Research Report

To

U.S. Army Corps of Engineers, Detroit District
and
U.S. Department of Homeland Security, Grand Rapids, MI

The Economic Value of Iron Ore Transiting the Soo Locks

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Talking Points

- Iron ore has become the world's **second** most valuable mineral resource, second only to oil.
- In the U.S., almost all (**99%**) of the usable iron ore comes from mines in Michigan and Minnesota.
- **79%** of the iron ore mined in the United States is shipped through the Soo Locks.
- Iron ore is the largest cargo shipped through the Soo Locks, accounting for **62%** of the total shipments.
- The direct value of the iron ore shipped through the Soo Locks in 2012 was **$5.4 billion**.
- The direct value of the steel made in the U.S. from iron ore shipped through the Soo Locks in 2012 was **$15.7 billion**.
- The direct value of steel intensive consumer products (e.g., automobiles) made from this steel was **$287.5 billion**.
- The indirect and induced value attributed to the iron ore, steel, and consumer products listed above equals another **$212.9 billion**.
- Thus the total dollar value attributed to the iron ore shipped through the Soo Locks in 2012 was **$500.4 billion, or 3.2% of U.S. GDP**.
- Over **650 thousand jobs** (direct, indirect & induced) depend on the iron ore shipments.

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Introduction

Steel is a strategic material. The prime ingredient in steel is iron ore. Most domestic iron ore (99%) comes from two States, Michigan and Minnesota. The vast domestic ores feed the vast domestic steel mills clustered around the southern shores of the Great Lakes. Therefore, most of the iron ore used to make steel in this country is shipped from ports on Lake Superior through the Soo Locks to steel mills on the southern shores of the lower Great Lakes.

This research evaluates the economic value of iron ore being shipped through the Soo Locks, the steel made from that ore and key steel-intensive consumer products made from the steel made from the iron ore. All of these are dependent on the Soo Locks operating properly.

U.S. National Security

The Soo Locks are a vital access way for bulk shipping traffic moving between Lake Superior in the north and the lower Great Lakes. Bulk commodities moving through the Soo Locks are critical to feeding the industrial infrastructure of the U.S. Mid-west, which is often referred to as the "Heartland of the U.S.A." There is also a small amount (about 7.4 million net tons) of iron ore coming through the Soo Locks that is destined for Canadian steel mills on Lake Erie or for export outside of the Great Lakes region. This research has attempted to put a dollar value on the benefits derived by the free flow of iron ore through the Soo Locks and its economic impact on the steel industry and steel-intensive consumer products made from it.

The American Iron and Steel Institute claims that: "steel is a strategic material."[1] American made steel is vital to the United States' national security. American made steel is almost exclusively made from American mined iron ore. The iron ore that is mined in the U.S. comes almost exclusively (99%) from just two states, Michigan and Minnesota.[2] And almost all of the iron ore mined in northern Michigan and northern Minnesota is shipped by water over the Great Lakes. The raw iron ore is allowed to pass from the "up north" mining areas around Lake Superior to the "Lower" Great Lakes where the steel mills are located. The Soo Locks at Sault St. Marie, Michigan, is the connecting link that allows passage around the 21 foot difference in lake levels between Lake Superior and the Lower Lakes. This difference in lake levels creates a rapids that the big ore boats cannot navigate.

The Soo Locks have been a strategic focal point for many years. They are a bottle neck that can, if constrained, interrupt much of the U.S. steel production and halt the manufacture of many steel-intensive consumer products.

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[1] American Iron and Steel Institute, "*Profile 2013*" (; p. 1 and p. 12.

[2] Jorgenson, J. D. "Iron Ore," U.S. Geological Survey, Mineral Commodity Summaries," (2012).

The vulnerability and, in response, the security of the Locks were highlighted during World War II. Prior to the U.S. involvement in the War, J. Edgar Hoover, Director of the Federal Bureau of Investigation, recognized that shipping iron ore on the Great Lakes was the "jugular vein" of the United States' war production effort. In 1941, Hoover wrote to the chairman of the Lake Carriers Association, A.T. Wood, stressing his concern and support regarding this issue, saying the:

> "…extreme importance of maintaining an uninterrupted flow of iron ore from the mines in the Lake Superior Region to blast furnaces in various industrial centers during the present national emergency is readily apparent….ship operators may be assured of this Bureau's cooperation in assisting them to minimize the possibility of sabotage or espionage affecting their facilities."[3]

Prior to Hoover's statement, British troops had been posted on the Canadian side of the Soo Locks on August 26, 1939. One week later, just after Hitler attacked Poland, the United States sent a detachment of 20 soldiers with machine guns to protect the Soo Locks.[4] They erected barricades of snow fences with barbed wire on top. By October, anti-aircraft guns, machine guns, sky-piercing searchlights, squads of infantry men, and a small fleet of craft were added to protect the Soo Locks. By February 15, 1941, a force of 546 Military Police was detached to guard the Locks. After the attack on Pearl Harbor on December 7, 1941, the fear of sabotage at the Soo escalated and a military force in excess of seven-thousand troops was dispatched to

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[3] J. Edgar Hoover's eight page letter to A.T. Wood, President of the Lake Carriers Association, LCA Collection (1941) as reported by George J. Joachim in his book, *Iron Fleet, The Great Lakes in World War II* (Wayne State University Press, Detroit, MI., 1994); p. 52.

