

Appendix

A- Literature Review

The following studies, papers, researches and reports on woody biomass transportation and the main technical and operational challenges regarding transportation were reviewed as part of the literature search (Table A-1). The review has concentrated in North America and Europe and only includes published references, excluding web pages or databases. The references in the table have been sorted based on their relevancy to woody biomass transportation. In “reference summary” column, the region or country of origin has been marked in the parentheses for each reference.

Table A-1- Summary of biomass transportation literature review

No.	Name	By	Type	Publisher	Year	Reference Summary
1	The profitability of transporting uncomminuted raw materials in Finland	T. Ranta, S. Rinne	Paper-PDF	Elsevier, Biomass and Bioenergy 30, pp 231–237	2006	(Finland) This paper concentrated on biomass transportation issue in Finland. In this paper, the consumed time and load size data have been gathered and evaluated based on a monitoring system combined with GPS installed in computers of trucks. The result shows that in the beginning of year 2004, the average total weight of loads for all types of uncomminuted raw material was less than maximum weight limit, 60 tons. There was around 10 tons of potential load capacity left. Recommendations for improvements include increasing the load size and decreasing the terminal waiting and processing times.
2	Michigan Log Truck Study II, Final Report	Christopher Green, et al	Report- PDF	Michigan Tech. University, Michigan Department of Transportation (MDOT)	2005	(USA) This study continues the Michigan Log Truck Study that was done in 2003. The primary focus areas of this study are: Update the Literature Review done in 2003, Inventory the Characteristics/Configurations of Log Trucks and Log Loads, Review Log Truck Crashes and Spills, and Recommend Practices and Innovations for Existing Documented Hazards. This study monitored sites in the Upper Peninsula and the northern half of the Lower Peninsula to determine the size and characteristics of trucks hauling logs in Michigan
3	The Relative Cost of Biomass Energy Transport	Erin Searcy, et al	Paper-PDF	Applied Biochemistry and Biotechnology; Vol. 136–140; pp 639-652	2007	(Canada) In this study, the relative cost of transportation by truck, rail, ship, and pipeline was estimated for some small- and large-project sizes. Study concluded that ship vs. rail transportation is not economic for distances under 800 km. Also transshipment from truck to rail is economical at 500 km for both if rail lines are available
4	Transportation logistics of Biomass for Industrial Fuel and Energy Enterprises	Klein Ileleji	Presentation- PDF	Purdue University-USA	2007	(USA) Complete presentation about biomass and the relevant definitions, including logistics and transportation procedure, operation and simulator tools (BmFLS) needed to deliver biomass productions specially corn stover to the destinations
5	Woody Biomass for Bioenergy and Biofuels in the United States—a Briefing Paper	Eric M. White	Report- PDF	Department of Forest Engineering, Resources and Management, Oregon State University	2009	(USA) This research focuses on potential biomass in US including different subjects such as woody biomass feedstock, and provides explanation of woody biomass from harvest residues, milling residues, municipal wastes and hazard fuel reduction. Through review of biomass from hazard fuel reduction, some information about treatment and transportation costs to remove and carry them to the roadside have been discussed. Supply curves of biomass feedstock and its relevant costs have been depicted and analyzed based on different types of biomass and different delivered prices.
6	Appendix F: Feedstock Transportation and Logistics,	James J. Corbett, et al	Paper-PDF	Renewable Fuels Roadmap and Sustainable Biomass Feedstock Supply for New York ;the NY	2010	(USA) This appendix discusses transportation and distribution (T&D) implications of increased biofuel feedstock and fuel production in New York State based on “renewable fuels roadmap and sustainable biomass feedstock supply for New York” studies. For each scenario presented in the Roadmap, this analysis evaluates capacity, energy, and environmental impacts associated with moving feedstock and fuel throughout the State. The analysis reveals potential capacity

No.	Name	By	Type	Publisher	Year	Reference Summary
				State Energy Research and Development Authority		constraints and economic issues regarding infrastructure needs and opportunities to support a sustainable biofuels industry.
7	Bioenergy out of byproducts from forestry in Finland	Dimitri Maertens	Thesis-PDF	KH Kempen University, Finland	2009	(Finland) Through this thesis, the main issues of woody biomass productions have been described in Finland. Supply chains of logging residue chips has been reviewed based on discussion about terrain chipping, roadside chipping, chipper-chip truck, terminal chipping, loose residue and bundling. In addition, the role of UPM Forest Company in forestry and bioenergy in Finland and all over the world has been reviewed through this thesis.
8	Modeling the Multi-Modal Transport of Logs and the Effects of Changing Fuel Prices	JUSTIN W HICKS	Thesis-PDF	Civil and Environmental Engineering Department, Michigan Tech. University	2009	(USA) In this M.S. thesis, log transportation by either truck or bi-modally by truck/rail has been compared in Upper Michigan to evaluate the price-optimal use of each mode. The study found that with current fuel cost, 22% of the logs moving by trucks should have moved bi-modally with truck and rail. In addition, the study suggested that 7% of the total ton-miles should shift from truck to rail for every one dollar increase in fuel prices.
9	Woody Biomass Supply Chain, Guidelines, Costs and Logistics, the Minnesota Experience	Dalia Abbas	Presentation- PDF	International Conference on Woody Biomass Utilization-Mississippi	2009	(USA) In this paper, main features of woody biomass supply chain including harvesting guidelines, supply chain costs and logistics have been reviewed. As case study a harvesting area in Minnesota has been selected and supply chain facilities and requirements have been analyzed, in addition to the sensitivity analysis of supply chain costs based on six hypothetical distance scenarios.
10	A Study of How to Decrease the Costs of Collecting, Processing and Transporting Slash	Craig Rawlings, et al	Report- PDF	Montana Community Development Corporation	2004	(USA) The state of the art for transporting forest residues in Montana has been reviewed. The study concluded that roll on/off container transport system was the most appropriate mean for wood products and this system has this capability to yield 9 to 10 chip van loads per day, as opposed to the current system's 3 to 4 loads
11	Forest Biomass Removal on National Forest Lands – first progress report	Placer County Chief Executive Office, TSS Consultations	Report- PDF	Sierra Nevada Conservancy, Placer County, and the Placer County Air Pollution Control District	2008	(USA) The primary objective of this project is the removal of woody biomass waste material from national forests located within the service area. In addition to review of some specifications of transport and collection machineries, study emphasized that the total costs to collect, process and transport are higher than current market value of biomass feedstock.
12	A Report on Conceptual Advances in Roll On/Off Technology in Forestry	Dave Atkins, et al	Report- PDF	Smallwood Utilization Network; the Montana Community Development Corporation	2007	(USA) This study focused on different approaches and advantages of using different types of roll on/off containers such as Hooklift-enabled truck, Hooklift-enabled forwarder and harvester, Roll on/off container for slash and Roll on/off bunk for logs and biomass transportation; because these trucks can reach slash piles that are too remote for large chip vans.

No.	Name	By	Type	Publisher	Year	Reference Summary
13	The Economics of Biomass Collection, Transportation, and Supply to Indiana Cellulosic and Electricity Facilities	Sarah C. Brechbill and Wallace E. Turner	Report- PDF	Purdue University-USA	2008	(USA) A complete research about corn stover and switchgrass biomass products through IN, including transportation analysis and rates based on varied acres and distances. Study doesn't have any specific data on woody biomass.
14	Wood to Energy	Martha C. Monroe, et al	Report- PDF	Interface South Program (BY University of Florida) USA	2007	(USA) A Complete research of wood biomass program in Florida including a list of bibliography and some limited description of transportation and logistics requisites, such as assessing transportation cost based on haul time rather than distance. Accounts for road infrastructure in a woodshed by using GIS to account for speed limits assigned to U.S. TIGER roads layers.
15	GIS for Sustainable Development	GIS Best Practices	Report- PDF	ESRI (ArcGIS software producer)-USA	2007	(USA) It contains summary of 5 different case studies developed in ArcGIS software regarding sustainable development, including summary of a project on "Measuring the Economics of Biofuel Availability" with some guidance and information about using ArcGIS on Biomass transportation.
16	Information Needs for Increasing Log Transport Efficiency	T. McDonald, et al	Paper-PDF	Forest Products Journal 47(9)- USA	1997	(USA) Through this paper, production aspects of utilizing used pallets to produce wood pellets and current markets for wood pellets and wood pellet stoves has been discussed and analyzed. It reviews three methods of dispatching trucks to loggers were tested using a log transport simulation model: random allocation, fixed assignment of trucks to loggers, and dispatch based on knowledge of the current status of trucks and loggers within the system.
17	Harvesting and Transportation of Forest Biomass	Bob Rummer	Paper-PDF	US Forest Service, Auburn-AL	2008	(USA) This paper addresses the usual methods of woody biomass harvesting applications as well as transportation models from harvesting site to the roadside. Also it has pointed out that primary transportation of small woody biomass can be performed by manual skidding or forwarding methods. A generic biomass removal model based on defining common parameters for the basic functions has been explained through this paper to compare alternative harvesting and removal approaches of woody biomass productions.
18	Economics of Harvesting Woody Biomass in North Carolina	James Jeuck	Report- PDF	NC Woody Biomass, NC State University	2009	(USA) In this research the basics of cost factors on biomass harvesting, processing and transportation process in North Carolina have been reviewed, since the cost of biomass harvesting and transportation reduces its value for market. Economical aspects of harvesting and transportation issues, such as average harvesting and transportation costs, cost analysis between biomass, pulpwood and saw-timber and review of biomass trucking methods are explained.
19	Woody Biomass Feedstock Yard Business Development Guide	The Federal Woody Biomass Utilization Working Group	Report- PDF	Biomass Research and Development Board, Forests and Rangelands.gov- USA	2010	(USA) This Guide provides an overview of the challenges and opportunities to establish a woody biomass feedstock yard in the United States. It includes information on biomass sourcing; facility site selection and equipment; biomass sort yards; biomass collection, concentration, and distribution; biomass handling, sorting, and economic considerations; etc. Information about transportation interaction with feedstock yard allocation has also been reviewed briefly.

