

7th Quarterly Program Progress Performance Report  
for  
National University Rail (NURail) Center:  
Tier 1 University Transportation Center



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USDOT OST-R Tier I University Transportation Center (UTC)

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## 1. Accomplishments

### a. What are the major goals of the program?

The NURail Center's principal goals are, as stated in the proposal, to achieve a set of Research, Education, Technology Transfer Collaboration and Leadership objectives that will not only fulfill center objectives, but support and assist achievement of goals beyond the consortium members. These include rail industry, AAR and FRA research and workforce development goals. They also include working with other colleges and universities, both domestically and internationally to advance academic rail education and research quality and quantity.

### b. What was accomplished under these goals?

#### **NURail Consortium**

- NURail Annual Meeting held in Chicago on June 3 – 4 with approximately 100 attendees. There were over 30 speakers and 25 poster presentations.

#### **University of Illinois Urbana-Champaign**

- Railroad Capacity: Master's thesis draft on incremental capacity of lines with variable siding spacing and siding expansion strategy for operation of long trains. Completed analysis of capacity of incremental expansion from double to triple-track rail corridors. Developing new parametric model to calculate delay distributions for different train types on shared rail corridors. Presented 11 conference papers on these topics.
- Railway Energy Efficiency: Master's thesis draft on commuter rail energy efficiency. Continued work on operational considerations for alternative fuel locomotives. Presented five conference papers.
- Hay Seminar Series: Hosted eight on-campus seminars from industry experts that were also broadcast online. Cumulative online and in person attendees for all seminars was 755.
- Engineering Open House: Together with UIUC AREMA Student Chapter, sponsored railway engineering exhibits at UIUC Engineering Open House event. Attended by 20,000 people, including over 12,000 primary and secondary students.
- Minority Student Outreach: At Engineering Open House in March, hosted 30 minority students from Springfield, IL nominated by their schools for interest in STEM topics.
- Boy Scout Merit Badge Clinic: With UIUC AREMA Student Chapter, Railroad merit badge clinic was hosted by NURail on UIUC campus on two April weekends.
- Railroad Safety and Risk: Completed three projects: "Causal Analysis of Passenger Train Accidents on Freight Rail Corridors", "Shared Rail Corridor Adjacent Track Accident Risk Analysis" and "Consequence Evaluation of Liquid Hazardous Material Release Using GIS Flow Modeling". Final reports being reviewed prior to posting to TRID database.
- Analytical Modeling of Concrete Crossties and Fasteners: Further documentation of results of parametric analyses using the FE model to investigate the frictional performance of the system. New project started to investigate performance of bolted rail joints in rail transit systems, building on FE model knowledge gained under prior projects.
- Research and Innovation Laboratory (RAIL): Detailed full-scale trackbed testing in lateral load path for multiple types of concrete crosstie fastening systems. Began focused research on flexural performance of concrete crosstie using new testing apparatus, promising results obtained to date.
- Railroad Grade Crossing Micro-Level Safety and Risk Analysis: Developed new models to estimate frequency and risk at grade crossings. Expected accident severity incorporated to frequency predictions to create risk assessment. Current work includes incorporating past

history and individual crossing characteristics to risk assessment, improving valuation of each crossing and generating a ranking of prioritized locations.

#### **University of Illinois Chicago – College of Engineering (COE)**

- All US DOT and UIC matching funds allocated in federal FY11/FY12 are expended.
- Research on four major projects complete. Final reports being written:
  - Integrated Dynamic Modeling of Rail Vehicles and Infrastructure
  - Modeling of Rail Track Substructure
  - Immersive Visualization of Rail Simulation Data
  - Rail Infrastructure Materials for High Speed Rail
- Fifth project will be concluded by end of 2015: Informed Railroad Traveler (phone app)

#### **University of Illinois Chicago – College of Urban Planning & Public Affairs (CUPPA)**

- VC (Value Capture Coordination): Finalized a few report versions, one accepted and presented at the American Real Estate Society Academic Conference in April.
- Rail Safety (Rail Crossing Safety): Continued compiling literature review and performing survey data analysis.
- GIS (GIS Analysis of Environmental Impacts of Rail Development): Final report preparation.

#### **Massachusetts Institute of Technology**

- Participated in several NEC outreach meetings. Made useful contributions based on NEC work by research team.
- Recruited one student who will join team in September 2015.

#### **Michigan Tech University**

##### **Student Projects: (New Projects)**

- Completed civil senior design project, Wayne Industries Site Expansion Plan, which explored options for new rail-served warehouse facility in constrained site.
- Completed electrical engineering senior design project, Rail Shunt Connection Test System, sponsored by Union Pacific.
- Continued work on two small projects with BNSF and Wisconsin Southern.

##### **Outreach and Technology Transfer:**

- Rail Info Night- February 17<sup>th</sup>, 2015
- Five on-campus industry guest speakers presented in CE 4490 Rail Transportation Seminar and/or as part of Railroad Engineering and Activities Club (REAC). Four additional industry guest speakers presented via web conference.
- REAC Spring Field Trip to UP Headquarters, Omaha, NE- March 27<sup>th</sup>-28<sup>th</sup>, 2015
- RTP and REAC supported expo event for the Women in Engineering camp (150 female high school students).
- Transportation careers session for TRAC workshop for high school teachers, conducted on Michigan Tech campus.
- Display and discussion table for Construction Career Days in southern Michigan.

##### **Research Projects:**

- Computer Vision and Machine Learning Method for Detection and Assessment of Wheel Anomalies Using Sensor Fusion of Thermal and Visible Spectrum Cameras; Proposed machine learning approach that automatically detects and identifies sliding wheels in thermal and visible spectrum imagery.
- Effects of Auditory Warnings and Driver Distraction on Rail Crossing Safety; Look at how different auditory cues can induce different behaviors at rail-crossings. Designed 32 auditory

