Waterway Traffic Forecasts for the Upper Mississippi River Basin

Volume IX: Steel & Steel Sector Raw Materials

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I. Introduction

At the request of Jack Faucett Associates, Inc., Criton Corporation has undertaken an analysis to evaluate past, present and prospective steel supply and demand relationships in geographic regions served by the upper Mississippi River Basin waterway transportation network. These analyses were undertaken to develop insight into the major determinants of riverborne volumes of steel and steel industry-related raw materials along the targeted waterways. The ultimate goal of these analyses was to develop riverborne steel sector-related traffic forecasts through 2050 for the Upper Mississippi River Basin waterways. Specifically, traffic levels were forecast for the upper Mississippi River between Minneapolis/St. Paul and the mouth of the Missouri River and the entire length of the Illinois Waterway. The commodities covered by these forecasts include the following raw materials: iron ore, iron & steel scrap, pig iron, direct-reduced iron, and ferroalloys. The forecasts also cover shipments of semi-finished steel (slabs, billets, and blooms) as well as all types of finished steel products.

The analysis was performed for Jack Faucett Associates under prime contract DACW72-90-D-0003 , Delivery Order No. 0010 "Waterway Traffic Forecasts for the Upper Mississippi River Basin," issued by the U.S. Department of the Amy, Ft. Belvoir District.

This report is divided into four sections including this introduction. Section II evaluates the current structure of the U.S. steel industry, historical steel supply and demand patterns, and recent riverborne traffic levels of steel and steel industry-related raw materials. Section III presents Criton's methodology for generating its waterway traffic forecasts for the steel sector, while section IV presents Criton's waterway traffic forecasts through the year 2050.

II. U.S. Steel Markets and Upper Mississippi Basin Steel Sector Waterway Traffic

Areas served by the upper Mississippi Basin waterways are home to the single highest concentration of raw steel production capacity in the United States. At the present time, this region has nearly 28 million tons of annual raw steel production capacity (see Table 1), representing approximately 25 percent of total U.S. raw steel production capacity. The vast majority of this steel production capacity is located in the Chicago metropolitan area, which includes sections of northern Indiana which border Lake Michigan. Steel

production capacity in the Chicago metropolitan area alone, which is in close proximity to the Illinois Waterway, totals over 20 million tons. Approximately three million additional tons of production capacity is just outside the Chicago area near the Illinois River.

The upper Mississippi above the Missouri River, meanwhile, has relatively little steel production capacity on or near its banks, especially when compared with the Illinois Waterway. Presently, the upper Mississippi is home to two major steel plants, while a third plant, IPSCO's Montpelier, IA minimill, is expected to enter commercial operation in 1997. Combined, these three steel facilities are capable of producing nearly 4.4 million tons of steel (see Table 2)

Table 1.
Major Steel Production Facilities in Within Proximity to the Illinois Waterway*

Company	Location	Facility Type**	Annual Capacity (000s)
A. Finkle & Sons	Chicago, IL	EAF	100
Acme Steel	Riverdale, IL	BOF	1,200
Beta Steel	Burns Harbor, IN	EAF (New)	1,000
Bethlehem Steel	Indiana Harbor, IN	BOF	5,300
Birmingham Steel	Kankakee, IL	EAF	750
Calumet Steel	Chicago Heights, IL	EAF	150
LTV Steel	Indiana Harbor, IN	BOF	4,100
N.W. Steel & Wire	Sterling, IL	EAF	2,200
U.S. Steel	Gary, IN	BOF	8,730
Total			**23,530**

Table 2.
Major Steel Production Facilities Within Proximity to the Upper Mississippi River above the Missouri River*

Company	Location	Facility Type**	Annual Capacity (000s)
IPSCO, Inc	Monpelier, IA	EAF (New)	1,250
Laclede Steel	Alton, IL	EAF	2,200
Northstar Steel	St. Paul, MN	EAF	900
Total			**4,350**

* Includes only facilities with steelmaking capabilities. Steel processing centers are excluded
** BOF - Basic Oxygen Furnace; EAF - Electric Arc Furnace
Sources: Various Industry Contacts

There are essentially two types of steelmaking techniques: fully integrated steel producers using basic oxygen furnaces (BOF) and steel minimills using electric arc furnace (EAF) technology. The distinction between the two steelmaking processes is critical since it largely determines the type of raw materials used in the steelmaking process. The integrated steel production process involves using iron ore and coke in a blast furnace to produce either molten iron or pig iron. After this process, the output

from the blast furnace is fed into the BOF to produce raw steel. In addition to molten iron, however, integrated steelmakers also feed considerable quantities of high-quality scrap steel, pig iron, or scrap substitutes such as direct reduced iron into the BOF.