No.	Name	By	Type	Publisher	Year	Reference Summary
20	Wood Fuel Production Chains in Europe	Matti Parikka	Paper-PDF	Swedish University of Agricultural Sciences, Department of Bioenergy	2006	(EU) The aim of this work is to assess sustainable production chains of wood fuel. Technical systems for the production of wood fuel are analyzed and the most suitable technologies are identified. Studying and comparing the most promising ECHAINES in European countries has indicated two factors: a) Different methodologies prevail to characterize the chains; no common terminology exists, b) There are large differences in geographical regions and accessibility (including seasonal accessibility).
21	Energy Wood Production Chains in Europe	Matti Parikka	Paper-PDF	Bio-Energy Enlarged Perspectives Conference; Budapest	2003	(EU) The idea of this paper is explaining the supply chains of wood productions in Europe as ECHAIN program which consists of several EU countries. Through this paper the framework and expectations of this program have been discussed and reviewed.
22	Woody Biomass Utilization Desk Guide	Barry Wynsma, et al	Report- PDF	Forest Management, Department of Agriculture; Washington D.C.	2007	(USA) This guide addresses definitions and the process of all woody biomass application stages in US. Information about woody biomass transportation technologies is discussed based on whole-tree and log-length transport, chip and loose material transport, and finally bundle transport. The harvesting and yarding tools and technologies are addressed including whole-tree and log-length, chipping and bundling and loose material handling equipments. Also some information about different types of wood harvesting and utilization contracts in the US are described through this guide.
23	Conventional Wisdoms of Woody Biomass Utilization	Dennis R. Becker et al	Report- PDF	USDA Forest Service Northern Research Station, University of Oregon, Michigan Tech, University of Minnesota	2009	(USA) Several subjects on technical and operational issues of woody biomass utilizations have been discussed and surveyed through ten different case studies and numerous interviews with biomass contractors in US territory. Also transportation cost concerns are emphasized and criteria that influences transportation price have been reviewed, such as distance, accessibility to the harvesting site, fuel cost, infrastructure conditions, legislation and policy, and appropriate scale of processing.
24	Evaluation of Roll-Off Trailers in Small-Diameter Applications	Bob Rummer, John Klepac	Paper-PDF	USDA Forest Service	2004	(USA) In this paper, using roll-off trailers through woody material transportation and collection has been evaluated based on time assessment of loading and un-loading actions, in addition to the cycle time evaluation of wood removal by roll-off trailers along different types of roads and highways.
25	Analyzing and Estimating Delays in Wood Chipping Operations	Raffaele Spinellia, Rien J.M. Visserb	Paper-PDF	Elsevier, Biomass and Bioenergy 33, pp 429–433	2009	(USA) This paper analyzes the delay component of sixty-three chipper time-study data sets from thirty-six different chipping machines. Regardless of operation type, two thirds of the total delay time is caused by organizational delays and remainder by either mechanical or operator delays.
26	Biomass Transportation and Delivery, Fact Sheets 4.5; Sustainable Forestry for Bioenergy and Bio-based Products	Schroeder, R; et al	Paper-PDF	Southern Forest Research Partnership, Inc., GA-USA	2007	(USA) In this Fact Sheet, two major delivery and transport systems for woody biomass material (trucks and trailers) were reviewed. It pointed that 90 percent of the pulpwood delivered to U.S. mills in 2005 arrived by trucks. It concluded that tractor-trailer/bulk van combination is the most economical mode of woody biomass transportation in the South region.

No.	Name	By	Type	Publisher	Year	Reference Summary
27	The harvest of forest residues in Europe	Leen Kuiper en Jan Oldenburger	Report- PDF	Report on bus ticket no. D15a, Netherlands	2006	(EU) This research has been performed to investigate whether Dutch forest owners would be willing to harvest forest residues (tops and branches) from their forests. It concluded that in Netherlands, the removal of forest residues after regular thinning is too expensive.
28	Increasing Security and Reducing Carbon Emissions of the U.S. Transportation Sector: A Transformational Role for Coal with Biomass	David Gray, et al	Report- PDF	National Energy Technology Laboratory- USA	2007	(USA) Good reference on Emission impacts of transportation when comparing with Biomass productions. Includes some information on biomass transportation topics.
29	Roadmap for Agricultural Biomass Feedstock Supply in the United States	Office of Energy Efficiency and Renewable Energy, Biomass Program	Report- PDF	U.S. Department of Energy	2003	(USA) A research on agricultural biomass in US includes varied subjects, such as Production, Harvesting and Collection, Storage, Preprocessing, System Integration and their corresponding technical barriers. The transportation section is the smallest section and without specific data.
30	Michigan's Wood Biomass Inventory	Anthony Weatherspoon	Presentation- PDF	Michigan Department of Natural Resources-USA	2007	(USA) This presentation file discusses briefly woody biomass definitions and sources, current uses and markets for woody biomass in Michigan. It does not include any specific information about biomass transportation in MI.
31	Wood Staging Area Concept Design Project for Biofuel Production Facility at Michigan State University	Michael Sonko, et al	Report- PDF	School of Planning, Design and Construction, Michigan State University	2009	(USA) This preliminary report is prepared to size a staging area for urban wood waste processing, used as a bio-fuel at the T. B Simon Power Plant at Michigan State University (MSU). Includes different activities such as receiving, sorting, grinding, chipping, loading, and transportation operations.
32	Woody Biomass for Energy in Michigan	Bill Cook	Abstract-PDF	Michigan State University Extension Forester	2010	(USA) In this short paper, a summary of movement and supply chains of woody biomass productions from the forest to the mills and plants have been depicted based on a research done at Technical Research Center of Finland (VTT).
33	The Biomass Assessment Handbook	Rossilo-Calle, et al	Book	Earthscan -UK	2007	Good reference for Biomass definitions and technical subjects but irrelevant to Transportation issues
34	Liquid Transportation Fuels from Coal and Biomass	National Academy of Sciences	Book	The National Academies Press- USA	2009	Technical issues about Biomass but irrelevant to Transportation problems

B- Meetings, Interviews and Discussions

B.1. Meetings and Discussions in Scandinavia

Since Finland is one of the leading countries in the use and transportation of biomass, the team looked at getting more familiar with the operational and technical research and activities of transportation and supply chain issues. Several meetings, site visits and discussions were arranged between Dr. Pasi Lautala and representatives of companies and academic institutions in October, 2010. The main discussions are summarized in following sections.

B.1.1 Meetings with Proxion Train Corporation

First meeting was conducted on October 12, 2010, with Kimmo Rahkamo from Proxion Train Corporation which is a new freight rail service provider established in April 2009, planning to start operations in 2012. The establishment of private rail services in Finland is interesting, as it shifts the freight rail system a step closer to the US system. Proxion sees energy biomass transportation to be significant area of business in future, but it's only getting started. Potential large volumes and their regularity are interesting for Proxion, but biomass industry hasn't really developed its strategy yet. Key points of other discussions include:

- Freight rail opened to competition in Finland in 2007, but so far no new operators have emerged, as the initial step and investments are high.
- The lack of alternative providers for rail traffic is considered a big problem in Finland by major customers. It's difficult to evaluate cost / benefits without competition.
 - o The new company thrives to have a high usage capacity of equipment (a typical freight car of the current national operator (VR) only makes 50 trips per year, with average distance of 270 km).
- Proxion's main customers are expected to be heavy industries (high and regular need for heavy transportation).
 - o Trains would be mainly shuttle trains and intermodal trains and would mainly use containers.
 - o Necessary volumes and consistency of demand are main challenges.
 - o Some of the transportation volume expected to come from trucks, some from VR.
 - o Two tentative customers would transport goods for approximately 300 km.

B.1.2 Meetings with VTT (National Research Center of Finland)

The second meeting was arranged with Arto Nokelainen from VTT (National Research Center of Finland) on October 12, 2010, about transportation and woody biomass researches conducted by VTT. The discussions evolved mainly around development of biomass industry, water transportation and transportation related emissions. Key points are highlighted below:

- Forest products industry is shifting toward biomass energy applications. A new power plant is being planned either to Porvoo or Imatra by StoraEnso and Fortum.
- VTT has done a lot of research on water transportation potential
 - o Floating of logs has been started again in Lake Saimaa and with some import of wood from Russia
 - o A new ship concept "barge-mother-ship" has been researched to transport paper directly from mills to the Central European customers. Four barges can be floated to the mother ship and then transported as one ship the rest of the way. Paper rolls would be in containers, containers in the barges. VTT is investigating, if this approach could be used for biomass and planning to simulate the "barge-mother-ship" concept with Aker Arctic Technology.
- VTT has developed an open-access database for emission data of all transportation modes, called www.Lipasto.vtt.fi. They also use is a life cycle model that uses the formulas and values from

Lipasto (KCL-Eco). VTT is currently working on a proposal to EU to establish “the Transport Chain Carbon Footprint” calculation model for the whole Europe which 14 institutions involved in the proposal.

- VTT is also working on a project to investigate the service level of ice-breakers.
 - o Current capacity is not enough even during regular winters.
 - o In winter 2010, some commercial ships waited 12 days in the ice (recommendation is 4 hours)
 - o Simulation model used one year production of Stora Enso as a starting point to define how many barges and tugboats would be needed.

B.1.3 Meetings with Jyvaskyla University Researchers

On October 18, 2010, representatives from Jyvaskyla University and Technical College were met for biomass discussion. Central Finland has been one of the most active clusters of biomass development in Finland. Discussion topics varied from general biomass discussions to transportation optimization and intermodal transportation. A newly developed system to ship biomass in bundles was also introduced.

B.1.3.1 General biomass discussions, Markku Paananen:

The forest resources in Finland have been increased for long time and about 70% of annual wood growth is currently used for production. By the end of 2010, there will be nine combined heat and power production facilities (10-500 MWh) using forest biomass and Finland is starting to see market forces to shape the business.

- Most counties in central Finland obtain their heating from district heating facilities that use biomass. In 2006, 50% of all energy in Jyvaskyla area was produced locally with biomass. The participants of the cluster have developed vision together for future objectives and are investing together to move toward common goal (and common projects and clients).
- 800 000 m³ of chips are used annually (close to 1 million)
- Finland is one of the leaders in bio-energy use and research, but profitability of supply chains is not very good at the moment. Transportation and harvesting tasks are the least profitable segments of supply chain.

B.1.3.2 Intermodal transportation opportunities, Antti Laakso, JYKES (Jyvaskyla Development Agency)

Latest priority of transportation planning is harmonization of bioenergy transportation within Scandinavia (through intermodal transportation). For rail transportation, the min. distance is 120-150 km, or in some cases closer to 180-200 km.

- Scandria is a project to establish “green corridor” through Europe. Sweden is way ahead of Finland in green transportation and some green corridors already exist in Sweden.
- Majority of biomass will move directly from forest to plants. Yards will be only for spring breakups. There is some interest to develop terminals into commodity marketplaces. It has been estimated that 8,000 containers are required to have competitive intermodal terminal in Jyvaskyla.

B.1.3.3 Biomass transportation optimization, Hannu Lahdevaara, JAMK

There is an optimization model used for biomass transportation in the whole country. Optimization model revealed that biomass could be transported from 150-180 km distance to Keljonlahti plant in the Jyvaskyla area (from North). Model used VR log transportation rail rates which are expected to be slightly too low, as biomass transportation can't take advantage of whole capacity of the car.

- Current transportation distance of biomass to Keljonlahti plant is 100 km on average, for railway the distance is about 200-250 km.

- Producers purchase biomass to their terminals, sell it and handle logistics. Sometimes subcontractor handles chipping and transportation (producer only purchases the right to harvesting from the owners.)
- Only 3 percent of biomass transportation moves by rail. In log transportation, percentage is closer to 30.
- Water transportation is not used much in Finland for biomass. New ship was developed (so-called “bioship”), but it was too expensive, so unit cost was too high. Objective was to fit approximately 5,000 m³ of loose chips to the ship. Ship was developed by Lafkomp and its price was about 2 million Euros, but distances are not long enough for economic water transportation, unless a lake needs to be crossed.
- Speeds of rail transportation are being increased, so transportation effectiveness could be improved.
 - o Rauhalahhti power plant in Jyvaskyla gets a weekend train that keeps the crusher busy (truckers don’t want to drive on weekends)
 - o Train size defined based on the facility.
 - o Moss and other types of biomass transportation have also been tested. Old chip cars are used for moss (old-fashioned unloading).
- Storage costs haven’t been investigated yet. The rule of thumb for energy plant is to have 1.5 years’ worth of wood in storage.
- The optimal location for chipping activities is still under debate. Chipping at mill could improve the quality and expedite the supply chain.