- warning signals, evaluated in terms of critical auditory display elements: overall, urgency, annoyance, startle, natural-in-car, meaning, and discriminability with 27 participants. Conducted auditory warning experiment based on result to investigate actual effects of selected sounds at simulated rail crossings.
- Rail Embankment Stabilization for Cold Climate Railroads – Case of Hudson Bay Railway; Probabilistic model built with surface vegetation and water indicators obtained from remote sensing to predict locations with recorded track geometry defects. Results obtained were compared with surface roughness values extracted from track geometry data to define severity levels.
  - Rescheduling/ Timetable Optimization of Trains along the U.S. Shared-use Corridors; “Hybrid Optimization of Train Schedule” (HOTS) model tested and applied for different case studies such as Washington DC-Baltimore and Detroit-Jackson segments for different scenarios and conditions.
  - Alloy Design and Testing of Austempered Ductile Iron for Rail Wheels; Initial trial pour conducted in February. Several test bars heat treated and microstructures analyzed. Samples extracted and tested to compare with prior samples. Further refinement of thermodynamic modelling ongoing in preparation for additional pours, expected this summer. New sample pattern developed to make heat treatment and sample machining easier.
  - Integrated Life Cycle Assessment (LCA) and Life Cycle Cost Analysis (LCCA) of Multi Modal Freight Transportation Alternatives to Copperwood Project; Completed literature review, tasks and items identified, and parameters list prepared for Highland Copper to collect data. Data was collected and started to prepare assemblies for LCA process in SimaPro.
  - Cross-Infrastructure Learnings for Alternative Bridge System Designs – A Case Study on the Hybrid Composite Bridge System; Focused efforts on final reporting and result dissemination.

#### **University of Tennessee, Knoxville**

- One Ph.D. student involved in development of simulation models for rail yards, optimization models and algorithms for classification yards, and capacity models for rail networks.
- Lateral impact test of Hybrid Composite Beam (HCB) Bridge conducted in March 2015. Data collection completed. Testing data from trial impact testing of prestressed concrete girder being analyzed. Team had three senior students working on project as undergraduates.

#### **Rose-Hulman Institute of Technology**

- Incrementally updated and modified CE 483 Railroad Engineering over past three years. Most recent course was 2015 spring quarter. Total enrollment 19 students - consisting of 6 Civil Engineering, 7 Mechanical Engineering and 6 Brazilian Exchange students.
- RHIT AREMA Student Chapter has 98 RHIT participants, with 12 students registered as AREMA members. Allison Phillips, Secretary-Treasurer, awarded AREMA Presidential Scholarship.
- Received pieces from a century old bridge being replaced by Indiana Rail Road. Several pin connections, roller bearing expansion joint, and gusset plate were obtained. Will be used as teaching aid for statics and structural engineering classes as well as CE 483 Railroad Engineering class for hands-on review of bridge design concepts.

#### **c. How have the results been disseminated?**

##### **NURail Consortium**

- NURail Annual Meeting had over 30 speakers and 25 poster presentations focusing on the

results from NURail funding.

#### **University of Illinois Urbana-Champaign**

- Conference papers and presentations delivered at:
  - TRB Annual Meeting in Washington D.C. in January.
  - Joint Rail Conference in San Jose in March.
  - International Association of Railway Operations Research conference in Tokyo in March.
  - International Heavy Haul Association conference in Perth, Australia in June.
- Railroad Capacity and Optimization:
  - Two TRB papers from 2014 published in the Transportation Research Record journal.
  - Made presentations on research to senior operations personnel from CSX and Union Pacific Railroad during campus visits.
  - Made presentations to AREMA Committee 16 during meeting hosted on UIUC campus.
  - Six TRB papers presented in 2015 received publication recommendations for the Transportation Research Record journal.
- Railroad Safety and Risk:
  - One paper published in the Journal of Transportation Planning and Technology.

#### **University of Illinois Chicago – COE**

- See publications noted below.

#### **University of Illinois Chicago – CUPPA**

- VC: Portions of interim reports have been covered by media outlets (Mass Transit Mag, Streetsblog, etc.) and presentations at ARES and for APTA have also occurred.

#### **Massachusetts Institute of Technology**

- Results continue to be disseminated through professional publications and presentations, as noted below.
- Participated in several NEC public-participation meetings at which MIT's results were discussed or implicit in comments. Work appears on the following website:  
<http://web.mit.edu/hsr-group/index.html>

#### **Michigan Tech University**

- Rail Info Night- February 17<sup>th</sup>, 2015
- REAC Spring Field Trip to Union Pacific Headquarters, Omaha, NE- March 27<sup>th</sup>-28<sup>th</sup>, 2015
- Five industry guest speakers hosted on campus to present in CE 4490 Rail Transportation Seminar and/or as part of REAC throughout the spring. Four additional industry guest speakers provided a presentation via web conference.
- RTP and REAC supported an expo event for the Women in Engineering camp (150 female high school students).
- Presented a transportation careers session for TRAC workshop for high school teachers, conducted on Michigan Tech campus
- Provided display and discussion table for Construction Career Days in southern Michigan.

#### **University of Tennessee, Knoxville**

- Results disseminated through journal publications and conference presentations. One paper submitted to 2016 Precast/Prestressed Concrete Institute Convention and National Bridge Conference. One conference paper, titled "Full-Scale Lateral Impact Testing of Prestressed Concrete Beam," is under review.

### **Rose-Hulman Institute of Technology**

- NURail Annual Meeting –June 2015
- RHIT AREMA Student Chapter 2014-2015 – James McKinney
- Indiana Rail Road & Rose-Hulman Institute of Technology Partnership – James McKinney
- Reflections and Evaluation of Rail Experiences: RHIT Graduates Employed by Class I Railroads and Undergraduate Student Internships. – James McKinney
- CE 483 Railroad Engineering - Student evaluations from Spring 2015 reviewed with recommended changes and enhancements studied for incorporation. Modules reviewed and updated as appropriate. Class promoted as viable technical elective for CE/ME/EE students. New Bridge Engineering module developed for next offering of class.

### **d. What do you plan to do during the next reporting period to accomplish the goals?**

#### **University of Illinois Urbana-Champaign**

- Railroad Capacity & Optimization: Continue work on all projects, 2 pending Master's thesis.
- Railway Energy Efficiency: Continue work on all projects, 1 pending Master's thesis.
- Outreach and Education: Hay Seminar Series: UIUC will host (and broadcast online) several on-campus seminars from industry experts during Fall semester.

#### **University of Illinois Chicago – COE**

- Informed Rail Traveler - Research and develop software and smartphone apps for transfers to/from rail-stations.

#### **University of Illinois Chicago – CUPPA**

- VC: Finalize report of initial research phase.
- Rail Safety: Finalize research activities.
- GIS: Complete final report to NURail.
- Freight: Submit a paper to a journal in fall 2015 with additional analysis.