Electric arc furnace operators, meanwhile, bypass the coking and blast furnace steps by feeding scrap steel directly into the electric arc furnace. When scrap supplies are tight and prices high, however, minimill operators often will rely on scrap substitutes such as pig iron or direct reduced iron as raw material feedstocks.

Presently, the vast majority (82%) of the steelmaking capacity along the Illinois Waterway represents production from integrated steelmakers using basic oxygen furnaces. Practically all of the iron ore used at these facilities is delivered by lake vessel from Minnesota's iron range. All of the steel production capacity along the upper Mississippi River above the Missouri River, meanwhile, is handled by electric arc furnaces. One major integrated steel producer, National Steel, has production facilities on the upper Mississippi below the Melvin Price lock and dam in Granite City, IL.

U.S. Steel Supply and Demand Relationships

Since such a large percentage of U.S. steel production capacity is located within the upper Mississippi/Illinois Waterway study area, the markets served by these producers are national in scope. Consequently, steel production and traffic levels from these area producers are heavily influenced by overall U.S. steel demand patterns.

Recent data on U.S. steel production, demand and other factors are summarized in Table 3. Since 1988, U.S. raw steel production has generally hovered between 95 and 100 million tons per year. (U.S. raw steel production exceeds U.S. domestic shipments and exports because steelmakers are not able to achieve 100 percent salable yields on their raw steel production.) Production increased above 100 million tons in 1995 due to the commencement of production at several new major minimill operations.

Table 3.
U.S. Steel Market Dynamics: 1988-1995
(Millions of Tons)

	1988	1989	1990	1991	1992	1993	1994	1995
U.S. Raw Steel Production	99.9	97.9	98.9	87.9	92.9	97.9	98.1	103.2
U.S. Domestic Shipments	81.8	79.5	80.7	72.4	77.9	85.0	91.6	90.4
U.S. Exports	2.1	4.6	4.5	6.4	4.3	4.0	3.7	7.1
Imports	20.9	17.3	17.2	15.7	17.1	19.5	30.1	24.4
Apparent U.S. Consumption	102.6	96.8	97.7	88.1	95.0	104.5	121.7	114.8

Source: American Iron & Steel Institute

U.S. steel demand, as measured by apparent consumption, experienced a major increase in 1994 rocketing to 121.7 million tons. Demand levels in 1995, however, fell moderately, and are expected to continue falling in 1996 as well.

One critical point regarding the U.S. steel market is the relatively high volume of imports penetrating this market. Throughout the 1988 to 1995 period, imports accounted for approximately 20 percent of U.S. consumption, peaking at nearly 25 percent in 1994. As discussed later in this report, the U.S.'s current heavy reliance on imports will have a significant impact on overall U.S. steel supply and demand patterns.

Upper Mississippi and Illinois Waterway Steel Sector Traffic

Since 1990, riverborne shipments and steel and steel sector raw materials on the upper Mississippi River between the Twin Cities and the mouth of the Missouri River ranged from a low of 2.2 million tons in 1992 to a recent peak of 4.9 million tons in 1994 (see Table 4). The vast majority of this traffic, however, represents steel and steel sector raw materials moving onto or off of the Illinois River, which serves the massive Chicago-area steel-making complex.