B.1.3.4 Bundling harvesting system (Fixteri), Markku Hakkinen, Fixteri

Fixteri is a new bundling system for energy wood harvesting. It is used mainly for smaller trees with 4-15 cm diameter, but it can be also used for biomass, or for paper mill feedstock. Current technology can also separate cellulosic fibers from needles and leaves, etc. Fixteri has currently two machines in-use by clients and two own prototypes have been used for over 10,000 hours, since 2003. The company is currently concentrating in Finland, but they are interested in trying the machine abroad through research collaboration.

- Bundler by John Deere uses only residues, so it doesn’t work for same purpose as Fixteri.
- Logman provides currently the base for the machine (Ponsse won’t fit, as its cabin doesn’t spin). Some John Deere machines would already work.
- Each bundle weighs about 500-600 kg.
- Bundles are clean, as trees are cut while standing and inserted directly to bundling machine, so they won’t touch the ground, except during storage. This saves in equipment maintenance frequency and costs. In Finland the bundle length is 2.6 m, based on the size of trucks and rail cars.
- Wood dries faster, as the bundler breaks the surface fiber. The second advantage is the dryness and cleanness of the trees, which are both better in bundling method.
- Greatest challenge is currently the cost of bundling. The longer the distance, the more competitive the system is, as the unit cost for log truck transportation is much lower than for chip transportation.
- Finland and UPM want to double or triple forest energy usage by 2030. Distances will get longer and especially with train transportation, bundling may become the only sensible alternative.
- The volume and speed of transportation in the forest is several times faster than with typical harvesting and chipping methods and the bundling method removes the need for chipping at roadside. Bundles should never be chipped at roadside.
- When bundling is not used, roadside chipping is the only way to get enough weight to trucks. Currently over 60% of chips are done at roadside. However, chip transportation is complicated, as

in winter, they freeze and in summer they start “rottening”. Stumps are always crushed at final destination.

- Saimatec is developing chip-dryer, but the energy source for using the dryer hasn't been determined.

B.1.3.5 Meetings with Tamminen Co.

On October 11, 2010, Dr. Lautala met with representatives from a Finnish log and biomass transportation company to learn about various aspects of movements of woody biomass by truck or multi-modal transport. Main points of interest are summarized below.

- A typical Finnish rail log truck is equipped with a self-loader. Chip cars are also available for biomass residues. Typical fuel consumption for Finnish log trucks are 4.0 – 4.4 miles/gallon and loading times for a log truck vary from 30-45 min (logs, including securement) to 1 hour (biomass residues). Unloading typically takes 1 hr, including cleanup. Factory unloading machines can do it much more quickly (10 min), but longer wait times (up to an hour) are common.
- On-site chipping has been preferred for residues because it is inefficient to transport intact branches, tree tops, etc.
- Average truck transport distance from harvest landing to an intermediate storage yard is 80 km, but it is growing as rail costs increase.
- Contracts between loggers and forest products companies are normally 3-5 years, but the durations or procurement levels are not always honored by forest products companies.
- Log transportation information systems – vary for each major company, typically run through laptop or notebook over mobile phone network. Storage locations, mill orders all displayed in real-time. Drivers can make independent decisions or can be directed where to move (central dispatching)
- www.EHM.fi has more technical information on the trucks used in Finland.
- Some information about log/biomass transportation capacity in Finland:
 - Branches and stumps:
 - o Volume about 130-150 m3 (restrictive dimension for branches and stumps)
 - o Weight about 20-25 tons (metric) for stumps and branches
 - o Truck weight about 27-32 tons (leaves 10 tons extra)
 - Logs:
 - o Trucks about 18-19 tons, self-loader about 3 tons
 - o 60 tons total max.

B.2 Discussion with Log and Wood Biomass Companies

On August 1-3, the MTU transportation team visited with several individuals involved in log and wood biomass business in Michigan to gain industry input on the topic (Table B-1). Some of the topics discussed were issues and opportunities for wood biomass and biofuel transportation in Michigan as well as challenges. The discussions revealed that both Northern Lower Peninsula and Upper Peninsula have potential to increase the volume of woody biomass use and transportation although there are some operational and technical requirements that should be considered through development and planning.

Table B-1- Companies/individuals visited in UP and Lower Peninsula in August 2010

Date	Company name	Representative	Title
8/1	Carey Logging and Excavating	Jim Carey	CEO and Owner of Company
8/1	Verso Paper, Quinnesec Mill	Sid Dye	Procurement Coordinator
8/3	Northern Timberlands	Dan Glawe	NA

B.2.1 Discussions with Representative of Carey Logging and Excavating

On August 1st, the research team met with Jim Carey (owner of Carey Logging and Excavating). Jim was able to give insight into the shipping and chipping of biomass material. One of the topics was the factor that all log trucks have a log truck plate which restricts their use to hauling raw logs or chips. Hauling processed material (like processed lumber or other processed materials) is not allowed.

Jim runs a fleet of 1 log truck and 6 chip vans. He also has several independent contractors that haul for him (both logs and chips). Most of the equipment is 2002 and newer. His Forestry crews are made up of a harvester and forwarder for one crew and a feller buncher, skidder and delimeter for the second. His chipping crew consists of a whole tree chipper, two forwarders, horizontal grinder and chip van fleet.

Jims tries to work within about a 100 mile radius from the delivery point for his chipping operation. He supplies chips to a new plant at Gwinn that makes wood briquettes to power plants from chips. A different truck has to be used to ship the briquettes. Since the briquettes are a final product, a truck with commercial plates would have to be used. With current equipment, he has the capacity to produce 2,200 tons of chips per week.

B.2.2 Discussions with Representative of Verso Paper

The team met with Sid Dye (Quinnesec Procurement Coordinator) of Verso Paper at Quinnesec Mill to discuss how an industrial size mill operates and handles several different types of modal transportation shipments.

Verso paper is one of the main paper mills within the Upper Peninsula. Verso consumes about 1.65 million tons of hardwood per year. From the pulp that is made, 60% is sold to open markets with the other 40% being used for their own paper production. In November 2011, their new steam turbine generator will go online. It will use about an additional 250,000 tons of biomass a year. Electricity generated will be sent to the grid and a portion will be bought back (only way to get green credits) to power the plant. All deliveries of chips/biomass material will remain by trucks, no rail equipment or unloading facility will be needed. The steam turbine will also generate steam for paper production, making the plant over 30% self-sufficient.

Verso receives approximately 17% of their raw forestry material by rail (25% in 2008). Currently, Verso is receiving between 350 and 400 cars of logs a month (between 12,000 to 14,000 cords a month). Sid stated that for rail to be profitable, the wood would have to come from sources outside of 120 miles radius from the mill. Sid also mentioned that if logs have to be trucked over 30 miles to a siding site, that it is more economical for them to be trucked the rest of the way to the mill. Verso is currently leasing 40 to 44 log cars, but the \$2 dollar per cord reduction in cost does not cover the lease and maintenance fees.

Verso owns/leases several rail yards around the Upper Peninsula. Each of these yards is operated by an independent contractor that has the equipment necessary to load the cars. These yards allow a structured flow of wood into the mill, but it costs \$3 per cord extra to cover contractor expenses.

Verso contracts out all trucking with owner-operators which is recognized as the only economical way to do it. Verso pays these loggers by a shipping zone rate structure. There are 4 zones that are 50 miles apart, up to 200 miles. Anything over 200 miles out from the mill has a general rate assigned. Truck

drivers that haul into the mill, need an authorization card to be able to enter the facility (Authorization cards also identify truck and person/company to receive payment). The truck enters on a scale where he or she weighs their load and opens a transaction. After weighing, the truck proceeds to the unloading platform. Once unloaded, the trucker then proceeds to a different scale where they weigh up empty. This is where the trucker also closes out the transaction before he leaves.

B.2.3 Discussions with Representative of Northern Timberlands

On Wednesday (August 3rd) research team met with Dan Glawe from Northern Timberlands. Northern Timberlands opened the Caffey log yard about 30 years ago, which is currently being ran by them for Verso Paper. The Caffey yard has considerable amount of wood flow from the east end of the Lower Peninsula, but such movements are very difficult to justify without a back haul. Timberland sends logs to Pot Latch and bring back lumber to the Lower Peninsula (from LP plant at Sagola). They do this with b-train trailers to maximize payload for both directions. On rail side, Dan Said, “For their yards, the time to load a rail car if the pile is next to the car, takes about 35 to 45 minutes to load 35 cords of wood. If it has to be loaded to a trailer and hauled to the car, the time is about double”.

The bridge is a major obstacle for hauling wood in any direction, at the moment trucks have to pay \$4.50 per axle to cross the bridge. Loggers need to increase the number of axles on their trucks to maximize payload potential. By doing this, they are also increasing the cost to cross the bridge. There is talk at the Bridge Authority about raising toll cost for commercial trucks and there are no discount rates for trucks that frequently cross the bridge. Most of the companies that have to cross the bridge regularly are trying to get the Bridge Authority to set up a sliding price scale for frequent users, but the Bridge Authority stated that it does not want to do this because most of the damage/wear and tear on the bridge are from commercial trucks. The Bridge Authority also mentioned about bringing the bridge weight from 144,000 lbs to 100,000 lbs. For Dan, this means that the B-train trailers that are getting shipped to the Upper Peninsula would have to be split into two single trailers and ran across the bridge, raising the cost in which it would take to get across. Dan also mentioned that with the current rate structure, it costs about \$2 -2.25 a cord to ship over the bridge.

During the visit, research team had to cross the bridge several times, at each crossing, we saw several chip trucks either entering or exiting the Upper Peninsula. Dan mentioned most of the chip vans coming over the bridge that we have been seeing are coming from Beaver and Pine Tech (mills in the Cadillac area) and are hauling clean chips. Most of these trucks are going to New Page in Escanaba, but some go to a particle board plant in Sue St. Marie.

The logging infrastructure in Northern Lower Peninsula is almost absent, due to three major mills closing within the last six years. The industry lost a demand for 1.2 million tons of wood due to the closures. In the Lower Peninsula, there is hardly any pulp wood market which makes it hard to even get high value saw timber (as both are logged simultaneously). Northern Timberlands has a mechanical sorter in Vanderbilt that sorts between pulp and saw logs (learned from Finland) but it is sitting most of the time because there is no market for the pulp logs that come out of it.

Northern Timberlands has 14-15 wood product trucks, out of which 7-8 trucks run 24 hours a day. They only have two self loaders, and they own 36 b-train trailers. B-train trailers allow them to maximize the weight going over the bridge and allow them to bring lumber back down to the Lower Peninsula. The use of the trailers allows for back haul potential. All trucking operations for Northern Timberlands are controlled by one central dispatch in Vanderbilt.

Dan said, “Any trucks that strictly carry logs or chips are registered under a Log license plate”. These plates are a lot cheaper than commercial plates. Any vehicle that would carry processed material, like pellets or lumber needs to have a commercial license plate. The team didn’t receive actual rates, but Dan said the cost comparison between plates would be like paying \$200 for a log plate a year compared to \$2,000-3,000 thousand for a commercial plate. Trailers have a onetime registration fee.

Northern Timber used to ship logs by rail from the Lower Peninsula through Chicago and to a mill in Pennsylvania, but had some problems with shipments. They also barged wood from the Lower Peninsula across Lake Michigan for three years in the mid 90's. They shipped from Frankfort, MI to Manitowoc, WI for Thilmany Paper. The mill had a need for pulp wood and the Lower Peninsula had the quantities needed to fulfill it. Northern Timberlands had a three stage barge system going. One barge would be loading while one was being hauled across the lake and the final one would be unloading (each barge could carry about 1,200 tons of wood per load). All three duties would be going on simultaneously to minimize down time between zones. They had a deal with a towing company out of WI to tow the barges across the Lake Michigan.