#### **Massachusetts Institute of Technology**

- Recruit undergraduates to work as part of MIT Undergraduate Research Opportunities Program (UROP).
- Several papers and publications in the pipeline, relating to theses completed in June 2015.

#### **Michigan Tech University**

- **Student Projects:**
  - Initiate and complete a civil senior design project for yard and capacity improvements at the Lake State Railway yard in Saginaw, MI.
  - Initiate two additional undergraduate projects; one investigating use of dye penetrants in cold weather and another to look at detecting wheel contamination at hump yards.
  - Continue work with BNSF and Wisconsin Southern on a couple of small projects.
- **Outreach and Technology Transfer:**
  - Rail and Intermodal Transportation Summer Youth Program will be conducted- July 26<sup>th</sup>- August 1<sup>st</sup>, 2015. Currently 24 participants, including several female/minority students.
  - 3<sup>rd</sup> Annual Michigan Rail Conference- August 19<sup>th</sup>-20<sup>th</sup>, 2015.
  - Dr. Lautala (among other NURail faculty) will present on “Railway recruitment challenges at Railway Interchange 2015- October 4<sup>th</sup>-7<sup>th</sup>, 2015.
  - 2<sup>nd</sup> Annual Rail Day/Expo and Railroad Night XI, Michigan Tech, October 20<sup>th</sup>, 2015.

- **Ongoing Research Projects:**
  - Computer Vision and Machine Learning Method for Detection and Assessment of Wheel Anomalies Using Sensor Fusion of Thermal and Visible Spectrum Cameras; Continue to develop thermal imagery-based sliding wheel detection algorithm to obtain more precise detection of defective wheels, testing on simulated thermal images and real images collected by UP. Propose to implement another algorithm for visible-spectrum camera images to detect wheel and identify possible features for enhanced detection statistics. Develop algorithms that extract useful information about each wheel such as its car number. Propose to fuse information from thermal and vision imagery in order to detect and report sliding wheel and its exact position on train.
  - Effects of Auditory Warnings and Driver Distraction on Rail Crossing Safety; conduct a series of experiments with different types of visual and auditory warnings using a Mid-fidelity driving simulator. Conduct experiments with different types of distraction tasks to secure external validity of research.
  - Rail Embankment Stabilization for Cold Climate Railroads – Case of Hudson Bay Railway; Improve current predictive model by incorporating subsurface data obtained from GPR survey together with surficial based predictive model developed last during this reporting period. Provide more robust model combined with track geometry data to produce an improved severity rating scheme. Investigate different track stabilization techniques used to stabilize the track embankment along the HBR line.
  - Rescheduling/ Timetable Optimization of Trains along the U.S. Shared-use Corridors; Two new papers under development: TRB 2016: Review of LOS and Capacity Utilization Trade-off in Railway Operations and Journal of Rail Transport Planning & Management: Developing a decision model to evaluate the directional vs. bi-directional operation pattern of a multiple track corridor.
  - Alloy Design and Testing of Austempered Ductile Iron for Rail Wheels; several heats of ductile will be poured in next two months. Resulting samples will be characterized and used to develop a response surface for austenite stability as a function of chemistry and heat treatment.
  - Integrated LCA and LCCA of Multi Modal Freight Transportation Alternatives to Copperwood Project; Next phase is to complete data collection for few remaining items. Available data then used to perform LCA and LCCA for all alternatives. Results checked for sensitivity and uncertainty. Overall emissions from LCA are converted into costs and combined with overall costs from LCCA. Alternatives assessed on overall costs and results from sensitivity analysis.

#### **University of Tennessee, Knoxville**

- Finish capacity modeling and analysis for railway network in US. Work on in-depth FE modeling of HCB to calibrate collected testing data from impact test. After testing results verified, parametric study will be performed using FE model to study collision and damage mechanism caused by over-height vehicles.

#### **Rose-Hulman Institute of Technology**

- Partner with Wabash Valley Railroaders Museum to develop railroad displays and hands-on activities used by Railroad Engineering class, Rose-Hulman AREMA student chapter, and greater Terre Haute community.



## 2. Products: What has the program produced

### a. Publications, conference papers, and presentations

#### University of Illinois Urbana-Champaign

- Atanassov, I. and C.T. Dick. 2015. Delay and Required Infrastructure Investment to Operate Long Freight Trains on Single-track Railways with Short Sidings. In: Proceedings of the 11th International Heavy Haul Association Conference, Perth, Australia, June 2015.
- Fullerton, G.A. and C.T. Dick. 2015. Operational Considerations of Transitioning to Emerging Ultra-low Emission Locomotive Technologies for Heavy-haul Freight Rail Applications. In: Proceedings of the 11th International Heavy Haul Association Conference, Perth, Australia, June 2015.
- Shih, M.-C., C.T. Dick and Y.-C. Lai. 2015. Optimizing Location and Length of Passing Sidings on Single-track Lines for Long Heavy-haul Freight Trains. In: Proceedings of the 11th International Heavy Haul Association Conference, Perth, Australia, June 2015.
- DiDomenico, G.C. and C.T. Dick. 2015. Influence of System Characteristics and Scheduling Patterns on Commuter Rail Energy Efficiency. In: Proceedings of the International Association of Railway Operations Research (IAROR) 6th International Conference on Railway Operations Modelling and Analysis, Tokyo, Japan, March 2015.
- Tang, H., C.T. Dick, B.M. Caughron, X. Feng and C.P.L. Barkan. 2015. A Project Selection Model for Improving Running Time and Operating Cost Efficiency on a Passenger Rail Corridor. In: Proceedings of the International Association of Railway Operations Research (IAROR) 6th International Conference on Railway Operations Modelling and Analysis, Tokyo, Japan, March 2015.
- Fullerton, G., C.T. Dick, T. Hwang and Y. Ouyang. 2015. Exchange Point Delay and Mode Shift Associated with Regional Deployment of Alternative Locomotive Technology on the North American Line-Haul Freight Network. In: Proceedings of the International Association of Railway Operations Research (IAROR) 6th International Conference on Railway Operations Modelling and Analysis, Tokyo, Japan, March 2015.
- Shih, M.-C., C.T. Dick and Y.-C. Lai. 2015. Optimization of Siding Location for Single-track Lines with Non-Uniform Track Speed. In: Proceedings of the International Association of Railway Operations Research (IAROR) 6th International Conference on Railway Operations Modelling and Analysis, Tokyo, Japan, March 2015.
- Lovett, A.H., C.T. Dick and C.P.L. Barkan. 2015. Determining Freight Train Delay Costs on Railroad Lines in North America. In: Proceedings of the International Association of Railway Operations Research (IAROR) 6th International Conference on Railway Operations Modelling and Analysis, Tokyo, Japan, March 2015.
- Atanassov, I. and C.T. Dick. 2015. Incremental Capacity in Transitioning from Double to Triple Track on Shared Rail Corridors. In: Proceedings of the International Association of Railway Operations Research (IAROR) 6th International Conference on Railway Operations Modelling and Analysis, Tokyo, Japan, March 2015.
- Atanassov, I. and C.T. Dick. 2015. Capacity of single-track railway lines with short sidings to support operation of long freight trains. Accepted, Transportation Research Record: Journal of the Transportation Research Board.
- Shih, M.-C., C.T. Dick and C.P.L. Barkan. 2015. Capacity and level of service impact of passenger trains on shared rail corridors with multiple types of freight trains. Accepted, Transportation Research Record: Journal of the Transportation Research Board.
- Lovett, A.H., C.T. Dick, C.J. Ruppert, Jr. and C.P.L. Barkan. 2015. Cost and delay of railroad timber and concrete crosstie maintenance and replacement. Accepted, Transportation Research Record: Journal of the Transportation Research Board.