Steel sector traffic on the Illinois Waterway, meanwhile, has ranged from a low of two million tons in 1992 to a recent high of 4.6 million tons in 1994 (see Table 5.). The traffic surge experienced in 1994 is believed to be a short-term phenomenon precipitated by several factors. First, an overall surge in U.S. steel demand in 1994 helped boost traffic. In addition, several major Chicago-area blast furnaces experienced extended maintenance outages during the year. As a result, steelmakers were forced to purchase substantial volumes of semi-finished steel slabs on the international market to feed their rolling mills. Much of this material was imported via the lower Mississippi and moved by barge to the Chicago area. The steelmakers also were forced to purchase substantial volumes of scrap steel and pig iron to supplement their temporarily limited molten iron production.

Table 4.
Riverborne Shipments of Steel-Sector Commodities on the Upper Mississippi River Between the Twin Cities and the Mouth of the Missouri River
(000s of Tons)

	Raw Materials					Steel Products			
Year	Iron Ore*	Scrap	Pig Iron	Ferro-Alloys	Total	Semi-fin Steel	Finish Steel	Total	Grand Total
1990	443	988	152	195	1778	200	905	1105	2883
1991	190	745	149	195	1279	173	1143	1316	2595
1992	134	765	167	188	1254	142	845	987	2241
1993	143	821	193	256	1413	253	799	1052	2465
1994	200	1030	706	259	2195	1421	1283	2704	4899

Table 5.
Riverborne Shipments of Steel-Sector Commodities on the Illinois Waterway
(000s of Tons)

	Raw Materials					Steel Products			
Year	Iron Ore*	Scrap	Pig Iron	Ferro-Alloys	Total	Semi-fin Steel	Finish Steel	Total	Grand Total
1990	346	829	100	166	1441	165	805	970	2411
1991	170	721	109	164	1164	165	1189	1354	2518
1992	75	753	127	152	1107	130	794	924	2031
1993	102	900	149	192	1343	252	735	987	2330
1994	157	1078	580	206	2021	1399	1159	2558	4579

* Includes Direct-Reduced Iron

Source: Waterborne Commerce of the United States.

III. Steel Sector Waterway Traffic Forecast Assumptions

As noted earlier in this report, the upper Mississippi and Illinois Waterways serve the largest concentration of raw steel production capacity in the U.S. As a result, the markets these steelmakers serve is national in scope. Consequently, it was assumed that riverborne traffic levels for steel and steel-sector raw materials would be closely tied to overall U.S. steel demand conditions.

Since the vast majority of steel and steel-sector raw materials moving on the upper Mississippi River above the Missouri River represents traffic moving into and out of the Illinois Waterway, waterway traffic forecasts were first developed for the Illinois Waterway. Upper Mississippi waterway traffic forecasts were then largely developed using the results of the Illinois Waterway traffic forecasts.

For the Illinois Waterway, two separate forecasts were prepared: one for raw materials and the other for steel (which includes for finished and semi-finished steels). It was considered appropriate to group these commodities, especially in the raw materials segment, since pig iron, scrap steel, and direct reduced iron (included in iron ore) are generally substitute commodities.

In comparing macro U.S. steel demand data to riverborne traffic levels of steel and steel sector raw materials, fairly strong correlations between the data were found to exist. As

expected, Illinois waterway traffic for both steel and its raw materials were positively correlated with overall U.S. steel demand. The results of these regression analyses are summarized in Table 6. These regression results were used to generate the Illinois Waterway steel and steel-sector raw material forecasts.

Table 6.
Regression Results for Comparison of Illinois Waterway Steel and Raw Material Traffic to Overall U.S. Steel Demand

Commodity	Intercept	Coefficient	R-Squared
Steel*	-2906	42.00	0.60
Raw Materials**	-1269	26.47	0.86

* Includes both finished and semi-finished steel
** Includes iron ore, iron & steel scrap, pig iron and ferroalloys.