Some wood was stock piled at the dock site to make sure there was enough wood to fill the barge when the time came to load it. Dan said that they used a log loader with a 50 ft reach to load the barges. Sometimes, they would bring rocks back to MI as backhaul. When this was done, they would have to clean the barge to prevent contamination which would take about 8 hrs. What killed the whole operation was there were no long term contracts to justify in investing in the equipment needed. Northern Timberlands did find a tug and barges that they would have purchased if operations had continued. Also, economy and paper completion brought down the need for pulp and helped contribute to its loss.

At the end of our discussion, Dan mentioned that there several of the capable harbors (Table B-2) for this type of activities in the LP, but many have been lost due to development and lack of maintenance of shipping channels. Ports with potential to be used as a port or harbor for loading logs would need 20 ft of draft.

Table B-2 Review of Port and maritime facilities in MI

Port Location	Notes From Dan
Detour	Good deep water port near Kinross (located in Upper Peninsula)
Cedarville	Good deep water port near Kinross (located in Upper Peninsula)
Frankfort	Shut down
Ludington	Only Deep water port on West side of Lower Peninsula
Manistique	Tough to get into due to having to go up river
Rogersville	Would have potential for deep water port
Bay City	Is ok,
Alpena	Not to good, The bay has a lime stone bottom

The meeting with Mr. Glawe was very insightful and allowed us to see several shipping aspects that were tried within one company.

B.3 L'Anse Powerplant Site Visit

In August 5th, 2011 research team visited L'Anse Warden powerplant located in L'Anse-MI to obtain more practical information on biomass transportation and its processing issues within an existing powerplant. The L'Anse powerplant receives different types of fuel including Tire-derived Fuel, woody biomass and disposal wood ties of railroads. The key operational notes of biomass multimodal transportation of this site are summarized below.

Tire-derived Fuel (TDF):

- The consumption of TDF is about 40 tons / day, which is about 8% of daily fuel input (500 ton/s day total)
- TDF comes from a large tire shredding operation in Savage, MN (southern suburb of Twin Cities, 350 miles away). Trucks haul about 25 tons on average; need 11-12 trucks per week of TDF. Usually about 2 trucks / day arrive.

Railroad Ties:

- MA Energy Resources (a 3rd party) is responsible for aggregating and delivering railroad ties to the site, so MA Energy is the main point of contact with CN Railroad.
- Shipments are highly variable, but the powerplant get deliveries usually 3-4 times per week.
- Rail cars are unloaded at the fuel aggregation facility (FAF) within 24hrs and are often picked up by CN after just one day.
- After chipping railroad ties by grinder, they are hauled from FAF to main plant via an access road.
- The procedure and different steps of RR tie shipment includes ordering empty railcar(s), securing track space/siding for car placement, moving loading equipment, loading cars, creating a waybill/release form
- M.A. supply zone for L'Anse Powerplant crossties is appx 600 miles to the West, appx 400 miles to the East, and appx 1,100 miles to the south

Woody Biomass:

- Another 3rd party (Norman Pestka-Ontonagon) is responsible for aggregating and delivering wood chips for the L'Anse Warden plant.
- Wood chip trucks typically haul between 35 and 38 tons of wood chips.
- The FAF is equipped with tippers for fast unloading of chip trucks. (Figure B-1)
- The chipped woody biomass is stored at the FAF along with the RR Ties, but they are kept separate throughout the handling and processing steps in the facility.
- When chipped biomass is delivered to the main facility, either from the FAF or from elsewhere, the total process of weighing in, filling out paperwork, backing up and unloading the fuel into a hopper, weighing out and filling out paperwork takes about 25-30 minutes. Actually unloading the fuel into the main facility hopper takes about half of this required time, which is restricted by the ability of the conveyor belts to move fuel into the main facility.
- Chip trailers unloading at the main facility must be equipped with a walking floor or a revolving belt to unload chips.



Figure B-1- Chip truck is tipped and unloaded at the facility close to the rail spur and piles of disposal ties-about half mile far from power plant (Photo by H. Pouryousef, Aug. 2011)

In addition to the site visit of L'Anse powerplant, the research team interviewed with MA Energy Resource representative, Scott Waring, about biomass transportation requisites and key challenges for L'Anse powerplant and other biomass facilities served by MA Energy Resource company. The main discussions with Scott are summarized below:

Multimodal Transportation Operations:

- M.A. utilizes the Inland Waterway System, Great Lakes, Rail, and Truck transportation to move their fuel products.
- M.A. woody biomass programs are very specific and limited in scope - mainly focused on export for international customers.
- M.A. Energy Resources supplies over 30 facilities in the Eastern half of the US (Rocky Mountains East). Customers include pulp/paper mills, power and combined heat/power utilities, and cement kilns. Their fuel programs consist of TDF (tire derived fuel), CDF (crosstie derived fuel), and woody biomass.
- The biomass demand does not have any particular monthly or seasonal peak, although the demand for TDF sometimes goes up in colder months because it has a higher BTU value.
- The most common types of trucks are either walking, rolling, or moving floor trailer, or end dump capability for processed materials.
- The common vessel used by MA is open hopper barges with 11 – 14 foot high sidewalls.
- The barge size used for biomass transportation by MA is: Rake (1400 tons), Box (1600 tons), Lake box barge (2500 tons for their materials, normally 5000 tons), there are 6-32 barges at a time on inland river system.
- There are no marine/rail movements though, except for some large energy utilities.
- The choice of end user and their ability to receive different shipments is the most important criteria to select the transport mode (truck only vs. truck/rail, or truck/barge, etc.)
- In reliability, the order of transport modes is: 1st-Trucks, 2nd-barges, and 3rd-Railroad. Rail services are the least reliable mode, especially with 2+ companies involved.

Railroad Operations:

- Railroads usually dictate the route taken for a given O-D pair. Main RR can coordinate the interchange, but then they own the shipment (more control for them), or client can try to coordinate interchange points. M.A. tries to determine the rail routes together with railroad representative. If an interchange is required (to second railroad track ownership), routing and rates must be established prior to car order. Downside is increased cost and transit time.
- Car freight, demurrage at both origin and destination, switch/interchange fee (if applicable), and car damage are other additional fees related to rail transportation.
- Securing an empty rail car takes 5-8 days depending on time of year, demand, weather conditions, origin location. Car loading origin and final destination drives time line. Example of a Chicago to L'Anse rail move would have 2- 2.5 car turns per month. MA tracks all car moves and monitor car turns (car velocity). They do the same for all barge movements. (days on marine/transit time)
- The most common types of rail cars are Standard or Wood chip gondolas (12 ft sides vs. 4 ft regular).
- 1, 3, 5 year commitments are typical long term contracts with rail companies.
- The rail car availability can be classified as:
 - Pool cars: 3rd party or RR owned, but these cars travel a user-defined route over and over, consistency!
 - Leased: you can send them anywhere, but no control over route, etc.
 - Own: do whatever you want with them

Railroad Tie Transportation:

- The burning of crossties for energy is very common. The buyers for RR ties have long-term procurement contracts with MA Energy, to deliver a certain quantity of material consistently, although there are some cases with short-term contract.
- MA Energy is the agent for one of the Class I railroads and has both spot and multi-year contracts with others, including some short line railroads.
- MA Energy handles from “cradle to grave” deliveries in some cases (client may expect MA to provide equipment and operators in field) and in other situations they accept crossties on a delivered basis.
- MA has fairly consistent flow of ties moving by rail through spring to fall. Winter months slow up due to several factors, but car loadings/unloading occur every week of the year. Due to the possibility of unexpected delays, including Force Majeure, the best way to control fluctuation is by holding inventory at end users location.
- The majority of cost for using rail ties mostly comes from A. Operations, B. Transportation, and C. Purchase. (sometimes B and C are inverted)
- The minimum quantity of ties per shipment when rail is used is: 1-40 cars at a time.

C- Mackinac Bridge Questionnaire

Table C-1 Information from Kim Nowack, Chief Engineer, Mackinac bridge authority

Question	Answer
Do you keep track of traffic that crosses the bridge? If so, what sort of characteristics do you monitor and how do you monitor them?	We record how many axles each truck has when they cross. They are charged per axle. The axles are counted visually by the collector and mechanically as they cross the treadle in the pavement at the toll booths. We can only differentiate the trucks by axle counts. Most log/chip haulers are 11 axle vehicles, but not all 11 axle vehicles are log/chip haulers.
For traffic, about how much truck traffic goes into the UP? How much goes to the Lower Peninsula? What is the % into/out of the UP?	We have log trucks, bark/chip haulers etc. moving both northbound and southbound across the bridge at a regular frequency. It is about 50-50 % north vs south bound. See attached traffic counts.
How many Tractor trailer trucks pass over the bridge per day (roughly)?	See attached traffic counts. 11 axle trucks are class "21" vehicles. Trucks in general are class 5 through 21.
How many log trucks pass over the bridge per day (roughly)?	Undefined (see above)
How many chip trucks pass over the bridge per day (roughly)?	Undefined (see above)
What the general procedure is for a large truck to cross the bridge: Do any of these vehicles have to be escorted across the bridge?	They require an escort since they are so heavy. This doesn't cost anything and if they are frequent crossers they can sign up for our trucker permit program. This requires that they get training in our rules for crossing and then eventually they receive a permit card and can cross without an escort
Are there any other restrictions or requirements placed for trucks crossing the bridge?	Regulations for crossing the bridge found on bridge website.
What are the maximum weights for trucks crossing the bridge?	72 tons gross plus Michigan axle weight regulations apply.
What are fare rates for tractor trailer trucks (log trucks / chip trucks)?	They pay \$4.50 per axle. Frequent commercial users can also sign up for the MBA debit account program and then they don't have to pay with cash.
Are there discounts on fare rates for trucks that cross the bridge frequently?	We have had representatives from the forest products industry approach the Mackinac Bridge Authority board to ask for a reduced frequent user rate for these wood hauling trucks, but this will probably not happen due to the weights of the trucks in question and the fact that these vehicles cause the vast majority of wear and tear on the bridge and result in our need for maintenance.
What is "regular frequency" for crossing?	See attached traffic counts.
What are typical axle configurations seen for forestry product vehicles crossing the bridge?	Most log/chip haulers are 11 axle vehicles, but not all 11 axle vehicles are log/chip haulers.
Are there truck inspections before trucks pass over the bridge?	There are no routine inspections before crossing. The MSP has a presence at the bridge they will inspect vehicles at their discretion. The Dept of Agriculture has inspection check points for emerald ash borers in the welcome centers at Mackinaw City and St. Ignace. We believe that frequent wood haulers are allowed to declare ahead of time what they are hauling and bypass the check points.

Do you see a larger amount of forestry product trucks crossing the bridge during spring break up?	See attached traffic counts.
At what wind speeds in the straits do you shut down truck crossings? How often does this happen?	We begin escorting high profile vehicles at an average wind speed of 35 mph. We do not allow high profile vehicles at an average wind speed of 50 mph (called "partial closure") Loaded log trucks are considered high profile and would be escorted in winds between 35 and 50 mph. Unloaded log trucks would not be high profile and could cross without escort with winds between 35-50. No trucks of any kind can cross with winds above 50 mph. See attached summary of closures for more info. Most closures are short (1-3 hours), but closures over 10 hours have occurred 5 times in the last 15 years.
What is average wait time (for log trucks) to cross the bridge? And how long does it take to cross the full span of the bridge?	Trucks with a permit can cross immediately without waiting. Those requiring an escort may have to wait up to 20 minutes depending on what the MBA staff is working on at the time. Crossing takes about 15 minutes. Escort service is available 24-7.
How are truck weights monitored at the bridge?	MBA has weigh in motion (WIM) scales northbound and southbound. MBA also has a static scale for MSP motor carrier use. When an overweight truck alarms the WIM, a motor carrier is called to investigate and issue a ticket or impound the vehicle.