- Atanasov, I. and C.T. Dick. 2015. Influence of Siding Connection Length, Position, and Order on the Incremental Capacity of Transitioning from Single to Double Track. In: Proceedings of Transportation Research Board 94th Annual Conference, Washington, D.C, January 2015.
- Fullerton, G.A, G.C. DiDomenico and C.T. Dick. 2015. Sensitivity of freight and passenger rail fuel efficiency to infrastructure, equipment and operating factors. Accepted, Transportation Research Record: Journal of the Transportation Research Board.
- DiDomenico, G.C. and C.T. Dick. 2015. Methods of analyzing and comparing energy efficiency of passenger rail systems. Accepted, Transportation Research Record: Journal of the Transportation Research Board.
- Greve, M.J., M.S. Dersch, J.R. Edwards, C.P.L. Barkan, J. Mediavilla and B. Wilson. 2015. The Effect of Particle Intrusion on Rail Seat Load Distributions on Heavy Haul Freight Railroads. In: Proceedings of the 11th International Heavy Haul Association Conference, Perth, Australia, June 2015.
- Wolf, H.E., J.R. Edwards, M.S. Dersch and C.P.L. Barkan. 2015. Flexural Analysis of Prestressed Concrete Monoblock Sleepers for Heavy-haul Applications: Methodologies and Sensitivity to Support Conditions. In: Proceedings of the 11th International Heavy Haul Association Conference, Perth, Australia, June 2015.
- Scheppe, A.J., J.R. Edwards, M.S. Dersch and C.P.L. Barkan. 2015. Quantifying Lateral Wheel Loading Variation Using Truck Performance Detectors. In: Proceedings of the 11th International Heavy Haul Association Conference, Perth, Australia, June 2015.
- Greve, M.J., M.S. Dersch, J.R. Edwards and C.P.L. Barkan. 2015. Evaluation of Laboratory and Field Experimentation Characterizing Concrete Crosstie Rail Seat Load Distributions. In: Proceedings of the 2015 Joint Rail Conference, San Jose, CA, March 2015.
- Csenge, M., H.E. Wolf, M.S. Dersch, J.R. Edwards, R.G. Kernes and M.G. Romero. 2015. Exploration of Alternatives for Prestressed Concrete Monoblock Crosstie Design Based on Flexural Capacity. In: Proceedings of the 2015 Joint Rail Conf, San Jose, CA, March 2015.
- Wolf, H.E., S. Mattson, J.R. Edwards, M.S. Dersch and C.P.L. Barkan. 2015. Flexural Analysis of Prestressed Concrete Monoblock Crossties: Comparison of Current Methodologies and Sensitivity to Support Conditions. In: Proceedings of Transportation Research Board 94th Annual Conference, Washington, D.C, January 2015.
- Scheppe, A.J., J.R. Edwards, M.S. Dersch and C.P.L. Barkan. 2015. Quantifying Lateral Wheel Loading Variation Using Truck Performance Detectors. In: Proceedings of Transportation Research Board 94th Annual Conference, Washington, D.C, January 2015.

#### **University of Illinois Chicago – CUPPA**

- Presentation and feature in conference proceedings of 2015 American Real Estate Society (ARES) Academic Conference.
- Marcella Bondie presentation, NURail Annual Meeting 2015 – NURail Graduates in Action.
- Final Report – “Environmental Impact Assessment of Rail Infrastructure.” A Technology Transfer Communications Plan was prepared and will be executed in second quarter 2015.

#### **Michigan Tech University**

[Final design reports for the following undergraduate student projects.]

- “System to Measure Effectiveness of Rail Shunt”, Electrical Engineering Senior Design project (five students)
- “Wayne Industries Site Expansion Plan”, Civil and Environmental Engineering senior design project (twelve students)

[Conference Presentation: abstract only]

- Croschere, J., Landry, S., Perelman, B., Jeon, M., Lautala, P., & Nelson, D. (2015). Driver awareness at railroad grade crossings: Examining effectiveness of auditory and visual warnings to improve safety. Proceedings of the Midwest Cognitive Science Conference, Mackinac Island, MI.

