BRC
BIODYNAMIC RESEARCH CORPORATION

December 19, 2011

Mr. Matthew D. Stockwell
Callahan & Fusco
72 Eagle Rock Avenue, Suite 320
East Hanover, NJ 07936

Re: ***Kline, Thomas vs. Loman Auto Group***

Dear Mr. Stockwell:

At your request, I have performed an injury causation analysis in this matter. The purpose of this report is to set forth my general qualifications and preliminary opinions regarding the biomechanical forces experienced by Ms. Kline and the motion of her body during the subject accident.

My professional background includes a B.S.E. degree in Biomedical Engineering from Duke University, and M.S.E. and Ph.D. degrees in Biomedical Engineering from the University of Virginia. I am an Adjunct Assistant Professor in Biomedical Engineering at Virginia Tech and Clinical Faculty in Graduate Medical Education for the United States Air Force School of Aerospace Medicine. I am a licensed professional engineer in the fields of mechanical and biomedical engineering (Texas P.E. #104623). I have specific training in accident reconstruction, and I am accredited as a traffic accident reconstructionist (ACTAR #1705). I have authored more than fifty peer-reviewed scientific papers in the areas of orthopaedics, biomechanics, accident reconstruction, and injury risk analysis. My professional background and publications are documented in more detail in the attached copy of my curriculum vitae.

During the course of my study of this matter I have been provided the following items:

- New Jersey Police Crash Investigation Report;
- Reports of:

  Paul Victor Sheridan, BS, MBA, dated 11/30/2009 and 04/28/2011
  Donald R. Phillips, PE, dated 04/22/2009 and 07/25/2011
  William R. (Chip) Bush, Jr.
  Neil Hannemann

Robert D. Banta
Nicholas J. Durisek, Ph.D., PE
Thomas L. Bennett, MD, dated 01/01/2009 and 09/09/2011
Ross I.S. Zbar, MD, FACS;

- Various Pleadings and Discovery Responses;

- Statement of Natalie S. Rawls;

- Depositions of:

  Natalie Rawls
  Victoria Morgan-Alcala
  Trooper Elkin Orellano
  Detective I. Kevin Bartels
  Paul Victor Sheridan
  Bernard Robertson
  Francois Castaing
  Owen Viergutz
  Phillips Kaeser;

- Color Photocopies of Photographs of:

  6 Photographs of the Ford Taurus and the Jeep Grand Cherokee Crash Test
  15 Photographs of the Accident Site Inspection by Dynamic Analysis Group, LLC
  16 Photographs of the Accident Site Inspection by Dynamic Analysis Group, LLC
  16 Photographs of the Accident Site Inspection by Dynamic Analysis Group, LLC
  20 Photographs of the Ford Taurus and the Jeep Grand Cherokee Crash Test w/Dummy Pre-Test
  41 Photographs of the Accident Scene
  71 Photographs of the Jeep Grand Cherokee Vehicle Inspection
  71 Photographs of the 1996 Grand Cherokee Exemplar Inspection by RD Banta
  267 Photographs of the 1996 Jeep Grand Cherokee Vehicle Inspection by RD Banta
  267 Photographs of the 1999 Jeep Grand Cherokee Vehicle Inspection
  420 Photographs of the 1996 Jeep Grand Cherokee Vehicle Inspection by Dynamic Analysis Group, LLC
  421 Photographs of the 1999 Jeep Grand Cherokee Vehicle Inspection by Dynamic Analysis Group, LLC;

- DVD Containing Color Photographs, Videos and Test Reports for the 1987 Ford Taurus And the 1999 Jeep Grand Cherokee by KARCO Engineering;

- Flash Drive Containing Various Documents to Include: Pleadings, Various Depositions,

Chrysler Production; Claims and Investigations; Expert Reports; and NHTSA Investigation;

