3.5 INFRASTRUCTURE

3.5.1 Introduction

Commercial dredging activity could contribute to the ongoing river bed degradation in the LOMR, creating maintenance and operational impacts for infrastructure that relies on predictable minimum water levels and stable stream channels. These infrastructure facilities include water intakes for municipal water supply and power generation processes; federal and non-federal levees; BSNP dikes and revetments; vehicle and railroad bridge crossings; pipeline, power line, and telecommunication line crossings; and docks, ramps, wharfs, and marinas associated with industrial and recreational land uses.

This section begins with a brief overview of the regulatory setting that pertains to construction, operation, and maintenance of infrastructure on the LOMR. The general types of infrastructure present in the Project area (i.e., between RM 498 and RM 0) is presented, followed by a more detailed description of infrastructure by river segment.

3.5.2 Infrastructure Categories

The following general categories of infrastructure facilities are addressed in this section:

- Water intake facilities – water supply facilities that operate and maintain intakes within the Missouri River channel;
- Water supply wells – horizontal collector wells along the Missouri River that rely on river bed filtration to remove turbidity, pathogens, bacteria, and viruses;
- Levees – federal and non-federal levees maintained by local levee unit authorities to protect those levee districts from flooding;
- BSNP structures – dikes and revetments that stabilize the banks and form and maintain the navigation project;
- Bridge, pipeline, and cable crossings – facilities that cross the LOMR with support structures in the main channel or buried within the channel bottom; and
- Wharf and dock facilities – wharves, docks, material loading and offloading structures (conveyors, for example), ramps, and marinas.

3.5.2.1 Water Intake Facilities

Water is withdrawn from the Missouri River for make-up and cooling purposes in the production of electricity; for municipal water supply; and for commercial, industrial, domestic, and public uses. Water intake facilities on the LOMR are the primary water source for many municipalities and utilities. Groundwater wells near and under the river channel serve as primary sources of water in some cases and as a secondary or backup source in other cases. The Missouri River Navigation Charts (Sioux City, Iowa to Kansas City, Missouri; Kansas City, Missouri to the Mouth) and others identify 31 water intake facilities in the Project area between RM 498 and RM 0.[1] Most of these intakes are located in river segments that are currently being dredged and are also experiencing river bed degradation. These intakes provide drinking water to approximately 2.2 million people, and cooling and process water to power plants that generate over 6,000 megawatts (MW) of electricity (Kelly 2004).

Water intake facilities rely on a predictable minimum water level at each river intake structure. Low pool levels in upstream reservoirs and below-normal project releases during recent drought conditions forced many intake operators to make modifications, including to the intake structures themselves (Kelly 2004). Even with strict water conservation measures in place, most water purveyors with water supply intakes have only approximately 1–2 days of water supply in storage. To increase the amount of water available, some municipalities have drilled new wells (as an alternate water source) or increased pumping capacities at existing wells (Kelly 2004).

Dredging is currently prohibited within a zone extending 4,000 feet upstream and 500 feet downstream from any municipal drinking water intake structure located along either bank of the river; and within a zone extending 500 feet upstream and 500 feet downstream from any other water intake structure, other than those used for municipal drinking water. This condition may be exempted by the USACE if requested by the Dredger and approved by the company owning and operating the water intake.

3.5.2.2 Water Supply Wells

Several large-capacity collector wells are located in the Project area that supply drinking water to thousands of customers, including wells operated by the Kansas City Board of Public Utilities that provide water to over 145,000 residents in Kansas City and Wyandotte County, Kansas; by the Missouri American Water Company in St. Joseph that provide water to over 30,000 customers in

[1] Note that names of water intake facilities included in the segment-specific tables were obtained from the Missouri River Navigation Charts and may not correspond to the current facility name or operating utility.

northwest Missouri; and by the Water District No. 1 of Johnson County, Kansas (WaterOne) that serves 15 cities and approximately 408,000 individuals throughout Johnson County.

These wells are horizontal collector wells, which are different from traditional vertical water wells that are unlikely to be affected by river bed degradation or low-flow water elevations. Horizontal collector wells have a vertical shaft extending down 75–100 feet near the river. At the bottom, numerous lateral shafts radiate out horizontally from the central shaft into the alluvial aquifer that is under and adjacent to the river. Several water purveyors that operate these types of wells in the Project area are concerned that dredging operations could remove significant amounts of permeable aquifer materials and disrupt the natural filtration capacity of the streambed (Uden pers. comm.).

Dredging is currently prohibited within a zone extending 1,000 feet upstream and 1,000 feet downstream from any municipal drinking water horizontal collector well located along either bank of the river. This condition may be exempted by the USACE if requested by the Dredger and approved by the company owning and operating the water intake.

3.5.2.3 Levees

Levees are among the most noticeable and extensive infrastructure features along the LOMR; levees line hundreds of miles of river bank and protect thousands of acres of developed land and agricultural fields. Levees on the LOMR and major tributaries have been constructed by the USACE and a variety of local sponsors, including levee districts, drainage districts, conservation districts, and not-for-profit levee associations. The federal and non-federal levees located in the Project area are described below.