D- Shortline Railroad Questionnaire

Several shortline railroads from Lower Peninsula of Michigan were contacted to inquiry on rail transportation services. Outcomes, as received, are presented in Table D-1.

Table D-1- Railroad questionnaire data

Railroad	Infrastructure			Operation						
	Miles of Track	Public sidings capable for Biomass	Private Sidings capable for Biomass	Number of interchange points	Percent of moves interchanged	Average Delivery Time (In Days)	Average Haul Length (Miles)	Availability of Cars for Biomass	Main Commodities	Approx price (\$/ton mile)
1	123	40	40	4	99%	1	50	Can be Obtained, if necessary	Auto parts, plastics, metals, forest products, agricultural and aggregates	Depends on Quantity
2	400	Everything	N/A	4	98%	1	220	Can be Obtained, if necessary	Just about Everything	\$110-\$130 Mostly based on contract rates
3	300	24	A Lot	4	Majority	1	25-90	Can be Obtained, if necessary	Everything except Auto's	Depends on Length and number of cars
4	18	3	2	2	100%	1.5	14	Can be Obtained, if necessary	Pulp board, plastics, fertilizers, soybean oil	\$25
5	15	1	1	1	100%	1.5	2	None	Food Products	\$150
6	130	8-9	--	2	100%	1-2	50-118	None (owner lease cars)	Bulk board, chemicals, agricultural, lumber, boards, fertilizers	Tariff rate (discount on car loads over 25 per year)

E- Port Infrastructures, Origins and Destinations

E.1 Biomass Destination Ports and Docks

E.1.1 Charlevoix Harbor, MI

Located on the east shore of Lake Michigan, 276 miles northeast of Chicago, IL and 75 miles northeast of Frankfort, MI, Charlevoix is a commercial harbor with facilities in the town of Charlevoix and on Lake Charlevoix. (Figure E-1) The port was ranked 31st among the Great Lakes Harbors with 1.5M tons of commerce in 2007.

The U.S. Army Corps of Engineers has project depths of 18 feet in Lake Michigan and; 17 feet in inner channels to Lake Charlevoix. However, recent shoaling and a lack of maintenance dredging may have reduced the allowable draft in portions of the channel. Lake Charlevoix extends about 14 miles SE from the head of Pine River and is from 1 to 2 miles wide, with depths to over 100 feet and deep water generally close to shore. Boyne City, MI, is at the SE end of the lake.

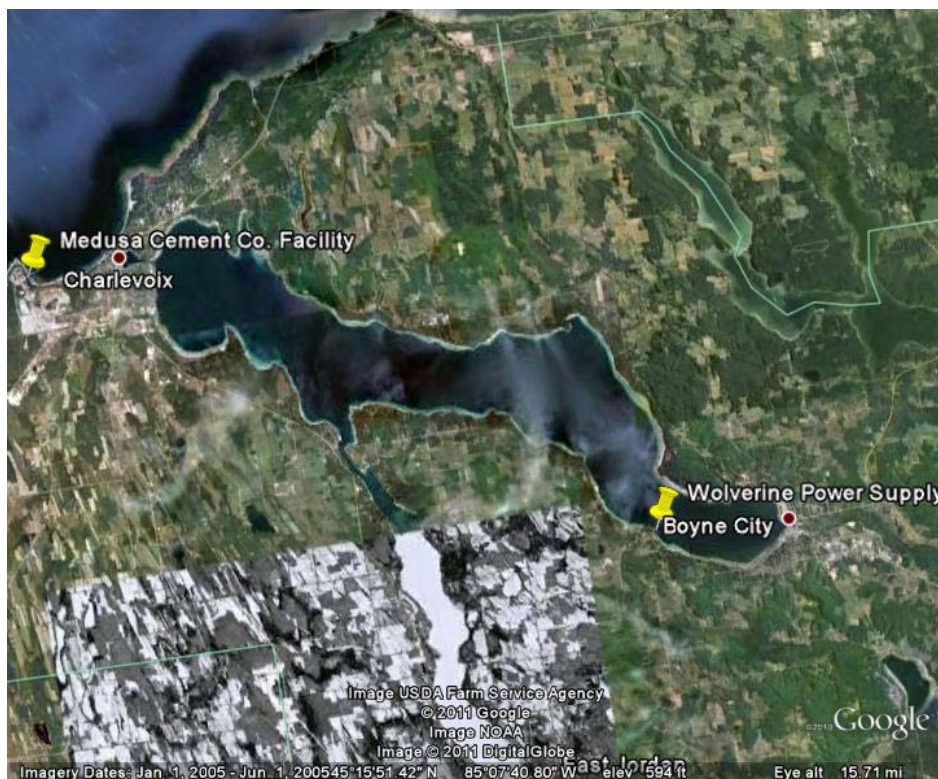


Figure E-1- Charlevoix, MI Harbor, Google Earth

Potential Biomass Docks in Charlevoix Harbor:

All the docks in this harbor have highway connections. Depths alongside are reported depths and not verified. The availability of the docks for biomass use has not been confirmed. At Advance, MI, about 2.5 miles west of Boyne City on Lake Charlevoix the Wolverine Power Supply Cooperative has a coal dock providing 630 feet of berthing space with dolphins, a deck height of 11 feet, and a depth of 25 to 30 feet alongside. This site may provide an option for the unloading of biomass if there is sufficient space and the owners were interested.

Approximately 1.5 miles west of the port of Charlevoix along the Lake Michigan shoreline there is located a facility for shipping cement and receiving coal. This is a privately owned and maintained facility by Medusa Cement Company. According to the Coast Pilot the entrance channel and slip are reported to be dredged to 24 feet annually. The slip is about 100 feet wide. The N side, 645 feet long, is used to ship cement. The south side dock is 556 feet long and is used to receive coal for plant consumption. The docks have a deck height of 10 feet. This site may provide an option for the unloading of biomass if there is sufficient space and the owners were interested.

E.1.2 Frankfort

Frankfort is a commercial port located on the east shore of Lake Michigan, 204 miles northeast of Chicago, IL and 28 miles north of Manistee, MI. Frankfort Harbor, 4.3 miles south of Point Betsie, is in Betsie Lake, which is connected to Lake Michigan by an entrance channel. (Figure E-2) In October 2005, the controlling depth of the channel was 22 feet in the entrance, through the outer basin and between the piers to the inner basin.

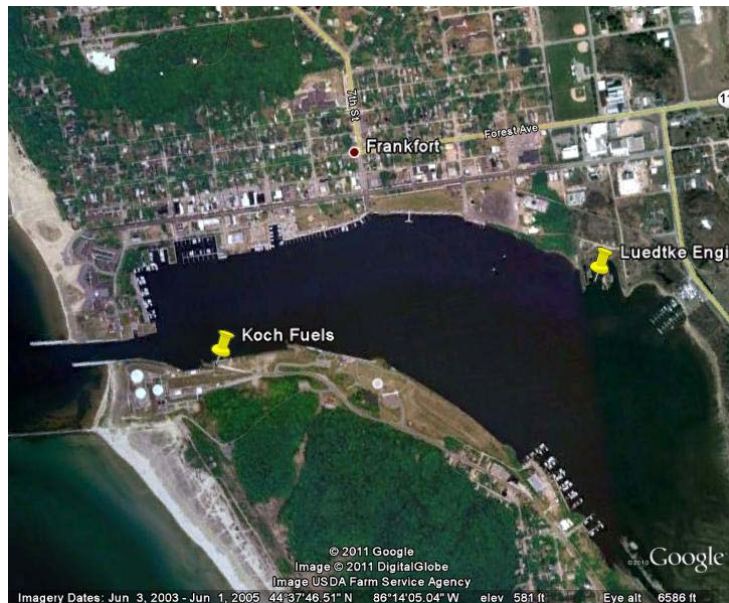


Figure E-2- Frankfort Harbor, Google Earth

Potential Biomass Docks in Frankfort:

All the docks in this port have highway connections. Depths alongside are reported depths and not verified. The availability of the docks for biomass use has not been confirmed. Koch Fuels, Inc. receives petroleum products at a 425-foot wharf on the S side of the inner basin. The wharf has a deck height of 8 feet with reported depths of 18 to 20 feet alongside. There is tank storage for 310,000 barrels of petroleum.

Luedtke Engineering has a dock facility at the north end of the inner basin with (according to chart 14907) a depth of 7 feet. Of note is the fact that in the U.S. Army Corps of Engineers Port Series 48 published in 1995 the following dock in Frankfort is listed as shipping or receiving logs at that time. The dock at the time of the survey was owned by the state of Michigan and the facility operated by Woodland Harvesting Inc.

“Woodland Harvesting Dock. Elberta, south side, Lake Betsie, approximately 2,300 feet east of entrance from Lake Michigan. 1213 Furnace Avenue Elberta County: Benzie Purpose: Shipment of pulpwood. Owner: State of Michigan Operator: Woodland Harvesting Inc. Latitude N 44.628611

Longitude W 86.23889 Depth Alongside (feet): 30 Total Berthing Space (feet): 400 Remarks: Open storage area at rear has capacity for approximately 30,000 cords (3,840,000) cubic feet) of pulpwood". A Google earth image observed in 2011 indicated that this area may be undeveloped and have potential.

E.1.3 Traverse City, MI

Traverse City, MI, at the head of West Arm of Grand Traverse Bay, is the principal harbor on Grand Traverse Bay. (Figure E-3) The cargoes handled in the port are petroleum products and coal. The commercial docks are located north of the village of Greilickville and Traverse City.

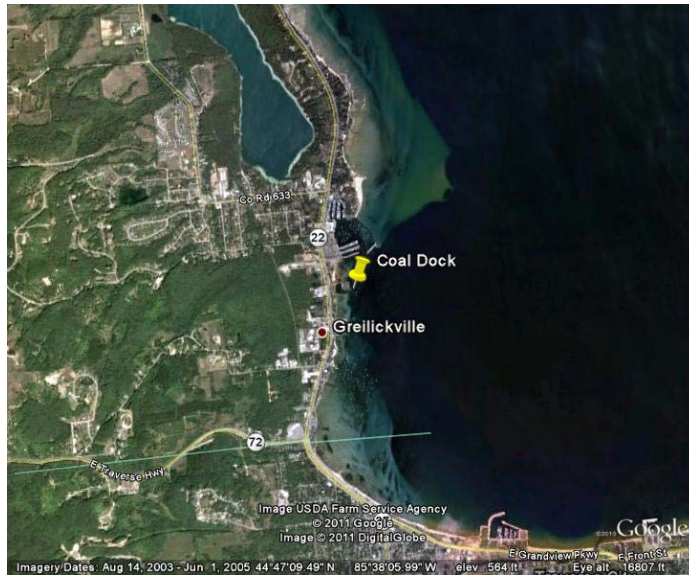


Figure E-3- Coal Dock north of Traverse City, MI, Google Earth

Potential Biomass Docks in Traverse City:

Traverse City has three active deep-draft facilities. However two of them handle petroleum products and biomass operations may be difficult if not impossible at petroleum docks. All the docks described have highway connections. Depths alongside are reported depths and not verified. This is not listed as a federal dredging project. The availability of the docks for biomass use has not been confirmed.