- Dynamic Analysis Group, LLC Vehicle Measurements;
- Robert Banta (Auto Safety) Real World Crash Study Reports;
- Analysis of the Real World Crash Performance of 1993-1998 Jeep Grand Cherokees By Paul M. Taylor, Ph.D., PE;
- SAE Reports;
- The Center for Auto Safety 50 MPH Vehicle-to-Vehicle 30% Offset Rear Impact of 1999 Jeep Grand Cherokee Laredo and 1987 Ford Taurus by KARCO Engineering;
- Experimental Test of Occupant Entrapment – Ford Taurus into Rear of a Jeep Grand Cherokee 30% Offset, 50 MPH Prepared by the Federal Outdoor Impact Laboratory;
- Guide for Fire and Explosion Investigations – 2011 Edition;
- 1996 Jeep Grand Cherokee Exemplar Vehicle Inspection Notes by Dynamic Analysis Group, LLC;
- Dr. Carlos A. Fonseca Deputy Medical Examiner File;
- Medical Records of Susan Morris-Kline From:

  County of Morris Medical Examiner
  Morristown Memorial Hospital
  Death Certificate of Susan V. Morris; and

In addition, I personally inspected the Kline vehicle on December 1, 2011 in Bound Brook, New Jersey.

A brief summary of the background information concerning this incident follows:

- The subject accident occurred on Saturday, February 24, 2007 at approximately 8:53 a.m. in the southbound lanes of I-287 near exit 42 in Parsippany, New Jersey. Ms. Natalie Rawls was driving 1998 Subaru Legacy and had slowed or stopped in the right hand lane of the expressway after missing her exit. Ms. Susan Kline was driving behind Ms. Rawls in a 1996 Jeep Grand Cherokee and slowed or stopped, as well. Ms. Victoria Morgan-

Alcala was driving a 2004 Toyota Sienna minivan behind Ms. Kline and rear ended the Jeep at a high speed. The impact pushed the Jeep into the Subaru. As a result of the collision, the Jeep spun around about 180 degrees and caught fire. Afterwards, Ms. Kline was found deceased and severely burned in the right front passenger seat of the Jeep.

- An autopsy performed on Ms. Kline revealed extensive, full-thickness thermal damage with 90% body surface charring; multiple head fractures of the skull, upper extremities, and lower extremities associated with abundant deposition in the upper and lower airways; and carbon monoxide quantification of 26.1%. Blunt trauma of the chest with undisplaced fractures of the right fourth and fifth ribs was also noted. No other pre-mortem injuries were identified. The cause of death was determined to be smoke inhalation and thermal injuries.

My independent investigation has yielded the following observations:

- In this case, I have been asked to determine whether or not Ms. Kline was most likely conscious or unconscious following the accident as a result of the biomechanical forces involved in the crash. It has been alleged that immediately after the accident, Ms. Kline was conscious and voluntarily moved to the passenger side of the Jeep in an attempt to exit the vehicle before succumbing to the fire. Both Dr. Zbar and Dr. Bennett agree that Ms. Kline was breathing for some period of time after the crash. However, they disagree as to whether or not she was conscious based on their medical analyses. There are no witnesses who observed any conscious activity from Ms. Kline, and the post-mortem destruction of her body likely obscured any potential medical evidence of minor or moderate head injury. A biomechanical analysis can provide additional insight into this issue.

- In the field of automobile safety, the severity of a collision in terms of both vehicle damage and occupant injury potential is typically characterized by the speed change, or "delta-V" (change in velocity) of the vehicle during a collision. Real world crash data have shown that delta-V is the single most important predictor of occupant injury in a collision, although other variables are also important (Malliaris et al., 1997; Augenstein et al., 2003; Funk et al., 2008). The subject accident involved two major impacts to the Jeep Grand Cherokee: a high speed rear impact followed by a moderate speed frontal impact.

- The subject accident has been reconstructed by three experts: Mr. Donald Phillips, Dr. Nicholas Durisek, and Mr. Stephen Fenton. In Mr. Phillips' supplemental report, he stated that "...the total speed energy transferred into the Morris-Kline Jeep Grand Cherokee was approximately 42.6 to 51.4 miles per hour, approximately 29.2 miles per hour to a maximum of 41 miles per hour was absorbed during the rear underride collision from the Morgan-Alcala Toyota Sienna van." It is not entirely clear whether Mr. Phillips was referring to barrier equivalent velocities (BEV), which relate to the damage energy, or velocity changes (delta-Vs) during the collision. Dr. Durisek opined that the initial

rear impact from the Toyota Sienna minivan caused the Jeep Grand Cherokee to experience a delta-V of 36 – 40 mph. Mr. Fenton opined that the Jeep Grand Cherokee experienced a rear delta-V of approximately 38 mph as a result of the collision with the Toyota Sienna minivan. The delta-V calculations of all three reconstructionists are therefore in good agreement.