[4] *Ibid*, p. 60.

protect the Locks. Fear of German paratroopers, long-range bombers, torpedo-planes and dive bombers grew. Strategic thinking included enemy ships going into remote Hudson Bay carrying torpedo-planes. From there, the planes could be launched and fly the much shorter distance to destroy the Locks. Also, long-range German seaplanes could dispatch paratroopers in wilderness areas near the Locks and they could mount an attack.[5] Throughout the War, however, ships laden with iron ore were able to transit the Soo Locks in record amounts.

After World War II, concern shifted to the potential depletion of iron ore in northern Michigan and northern Minnesota. In 1947, Republic Steel's president, C. M. White, exclaimed in a speech reported by *The New York Times* that "at the present consumption rate the Mesabi open pits … will be exhausted within five to ten years." He went on to say that after the "cream of the Mesabi" is skimmed off, the rich hematite ore in the United States will be a "rusty memory."[6]

By 1955, the same *New York Times* reporter had a different story to tell, exclaiming "Depletion Danger Met,"[7] and the *U.S. News and World Report* proclaiming "One More 'Scarcity' Ends for U.S. Industry."[8] It was the newly developed technology that allowed the low-grade ores to be successfully up-graded and transformed. Thus the pelletized Taconite era began and iron ore mining was re-invigorated in northern Michigan and northern Minnesota. Advanced processing of

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[5] *Ibid*, p. 64.

[6] T.E. Mullaney, *New York Times* (March 30, 1947); sect. 3, p. 1.

[7] T.E. Mullaney, *New York Times* (June 19, 1955); sect. 3, p. 1.

[8] *U.S. News and World Report* (June 17, 1955); pp. 90-94.

low-grade Taconite ores produced a highly superior iron ore pellet that revolutionized the American iron mining industry.[9] Iron ore mine production boomed, shipping continued, a bigger lock was built and a new class of larger ships, the 1,000-footers, was created.[10]

Efficiency of Shipping Bulk Commodities

Over 90% of the world's goods are shipped by water.[11] It is easier and more efficient to float heavy cargos than haul them over land by rail or truck. Simply put, floating heavy commodities is more efficient than wheeling or flying them. The most efficiently transportation of heavy commodities is in the very largest ships available. These large ships of today can carry far greater loads than any train, truck or plane.

For example, a 1,000-foot ship on the Great Lakes normally can carry about 70,000 net tons of iron ore, but in 2012 with the lower water level the largest cargo recorded was 66,662 net tons of iron ore.[12] If the 46,213,401 net tons of iron ore that was shipped through the Soo Locks in 2012 were transported exclusively in the 1,000-

[9] P.J. Kakela, "Iron Ore: Energy, Labor, and Capital Changes with Technology," *Science* (December 15, 1978); vol. 202, pp. 1151-1157.

[10] P.J. Kakela, "Iron Ore: From Depletion to Abundance," *Science* (April 10, 1981); vol. 212, pp. 132-136.

[11] United States Navy, "Naval History-Answering the Call to Serve for 237 Years and Counting," http://www.navy.com; p.2.

[12] U.S. Army Corps of Engineer, Detroit District, Soo Area Office "Traffic Statement, 2012 Navigation Season, St. Marys Falls Canal, Michigan" (2012- Comparative Statistical Statement For the season of 2011 and 2012); p.2.

footers, it would require approximately 700 ship loads or just about 55 trips for each of the thirteen (13) 1,000-footers. This is very close to what happened in 2012.

If the Soo Locks were shut down, however, and there was an attempt to transport the same volume of iron ore by other means, it would be very difficult, to nearly impossible, to accomplish for several reasons. First, if the 46,213,401 net tons of iron ore was attempted to be transported by railroad, it would require more than 4,600 train loads of 100 cars each, or 460,000 train cars, with 100 net tons of iron ore in each car. Also at most integrated steel mills in the U.S. there simply are not appropriate existing railroad links, in terms of gage, to receive the over-land train loads. If trucks are considered, it would require more than 2.0 million truck loads, each with a 23 net ton capacity. It is doubtful that there are sufficient trucks available to make this haul or acceptable road and traffic conditions, especially around Chicago, to allow this added vehicular traffic.

