the Environmental Health Division at Baylor, and hers is the study I know about. It has some Mickey Leland money funding that. She is going to systematically examine the association between health effects and exposures at a population level. So, it is distinct from the study that Tom Stalk did which is of personal monitors again where you can catch 2 or 3 chemicals at concentrations that you know people are breathing and they are acute concentrations and they are not based on averages of anything. You can literally get the levels that people are exposed to off these personal badges that they wear. And he has done . . .

CC: It is like x-ray _____

SL: Yes. That study ought to be released in a couple of months as well. So, in the next year, there ought to be some good things out. We just happen to have our timing right so that we came out first of these series of studies.

CC: So, this problem is becoming known in the population?

SL: Sure, and much more momentum, I think. The mayor, of course, used the report in order to make known and reaffirm the priority of cleaning up the air in Houston. And he is going to develop a regional group to deal with benzene primarily. Carol Alvarado set up a group of City Council persons to worry about environmental threats to health and we testified there several weeks ago along with TCEQ.

CC: What would you personally or professionally recommend be done about this problem?

SL: I think the first thing I would worry over from an academic perspective is the

quality of the monitoring going on so that we can get a much better, more consistent, more thorough look at exactly what is in the air and when it is in the air. From there, I would worry about developing collaboratives for action because it is difficult to see given the complexity of this problem and of all the different processes that are involved in the split across jurisdictions how, without a collaborative, anyone actor can do much about all of this because it is not just industrial sources and it is not just automobiles and it is not just a particular perpetrator behind all of this. It is a confluence of all of those things. It seems to me problems of that kind do best when you can put together some sort of collaborative that includes industry and different sectors of the society with some leadership by elected officials so that you can get something done. There has been some success in other large urban areas - St. Louis in Missouri and an inventory of other areas the EPA maintains as part of a program for encouraging these kinds of collaboratives. Houston does not have one. There have been some efforts to start one but it hasn't really managed to bring the sectors together -- I mean, the greater Houston partnership and elective officials and a variety of different sectors together in a way that could lead to some systematic action.

CC: Obviously, the City has been pretty involved. How about the County?

SL: The City had the advantage, I think, in actually having a contractual relationship with TCEQ. The County, I am not sure they had the same experience or the same capability when it came to air pollution that the City did but clearly, the County would have to be involved as well in order to make any of this happen. We haven't heard much from the County. I am not sure this is central to their worry over ozone compliance.

CC: You've got a lot ofthese industrial plants.

SL: They are in east Harris County principally. I mean, that is the largest concentration that is outside the city limits in east Harris County, along the Ship Channel and south down to Surf Side.

CC: So, they would be directly involved just with the County?

SL: Yes, that is right.

CC: So, you know of no task force that the County ...

SL: Not to deal with air pollution, no. I do not know of any county-based initiatives. It doesn't mean there aren't any, I just don't know about them. CC:

SL: No, I sure don't.

CC: What role could industry play in helping ... just lowering emissions might actually make a difference or just changing chemicals?

SL: First, the conventional wisdom is that it is an 80/20 kind of problem; that 80% of the emissions are the responsibility of 20% of the firms; that is, the emissions that are not controlled, not contained. I am not sure about that. I haven't validated it. But one of the things that we found in our conversations with the City and the people who actually ride the fence lines trying to find where the emissions are coming from is that a lot of this is linked to maintenance of firms that maintain these acres and acres of pipes and complex refinery processes and that, to the extent that there is aggressive maintenance, you cut down on a lot of the fugitive emissions and you cut down on what is known as an upset event. An upset event is where you have an accident of sorts where you have something break or you have a maintenance process that leads to an uncontrolled release and these are acute episodes where a fairly sizeable amount of some chemical will get released and

then it will be contained again. If those upset events can be planned for and some diagnostic work done on what went wrong and how it went wrong, and all of that takes money to be able to do that, then you would be able to reduce the added emissions that are contributed by those acute events. If you stepped up the maintenance, you would be able to deal with all of those fugitive emissions. And then, if you went to the firms that didn't have the best available technology and provided some incentives for them to adopt the best available technology, then you could bring the 20% up and typically, I think the people who do enforcement know who those firms are and deal with them on an ongoing basis to try and help them along or at least provide a watchful eye over them. But it clearly takes their cooperation because for these hazardous air pollutants, there is not the federal regulatory sword hanging over it. They don't get taken to court and fined and so on. And so, it has to be negotiated out, it has to be cooperative, it has to be contractual. And the thing is for the most part, when the City has concentrated on those things, they have been able to make some headway. No firm wants to be identified as bad actors and polluting the air and all of that and you can induce some cooperation and get people to do better maintenance or to embrace a little bit better technology or make some changes in their industrial process to substitute less harmful chemicals for more harmful chemicals and so on. It just takes time and attention to each of the firms. And so, the concentration here has been on benzene and butadiene and I think rightly so. They have made some headway, especially with butadiene. The level of butadiene appears to be going down principally because the two main producers of butadiene have come to an agreement with the City for either changing their maintenance schedule or changing their control technology to reduce the amount of butadiene going out into the air. So, it seems to be

working in that sense. Benzene is a little more difficult. It is a little less attractable and it is the case, too, that when you have a large number of off-road sources of something like diesel particulate, it is very difficult to induce changes in them without federal cooperation, mandating changes in the fuel mix, for example, and mandating changes in the way the exhaust is filtered to deal with particulates. Some states have been fairly aggressive about diesel particulate matter like New Jersey and they actually have active filtration programs and so on and they expect firms to come into compliance. And we have not approached that at all and it is something we could do. I know the City was attempting to get its fleet of trash trucks with filters installed and couldn't quite find the technology that worked with the garbage trucks but something needs to be done about the diesel particulate matter clearly.