- The rear impact to the Jeep Grand Cherokee can only be described as very severe based on the delta-V level. Only 1.2% of all tow-away rear impact crashes involve a delta-V of 35 mph or greater (Viano and Parenteau, 2008). The severity of the subject collision greatly exceeded the severity of the crash test required by the Federal Motor Vehicle Safety Standard (FMVSS) 301 for fuel system integrity, which typically results in a rear impact delta-V of 15 – 20 mph. According to real world accident data, the risk of serious injury to an occupant involved in a rear impact having a delta-V of 35 – 40 mph is substantial, with risks ranging from 10% to 50% for belted occupants (Augenstein et al., 2003; Viano and Parenteau, 2008), and the risk to unbelted occupants ranging as high as 60% - 80% (Malliaris et al., 1997). The risk of head injury was elevated in crashes where a high speed rear impact was followed by a frontal impact (Galli and Digges, 2008), which is what occurred in the subject accident. In these studies, serious injury is defined as an injury having a score of 3 or greater on the Abbreviated Injury Scale, which is a trauma scale ranging from 0 (no injury) to 6 (maximum). The risk of minor (AIS 1) or moderate (AIS 2) injury at these delta-V levels is even higher. A concussion resulting in a loss of consciousness would be coded as either an AIS 1 or 2 injury.

- Based on the accident statistics cited above, it is probable that Ms. Kline sustained a serious injury during the initial rear impact. However, a more specific evaluation of her risk of head injury can be made by analyzing of high speed rear end crash testing. From 1996 to 1999, the National Highway Traffic Safety Administration (NHTSA) conducted vehicle crash tests to determine the feasibility of a high speed offset deformable barrier (ODB) rear impact test program (Viano et al., 2008). A total of 21 tests were conducted in which a 3000 lb. moving deformable barrier traveling at 50 mph struck the rear end of the stationary test vehicle. The direction of impact was rear-to-front with a 70% overlap on the side of the vehicle where the fuel filler neck was located. The average delta-V of the struck vehicles was 27 mph. The severity of the test collisions was quite high, but still substantially lower than Ms. Kline's collision.

- In the 50 mph ODB tests run by NHTSA, crash tests dummies were belted in the driver and right front passenger seats. The motion of these dummies provides information about the general movement of a belted driver in a high speed rear impact. In the tests, the dummies initially remained stationary as their seats were accelerated forward beneath them. The inertia of the dummies' bodies loaded the seatbacks and caused them to yield rearward. In many cases, the deformation of the rear of the vehicle was so extensive that it pushed the rear seatbacks forward and stopped the rearward rotation of the front seatbacks. The dummies' heads then struck the rear seatbacks, which were stiffened by the stack-up of rear structures (Viano et al., 2008). At delta-V levels of around 27 mph,

this phenomenon was observed in passenger cars, but not SUVs or minivans. In the subject accident, the delta-V was higher, so this phenomenon was observed in the Jeep Grand Cherokee. The rear impact pushed the floorpan in the cargo area upward and forward, causing it to stack up against the rear seatbacks, which were then pushed forward. The forward deformation of the left rear seatback extended so far forward that it appeared to have limited the rearward deformation of the driver's seatback (Figure 1). Therefore, it is likely that Ms. Kline struck her head on the left rear seatback, which was stiffened by the stack-up of the rear structures, in a similar manner to the 50 mph ODB tests but at a much greater severity.

Figure 1. Photograph showing the deformation of the first and second row seatbacks.