Therefore, ships are preferred because of their efficiency and because they can sail places where there are no roads or rail systems. As a result, the vast majority of the world's bulk and/or heavy commodities are transported by ships or barges. This is true for the transport of goods on the Great Lakes just as much as it is true for transport on the oceans of the world. On the Great Lakes, the most prominent commodities shipped through the Soo Locks at Sault Ste. Marie, Michigan, for the shipping season of 2012 were:[13]

[13] U.S. Army Corps of Engineer, Detroit District, Soo Area Office "Traffic Statement, 2012 Navigation Season, St. Marys Falls Canal, Michigan" (2012- Comparative Statistical Statement For the season of 2011 and 2012); p.5.

% of Total	Commodity
62%	Iron ore
18%	Coal
8%	Wheat
6%	Limestone
6%	All (30+) others

Of the four largest commodities, iron ore is clearly the largest volume and, as it turns out, the most valuable. This has long been the case because of the large volume of iron ore being shipped on the Great Lakes. Recently, however, the traditional high volumes of iron ore have been coupled with extremely high prices for this commodity. The doubling and then redoubling of iron ore prices in the last ten (10) years has caused the value of iron ore transported on the Great Lakes to stand out well above all other commodities shipped on the Lakes. Following decades of low and stagnant prices, the price of iron ore began a remarkable climb after the 2001-2 recession. Iron ore prices on the world market quadrupled from 2002 to 2012 and they remain high in the early stages of 2013.

Iron Ore is the Largest Commodity through the Locks

The Soo Locks, at Sault Ste. Marie, Michigan, are a critical link in the Great Lakes system. The Soo Locks allow major bulk commodities to be shipped from ports on Lake Superior to the lower Great Lakes and vice versa. The Soo Locks allow ships sailing down the Lakes to avoid the rapids and still drop down the approximately 21 feet difference in lake levels between Lake Superior and the Lower Lakes.

On the world market, prices for iron ore have increased more than four fold since 2002. Iron ore prices in North America have also increased greatly to triple what they were a decade ago.

In addition to higher prices, the volume of iron ore demanded in the world market has continued to escalate as the developing countries build their infrastructure. This is especially true of development in China, but also the basic development in Brazil and India, and the re-development in Russia. These four countries have been dubbed the BRICs. They are leading the feverish consumption of iron ore to make steel that is used to build bridges and buildings, to forge tools and supply steel reinforcing rods to be buried in road construction. These developing countries are growing in population, but even faster in material ways and basic infrastructure construction.

The supply of iron ore on the world market is still meeting the growing demand, but it appears to be tightening. China's growth is remarkable, with imports rising 11% in 2011 to 686.8 million metric tons and another 7.5% in 2012 to a record of approximately 740 million metric tons.[14] In addition to rising demand, prices have been influenced by the threat of constrained supply. Simply put, the expansion of iron ore mining is not keeping pace with the world's raising demand. The impact of the growing global demand on domestic mines in northern Minnesota and Michigan is modest, but still positive. The growing demand has raised prices and drawn foreign sources of iron ore to off-shore ports, especially in Asia.

[14] J. D. Jorgenson, "Iron Ore," U.S. Geological Survey, Mineral Commodity Summaries," (2012); and World Steel Dynamics, "Inside Track #125" (December 7, 2012); p.24.

The increase in volume demanded and the escalations of prices has boosted the value of iron ore in the world market. Recently, it was announced that iron ore had become the second largest mineral commodity traded on the world market in dollar value, second only to oil (as reported by Mecklai Financial).[15]

Iron ore is more valuable than diamonds or gold with their high prices, but small volume. Iron ore is also more valuable than coal or limestone with their high volumes, but lower prices.

In North America, the ore being mined, processed, and shipped in 2012 was at full or near full capacity. This means shipping traffic with the large bulk carriers, and especially the 1,000-footers was also at full or near full capacity. Therefore, demand for iron ore shipped through the Soo Locks is very great right now.

These shipments through the Soo Locks, however, are simply the bulk raw materials. They are the critical first stage of materials for the production of more refined products (e.g., steel). These refined materials are then used in the manufacturing of end-use consumer products (e.g., automobiles and refrigerators). As one moves up the manufacturing scale from raw materials to end-use consumer goods, the economic value increases greatly.

Calculating the Economic Value of the Soo Locks

This research evaluates the economic value that can be attributed to the free functioning of the Soo Locks. It starts with the value of the raw materials that passed

[15] Mecklai Financial, "Structural changes in iron ore market: Mecklai Financial" on *Moneycontrol.com*, May 25, 2011.

through the Soo Locks. This research is confined to just the major raw material passing through the Locks, which is iron ore. Also, the focus is on the past year, 2012. Once the value of this raw material is evaluated, the next step is to add the value of the refined materials, and in this case it is steel made in the Mid-west. Finally the value of the finished products that were made from the steel that, in turn, was made from the iron ore that was shipped through the Soo Locks was calculated. A portion of the finished products, such as automobiles and appliances, is therefore directly dependent on shipments traveling through the Soo Locks.