One dock that may have potential is the Traverse City Coal Dock: (44°47'11"N., 85°38'08"W.); 210-foot face; 18 feet alongside the north end with a deck height of 6 feet; vessels dock port side to; open storage for 16,000 tons of coal; receipt of coal and slag. The facility is owned and operated by Traverse City.

E.1.4 Manistee Harbor, MI

The port of Manistee is located on the east shore of Lake Michigan, 179 miles northeast of Chicago, IL and 26 miles north of Ludington, MI. Manistee Harbor is on the Manistee River, which flows from the N end of Manistee Lake for 1.5 miles to Lake Michigan. (Figure E-4) There are extensive facilities along both sides of the river and on the W side of Manistee Lake. The principal cargo handled in the port is coal, with occasional shipments of salt and machinery.

The entrance to Manistee River is protected on the SW by a breakwater. A dredged entrance channel leads from deep water in Lake Michigan through the north part of the outer harbor basin to the river

entrance between two piers and through the river channel to Manistee Lake. In February 2011, the controlling depths were 25 feet in the entrance and 23 feet in the river channel to Manistee Lake.

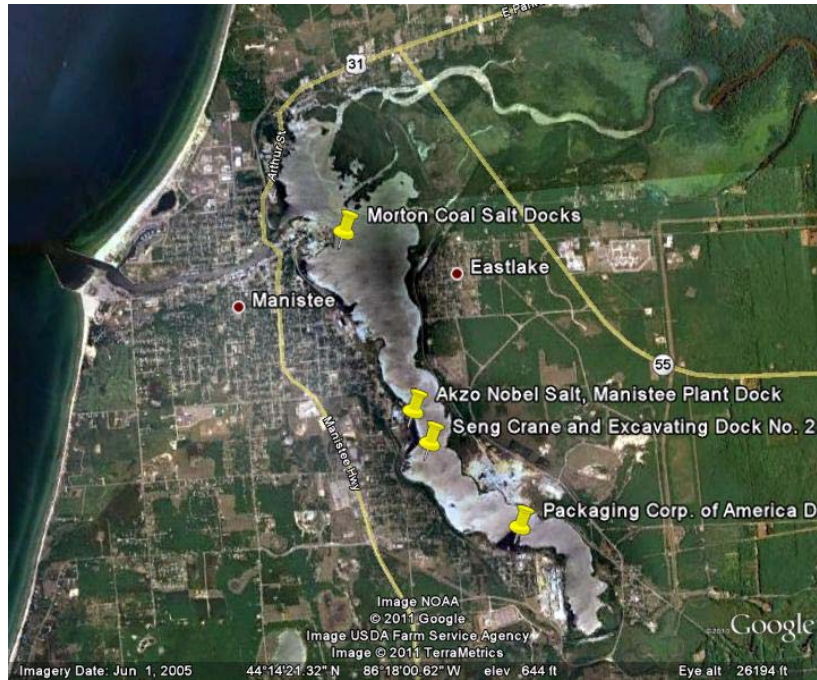


Figure E-4- Manistee, MI, Google Earth

Potential Biomass Docks in Manistee Harbor:

Manistee has several deep-draft facilities that are all privately owned and maintained. All the docks have highway connections; some were reported to have rail connections but the condition of the rail service is unknown. Depths alongside are reported depths and not verified. The availability of the docks for biomass use has not been confirmed.

Seng Crane and Excavating Dock No. 1 on the south side of the head of Manistee River has a 900-foot face with 20 to 25 feet depth alongside. There is a deck height of 5 feet with open storage for 300,000 tons of material; receipt of sand, salt, and coal; owned and operated by Seng Crane and Excavating, Inc.

Morton Salt Co. Coal Dock: (44°14'36"N., 86°18'29"W.); 400-foot face; deck height, 4 feet; open storage for 45,000 tons of coal; receipt of coal; owned and operated by Morton Salt Division of Morton International, Inc.

The Packaging Corp. of America Dock is located on the south side of the head of the Manistee River (44°13'10"N., 86°17'22"W.). The dock has a 767-foot face with 24 feet alongside. Coal is the principal product received and it is reported to be owned by Packaging Corp. of America and operated by TES Filer City Station Ltd.

Morton Specialty Chemical Products, Manistee Stone Dock: across slip S of Coal Dock; 600-foot face; covered storage for 10,000 tons of limestone; receipt of limestone; owned and operated by Morton Specialty Chemical Products, Division Morton International Inc.

Akzo Nobel Salt, Manistee Plant Dock: (44°13'51"N., 86°18'06"W.); about 400 feet of berthing space; 19 to 21 feet alongside; deck height, 6 feet; open storage for 200,000 tons of coal; receipt of coal; owned and operated by Akzo Nobel Salt, Inc.

E.1.5 Cheboygan

Cheboygan harbor is located at the mouth of the Cheboygan River, emptying into western Lake Huron approximately 16 miles southeast of the Straits of Mackinac. (Figure E-5) According to the USACE the channel has a project depth of 21 feet to the turning basin and 18.5 feet above the basin. Durocher Marine, a tug barge operator, is located in Cheboygan. This is the home port of the U.S. Coast Guard's only U.S. heavy ice breaking resource, the cutter Mackinaw.

Potential Biomass Docks in Cheboygan:

There may be docking space and log storage space on the west side of the channel across from the turning basin. The US Coast Pilot lists three docks. One dock is a tanker berth and the other two may have the potential to handle biomass.

G.E.F.S. Marine Terminal: W side of the river immediately above Northwood Oil Co. Dock; two 300-foot sections; 21 feet alongside; deck height, 3 feet; open storage for 40,000 tons of coal; receipt of coal; owned and operated by G.E.F.S. Marine Terminal.

Aggregates Dock: E side of the river above Amoco Oil Co. Wharf; deep-draft vessels lay in dredged channel and discharge by boom; 160,000 square feet open storage; receipt of aggregates; operated by various concerns.

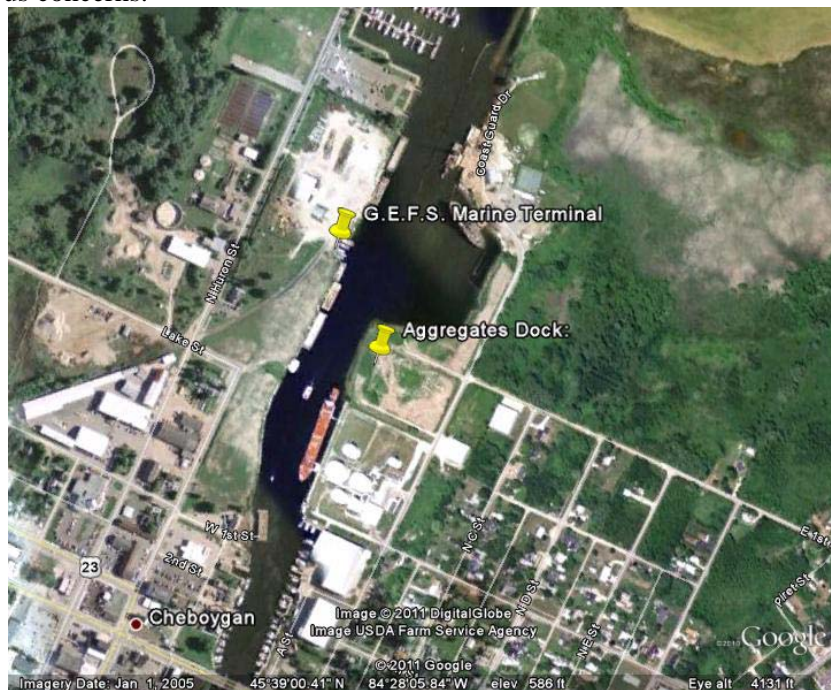


Figure E-5- Cheboygan, MI, Google Earth

E.2 Biomass Origin Ports

E.2.1 Menominee, MI

The twin ports of Marinette, WI, on the S side, and Menominee, MI, on the N side, form a deep-draft harbor at the mouth of Menominee River. The harbor is on the west side of Green Bay, about 33 miles SW of Porte des Morts Passage and 17 miles NW of the Sturgeon Bay Ship Canal. (Figure E-6) A dredged entrance channel leads SW from deep water in Green Bay between parallel piers at the mouth of

Menominee River and thence upstream for about 1.7 miles to about 600 feet below the Dunlap Avenue Bridge. In July 2009, the controlling depths were 19 feet in the entrance, between the piers, and in the river channel to just above the turning basin. Shoaling has been reported upriver from the turning basin.

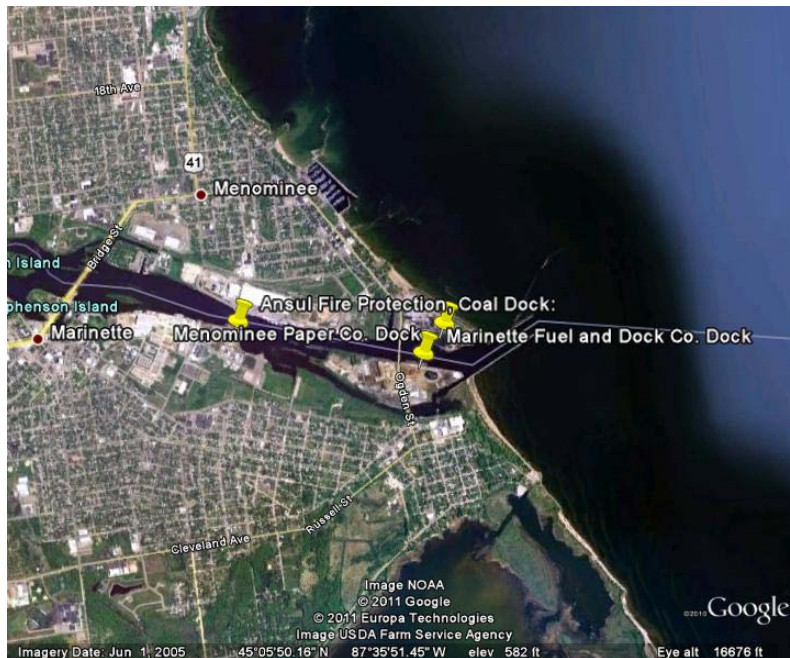


Figure E-6- Menominee, MI Google Earth

Potential Biomass Docks in Menominee:

There are three deep-draft facilities at Menominee and Marinette that are privately owned and maintained. All the docks described have highway connections and some have railway connections. Depths alongside are reported depths and not verified. The availability of the docks for biomass use has not been confirmed.

Menominee Paper Co. Dock is located on the north side of the river mouth. It has 550 feet of berthing space with a depth of 18 feet alongside. The dock has a deck height of 6 feet with open storage for 60,000 tons of coal; receipt of coal for plant consumption; owned and operated by Menominee Paper Co.