CC: You said they couldn't find the technology but yet, it is being used in New Jersey?

SL: They couldn't make the technology work for that fleet of trucks, yes and they are still trying to make that work.

CC: So, it might take getting all new trucks?

SL: Well, it could because the engine technology itself is probably going to change in about the next 10 years and the improvements, for example, in the extent to which cars contribute to ozone have really been dramatic so that our vehicle mile travels per year have gone up pretty dramatically but the ozone hasn't gone up parallel to the increase in vehicle miles traveled. I mean, the ozone is either the same or going down a little and the vehicle miles traveled are going way up. And it is principally because they changed both

the formulation of gasoline and added those catalytic converters to get most of the byproducts that combustion out.

CC: Well, I know that for many, many years, public health has always tracked outbreaks of contagious diseases - TB being one of them, of course. Have they ever tracked increase in certain cancers, upper respiratory problems, that type of thing since plants have been around _ _ _ _ _ _ ?

SL: In the Houston area, there have been some studies related to asthma and the increases in asthma related to exposures and how those relationships have varied over time and the extent to which pollution is at least an attributable source of asthmatic episodes. Other than that, there is not much that I know about of the kind that have been launched in, say, California and Chicago and New England where they have large cohort studies that cost millions and millions of dollars to put on and last, say, a decade, and they are able to track people not unlike, say, the Framingham Heart Study. When you have morbidity and you have mortality occurring and you've got a control group and you are able to vary the exposure and so on, then you are able to attribute those outcomes to particular kinds of exposures. Then you are able to generate data that makes a difference and I think most of the ... especially for fine particulate matter, the standards regulating particulate matter came out of some comprehensive studies that had a lot of respiratory endpoints and they were largely cohort long-term studies tracking a large population.

CC: When you are talking about an increase in the long-term exposure to butadiene, do we know what type of cancer it causes or is it multiple?

SL: We do but I

don't. CC:

SL: Benzene is probably the one that has been studied the most, so there is probably more known about benzene than many of these other chemicals. Butadiene is close behind - what we know about butadiene and don't know about butadiene. Chrome 6, it is less clear to me. A lot of the studies, animal studies and so on ... it is not the case that there is a particular kind of brain tumor that is only caused by chrome 6. I mean, there is no ... what was it, mesothelioma that is tied to asbestos and was the smoking gun and so on. I don't know.

CC: Squamous cell carcinoma with radon.

SL: Yes. I don't know. The literature is extensive though. The toxicological literature on it.

CC: And what do you foresee for the future of Houston's air problem?

SL: I am really much more optimistic than I was when I first started this study principally because of the attention the study has gotten. I didn't expect that. I didn't expect this much attention. As the study drew are the fact that there were elected officials who were anxious to have a study like this to be able to make their case to the larger community that not only is this a serious problem but it represents a priority we all need to commit to. I mean, that kind of talk is really good talk to me and I think it bodes well for future politics having to attend to these issues in a way that they didn't have to in the past. The other huge development to me is that industries' voices have changed and they have changed in that had this report come out, say, 5 years ago, I expect that there would have been a much more aggressive and fairly hostile response on the part of the collection of firms, the individual firms, in being sure that the report didn't get traction or have much credibility and there was that kind of adversarial relationship between the

proponents of environmental quality and clean air and industrial sectors that were responsible for at least the point source emissions. That has changed, too. We largely have not heard any criticism from industry at all. It doesn't mean that there won't be but I expected at least something to be said or, you know, a letter to the editor or an oped piece. There were op ed pieces, there was an editorial in the Chronicle and, of course, the mayor's press conference was covered on several TV channels. The radio coverage went several days and although some of the press coverage attempted to draw spokespersons from either the petrochemical industry or from the partnership or other spokespersons for industry. There was no comment to be gotten. I think that is different and I also think that that is healthy, that is a good thing. What that does is it lays the groundwork for a collaboration because there is not that us versus them kind of mentality that is still in place as there was, say, 5 years ago. So, we may well be on that. So, what we have emerging is a political agenda that is being promoted by several, I think, visionary elected leaders and we have got industry at least not attempting to undermine the bases of cooperation on these issues. So, I think we are better off than we were 5 years ago.

CC: Well, I want to thank you very much for contributing to this oral history program and to giving your time.

SL: You are very welcome. It has been a pleasure. Thank you.