To calculate the economic impact of the iron ore shipped through the Soo Locks requires knowledge of the volume of iron ore shipped and price of the ore. Therefore, tonnage shipped times (x) price equals (=) **value** of the iron ore. Based on the shipment of iron ore, one can calculate the amount of steel that can be made from this ore. Its value also is a calculation of tonnage times (x) price to equal (=) **value** of the steel made.

For finished products, one simply adds the price of the finished products sold that are dependent on the steel made from the ore shipped. So price equals number of steel-dependent products times (x) retail price of the products (=) **value**. This then is the total dollar value attributed directly to the iron ore shipped through the Soo Locks.

In 2012, the total mine production of iron ore in the United States was 53.0 million metric tonnes.[16] This was down slightly from the 2011 mine production of 55.0 million metric tonnes. Almost all (about 99%) of the iron ore mined in the United States originates from just two iron ranges, with about three-quarters coming from the Mesabi Range in northern Minnesota and the other one-quarter from the

[16] U.S. Geological Survey, “Mineral Commodity Summaries” (January 2013), p. 85.

Marquette Range in Michigan's Upper Peninsula. Most of this iron ore, but not all of it, is shipped on the Great Lakes. Also most of the iron ore shipped on the Great Lakes, but not all of it, passes through the Soo Locks.

Value of 2012 Iron Ore Shipments

For the calendar year 2012, the amount of iron ore shipped through Michigan's Soo Locks was 46,213,401 net tons according to the U.S. Army Corps of Engineers records.[17] However, iron ore in the U.S. is not sold or priced on a net ton (2000 lb.) basis, but as long tons (2240 lb.). Therefore the Corps of Engineers' figure was converted to **41,261,965 long tons** of iron ore for 2012.

Cliffs Natural Resources Ltd. ("Cliffs") is a key source for the price of iron ore mined and, for the most part, sold in the United States. Cliffs is the primary merchant seller of iron ore mined in the United States. Cliffs has published their contract prices for their 2012 U.S. sales at $114.29 per long ton, FOB-mine.[18] This price does not include cost and revenue related to domestic freight. Therefore, the average delivered price of Cliffs ore would need to include $9.80/long ton shipping cost and a $6.75/long ton cost of rail freight.[19] This gives a total of $16.58 + $114.29 = **$130.87** per long ton of iron ore pellets delivered to Lower Lakes.

[17] U.S. Army Engineer District, Detroit, Sault Ste. Marie Area Office, "Soo Locks (SM01); Lock Commodities Report 23," (each month from January 1, 2012 to December 31, 2012); p.1 per month.

[18] Cliffs Natural Resources Inc. "Reports Fourth-Quarter and Full-Year 2012 Results." February 12, 2013. p. 2.

[19] Kakela, P. J., Marcus, P. F., and Kirsis, K.M. "North American Iron Ore: Consolidated Survival. Core Report J." **World Steel Dynamics**. February 2010. p.35. Adjusted for inflation.

Therefore, the value of iron ore passing through the Soo Locks in calendar year 2012 is calculated to be:

Iron ore

41,261,965 long tons (x) $130.87 **= US$ 5,399,953,360.**

Direct Value of Steel (2012)

Steel clearly is the major and almost sole (about 98%) consumer of iron ore. Also, going the other way, iron ore is by far the most predominant component in making the highest quality steel. The highest quality steel is the steel made at integrated steel mills, those with blast furnaces that can smelt the oxygen out of the iron ore and convert it to molten iron or pig iron. Therefore, the integrated steel mills are dependent on iron ore as their primary ingredient. Most of the integrated steel mills in North America are located around the Great Lakes.

Steel is also made from recycling iron and steel scrap. These so-called “mini-mills” now produce a little over half of the steel made in the U.S. today. In terms of location, the mini-mills are scattered much more widely around the U.S. than the integrated mills. The scrap based mini-mills are tied more closely to major urban areas around the country where obsolete steel is being generated and recycled.

The focus here, however, is on the integrated steel mills that are located primarily around the southern shores of the Great Lakes. The geography is that the iron ore is shipped down (“south”) from the upper lakes mines to feed the blast furnaces of the great steel mills located along the lower Great Lakes. Also, to fill in the picture, coal, the second largest ingredient in making steel, is brought “up” from mines in West Virginia, Kentucky, southern Indiana and Illinois and elsewhere along the Ohio River valley to meet the iron ore coming down to Chicago, East Chicago, Gary, Detroit, Cleveland and elsewhere in the U.S. and Canadian Mid-west.