- The crash test dummies in the 50 mph ODB rear impact tests were instrumented with sensors that records head accelerations, from which Head Injury Criterion (HIC) values were calculated. The HIC is a unitless value that takes into account not only the peak, but also the time duration of the head acceleration. The HIC is based on several decades' worth of biomechanical research, and risk curves have been developed that relate the HIC value recorded in a dummy to the risk of head injury in a person (Mertz et al., 2003). Government regulations (FMVSS 208) require that head injury potential in a crash test be assessed using the HIC. An injury assessment reference value (IARV) that has been used in the past for compliance testing is a HIC of 1000, which represents a 16% risk of severe (AIS 4 or greater) brain injury (Mertz et al., 2003). The current pass/fail value for HIC in government regulations is 700 (NHTSA, 2008). In the high speed rear impact tests run by NHTSA, the average HIC value was 983 for the near-side dummies and 1054 for the far side dummies. The corresponding risk of severe brain injury to a human in a rear impact having a delta-V of about 27 mph would be substantial at roughly 16%. It is likely that Ms. Kline experienced a HIC value much higher than 1000 in the subject accident due to the fact that she was unbelted and the collision severity was much higher than the ODB tests.

- The issue in this case is not whether Ms. Kline sustained a severe (AIS 4+) head injury, which would be potentially fatal, but whether she sustained a concussion (AIS 1 or 2). The risk of concussion as a function of head impact severity has been studied extensively in athletes. I have personally studied the association between head impact severity and the risk of concussion using data from over 60,000 head impacts recorded in collegiate football players (Funk et al., 2007; Funk et al., 2011). The head impacts were recorded in real time using helmet-mounted accelerometers and the diagnosis of concussion was made by the team physician (Duma et al., 2005). Only 1% of head impacts sustained by collegiate football players exceed a HIC value of 200 (Greenwald et al., 2008). Concussions in football are typically associated with average HIC values in the 400 – 600 range (Pellman et al., 2003; Funk et al., 2007; Funk et al., 2011). Similar results have been found for Australian rules football and rugby (Frechede and McIntosh, 2009). Based on data from collegiate football, I determined that a HIC value of 1000 represents a nearly 100% risk of concussion in these athletes (Pellman et al., 2003; Funk et al., 2007).

- The severity of the blow to the head experienced by Ms. Kline in the initial rear impact can also be compared to the severity of head impacts seen in boxing. Pincemaille et al. (1989) measured head impacts in helmeted amateur boxers and recorded a maximum HIC value of 348 in five bouts. Walilko et al. (2005) and Viano et al. (2005) measured punch force and head impact severity in Olympic boxers striking the unprotected head of a crash test dummy. They found that boxers could deliver punch forces exceeding 1000 lbs. However, the maximum HIC value recorded was 164 due to a punch from a superheavyweight. In short, the head impact experienced by Ms. Kline in the initial rear impact was far more severe than a punch from a heavyweight boxer or a hit from a professional football player. It is extremely unlikely that Ms. Kline could have remained conscious and alert following such a head impact.

- Given that Ms. Kline was most likely rendered unconscious immediately after being rear ended by the Toyota Sienna minivan, it remains to be explained how she came to rest in the right front passenger seat of her vehicle after the crash. An analysis of the vehicle motion during the entire crash sequence reveals that the right front passenger seat is in fact the position where an unconscious, unbelted driver would be expected to come to rest.

- The subject accident was not simply a straightforward rear impact. Based on the accident reconstruction performed by Mr. Fenton, it is my understanding that the driver's side of the Jeep Grand Cherokee was elevated as a result of the initial rear impact from the Toyota Sienna minivan such that it attained a substantial roll angle towards the right side. As the driver's seat of the Jeep was pushed forward and upward, Ms. Kline's body initially moved rearward and downward with respect to the seat. However, her rearward motion was rapidly arrested by the deformed left rear seatback and her downward motion was rapidly arrested by the driver's seatback and seat bottom. Afterwards, Ms. Kline's body was propelled forward and upward as it rebounded off the forward and upward

moving driver's seat. Some of the rearward motion of Ms. Kline was also converted to upward motion as she ramped up the seatback. Due to the roll angle of the Jeep, there was also a component of rightward motion relative to the Jeep.

- Very shortly after the rear impact, the Jeep Grand Cherokee experienced a frontal impact with the Subaru Legacy, which rapidly slowed down the Jeep. Ms. Kline's body, however, continued to move forward in accordance with Newton's first law of motion. Her forward motion was arrested by contact with the forward structures of the Jeep's interior, which likely included the driver's airbag, the steering wheel, the windshield, and the instrument panel. Ms. Kline's body may have deflected upward and possibly rightward due to contact with the driver's airbag at this point.