While approximately 85 percent of upper Mississippi steel traffic represents steel-sector materials moving onto or off of the Illinois Waterway, it was non-the-less necessary to forecast traffic levels for the remaining 15 percent of the waterway's steel sector tonnage which is considered local in nature. As with the Illinois Waterway, local upper Mississippi steel and steel-sector raw material traffic is positively correlated with overall U.S. steel demand. This relationship can be estimated with the following function:

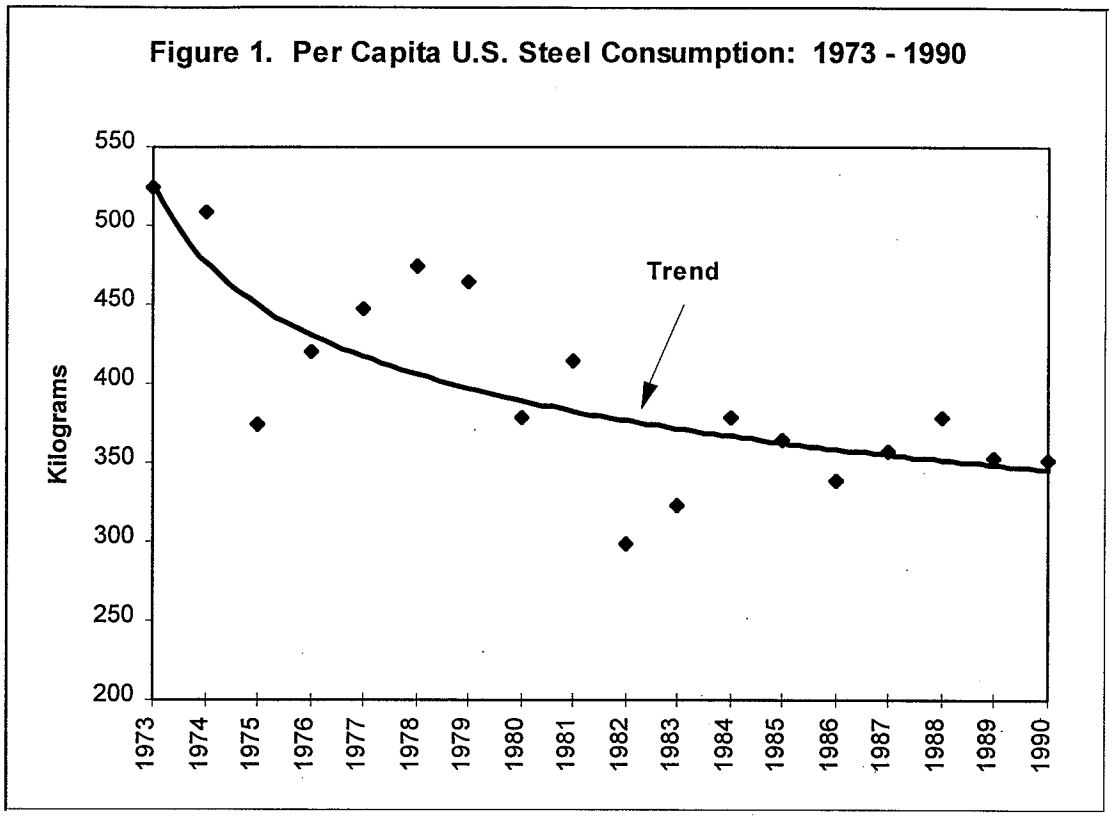
$$Ya = 48.3 + 4.04(Xa)$$

where Ya represents total steel sector-related traffic on the upper Mississippi while Xa represents overall U.S. steel demand.

Forecast U.S. Steel Demand

Since Criton's forecast model specified that overall upper Mississippi and Illinois Waterway steel sector traffic is largely dependent on overall U.S. steel demand , it was necessary to generate long-term forecasts of U.S. steel demand.

This process was accomplished by evaluating historical per capita U.S. steel consumption. Per capita U.S. steel consumption for the 1973 to 1990 period is reflected in Figure 1.



In general, per capita U.S. steel consumption has experienced a significant decline since the early 1970s, falling from 522 KG in 1973 to approximately 352 KG in 1990. Much of this decline has been due to a major shift away from steel to lighter weight materials such as aluminum, plastics, and composite materials in many former steel-dominated sectors such as the beverage can industry, the railcar manufacturing industry, and the automobile industry.

It was assumed that the trend shown in Figure 1 would continue through the forecast period with the decline in per capita steel consumption slowing. Future per capita steel consumption levels were estimated using the following function:

$$Yb = 527.7(Xb - 1972)^{-0.1464}$$

where Yb represent per capita steel consumption measured in kilograms while Xb represents the forecast year.