To calculate the amount of primary steel that could be made from the quantity of iron ore that is shipped through the Soo Locks, one must convert the long tons (2240 lb.) of iron ore back into net tons (2000 lb.) of steel that could be produced. Also, the iron ore must be adjusted for the iron content of the ore. This means boosting the approximate average iron content of the ore up from 63.5% Fe to 100% Fe in the steel. Further, the amount of ore shipped through the Soo Locks must subsequently be adjusted (decreased) for the amount of iron ore that goes to Canadian steel mills or shipped abroad, as well as the small amount that does not go into steel making.

As previously cited, the Corps of Engineers reported shipments of 46,213,401 *net* tons of iron ore through the Soo Locks for calendar year 2012. A small portion of these shipments was exported out of the Mid-west. The Lake Carriers' Association reported that of the shipments of iron ore on the Great Lakes in 2012, there were: "3.7 million [net] tons transshipped to Quebec City for loading into oceangoing vessels." This leaves some **42,513,401** net tons of iron ore shipped to Mid-west steel mills. This includes about 3.74 million net tons shipped to Mid-west Canadian steel mills at Nanticoke and Port Colborne, Ontario. When this iron ore that goes to Canadian steel mills is subtracted from the ore shipped through the Soo Locks, it gives a figure of 38,770,475 net tons. After subtracting the 2% of this iron ore that is use for something other than steel making, the 98% that does go to steel making would equal 37,995,066 net tons.

In the steel making process, the average iron content of the U.S. iron ore pellets is approximately 63.5% Fe. Therefore, the iron ore must be smelted down to make 100% Fe molten iron or pig iron for the first step in converting the iron ore to steel. Thus, the 37,995,066 net tons of iron ore times (x) 63.5% gives the value of **24,126,867 net tons** of steel that could be produced in U.S steel mills from the iron ore shipped through the Soo Locks in 2012.

The average price of steel made in the U.S. varies greatly with quality and finishing characteristics. A generally low priced, but highly versatile steel product is in the form of hot-rolled band (or HRB) steel. The average price of HRB in the United States as published by World Steel Dynamics in the *SteelBenchmarker* for the year 2012 was $650.71 per net ton.[20] This price was used to calculate the total value of the steel produced from the iron ore shipped through the Soo Locks in 2012. Specifically, the value of steel comes to:

Steel

24,126,867 net tons of steel (x) $650.71 = **U.S. $ 15,699,593,367**.

Direct Value of Automobiles

The steel made from the iron ore shipped through the Soo Locks in 2012 would be used in the production of consumer products such as automobiles or refrigerators. To use cars as an example, the steel content of North American automobiles is

[20] Karlis M. Kirsis, "HRB Prices – Firming," World Steel Dynamics' *SteelBenchmarker* (February 13, 2013, and previous by-weekly additions); 2pp.

approximately 63% by weight.[21] Therefore, a simple estimate for the value of HRB steel in a consumer product was calculated based on a relatively inexpensive, small car with a 2013 list price of $15,995.[22] The average weight of North American automobiles is approximately 4,257 lbs.[23] with steel accounting for about 63% of the weight, so each car would require 2,685 lb. (or 1.3425 net tons) of steel. Based on these figures, the steel made from the iron ore shipped through the Soo Locks to U.S. steel mills in 2012 could make 17,971,595 small cars, selling for about U.S. $15,995.

Based on the data above, the value of **automobiles** that could be built with steel produced from iron ore that was shipped through the Soo Locks in 2012 is:

Automobiles:

17,971,595 cars (x) $15,995 = **U.S. $ 287,455,664,176.**

Other steel dependent consumer products that tend to be made in the Mid-west were reviewed to corroborate this calculation of end product value. For example, figures for refrigerators show that a 21.1 cubic foot white refrigerator cost about $805[24] and weighs approximately 200 to 250 lb.[25] The Appliance Recycling

[21] John Schnatterly, Mega Associates Ltd., "Watching our Weight; Steel Content of N. American Auto," *Great Designs in Steel Seminar*, www.autosteel.org

[22] Edmunds.com/finder/car-finder, "2013 Jeep Patriot SUV" at $15,995/ car; this is about one-half the average price transaction price for new light vehicles in the United States that reached $30,748 in March of 2012 (see http://www.carscoops.com, "Car Prices Hit Record Highs in the U.S., Average Transaction up 7% from Last Year" (April 9, 2012); p.1.

[23] John Schnatterly, Mega Associates Ltd., *loc. cit.*

[24] See internet for "Whirlpool," 21.1-cu. ft. top-freezer refrigerator – White – WRT351SFYW.