- Due to the left offset of the frontal impact with the Subaru, the Jeep began yawing counterclockwise. After the crash pulse was over, the Jeep's counterclockwise rotation was slowed and eventually brought to a stop by the frictional forces between the Jeep's tires and the road. During this spinout phase of the crash sequence, the deceleration of the Jeep was low but lasted for a long period of time. The direction of the Jeep's deceleration was initially leftward with a rearward component, then straight leftward, and finally leftward with a frontal component. The motion of Ms. Kline during the spinout phase was generally in the opposite direction of the vehicle deceleration, in accordance with Newton's first law of motion. In other words, as the Jeep started yawing, her body was moving forward and to the right relative to the Jeep. When the Jeep was sliding sideways down the road with the right side leading, Ms. Kline's body was moving towards the right side of the Jeep. As the Jeep continued to yaw beyond 90 degrees, Ms. Kline's body moved to the right and rearward with respect to the Jeep. Ultimately, Ms. Kline fell down into the right front passenger seat and her motion was limited by its contact with the seat bottom and seatback. Finally, the vehicle came to a stop.

- Ms. Kline's post-accident position in the vehicle is consistent with this analysis. Her body was seated in the right front passenger seat with the upper body and head leaned rearward and to the right. Her legs were angled towards the middle of the car. This position is consistent with involuntary motion to the right side of the car in which her legs interacted with the center tunnel and her buttocks interacted with the right front passenger seat bottom, which slowed her lower body down while her upper body continued to move to the right until interacting with the right front passenger side door, B-pillar, and seatback.

- Although all of the seatbelt systems in the Jeep were burned, I did find a latchplate tongue in the left rear floorboard area. This position is consistent with where the latchplate tongue would fall after the seatbelt webbing burned with the seatbelt in the stowed position. Given all of the evidence, it is much more likely that Ms. Kline was unbelted at the beginning of the crash. It is unrealistic to suppose that Ms. Kline was belted, remained conscious after an extremely severe crash, then unbuckled herself and moved over to the passenger side of the vehicle. During my inspection, I noted that the

driver's door opened freely. Had Ms. Kline been conscious and belted in the driver's seat after the crash, it would have logical for her to attempt to exit the vehicle through the driver's door. In addition, Ms. Kline's post-accident body position was not consistent with a posture that would be assumed by a person attempting to exit a burning vehicle. Rather, her posture was consistent with an unconscious person who had been thrown towards the right side of the vehicle during the spinout phase of the crash.

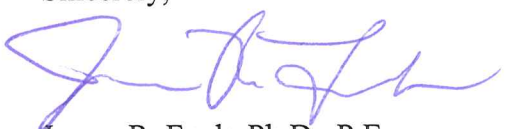
Based on my review of the above information and my independent analysis, my professional opinions held to a reasonable degree of scientific certainty can be summarized as follows:

- Ms. Kline was the driver of a Jeep Grand Cherokee that was involved in a very severe crash followed by a fire. The severity of the rear impact was in the top 1% of all tow-away rear impact crashes. Based on the crash severity, serious injury would be expected. During the rear impact, Ms. Kline's head likely struck the left rear seatback, which had been pushed forward into the back of her seat. The blow to Ms. Kline's head probably resulted in her experiencing head acceleration levels corresponding to a Head Injury Criterion value well over 1000, which corresponds to a substantial risk of severe brain injury and an essentially 100% risk of concussion. The head impact experienced by Ms. Kline during the rear impact was far more severe than a punch from a heavyweight boxer or a hit from a professional football player. Ms. Kline was almost certainly rendered unconscious immediately as a result of the rear impact. Her body then moved upward and forward during the subsequent frontal impact, then towards the right side of the Jeep as it spun out. The post-accident position of Ms. Kline's body is exactly where an unconscious, unbelted driver would be expected to come to rest at the conclusion of this accident sequence.

As additional information is made available to me or as new facts are uncovered during the investigation and discovery process, my professional preliminary opinions may change to reflect the newfound information. The preliminary opinions expressed herein, however, are current and accurately reflect my conclusions based upon the information reviewed and the analysis performed as of this date.