Federal Levees

Table 3.5-1 lists the 144.2 miles of federal levees located on the LOMR, including the land area, resident population, total investment protected, and the estimated damages prevented by each levee from the project's implementation date through fiscal year 2009 (see also Figure 3.4-2).

The Kansas City's Metropolitan Levee System is the most extensive levee system in the Project area. The system includes seven federal levee units initially constructed in the 1950s as part of the federal Flood Risk Management (FRM) system to provide flood protection for Kansas City and several surrounding communities. The system includes channel improvements, levees, and floodwalls on both the LOMR and the Kansas River; it covers a two-state and multi-community area with multiple levee districts and supporting agencies (USACE 2009a).

Table 3.5-1 Federal Levees on the Lower Missouri River

Levee Unit[a]	River Mile	Areas Protected (acres)	Affected Population	Investment (2010 dollars)	Damages Prevented to Property through 2009 (dollars)
R-513-512	497.5–495	11,800	17	8,065,000	6,534,000
R-500	484.4–480	1,550	--	795,000	1,272,000
L-497	482.4–476.7	6,840	18	17,779,000	5,650,000
L-488	475.3–465.2	8,365	5	44,649,000	7,009,000
R-482	468.4–458	4,730	12	15,178,000	3,943,000
L-476	461.0–454.0	6,000	136	23,710,000	4,605,000
R-471-460	456.5–441.8	13,424	1,631	637,810,000	8,0085,000
L-455	445.6–437.6	7,519	3,838	1,594,126,000	179,084,000
L-448-443	437.6–428	18,080	48	80,771,000	17,922,000
R-440	431–424.3	4,100	--	250,000	4,681,000
L-408	401.3–391.5	9,595	219	29,850,000	10,112,000
L-400	391–385	9,595	6	21,140,000	4,331,000
Kansas City's seven levees[b]	374–354.0	153,000	23,124	18,793,000,000	5,783,116,000
L-385	372.1-375.9	1,566	731	460,382,000	Unknown
R-351	350–339.7	8,861	265	15,000,000	5,033,000
L-246	250–239	25,000	161	36,784,000	28,688,000
L-234/Lower Chariton	238.8–227.3	19,200	72	30,717,000	14,545,000
New Haven	81.7–81.4	15	15	10,847,000	19,114,000
Total	144.2	309,240	30,298	21,820,853,000	6,175,724,000

Note: -- = Not available.

[a] R and L refer to right and left descending banks, respectively. The number is the river mile at the center point of the levee at the time it was authorized. The river miles do not match up exactly now, because of river cutoffs constructed since the levee was authorized.

[b] Includes Fairfax-Jersey Creek, North Kansas City, Central Industrial District, East Bottoms, Birmingham, Armourdale, and Argentine Levee Units.

Source: USACE 2010b.

The federal FRM systems are operated and maintained by public entities as sanctioned by the statutes of their respective states. In some cases, the FRM system structures share boundaries with BSNP structures. Maintenance responsibilities in these instances have been generally defined by the sloping reference plane called the CRP (see Section 3.4.6.1 for further information on the CRP).

Non-Federal Levees

In addition to the system of federal levees, approximately 97 systems of non-federal levees of 100 acres or more are located along the LOMR and its tributaries (Figure 3.4-2). These levees vary with respect to maintenance standards and levels of protection. In most cases, the levees range between 6 and 16 feet above the landside natural ground surface and provide a level of flood protection that exceeds the 5- or 10-year flood event. Non-federal levees provide protection to at least 476,000 acres of primarily agricultural lands in the Project area.

The USACE currently prohibits dredging within 500 feet of any levee centerline built or authorized by the U.S. Government.

3.5.2.4 Bank Stabilization and Navigation Project

The USACE Kansas City and Omaha Districts are responsible for construction, operation, and maintenance of the BSNP. The BSNP was first authorized by the RHA of 1912 and subsequent authorizations in 1925, 1927, and 1945. The 1912 RHA authorized a 6-foot-deep channel from the mouth to Kansas City, Missouri, and the 1925 RHA authorized a 200-foot-wide channel over the same area. The 1927 RHA extended the BSNP to Sioux City, Iowa. The 1945 RHA increased the authorized channel to 9 feet deep by 300 feet wide. The existing BSNP extends 735 miles from Sioux City, Iowa to the mouth near St. Louis, Missouri; within the states of Missouri, Kansas, Iowa, and Nebraska; and maintains a 9-foot deep by 300-foot-wide navigation channel (USACE 2003).