Information Center reports from their "tear-down study of new appliances" that the "average steel content of … refrigerators" is 123 lb.[26] Therefore, the iron ore that was shipped through the Soo Locks to U.S. steel mills in 2012 could make enough steel for approximately 392.3 million of these refrigerators. The total value of the **refrigerators** that could be made from the iron ore shipped through the Soo Locks in 2012 would be;

Refrigerators:

392.3 million (x) $805 = **U.S.$ 315,800,413,300.**

The direct value of mining iron ore, making steel, and manufacturing consumer products are not separate, independent costs. Actually, they are compound factors, and compound costs, because each one is embedded in the next one.[27] For example, the value of the iron ore ($ 5.4 billion) becomes part of the cost of making steel. Furthermore, the value of the steel ($ 15.7 billion) becomes part of the cost of steel-dependent consumer products (e.g., automobiles, refrigerators, etc.). This can be thought of when the first step (mining) is being embedded in the second step (steel) and, in turn, the second step becomes embedded in the third and final step (consumer

[25] Sophisticated Edge, "How Much Does a Refrigerator Weigh?" http://www.sophisticatededge.com; and http//www.Matag.com (2013).

[26] Appliance Recycling Information Center, "Recycling Major Home Appliances" *INFO Bulletin #1* (published about April 2001, but data based on ARIC tear-down study of new appliances in 1997); p. 2.

[27] Embedded in this context means inserted as an integral part of the surrounding whole. (http://www.thefreedictionary.com/embedded). Therefore, embedded refers to a cost that is included in the next developmental step of production, as the coast of iron ore is included in the cost of steel and the cost of steel is included in the cost to make a car.

products) that people can use. Therefore, the price of an automobile includes the price of the steel that the car required and, in turn, the price of the steel includes the price of the iron ore that the steel required. In this way, all of the direct costs at each stage of production are included ("embedded") in the cost of the steel-dependent-consumer-products made from the steel that was made from the iron ore that came through the Soo Locks. If the supply of iron ore was halted at the Soo Locks, the economy would suffer greatly.

The direct value of the open and safe transit of iron ore shipped through the Soo Locks must include the value of the iron ore and the value of the steel made from the iron ore, both of which are embedded in the price of the final consumer products made from the steel. If automobiles are used as the consumer product example, the direct value of the shipment of iron ore through the Soo Locks in 2012 is therefore calculated to be:

Direct Value of

Automobiles = **U.S. $ 287,455,664,176.**

It is remarkable that the value of the iron ore shipped through the Soo Locks is such a small portion of the total value of the products made from it. In fact, in 2012, the value of the iron ore was less than **1.9%** of the value of the cars that could be made from it. And yet the cars (or refrigerators etc.) could not be made without the steel made from the iron ore shipped through the Locks. As an old saying goes, the shipment of iron ore is like "the tail that wags the dog."

Indirect and Induced Benefits

The indirect benefits are quite different from direct benefits. For example, the direct benefits of mining the iron ore includes wages for the miners, the mining trucks, drilling and blasting equipment, grinding and concentrating equipment, plus profits and amortization expenses, etc. The "indirect and induced" benefits include the periphery spending that occurs outside of the mining operation itself, but is there only because the mining exists. For example, when miners buy groceries or fill up their pick-up trucks with gasoline, when they eat at the local restaurant or have a beer at Mugga's Pub, the dollars spent are not directly part of the mining of iron ore, but they occur because the miners have money (that came directly from the mining of iron ore) and they are spending some of their wages in the communities surrounding the mines.

A major on-going research project at the University of Minnesota-Duluth ("UMD") has been analyzing the economic impact of mining in Northern Minnesota. This study, led by James A. Skurla of the Labovitz School of Business and Economics at UMD, calculated the indirect and induced wages, rent, interest and profits associated with the iron ore mining in Northern Minnesota.[28] The value they calculated of indirect and induced economic benefit was an additional $0.69 for every $1.00 of direct value generated by iron ore mining.

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[28] James A. Skurla, et.al., "The Economic Impact of Ferrous and Non-Ferrous Mining on the State of Minnesota and the Arrowhead Region, including Douglas Co, Wisc," Labovitz School of Business and Economics, U. of MN-Duluth (Nov. 2012); p.11.

Unlike the direct benefits, the indirect and induced benefits are not embedded in the next step of production; they are independent at each step. For example, one needs banks and restaurants at all stages of production, from mining towns to steel mills and to automobile manufacturing towns. If the workers are working, than there will be a need for restaurants. If the workers are not working, than restaurant chefs and wait staff at all levels will be suffering. Therefore, the indirect and induced benefits are cumulative. They are also proportionate to the direct benefits at each stage of production. All three stages as identified here include the following:

Indirect & Induced Benefits

Mining	$ 3,725,967,818.
Steel	$ 10,832,719,363.
Autos	$198,344,408,281.

As a result, the total indirect and induced benefits that are tied to the shipment of iron ore through the Soo Locks in 2012 equals:

Total Indirect and Induced benefits

U.S. $212,903,095,462.