[Peer Reviewed Paper, Conference Proceedings, and Presentation]

- Pouryousef, H, Lautala, P.; Capacity Evaluation of Directional and Non-directional Operational Scenarios along a Multiple-Track U.S. Corridor; Proceedings of the TRB 2015, Washington-DC, Jan. 2015
- FakhrHosseini, S. M., Jeon, M., Lautala, P., & Nelson, D. (2015). An investigation on driver behaviors and eye-movement patterns at grade crossings. Proceedings of the Joint Rail Conference (JRC2015), San Jose, CA.
- Landry, S., Croschere, J., & Jeon, M. (2015). Subjective assessment of in-vehicle auditory warnings for rail grade crossings. Proceedings of the 21st International Conference on Auditory Display (ICAD2015), Graz, Austria.
- Addison, P., Oommen T., and Lautala P. (2015). A review of past geotechnical performance of the Hudson Bay rail embankment and its comparison to the current condition. 2015 Joint Rail Conference March 23-26, 2015. San Jose, California.
- Hanieh Deilamsalehy presented paper at JRC 2015, Hanieh Deilamsalehy, Timothy C. Havens, Pasi Lautala, "Automatic Method for Detecting and Categorizing Train Car Wheel and Bearing Defects", JRC 2015, San Jose, CA.
- Harris, D.K., Gheitani, A., and Civitillo, J. M. (2015). "Field Testing and Numerical Simulation of a Hybrid Composite Beam Bridge in Virginia." 16th European Bridge Conference, Edinburgh, UK. – Presented June 2015

[Presentation]

- Pouryousef, H.; "Introducing Hybrid Optimization of Train Schedule (HOTS) Model as Timetable Management Technique", The William Hay Railroad Engineering Seminar, University of Illinois at Urbana-Champaign, Urbana- IL, April 2015

#### **University of Tennessee, Knoxville**

- H. Li, M. Jin, and S. He "Sequencing and Scheduling in Railway Classification Yards," Accepted by Transportation Research Record, Journal of Transp. Research Board, 2015.
- Jing, Y., Ma, Z. J., Bennett, R. M., and Clarke, D. B., "Full-Scale Lateral Impact Testing of Prestressed Concrete Beam", 2016 Precast/Prestressed Concrete Institute Convention and National Bridge Conference (2016 PCI/NBC) [under review].

#### **b. Journal publications:**

##### **University of Illinois Urbana-Champaign**

- Shih, M.C., Y-C Lai, C.T. Dick and M-H Wu. 2014. Optimization of siding location for single-track lines. Transportation Research Record: Journal of the Transportation Research Board. 2448: 71-79.
- Shih, M-C., C.T. Dick, S.L. Sogin and C.P.L. Barkan. 2014. Comparison of capacity expansion strategies for single-track railway lines with sparse sidings. Transportation Research Record: Journal of the Transportation Research Board. 2448: 53-61.
- Saat, M.R. and J. Aguilar Serrano. 2015. Multicriteria high-speed rail route selection: application to Malaysia's high-speed rail corridor prioritization. Transportation Planning and Technology. 38 (2): 200 - 213.

### **University of Illinois Chicago – COE**

- J. Lin, P. Szczurek, O. Wolfson and B. Xu, “The Observe-Driver-and-Learn Platform for Relevance Estimation in VANET Safety Warning Applications,” Journal of the Transportation Research Board, In Press
- B. Zou, N. Kafle, O. Wolfson and J. Lin, “A Mechanism Design Based Approach to Solving Parking Slot Assignment in the Information Era,” Transportation Research Part B: Methodological, In Press. Online First, doi:10.1016/j.trb.2015.05.015.
- S. Ilarri, O. Wolfson, T. Delot, "Collaborative Sensing for Urban Transportation" (invited), IEEE Data Engineering Bulletin, special issue on "Urban Informatics", IEEE Computer Society Press, 2015.
- Hamper, M.B., Wei, C., and Shabana, A., “Use of ANCF Surface Geometry in the Rigid Body Contact Problems: Application to Railroad Vehicle Dynamics”, ASME Journal of Computational and Nonlinear Dynamics, Vol. 10, March 2015, pp. 021008-1 - 021008-12

### **Massachusetts Institute of Technology**

- Levy S., Pena-Alcaraz M., Prodan A., Sussman JM. Analyzing the Financial Relationship between Railway Industry Players in Shared Railway Systems: The Train Operator's Perspective. (In press)
- Pena-Alcaraz M., Sussman JM., Webster M. Analysis of Capacity Pricing and Allocation Mechanisms in Shared Railway Systems: Lessons for the Northeast Corridor. (In press)

### **Michigan Tech University**

- Harris, D.K., Civitillo, J., and Gheitasi, A. (2015-accepted) – “Performance and Behavior of Hybrid Composite Beam Bridge in Virginia - Live Load Testing.” ASCE Journal of Bridge Engineering.
- Pouryousef, H. and P. Lautala, Hybrid Simulation Approach for Improving Railway Capacity and Train Schedules. Journal of Rail Transport Planning & Management, Elsevier (Under review), 2015.
- Pouryousef, H, P. Lautala, and D. Watkins, Development of Hybrid Optimization of Train Schedules (HOTS) Model for Railway Corridors. Transportation Research Part C: Emerging Technologies (Under review), 2015.

### **University of Kentucky**

- Malloy, Brett R., and Jerry G. Rose, “Effect of Enhanced Trackbed Support on Railway/Highway At-Grade Crossing Performance,” Kentucky Transportation Center Report No. KTC-14-19/SPR452-13-1F. December 2014 180pp.  
[http://www.ktc.uky.edu/files/2015/01/KTC\\_14\\_19\\_SPR\\_452\\_13\\_1F\\_.pdf](http://www.ktc.uky.edu/files/2015/01/KTC_14_19_SPR_452_13_1F_.pdf)
- Malloy, Brett R., and Jerry G. Rose, “Railway/Highway At-Grade Crossing Surface Management: An Overview,” Kentucky Transportation Center Report No. KTC-14-19/SPR452-13-2F. December 2014. 62pp.  
[http://www.ktc.uky.edu/files/2015/01/KTC\\_14\\_19\\_SPR\\_452\\_13\\_2F\\_.pdf](http://www.ktc.uky.edu/files/2015/01/KTC_14_19_SPR_452_13_2F_.pdf)
- Malloy, Brett R., Jerry G. Rose, and Macy Purcell, “Recommendations for KYTC’s Railway/Highway At-Grade Crossing Management Practices,” Kentucky Transportation Center Report No. KTC-14-19/SPR452-13-3F. December 2014. 30pp.  
[http://www.ktc.uky.edu/files/2015/01/KTC\\_14\\_18\\_SPR\\_452\\_13-3F\\_.pdf](http://www.ktc.uky.edu/files/2015/01/KTC_14_18_SPR_452_13-3F_.pdf)
- Malloy, Brett R., Jerry G. Rose, and Macy Purcell, “Railway/Highway At-Grade Crossing Surface Rehabilitation Manual: Recommendations and Guides,” Kentucky Transportation Center Report No. KTC-14-19/SPR452-13-4F. December 2014. 60pp.  
[http://www.ktc.uky.edu/files/2015/01/KTC\\_14\\_19\\_SPR\\_452\\_13\\_4F\\_.pdf](http://www.ktc.uky.edu/files/2015/01/KTC_14_19_SPR_452_13_4F_.pdf)

### **University of Tennessee, Knoxville**

- H. Li, M. Jin, and S. He, "Sequencing and Scheduling in Railway Classification Yards," Transportation Research Board, Washington, DC, January 2015.
- H. Li, M. Jin, R. Song, S. He, and J. Song, "Dynamic Railcar Connection Planning in Classification Yards," Accepted by Transportation Letters, The International Journal of Transportation Research, 2015.
- A.A. Khaled, M. Jin, D. Clarke, and M.A. Hoque, "Train Design and Routing Optimization for Evaluating Criticality of Freight Railroad Infrastructures," Transportation Research B, 71 (1) pp. 71-84, 2015.