Marinette Fuel and Dock Co. Dock: (45°05'42"N., 87°35'42"W.), located on the south side of river mouth; 1,400-foot face, N side, and 700-foot face, S side; 22 feet and 16 feet depth alongside, respectively; deck height, 2 feet; two 50-ton crawler cranes; open storage for 150,000 tons of coal; receipt of dry bulkhead commodities, including coal, pig iron, salt, limestone and lime; owned and operated by Marinette Fuel & Dock Co. No rail connection

Ansul Fire Protection, Coal Dock: (45°05'42"N. 87°36'42"W.), S side of the river 1.5 miles above the pierheads; 600-foot face; 19 feet alongside; deck height, 8 feet; open storage for 8,000 tons of coal; receipt of coal by self unloading vessel; owned and operated by Ansul Fire Protection.

K&K Warehousing Menominee Wharf is located in Menominee on the left bank of the Menominee River approximately 0.5 mile above Ogden Street Bridge. Latitude (decimal): 45.096389 Longitude (decimal): -87.60917. The facility has a railway connection of one platform level track inside the warehouse. The depth alongside the 600 foot wharf was 25 feet. This facility has a steel frame metal-covered warehouse at rear with 300,000 square feet of storage area for wood pulp and other commodities.

Specification Stone Products, Inc., Manitowoc Dock Manitowoc, left bank, Manitowoc River, above 10th Street Bridge is used for the shipment of stone and rip rap, and logs. There is a railway connection where the tracks in the rear of the dock connect with CN railroad. The reported depth alongside is 20 feet with 300 feet of berthing space. Note: in the early 1990s logs were shipped from this dock which at the time had approximately 2 acres of open storage area is located at rear.

E.2.2 Escanaba, MI

Little Bay de Noc is the west arm of the north end of Green Bay and forms the entrance waters to the ports of Escanaba and Gladstone Michigan. Escanaba, MI, is on the West side of Little Bay de Noc, 6 miles NE of Ford River and 7 miles NW of Peninsula Point. (Figure E-7) The harbor has depths of 28 to 40 feet within 0.4 mile of shore. Escanaba has several deep-draft facilities on the W side of the harbor N of Sand Point.

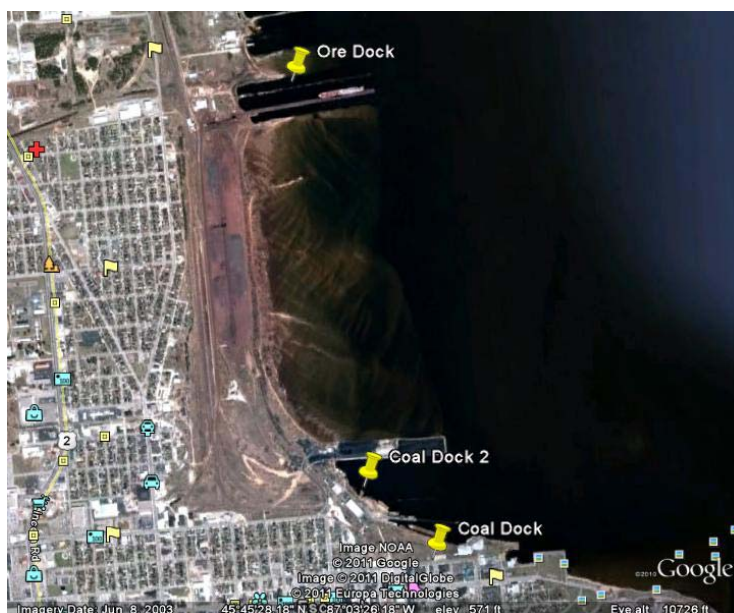


Figure E-7- Escanaba, MI, Google Earth

Potential Biomass Docks in Escanaba:

All the docks described have highway connections and some have railway connections. Depths alongside are reported depths and not verified. The availability of the docks for biomass use has not been confirmed.

The C. Reiss Coal Co., Dock No. 2: 1 mile WNW of Escanaba Light; 1,900-foot face; 21 to 24 feet alongside; deck height, 7 feet; open storage for 120,000 tons of coal and 360,000 tons of limestone; receipt of coal and limestone; owned and operated by The C. Reiss Coal Co.

The C. Reiss Coal Co., Escanaba Dock No.1: 2.1 miles NW of Escanaba Light, 1,050-foot face; 21 to 27 feet alongside; deck height, 5 feet; open storage for 125,000 tons of coal; receipt of coal; owned by The C. Reiss Coal Co. and operated Upper Peninsula Power Co.

E.2.3 Gladstone, MI

The port of Gladstone is on the west side of Little Bay de Noc, 7 miles N of Escanaba. A dredged channel leads from the deep water in Little Bay de Noc to a basin off the waterfront at Kipling, 1.5 miles N of Saunders Point. (Figure E-8) In 1990, the controlling depth was 22 feet in the channel and basin except for 20 feet along the E edge of the basin.

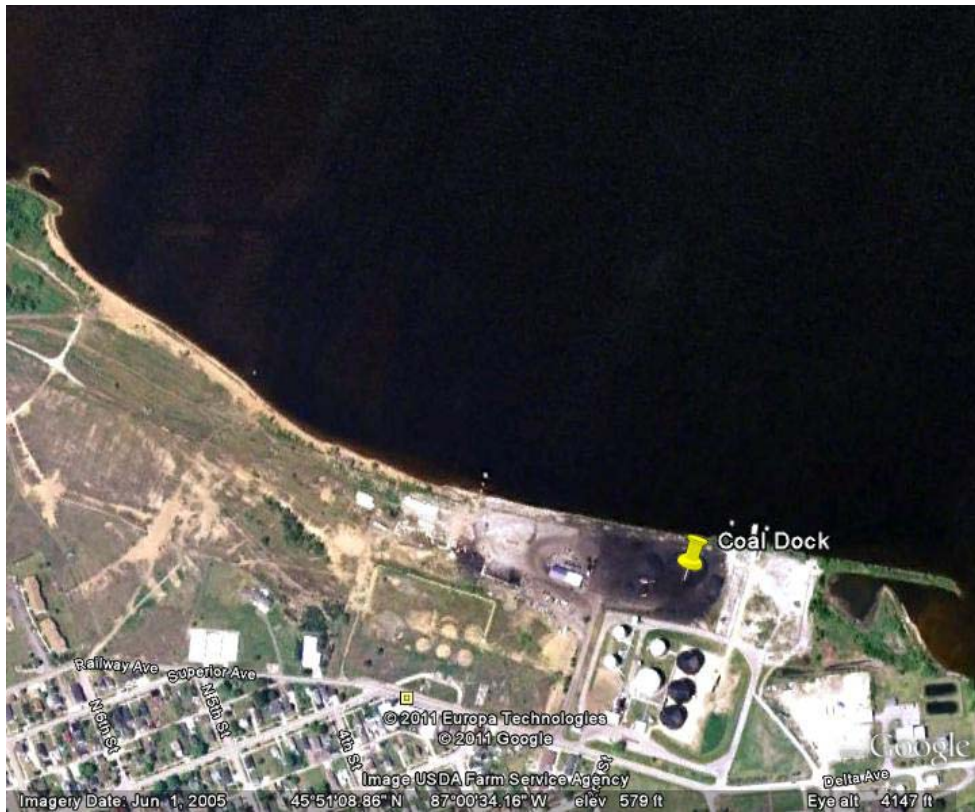


Figure E-8- Gladstone MI, Google Earth March 2011

Potential Biomass Docks in Gladstone:

Gladstone has two deep-draft facilities on the N side of Saunders Point. All the docks described have highway connections. Depths alongside are reported depths and not verified. The availability of the docks for biomass use has not been confirmed.

Payne and Dolan, Inc., Escanaba Dock: 0.3 mile NW of Saunders Point Light; 250 feet of berthing space with dolphins; 23 feet alongside; deck height, 5 feet; tank storage for 161,000 barrels; receipt of asphalt; owned and operated by Payne and Dolan, Inc. This is tanker dock and unlikely to be available for biomass movement.

Upper Lakes Coal Co., Dock: immediately W of Payne and Dolan, Inc. Dock; 910-foot face; 21 feet alongside; deck height, 10 feet; open storage for 328,000 tons of bulk material; receipt of limestone, coal, salt, and miscellaneous bulk materials; owned and operated by Upper Lakes Coal Co., Inc. This facility has no rail connection.

E.3 Discussion with Mr. Dan Glawe:

Cedarville, MI, is on the Upper Peninsula of Michigan on the Lake Huron shoreline in the Les Cheneaux Islands Channels, MI. According to the US Coast Pilot the approach to the harbor is through shallow, privately maintained channels. The port of Cedarville has a marina with a 50-ton lift that can handle 60-foot boats for hull and engine repairs. There are no commercial docks listed in the Coast Pilot or in the USACE port listing. The USACE lists this port as a shallow draft recreational harbor with over 7.5 miles of maintained federal channel at project depth of 7 feet. With no commercial dock facilities and a shallow harbor Cedarville is unsuitable for an origin port.

Port Dolomite, MI, is on the Upper Peninsula of Michigan on the NE side of the entrance to McKay Bay about 4 miles E of Cedarville. This is a private dock owned by the Michigan Limestone Operation's Cedarville Plant. There is a privately dredged approach channel, marked by a private 309° lighted range, leading to the SW side of the dock where vessels berth. In July 2004, the controlling depth alongside the main dock was 23 feet. This dock has a loading system that moves up and down the dock and is connected to a conveyor system. This dock is unsuitable for the stowage of logs. Northwest of the main dock there is a smaller dock that has no facilities, but does have storage space and road access. This second dock may have potential to support the marine transportation of biomass if: there is sufficient draft alongside, the dock is in good repair, it is long enough for a barge to secure alongside and most important a business deal could be worked out with the owners. This dock area is too close to the destinations for the FBBSC study region to be cost effective even if it could be used. However if biomass were being shipped in from ports at the south end of the lower peninsula of Michigan it could have potential to feed Kinross.

Detour, MI is located on west side of the Upper Peninsula of Michigan in the approaches to St. Mary's River. The USACE lists it as a shallow draft recreational harbor with project depth ranges between 8 and 10 feet. With no commercial dock facilities and a shallow harbor Detour is unsuitable for an origin port.

Manistique Harbor, MI at the mouth of Manistique River is located on the north shore of Lake Michigan 73 miles west of the Straits of Mackinac. According to the USACE the harbor has a channel with a maintained depth of 12.5 feet. The harbor is used by a tug-barge operator serving Beaver Island. Based on examinations of satellite photos there appears to be no storage space at the dock used by the tug barge for Beaver Island.

Port Inland, MI is a private harbor of the Inland Lime & Stone Co., built on the lake in front of the company's plant about 10 miles NE of Manistique. According to the US Coast Pilot, the privately dredged entrance channel has a depth of 25 feet up to and alongside the 900 foot dock. On that dock a shiploader that moves up and down the dock would make the storage of logs difficult if not impossible. There is a smaller dock area at the north end of the harbor. This second dock on the north end may have potential to support the marine transportation of biomass if: there is sufficient draft alongside, the dock is in good repair, it is long enough for a barge to secure alongside and most important a business deal could be worked out with the owners.