Therefore, the combined value of the direct, indirect and induced benefits of the free flowing shipments of iron ore through the Soo Locks using data for 2012 equals:

Grand Total

Direct, Indirect & Induced Benefits

<u>U.S. $ 500,358,759,638.</u>

This amount, $500.4 billion, is approximately **3.2%** of the U.S. gross domestic product (GDP).[29]

[29] U.S. Department of Commerce, "U.S. Bureau of Economic Analysis." U.S. Gross Domestic Product as of 4th quarter, Calendar Year 2012.

Table 1:

$ Value of Iron Ore through the Soo Locks					
2012					
Direct Values:					
	Millions		Price		Value
	of Units		$/unit		Millions $
Long tons of		(1)		(2)	
Iron Ore	41.3		$131		$5,400
Net tons of		(3)		(4)	
Steel	24.1		$651		$15,700
Number of		(5)		(6)	
Automobiles	18.0		$15,995		**$287,456**
Embedded Sub-TOTAL:					**$287,456**
Indirect & Induced Effects:					
2012			Indirect-Induced		
			Wage, rent, interest, prof		Value
	Direct $		$/$		Millions $
Long tons of				(7)	
Iron Ore	$5,400		$0.69		$3,726
Net tons of				(7)	
Steel	$15,700		$0.69		$10,833
Number of				(7)	
Automobiles	$287,456		$0.69		$198,344
Cumulative Sub-TOTAL:					**$212,903**
Footnotes:		**Grand-TOTAL:**			**$500,359**

(1) U.S. Army Corps of Engineers, "Lock Commodities Report 23 -- Soo Locks (SM01)"
for 11 reporting months of 2012 (February = no traffic); last report, January 9, 2013.

(2) Cliffs Natural Resources Inc., "Reports Fourth-Quarter and Full-Year 2012 Results,"
(Cleveland, February 12, 2013 /PRNewswire): p. 2.

(3) Coverts long tons of iron at 63.5% Fe to net tons of steel.

(4) See Peter Marcus and Becky Hites, "Inside Track # 127," World Steel Dynamics
(Englewood Cliffs, New Jersey, January 31. 2013); pp.8 & 18.

(5) John Schnatterly, Mega Associates Ltd., "Watching our Weight; Steel Content
of N. American Auto," www.autosteel.org

(6) Edmunds.com, "2013 Jeep Patriot SUV by Chrysler LLC," price = $15,995.
The price for this Jeep is rather low for any small, American made car.

(7) James A. Skurla, et.al., "The Economic Impact of Ferrous and Non-Ferrous Mining
on the State of Minnesota and the Arrowhead Region, including Douglas Co, Wisc,"
Labovitz School of Business and Economics, U. of MN-Duluth (Nov. 2012); p.11.

Jobs and Employment

The number of jobs that are dependent on the free shipment of iron ore through the Soo Locks in 2012 is another critical measure of the benefit (or potential loss) of this passage way. It was possible to estimate the number of direct mining jobs required to prepare the ore for shipment, given the tonnage of iron ore shipped in 2012 and the employee numbers presented in the St. Louis Co., Minnesota, Inspector of Mines "*Annual Report – 2012*." This approach resulted in a calculation of 4,441 direct mining jobs needed to produce the tonnage of iron ore shipped through the Locks in 2012.[30]

The number of direct jobs created at the steel mills is calculated from data published by the U.S. Geologic Survey.[31] With an estimated 605 net tons of steel produced per employee per year, the total number of direct jobs at the steel mills that have been created in order to produce the steel that this iron ore would yield equals 39,879. Furthermore, another 188,522 motor vehicle manufacturing jobs would be developed using the steel made from the iron ore shipped through the Locks in 2012.[32]

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[30] Joseph J. Austin, Interim Mine Inspector, St. Louis Co., Minnesota, "Annual Report of the Inspector of Mines – 2012 (2013) calculated from pp. 9-10."

[31] Michael D. Fenton, "Iron and Steel" US Geologic Survey, Mineral Commodity Summaries (January 2012); p.78; The average of 2010 and 2011 was used and yielded 667 metric tons/employee; or 605/net ton.

[32] From U.S. Census Bureau, Annual Survey of Manufacturers, "Geographic Area Statistics for all Manufacturing by State: 2009 and 2008:" December 2010.

Jobs are cumulative, not embedded. Therefore, each step of development adds to the total. In this way, the total direct employment attributable to the iron ore shipped through the Soo Locks in 2012 accumulates at each step to equal:

Direct Employment = 232,842 Jobs.