To determine total U.S. forecast steel consumption, the results of each per capita steel forecast was multiplied by the total U.S. population as forecast by the Census Bureau. The results of these analyses are summarized in Table 7.

Table 7. Projected U.S. Steel Consumption: 2000-2050			
Year	Per Capita U.S. Steel Consumption (Kilograms)	Projected U.S. Population (Millions)	Projected U.S. Steel Demand (Millions of Tons)
2000	324.0	276,241	98.6
2001	322.3	278,609	99.0
2002	320.8	280,997	99.3
2003	319.2	283,406	99.7
2004	317.7	285,836	100.1
2005	316.3	288,286	100.5
2006	314.9	290,675	100.9
2007	313.6	293,084	101.3
2008	312.3	295,513	101.7
2009	311.1	297,962	102.1
2010	309.8	300,431	102.6
2011	308.7	302,926	103.0
2012	307.5	305,442	103.5
2013	306.4	307,979	104.0
2014	305.3	310,537	104.5
2015	304.3	313,116	105.0
2016	303.3	315,599	105.5
2017	302.3	318,101	106.0
2018	301.3	320,623	106.5
2019	300.3	323,165	107.0
2020	299.4	325,727	107.5
2025	295.1	338,338	110.0
2030	291.2	349,198	112.1
2035	287.7	360,059	114.2
2040	284.5	370,919	116.3
2045	281.6	381,779	118.5
2050	278.9	392,639	120.7

IV. Projected Riverborne Steel Sector Traffic

Using the data and methodologies in the previous section, waterway traffic forecasts for the steel sector were developed for both the Illinois Waterway and the upper Mississippi River between the Twin Cities and the mouth of the Missouri River. The forecast for the Illinois Waterway is summarized in Table 8.

Table 8. Steel Industry Related Barge Traffic: Illinois Waterway (000s of Tons)			
Year	Raw Materials*	Steel**	Total
2000	1342	1240	2582
2001	1351	1255	2605
2002	1360	1269	2630
2003	1370	1285	2655
2004	1380	1301	2682
2005	1391	1318	2709
2006	1401	1335	2736
2007	1412	1352	2764
2008	1423	1369	2793
2009	1435	1388	2822
2010	1446	1406	2853
2011	1459	1426	2884
2012	1471	1445	2917
2013	1484	1466	2950
2014	1497	1487	2984
2015	1510	1508	3018
2016	1523	1528	3051
2017	1536	1548	3084
2018	1549	1569	3118
2019	1562	1591	3153
2020	1576	1612	3188
2025	1644	1720	3363
2030	1698	1805	3503
2035	1753	1894	3647
2040	1810	1983	3793
2045	1867	2075	3942
2050	1925	2167	4092

* Includes iron ore, iron & steel scrap, pig iron, and ferroalloys.
** Includes both finished steel and semi-finished steel.

Waterway traffic forecasts for the upper Mississippi River between the Twin Cities and the mouth of the Missouri River, meanwhile, are summarized in Table 9.

Table 9. Steel Industry Related Barge Traffic
Upper Mississippi
(000s of Tons)

Year	Local Steel & Raw Materials	Ill River Through Raw Materials*	Ill River Through Steel**	Total
2000	446	1165	1219	2831
2001	448	1173	1233	2854
2002	449	1181	1248	2878
2003	451	1189	1263	2903
2004	452	1198	1279	2930
2005	454	1207	1296	2957
2006	456	1216	1312	2984
2007	457	1226	1329	3012
2008	459	1235	1346	3040
2009	461	1245	1364	3070
2010	462	1256	1382	3100
2011	464	1266	1401	3132
2012	466	1277	1421	3164
2013	468	1288	1441	3197
2014	470	1299	1461	3231
2015	472	1311	1482	3265
2016	474	1322	1502	3298
2017	476	1333	1522	3331
2018	478	1345	1543	3365
2019	480	1356	1564	3400
2020	482	1368	1585	3435
2025	492	1427	1690	3610
2030	501	1474	1775	3749
2035	509	1522	1861	3892
2040	518	1571	1950	4038
2045	527	1621	2039	4187
2050	535	1671	2130	4336

* Includes iron ore, iron & steel scrap, pig iron, and ferroalloys.
** Includes both finished steel and semi-finished steel.