### **c. Books or other non-periodical, one-time publications:**

#### **Massachusetts Institute of Technology**

- Peña-Alcaraz, M. (2015). Analysis of Capacity Pricing and Allocation Mechanisms for Shared Railway Systems (Ph.D. Engineering Systems)
- Ogunbekun, T. (2015). The Impact of Amtrak Performance in the Northeast Corridor (Master of Engineering in Transportation)
- Agosta, B. (2015). Development of a methodology for evaluating investments in infrastructure for the sustainable exploitation of shale energy in Argentina. (Master of Science in Transportation)
- Levy, S. (2015). Capacity Challenges on the California High-Speed Rail Shared Corridors: How Local Decisions have Statewide Impacts. (Master of Science in Transportation)

### **d. Other publications, conference papers and presentations:**

#### **University of Illinois Chicago – COE**

- N. Padhariya, O. Wolfson, A. Mondal, V. Gandhi and S. Madria, "E-VeT: Economic Reward/Penalty-based System for Vehicular Traffic Management," Proc. of the 15th IEEE International Conference on Mobile Data Management (MDM), pp. 99-102, July 2014.
- Q. Guo, O. Wolfson, D. Ayala, "A Framework on Spatio-Temporal Resource Search", Proc. 11th IEEE International Wireless Communications & Mobile Computing Conference (IWCMC), Aug. 2015.
- J. Lin, P. Szczurek, O. Wolfson, B. Xu, "The Observe-Driver-and-Learn Platform for the Development of VANET Safety Applications," the 2015 Transportation Research Board Annual Meeting, paper no. 15-4657, 2015
- Keynote speaker, The first ACM SIGSPATIAL 2014 PhD Symposium, "What to Research in Spatial Information and How to Do So", Dallas, TX, Nov. 2014.
- Keynote speaker, The 7th ACM SIGSPATIAL International Workshop on Computational Transportation Science, "The Opportunities and Challenges in Temporary Geospatial Information", Dallas, TX, Nov. 2014.
- Invited speaker "Spatio-temporal urban resources, their pricing, and truthfulness", The 3rd ACM SIGKDD International Workshop on Urban Computing (UrbComp 2014), NYC, NY, Aug. 2014
- "Spatio-temporal Search for Transportation Resources", invited talk, National ICT Australia (NICTA) Research Center, Sydney, Australia, June 2015.
- "Spatio-temporal Search for Transportation Resources", invited talk, University of Melbourne, Melbourne, Australia, June 2015.

### **Massachusetts Institute of Technology**

- The Amtrak Accident on the Northeast Corridor: A Systems Perspective. Sussman, J.M. Presentation and Seminar: MIT Department of Civil & Environmental Eng (May, 2015)
- HSR in the US with Emphasis on the NEC. Guest Speaker: Sussman, J.M. Interviewed by: Marketplace, National Public Radio (May, 2015)
- Impact of institutional relationships on hub stations: A case study of Penn Station, NYC. Heywood, R. Presentation: JRC Conference (April, 2015)
- Capacity Challenges on the San Francisco Peninsula Corridor – How Local Decisions have Statewide Impacts. Levy, S. Presentation: JRC Conference (April, 2015)
- HSR as Transit: The Continuing Transportation-driven Evolution of Metropolitan Form Westrom, R., Sussman, J.M. Presentation: Transportation Research Forum, Atlanta GA (March, 2015)
- Analysis of Capacity Pricing and Allocation Mechanisms in Shared Railway Systems: Lessons for the Northeast Corridor Peña-Alcaraz, M., Sussman, J.M. Presentation: Transportation Research Forum, Atlanta GA (March, 2015)

### **Michigan Tech University**

- Pouryousef, H, P. Lautala, Development of Hybrid Optimization of Train Schedules (HOTS) Model for Railway Corridors. Poster presentation, NURail Annual Meeting, Chicago, June 2015.
- Hamed Pouryousef, "Introducing Hybrid Optimization of Train Schedule (HOTS) Model as Timetable Management Technique, 3-minute Thesis Presentation, NURail Annual Meeting, Chicago, June 2015.
- Addison, P., Baeckeroot, J., Oommen T., Lautala P. (2015). Rail embankment investigation using remote sensing and Track Geometry Data for a Permafrost region. NURail Annual Meeting June 3-4, 2015, Chicago, Illinois.

### **University of Kentucky**

- Presentation: Rose, J.G. and J.K. Secor “Anatomy of the U.S. Railway Industry – Past, Present, and Future” 101st Purdue Road School Transportation Conference, March 2015 West Lafayette, IN
- Presentation and Publication: Stark, T.D., Wilk, S.T., Rose, J.G. and M. Purcell “Monitoring and Repair of Bridge Transitions” 2015 Joint Rail Conference, March 2015, San Jose, CA
- Presentation and Publication: Rose, J.G., Stark, T.D., Wilk, S.T., and M. Purcell “Design and Monitoring of Well-Performing Bridge Transitions” 2015 Joint Rail Conference, March 2015, San Jose, CA
- Presentation: Rose, J.G. “Maintaining Adequate Trackbed Structural Support: An Important Railway Infrastructure Issue” AREMA Committee 1 Meeting, February 2015 Charlotte, NC

### **e. Website(s) or other Internet site(s):**

#### **University of Illinois Urbana-Champaign**

Released new NURail website: [www.nurailcenter.org](http://www.nurailcenter.org)

#### **University of Illinois Chicago – CUPPA**

Continued hosting of GIS database on NURail/UIC sites.