F- List of Truck Variations

Table F-1-Complete list of truck variations

Type of biomass	Transportation equipment type	Number of axle configuration (truck + trailer)	Weight (lbs)	Self loading	Self unloading	Notes
chips	Walking Floor Chip van	3+8	164,000	no	yes	example
chips	chip van	3+2	80,000	no	no	tandem axle grouping
chips	Walking Floor Chip van	3+2	80,000	no	yes	tandem axle grouping
chips	chip van	3+3	86,400	no	no	(3 axle grouping)
chips	Walking Floor Chip van	3+3	86,400	no	yes	(3 axle grouping)
chips	chip van	3+4	104,400	no	no	triaxle grouping with a 9ft spread axle set forward
chips	Walking Floor Chip van	3+4	104,400	no	yes	triaxle grouping with a 9ft spread axle set forward
chips	chip van	3+5	117,400	no	no	four axle grouping with 9ft spread set ahead
chips	Walking Floor Chip van	3+5	117,400	no	yes	four axle grouping with 9ft spread set ahead
chips	chip van	3+6	130,400	no	no	five axles grouping with a 9ft spead set ahead
chips	Walking Floor Chip van	3+6	130,400	no	yes	five axles grouping with a 9ft spead set ahead
chips	chip van	3+7	148,400	no	no	five axles grouping with two 9ft spread axles set ahead
chips	Walking Floor Chip van	3+7	148,400	no	yes	five axles grouping with two 9ft spread axles set ahead
chips	chip van	3+8	156,400	no	no	seven axle grouping with a 9ft spread axle set ahead
chips	Walking Floor Chip van	3+8	156,400	no	yes	seven axle grouping with a 9ft spread axle set ahead
chips	Chip Truck	2	42,000	no	yes	single rear axle
chips	Chip Truck	3	50,000	no	yes	tandem axle grouping
chips	Chip Truck	4	68,000	no	yes	three axle grouping
chips	Chip Truck	5	70,000	no	yes	four axle grouping
pulp/logs/biomass bundles	log truck	3+2	86,000	yes	yes	tandem axle
pulp/logs/biomass bundles	log truck	4+2	104,000	yes	yes	tandem axle with spread on truck
pulp/logs/biomass bundles	log truck	4+3	122,000	yes	yes	tandem with spread on turck, three spread axle on pup
pulp/logs/biomass bundles	log truck	5+3	106,000	yes	yes	four axle grouping
pulp/logs/biomass bundles	log truck	5+3	129,000	yes	yes	three axle grouping with spread axle on truck, three spread axle pup
pulp/logs/biomass bundles	log truck	5+4	143,000	yes	yes	three axle grouping with spread axle on truck, tandem dolly with two spread axle on pup
pulp/logs/biomass bundles	log truck	5+5	146,000	yes	yes	three axle grouping with spread axle on truck, tandem dolly with two spread axles on pup

Type of biomass	Transportation equipment type	Number of axle configuration (truck + trailer)	Weight (lbs)	Self loading	Self unloading	Notes
pulp/logs/biomass bundles	log truck	6+3	137,000	yes	yes	five axle grouping on truck and three spread axle on pup
pulp/logs/biomass bundles	log truck	6+4	151,000	yes	yes	five axle grouping on truck and tandem axle dolly with two spread axles
pulp/logs/biomass bundles	log truck	6+4	156,000	yes	yes	four axle grouping with spread axle on truck and tandem axle dolly with two spread axles
pulp/logs/biomass bundles	log truck	6+5	154,000	yes	yes	four axle grouping with spread axle on truck and tandem axle dolly with triaxle grouping on pup
pulp/logs/biomass bundles	log truck	6+5	159,000	yes	yes	four axle grouping with spread axle on truck and tandem axle dolly and triaxle grouping on pup
pulp/logs/biomass bundles	log truck	7+4	164,000	yes	yes	six axle grouping on truck with tandem axle dolly with two spread axles on pup
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+2	80,000	All trailers can have the possibility of having a loader		tandem axle grouping
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+2	83,400			9ft spread axle
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+2	83,400			crib trailer, spread axle
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+3	86,400			(3 axle grouping)
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+3	91,400			tandem axle with 9ft spread axle
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+3	101,400			three axles, 9ft spread between each
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+4	104,400			triaxle grouping with a 9ft spread axle set forward
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+4	119,400			four axles, 9ft spread between each
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+5	117,400			four axle grouping with 9ft spread set ahead
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+6	130,400			five axles grouping with a 9ft spread set ahead
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+7	143,400			6 axle grouping with 9ft spread axle set ahead
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+7	148,400			five axles grouping with two 9ft spread axles set ahead

Type of biomass	Transportation equipment type	Number of axle configuration (truck + trailer)	Weight (lbs)	Self loading	Self unloading	Notes
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+8	151,400			eight axles grouping
pulp/logs/biomass bundles	tractor trailer (log hauler)	3+8	156,400			seven axle grouping with a 9ft spread axle set ahead
pulp/logs/biomass bundles	B-Train Log hauler	3+3+2		no	no	three axle grouping on first trailer and two axle grouping on second
pulp/logs/biomass bundles	B-Train Log hauler	3+3+3	145,400	no	no	four axle grouping with a 9ft spread axle on first trailer and two axle grouping on second trailer
pulp/logs/biomass bundles	B-Train Log hauler	3+5+2	143,400	no	no	four axle grouping with 9ft spread axle on first and two axle grouping with a 9ft spread axle
pulp/logs/biomass bundles	B-Train Log hauler	3+5+3	161,400	no	no	three 9ft spread axles on first trailer with a tandem axle grouping and 9ft spread axle on second

G- List of Truck Dealers

G.1. Truck Dealers Contact in Michigan and Northern Wisconsin

Table G-1- List of equipment dealers and manufacture to contact

Company	Interviewed
Central Wisconsin Body and Hoist Inc.	No
Great Lakes Trailers	Yes
Lakeshore Equipment Sales	No
Peterbilt Wisconsin	Yes
Prairie Trailer	No
Scaffidi Truck Center	No
Schultz Equipment and Parts Co	Yes
Three Lakes Truck and Equipment	Yes
U.P. Truck Center Inc.	No
V&H	No
Wisconsin Kenworth	Yes
Reefer Peterbilt	Yes
Brecheisen Diesel Service	Yes
Dearborn Kenworth	Yes
Grand Rapids Kenworth	Yes
Wolverine Freightliner	Yes
Great Lakes Western Star	Yes
JX Peterbilt	Yes

G.2- Interview with truck dealers and manufacturers:

G.2.1- Equipment Interview Summary

Through an analysis of the collected data, the team was able to determine equipment types, years and trends within the study area. It was determined that 75% of dealers deal in both new and used equipment sales. Most dealers tried to keep inventory stock of equipment from early 2000's to new. Older trucks that are traded in are either sold to smaller used equipment dealers (which commonly deal in older equipment) or parted out. Most dealers try to keep their stock within 10 years of age. Only about 25% of dealers within Michigan and Northern Wisconsin deal large 10 to 11 axle Michigan log trucks, but almost all dealers carried Michigan Special Tractors (tractors with high horsepower – 550 to 600 hp) with 18 speed transmissions, 20,000 lb front axles and either 46 to 52 thousand lb rear axles. These trucks are very versatile and are used mainly for the forestry and construction industries. Less than half of the dealers interviewed deal with or sell forestry equipped trailers.

G.2.2- Equipment Service

As equipment prices on new models increase, more owners are choosing to refurbish older trucks lengthening their life spans. About 90% of the dealers interviewed mentioned that they own a truck service shop but only 60% use facilities for commercial maintenance and service centers. Truck serviceability depends to the region of the state they are located in. Northern Wisconsin and Southern Lower Peninsula locations only service very few if any. Upper Peninsula locations see several hundred biomass trucks a year where as the Lower Peninsula sees mainly Class 8 (80,000 GVW) over the road commercial trucks.

G.2.3- Sales and Inquires

As a tool to predict the future expansion of the industry if needed, dealers were surveyed on equipment sales (past, present and future), biomass inquires and changes that they have seen within the industry and what they see to come. All dealers mentioned that sales for 2010 were down drastically (compared to 2004-2007 years) but rose from 2009 numbers. For most dealers, 2004-2007 were great years for them. A lot of companies were upgrading and buying trucks before 2008 when the new emission regulation engines came into production. For dealers, 2011 is looking to be a better year (but not to the standards of pre 2008 sales) but many are remaining optimistic.

When talking to dealers on biomass equipment inquires, most said that they receive very few to none. They mentioned that a large reason for this is due to the industry being unstable, rising transportation/maintenance costs and dwindling markets make it hard for transportation companies, manufactures and dealers to invest the time and money needed to develop products. A few dealers are getting more inquires for smaller versatile trucks and trailers allowing them to be open to more markets.

One of the major changes that dealers mentioned was the emission regulations and new engine requirements. Dealers said there 2007 year was so good for truck sales, was due to owners and companies wanting to upgrade their fleet before the new regulations went into effect. Most companies didn't want to deal with the new engines due to the fear of problems and added expense on both base prices and maintenance costs. For them, emissions are playing a major role in how people are buying and refurbishing equipment.

G.2.4- Cost

Since the 2008 emission regulations, rise in equipment costs are causing owner operators to skip maintenance as a way to cut costs. Since 2009 the base price on a chassis has raised \$30,000 due to new government regulations on emissions and safety standards. One dealer mentioned that he priced a truck for a municipality last year for \$146,000 and he just priced the same truck at \$177,501. The prices of trucks are going up drastically due to new standards and regulations coming out and product prices are dropping at mills. This makes it very hard for owners to not only justify a huge investment but also to get financing and to keep up with additional system and maintenance costs.

H- List of Rail Car Dealers and Equipment Manufacturers

Table H-1- List of contacted rail car dealers and manufacturers

Company Name	Website	Contact	email
ACF Industries	http://www.acfindustries.com	Dennis Nibert	Dnibert@ACFindustries.com
American Railcar Industries, Inc.	http://www.americanrailcar.com	Al Lullman	alullman@americanrailcar.com
A-Z Railcar	http://www.azrailcar.com	NA	info@azrailcar.com
C.K. Industries, Inc.	http://www.ckindustries.net	Richard E. Meyers	rmeyers@ckrail.net
Chicago Freight Car Leasing Co.	http://www.crdx.com	Bill Elwess	Bill.Elwess@crdx.com
David J. Joseph Company	http://www.djj.com/VideoDefault.aspx	NA	info@djj.com
Everest Railcar Services	http://www.everestrailcar.com	NA	admin@everestrailcar.com
GATX	http://www.gatx.com/wps/wcm/connect/gatx/gatx_site/home	Thomas Clark	thomas.clark@gatx.com
GLNX	http://www.glnx.com	Cyndy Rabbitt	cyndyr@glnx.com
JFS Railcar, Inc.	http://www.jfsrailcar.com	NA	sales@JFSRailcar.com
Kasgro Rail	http://www.kasgro.com	Jeff Ketterman	jeff.kasgro@wildblue.net
Pioneer Railcorp	http://www.pioneer-railcorp.com	Joseph Evans	evans@pioneer-railcorp.com
Procor	http://www.procor.com	NA	enquiry@procor.com
Railcar Deals	http://railcardeals.com	NA	information@railcardeals.com
RGCX	http://www.rgcx.com/index2.htm	Robert Hebbeler	robert.hebbeler@rgcx.com
Rocky Mountain Transportation Services, Inc.	http://www.railcar.com/RMTS/Index.html	NA	tc@railcar.com
SEA-Inc	http://www.slvx.com	NA	SEA-Inc@slvx.com
Southern Illinois Railcar Company	http://sircrail.com	Jon Sparks	jsparks@sircrail.com
Southern Rail Leasing	http://www.srlx.com	John Chambers	chambers@srlx.com
Southwest Rail Industries	http://www.southwestrail.com	Jason Huette	jhuette@southwestrail.com
Texas Railcar Leasing	http://www.trlx.net	NA	sales@TRLX.net