Overall Illinois Waterway steel sector traffic is projected to reach approximately 2.6 million tons in 2000. This is expected to grow to approximately 3.2 million tons by 2020 and 4.1 million tons by 2050. Given the dominance of Illinois Waterway-related traffic on the upper Mississippi, similar growth patterns are expected on that waterway.

One interesting item to note in the waterway traffic forecasts is that waterway shipments of steel are expected to grow at a substantially higher rate than waterway shipments of raw materials. This is not unexpected since the vast majority of Illinois Waterway and upper Mississippi raw material traffic consists of scrap iron and steel, much of it moving outbound to markets on the lower Mississippi and Ohio Rivers. Since scrap supplies are inherently limited, growth in this sector should be contained.

Impact of U.S. Minimill Construction Boom

One issue not addressed thus far in this report is the potential impact of an expansion of U.S. minimill capacity on Illinois Waterway and upper Mississippi River steel sector traffic. In response to recent booming demand for steel in the U.S. and rising prices, the U.S. steel industry currently is experiencing a major capacity expansion. Overall, Criton estimates that at least 15 million tons of new steelmaking capacity will be added throughout the U.S. during the 1995 to 2000 period. All of this new capacity represents new electric arc furnaces being built by both established and start-up minimill operators. Much of this capacity is being is being built in areas away from traditional steelmaking centers such as Chicago, Cleveland and Pittsburgh. A significant proportion of these minimills are being built along the inland river system.

While it is possible that competition from these new steel mills could impact Illinois Waterway and upper Mississippi steel traffic, the overall impact of these developments should be negligible due to several factors. First, as stated earlier in this report, U.S. steel imports have ranged between 15 and 30 million tons during the 1990 to 1995 period. It is generally expected that the increase in U.S. steel production capacity will first and foremost displace U.S. steel imports. Second, steel industry analysts indicate that the relevant steel producers within the study area are among the most healthy in the U.S. steel industry. While the increase in U.S. steel production capacity will no-doubt affect prices, it should not impact the overall financial viability of most of the steelmakers in the relevant study area. In addition, as steel prices fall, U.S. steelmakers will face great pressure to reduce costs. Because of the capital intensive nature of the industry, especially in the integrated steel sector, the most effective method of reducing unit costs to maximize output. In fact, U.S. steel exports should increase as production capacity grows. Finally, while most minimills are being built outside of the study area, additional capacity also is being added within the study area. The most notable among these capacity additions are IPSCO steel's new 1.25 million ton-per-year minimill currently under construction in Montpelier, IA and Beta Steel's new one million ton-per-year minimill which was recently completed in Portage, IN.

Given the factors discussed above, it was not felt necessary to adjust the forecasts presented in Tables 8 and 9 to reflect the potential impact of the current expansion of U.S. steelmaking capabilities.

Steel Forecasts and Relationship to Riverborne Coal Forecasts

This report is the second waterway traffic forecast study in this series which has dealt with the steel sector. Volume III of this series, which focused on coal, contained a sector-specific forecast for riverborne shipments of metallurgical coal used by the steel industry. The results of this forecast point towards slow growth in both overall steel demand and riverborne shipments of steel and ferrous raw materials. The results of the metallurgical coal traffic forecast meanwhile, indicated decline riverborne shipments of this commodity. These seemingly divergent results are not inconsistent. While it was assumed in this report that riverborne steel and ferrous raw material traffic would be driven by changes in overall steel demand, the metallurgical coal forecast did not contain a steel demand component. Instead, that forecast assumed that technological changes within the steel industry would result in a continued shift into less coke-intensive production technologies such as electric arc furnaces, pulverized coal injection, use of direct reduced iron in blast furnaces, and natural gas injection. All of these technologies will cut steel industry coke demand. This in turn, is expected to cut metallurgical coal demand and riverborne metallurgical coal traffic.