**Massachusetts Institute of Technology**

Work appears on the following website. <http://web.mit.edu/hsr-group/index.html>

**Michigan Tech University**

3<sup>rd</sup> Annual Michigan Rail Conference web site was launched.

**f. Technologies or techniques:**

**Michigan Tech University**

Simulated rail crossing scenarios with different types of visual warnings for the NADS MiniSim driving simulator

**g. Inventions, patent applications and/or licenses:**

None

**h. Other products:**

**Michigan Tech University**

Effects of Auditory Warnings and Driver Distraction on Rail Crossing Safety; Thirty-two potential auditory cues that can be used for in-vehicle auditory warnings for rail crossings, including verbal cues, earcons, and auditory icons

**3. Participants and Other Collaborating Organizations**

**a. Partners**

<b>Organization Name:</b>	<b>Location of the Organization:</b>	<b>Partner's Contribution to the Project:</b>	<b>Name (First and Last)</b>	<b>University</b>
<b>Indiana Rail Road</b>	Indianapolis, IN	In-Kind, Collaborative, Tech Assistance, Student Project Materials	Thomas Hoback Peter Ray, Justin Cronin	Rose-Hulman
<b>Wabash Valley Railroaders Museum</b>	Terre Haute, IN	Hands On Education Opportunities	Bill Foster	Rose-Hulman
<b>University of Porto</b>	Porto, Portugal	Contributions from students visiting MIT Joint proposal to FCT in Portugal	University of Porto	University of Porto
<b>IST (University)</b>	Lisbon, Portugal	Contributions from students visiting MIT Joint proposal to FCT in Portugal	IST (University)	IST (University)
<b>University of Coimbra</b>	Coimbra, Portugal	Contributions from students visiting MIT Joint proposal to FCT in Portugal	University of Coimbra	University of Coimbra
<b>East Japan Railway Co.</b>	Tokyo, Japan	Research sponsor; sponsors grad students in residence	East Japan Railway Co.	

<b>Central Japan Railway Co.</b>	Tokyo, Japan	Sponsors graduate students in residence	Central Japan Railway Co.	
<b>Region 1 UTC</b>	MIT, Cambridge, MA	Research sponsor	Region 1 UTC	
<b>Pontificia Universidad Católica Argentina</b>	Buenos Aires, Argentina	Developing joint project with YPF, a major energy provider based in Argentina	Prof. Roberto Agosta	Pontificia Universidad Católica Argentina
<b>MDOT</b>	Lansing, MI	Financial and Collaborative	Tim Hoeffner, Nikkie Johnson	MTU
<b>Omnitrax</b>	Colorado /Canada	Financial & Collaborative	Ken Koff /Zachary Vallos	MTU
<b>Union Pacific</b>	Omaha, NE	Financial & Collaborative	Tom Bartlett	MTU
<b>RoadScanners</b>	Finland	Collaborative	Mika Silvast	MTU
<b>NEW AFS</b>	Northeast Wisconsin	Funded Undergraduate Assistance	N/A	MTU
<b>Engineered Rail Solutions</b>	McHenry, IL	Project Review and Guidance	David Thomson	MTU
<b>Wayne Industries</b>	Wayne, MI	Financial, Project Review and Guidance	Paul Russo, Fred Schlemmer	MTU
<b>George Jerome &amp; Co.</b>	Roseville, MI	Project Review and Guidance	George Jerome	MTU
<b>BNSF</b>	Fort Worth, TX	Project Review and Guidance	Craig Morehouse	MTU
<b>Wisconsin &amp; Southern RR</b>	Madison, WI	Project Review and Guidance	Brad Peot	MTU
<b>CN</b>	Montreal, Quebec	Financial Support	Stephen Schlickman	UIC
<b>Beijing University of Transportation</b>	Beijing, China	Research collaboration	Haodong Li	Beijing Univ. of Trans.

**b. Additional collaborators**

**University of Illinois Chicago – CUPPA**

Staff from transit organizations and municipal authorities in Chicago, San Francisco, New York, and Washington, DC

Karin Allen, Regional Transit Authority  
 Donna Anderson, Regional Transit Authority  
 Christopher Barkan, University of Illinois  
 Lynnette Ciavarella, Metra  
 Edward Bury, University of Illinois-Chicago  
 Ron Collman, Natural Resources

Conservation Service  
 Bola Delano, IDOT  
 Rebecca Geissler, Chicago Transit Authority  
 Robert Ginsburg  
 Anne Haaker, IL Hist. Preservation Agency  
 Andrew Heckenkamp, Illinois Historic Preservation Agency



Craig Heither, Chicago Metropolitan Agency for Planning  
Brad Koldehoff, IDOT  
Lois Kimmelman  
David Kralik, Metra  
Xiang Liu, University of Illinois  
Andrew Martin, FRA  
Jennifer McNeil Dhadwal, URS  
Paul Metaxatos, UIC  
Jacquelyn Murdock, Chicago Metropolitan Agency for Planning  
Greg Newmark, Center for Neighborhood Technology  
Janet O'Toole, URS  
Lynne Otte, TranSystems

Elizabeth Panella, Chicago Metropolitan Agency for Planning  
Leanne Redden, Regional Transit Authority  
Mohd Rapik Saat, University of Illinois  
Nicole Sandidge, Illinois Commerce Commission  
Steve Schlickman, UIC  
Jordan Snow, University of Illinois-Chicago  
P.S. Sriraj, University of Illinois-Chicago  
Michael Stead, IL Commerce Commission  
Brad Thompson, Regional Transit Authority  
Gina M. Trimarco, TranSystems  
Robert VanderClute, AAR  
Patrick Waldron, CN Rail

#### **Rose-Hulman Institute of Technology**

Dr. Bill Eccles PhD PE - Emeritus Professor of Electrical & Computer Engineering – RHIT  
Dr. John Aidoo PhD – Assistant Professor of Civil Engineering - RHIT

## **4. Impact**

### **a. What is the impact on the development of the principal discipline(s) of the program?**

#### **University of Illinois Chicago – CUPPA**

VC: Project could assist transit and rail capital planners make more effective decisions concerning use and development of value capture strategies for funding.

Rail Safety: Project will continue work started by research team in area of pedestrian safety at rail crossings and expand on it with additional data and analysis.

GIS: Project expected to advance existing environmental impact assessment of rail infrastructure and services by providing system view of sustainability and one-stop database.