Should you require additional information, please do not hesitate to contact me.

Sincerely,



James R. Funk, Ph.D., P.E.

JRF/daw
Enclosure: Curriculum Vitae

References

Augenstein J, Perdeck E, Stratton J, Digges K, Bahouth G, "Characteristics of Crashes that Increase the Risk of Serious Injuries," *Proc. 47th Association for the Advancement of Automotive Medicine*, pp. 561-576, 2003.

Duma SM, Manoogian SJ, Bussone WR, Brolinson PG, Goforth MW, Donnenworth JJ, Greenwald RM, Chu JJ, Crisco JJ, "Analysis of Real-time Head Accelerations in Collegiate Football Players," *Clin J Sports Med*, 15(1), 3 – 8, 2005.

Frechede B, McIntosh AS, "Numerical Reconstruction of Real-Life Concussive Football Impacts," *Med Sci Sports Exerc*, 41(2):390-398, 2009.

Funk JR, Duma SM, Manoogian SJ, Rowson S, "Biomechanical Risk Estimates for Mild Traumatic Brain Injury," *Annual Proceedings of the Association for the Advancement of Automotive Medicine (AAAM)*, pp. 343 – 361, 2007.

Funk JR, Cormier JM, Gabler HC, "Effect of Delta-V Errors in NASS on Frontal Crash Risk Calculations," *Annals of Advances in Automotive Medicine*, 52: 155 – 164, 2008.

Funk JR, Rowson S, Daniel RW, Duma SM, "Validation of Concussion Risk Curves for Collegiate Football Players Derived from HITS Data," *Annals of Biomedical Engineering*, doi:10.1007/s10439-011-0400-8, in press.

Galli RM, Digges KH, "Severe Head and Neck Injuries in NASS Rear Impacts," *Society of Automotive Engineers*, Paper 2008-01-0190, 2008.

Greenwald RM, Gwin JT, Chu JJ, Crisco JJ, "Head Impact Severity Measures for Evaluating Mild Traumatic Brain Injury Risk Exposure," *Neurosurgery*, 62(4):789-798, 2008.

Malliaris AC, Digges KH, DeBlois JH, "Relationships Between Crash Casualties and Crash Attributes," *Society of Automotive Engineers*, Paper 970393, pp. 177 – 188, 1997.

Mertz HJ, Irwin AL, Prasad P, "Biomechanical Scaling Bases for Frontal and Side Impact Injury Assessment Reference Values," *Stapp Car Crash Journal*, 47:155-188, 2003.

National Highway Traffic Safety Administration. 49 CFR Ch. V Part 571 – Federal Motor Vehicle Safety Standards (Standard No. 208 Occupant Crash Protection). §571.208. Washington, DC: U.S. Government Printing Office, 2008.

Pellman, EJ, Viano DC, Tucker AM, Casson IR, Waeckerle JF, "Concussion in Professional Football: Reconstruction of Game Impacts and Injuries," *Neurosurgery*, 53(4), 799 – 814, 2003.

Pincemaille Y, Trosseille X, Mack P, Tarriere C, Breton F, Renault B, "Some New Data Related to Human Tolerance Obtained from Volunteer Boxers," *Proc 33rd Stapp Car Crash Conference*, Paper 892435, 177 – 190, 1989.

Viano DC, Casson IR, Pellman EJ, Bir CA, Zhang L, Sherman DC, Boitano MA, "Concussion in Professional Football: Comparison with Boxing Head Impacts – Part 10," *Neurosurgery*, 57(6):1154-1172, 2005.

Viano DC, Parenteau CS, Prasad P, Burnett R, "Occupant Responses in High-Speed Rear Crashes: Analysis of Government-Sponsored Tests," *Society of Automotive Engineers*, Paper 2008-01-0188, 2008.

Viano DC, Parenteau CS, "Serious Injury in Very-Low and Very-High Speed Rear Impacts," *Society of Automotive Engineers*, Paper 2008-01-1485, 2008.

Walilko TJ, Viano DC, Bir CA, "Biomechanics of the Head for Olympic Boxer Punches to the Face," *Br J Sports Med*, 39: 710 – 719, 2005.