To calculate the indirect employment attributable to the shipment of iron ore through the Soo Locks in 2012, a jobs multiplier was used as developed by Skurla and the Labovitz School of Business and Economics at the University of Minnesota Duluth. This figure is 1.8 jobs added for each direct job established. This results in:

Indirect and Induced jobs

Mining	7,994
Steel	71,782
Autos	339,340
	419,116 jobs

The total number of jobs attributable to the free passage of iron ore shipped through the Soo Locks is the sum of the direct, indirect and induced employment numbers. This is:

Direct Employment	= 232,842
Indirect and Induced jobs	= 419,116
Grand TOTAL:	**= 651,958 jobs**

Table 2:

Jobs Re. Iron Ore through the Soo Locks

2012				
Direct Jobs:				
	Number of **Jobs**		Number of Direct **Jobs**	
Mining		(1)		(1)
Iron Ore	4,441	. . . . . .	4,441	
Making		(2)		(2)
Steel	39,879	. . . . . .	39,879	
Manufacturing		(3)		(3)
Automobiles	188,522	. . . . . .	188,522	
Cumulative Sub-TOTAL Jobs:			**232,842**	
Indirect & Induced Jobs:				
2012				
	Number of Direct **Jobs**	Jobs added (multiplier)	Ind. + Induced Employment	
Mining			(4)	
Iron Ore	4,441	1.8	7,994	
Making			(4)	
Steel	39,879	1.8	71,782	
Manufacturing			(4)	
Automobiles	188,522	1.8	339,340	
Cumulative Sub-TOTAL Jobs:			**419,116**	
	Grand-TOTAL:		**651,958**	

Footnotes:

(1) Based on Joseph J. Austin, Interim Mine Inspector, St. Louis Co., Minnesota, "Annual Report of the Inspector of Mines – 2012 (2013) calculated from pp. 9-10

(2) Michael D. Fenton, "Iron and Stee,l" US Geologic Survey, Mineral Commodity Summaries (January 2012); p.78; The average of 2010 and 2011 was used and yielded 667 metric tons / employee; or 605 net ton.

(3) From U.S. Census Bureau, Annual Survey of Manufacturers, "Geographic Area Statistics for all Manufacturing by State: 2009 and 2008:" December 2010.

(4) James A. Skurla, et.al., "The Economic Impact of Ferrous and Non-Ferrous Mining on the State of Minnesota and the Arrowhead Region, including Douglas Co, Wisc," Labovitz School of Business and Economics, U. of MN-Duluth (Nov. 2012); p.11.

Conclusions

This report assessed the extended value of iron ore shipped through the Soo Locks. The focus is on the 2012 shipping year. The research includes calculating and then combining the value of the primary raw material, with the value of an appropriate portion of the secondary materials, and finally including the value of a proportion of the final consumer products that would be dependent on the free and open functioning of the Soo Locks.

The estimated value of iron ore alone traveling through the Soo Locks is currently worth $5.4 billion to the U.S. economy. If this supply of raw material was interrupted, the total impact to the steel industry and those consumer products dependent on this steel is estimated to be $287.5 billion to the U.S. economy. Furthermore, the indirect and induced impacts of cutting off the transit of iron ore through the Soo Locks would add another $212.9 billion in losses. Therefore, the total loss would amount to **$500.4 billion** dollars per year.

The potential loss of employment due to cutting off the transit of iron ore through the Soo Locks was also analyzed. Initially, the loss of 4,441 iron ore mining jobs occurred. Subsequently, another 39,879 steel workers would become unemployed and approximately 188,522 additional manufacturing jobs would be lost. This totals 232,842 direct jobs lost. An additional 419,116 indirect and induced jobs could be lost. This makes a grand-total of **651,958 jobs** that could be lost if iron ore was not able to be shipped through the Soo Locks.

Background of the Researcher

Dr. Kakela has been doing research on the North American iron ore industry for more than 35 years. His results have been published widely, including more than 100 professional publications on iron ore and steel, as well as numerous confidential consulting reports.

From his academic position, Dr. Kakela has access to a wide variety of corporate and public data that enables him to develop a unique, industry-wide perspective on the up-stream components to steelmaking in North America. Objectivity is vital. Kakela strives to present an objective analysis of the iron ore industry and its associated components. His research is recognized and respected internationally. He has been asked to consult and prepare confidential reports for a wide range of clients in the iron ore and steel industries, as well as major suppliers related to the mines and mills. He has served as an expert witness on several cases.

Dr. Kakela is a full-Professor with tenure in the interdisciplinary Department of Community, Agriculture, Recreation, and Resources Studies (being re-named Department of Community Sustainability) at Michigan State University. He has been a university faculty member since 1967, teaching in Canada and elsewhere in the United States before returning to his alma mater, Michigan State University, in January 1978. Professor Kakela teaches a well-received undergraduate course in environmental studies, as well as working with graduate students on natural resources management issues. Students have rated his teaching to be in the top 3% of the more than 2,000 teaching faculty at Michigan State University. Dr. Kakela has received several awards and scholarly fellowships, including the Michigan State University President's Award for Community Service in 2002 and being invited to be on the Editorial Advisory Board of the ***Great Lakes/Seaway Review*** international magazine since 2006.

Peter Kakela was born in Duluth, Minnesota, in 1940 and currently lives with his wife Mary Addison and their nine children in East Lansing, Michigan.

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