Freight: It is widely recognized that freight activities and economic outputs are intimately connected. This project will strive to develop a tool based on broad assumptions of General Equilibrium of the Economy.

#### **Massachusetts Institute of Technology**

Issues being researched are inherently interdisciplinary in content and approach. So while field of transportation is being advanced, it is done in the context of a deeper understanding of regional economics, land use planning, engineering systems and other related fields.

#### **Michigan Tech University**

Michigan Tech's projects are distributed over multiple disciplines on campus, increasing the visibility/expertise of faculty/grad students in several disciplines.

#### **University of Tennessee, Knoxville**

Railway models have been introduced into Industrial Engineering program at UT.

### **Rose-Hulman Institute of Technology**

CE 483 Railroad Engineering is a technical elective for Civil Engineering students while the RHIT AREMA Student Chapter is an opportunity for any engineering student to learn about the rail industry and explore career opportunities in the industry.

### **b. What is the impact on other disciplines?**

#### **University of Illinois Chicago – CUPPA**

VC: Coordination mechanisms studied under this project will apply and be of use to economic developers, municipal stakeholders, and private development community.

Rail Safety: Issues of safety will likely lead to an impact on rail crossing design, safety 19 devices, signs, and markings.

GIS: Project integrates safety, infrastructure, operations, planning, public transportation, and multimodal transportation into environmental impact assessment process.

Freight: Tool can be used for federal and regional transportation planning.

#### **Michigan Tech University**

Students and faculty from a variety of disciplines are involved in research projects:

Mechanical Engineering, Electrical Engineering, Materials Science Engineering, Civil Engineering, Geological and Mining Engineering and Cognitive Sciences.

### **Rose-Hulman Institute of Technology**

CE 483 Railroad Engineering is a technical elective for Mechanical and Electrical Engineering students while the RHIT AREMA Student Chapter is open to all students to learn about the rail industry and careers opportunities in the rail industry.

### **c. What is the impact on the development of transportation workforce development?**

#### **University of Illinois Urbana-Champaign**

UIUC taught 5 rail courses in Spring 2015, including one new class: Electric Traction. The total enrollment was 92 undergraduate and graduate students including 22 online students. Many students will be pursuing careers in rail transportation. Classes have dual impact of motivating student interest in such careers and improving their capabilities once they enter the workforce.

#### **University of Illinois Chicago – CUPPA**

Overall: Metra management training project will focus on developing current transportation employees into more effective managers.

VC: Graduate students will continue to assist with research and case studies.

Rail Safety: Educational tools that provide a better understanding about the risks and impacts of safety at rail crossings will likely be developed and be of use in the training of rail operators, and other stakeholders.

GIS: Project supported two graduate RAs in Urban Planning and Policy; one is a female and minority (Mexican-American).

Freight: Research will provide a rich case study of the relationship between freight-related development project and the regional economy that can be used as a course material.

#### **Michigan Tech University**

Various presentations by Michigan Tech help attract/prepare K-12 teachers and students toward transportation careers.

**University of Tennessee, Knoxville**

One graduate student was involved in project and Industrial Engineering graduate students were exposed to the optimization issues of railway planning and operations in IE 522.

**Rose-Hulman Institute of Technology**

Expectations for CE/EE/ME students to consider railroad engineering internships as well as potential career path.

**d. What is the impact on physical, institutional and information resources at the university or other partner institutions?**

**University of Illinois Chicago – CUPPA**

Overall: Program helps solidify research connections between internal groups at CUPPA and to develop further the CN Fellowship program.

GIS: Integrated environmental GIS database may allow users to specify rail facility or land area of interest, access data from multiple departments, and evaluate multi-facet environmental impacts in one database. Research may help facilitate the coordination among multiple departments in both rail system planning and operation processes.

**Rose-Hulman Institute of Technology**

Expectations for CE/EE/ME students to consider railroad engineering internships as well as potential career path.

**e. What is the impact on technology transfer?**

**University of Illinois Chicago – CUPPA**

All projects will be in public domain and available for use by public sector and rail industry.

**Michigan Tech University**

Industry guest speakers help Michigan Tech students and faculty better align their efforts with industry needs.

**University of Tennessee, Knoxville**

Models will be shared with railroads through PI's connection with them, such as NS and CSX.

**Rose-Hulman Institute of Technology**

Expectations for CE/EE/ME students to consider railroad engineering internships as well as potential career path.

**f. What is the impact on society beyond science and technology?**

**University of Illinois Chicago – CUPPA**

Research into environmental, safety, and economic issues surrounding freight and passenger rail positively impact society by trying to advance equitable and safe ideas for rail network development. Findings from the freight study will influence public policy toward prioritizing

various needs for public support for economic development/job creation initiatives, including intermodal terminal development.

#### **Massachusetts Institute of Technology**

Research being conducted under NURail directly affects mobility, economic development and potentially environmental impact and global climate change, all vital critical contemporary issues. Through our connection to the Engineering Systems Division at MIT, our work contributes to methods to study Complex Sociotechnical Systems (CSS). The impact on society of this research beyond science and technology can be profound. One would hope, for example, that we are able to create surface transportation systems that are truly sustainable. That is, economic growth, environmental protection and social equity will all be advanced if the results of this study – concerned with intercity rail access and its interface to urban transportation -- leads to implementation. One could imagine changing travel behavior; in the US people tend not to think of trains as the intercity mode of choice, but perhaps this research can help change that. Understanding how policies and decisions are made in both the private and public sector – using this research as a case study – can advance “public knowledge attitudes, skills and abilities.”

#### **Rose-Hulman Institute of Technology**

Expectations for CE/EE/ME students to consider railroad engineering internships as well as potential career path.

### **5. Changes/Problems**

#### **a. Changes in approach and reasons for change:**

None

#### **b. Actual or anticipated problems or delays and actions or plans to resolve them**

##### **Michigan Tech University**

- Alloy Design and Testing of Austempered Ductile Iron for Rail Wheels Project had spectrometer reliability issues which caused a delay in further test pours, and may have affected initial results. Instrument has been serviced and a gas purifier added. Spectrometer is now performing well, so pours can resume this summer.
- Technical challenges with driver simulator have somewhat slowed down the progress in grade crossing research.

#### **c. Changes that have a significant impact on expenditures:**

None

#### **d. Significant changes in use or care of human subjects, vertebrate animals and/or biohazards:**

None

#### **e. Change of primary performance site location from that originally proposed:**

None