The BSNP structures consist mainly of revetments along the outsides of bends and transverse dikes along the insides of bends that force the river into a single active channel that is self-maintaining (USACE 2003). The USACE maintains more than 2,700 dike structures and approximately 540 miles of bank revetments in the Project area as part of the BSNP. These structures are maintained to achieve the design function (i.e., a self-maintaining navigation channel) as measured against the CRP. The current CRP elevations are presented in Table 3.5-2 (USACE 2010a).

While the river essentially has been stabilized into a single channel that is self-maintained by the BSNP infrastructure, individual flood events and river bed degradation require review of BSNP structure elevations and comparison to the CRP. If the channel degrades and navigation season flows cannot meet the previous CRP elevations, the infrastructure—including the BSNP features—must be altered to maintain the design water surface elevations in a given river segment.

Table 3.5-2 Construction Reference Plane Adjusted Elevations (2010)

Gage Location (river mile)	Construction Reference Plane Adjusted Elevation (feet above mean sea level)
Rulo (498.10)	846.48
St. Joseph (448.20)	796.66
Kansas City (366.10)	716.36
Waverly (293.40)	657.07
Booneville (197.10)	573.47
Hermann (96.90)	488.68
Mouth (0.00)	400.00

Source: USACE 2010a.

Over time, the need to revise the CRP arises because of changes in the basin resulting from drought conditions, heavy flows, mitigation work related to endangered species, degradation, aggradation, and other river-related circumstances. The current CRP was revised in 2010.

Dredging is currently prohibited within 200 feet of any dike, revetment, or other structure built or authorized by the U.S. Government as part of the BSNP.

3.5.2.5 Bridge, Pipeline, and Cable Crossings

There are 38 bridge crossings, 31 pipeline crossings, nine cable crossings, and one water tunnel crossing along the mainstem of the Missouri River in the Project area. These include state and local bridges, railroad bridges, and numerous public and commercial pipeline and cable crossings. Bridges over rivers are held up by pylons or piers that extend deep into the ground, using the stability of the earth to strengthen foundational support. River bed degradation can erode river beds, exposing pylons and piers, and diminishing the support for the bridge (USACE 2009a). Pipelines and underwater cable crossings rely on relatively consistent river bed elevations to provide adequate cover to subsurface infrastructure. Pipeline and underwater cable crossings that become exposed are susceptible to damage from debris flows and vessel anchors. Exposed pipelines can also be at risk of failure due to buoyancy effects. Overhead utility crossings are constructed at heights above the water surface that provide more than minimal levels of clearance for navigation purposes and therefore were not investigated.

Dredging is currently prohibited within 500 feet of any bridge pier or abutment or the centerline of any pipeline or submerged utility crossing.

3.5.2.6 Wharf and Dock Facilities

Wharf and dock facilities include wharves, docks, boat ramps, and other shoreline loading facilities along the LOMR. There are 154 wharf and dock facilities along the mainstem of the Missouri River in the Project area. These facilities are sensitive to changes in water surface elevation and channel bed elevation; they require a fairly consistent depth and elevation to service vessels, and a fairly consistent distance to shore to maintain landward access. These facilities are susceptible to local scour and deposition as channel flow characteristics and the river bed change over time.

3.5.3 Availability of Data

Data requests were issued for operation criteria related to water surface and river bed elevations, maintenance records, annual maintenance costs, and as-built drawings for each facility were requested. Infrastructure data gathered to date are limited, due to the limited response from facility operators. Water intakes and water supply wells are operated by several private entities whose information is considered confidential and not publically available.

The USACE maintains federal levee information but does not separate the LOMR segments from the larger system. Levees include a mix of federal and non-federal interests with varying levels of reporting and record keeping. General BSNP structures were tallied from the USACE navigational charts. The MoDOT, KDOT, Union Pacific Railroad (UPRR), Burlington Northern Santa Fe Railway (BNSF), Norfolk Southern Railway, and Kansas City Southern Railway were contacted to collect information about major bridge crossings. Only limited information was available from private companies that own and maintain pipelines, and no major issues were reported. Investigations into wharf and dock facilities determined that most commercial/industrial wharves and docks have been abandoned due to lack of use. However, boat ramps and marinas are widely used and require regular maintenance stemming from changes in water level and river bed degradation. State and local parks departments provided information for many of the boat ramp facilities.

Key sources of information used to describe the existing condition of infrastructure on the LOMR in the Project area include:

- Interviews with USACE staff;
- Interviews with staff who operate and maintain potentially affected infrastructure;
- *Final Report, Missouri River Levee Unit L-385 Sediment Analysis* (West Consultants 1999);
- Master Water Control Manual, Appendix E (USACE 2006);
- Missouri River Navigation Charts—the Orange and Green Books (USACE 1991a, 1991b);
- Missouri River stage trends technical report (USACE 2007);
- *Missouri River Bed Degradation Reconnaissance Study* (USACE 2009a); and
- *Missouri River Degradation and Causes (Lower 498 River Miles)* (USACE 2009b).

3.5.4 Existing Infrastructure

This section describes the type and location of existing infrastructure on the LOMR in the Project area. Water intake facilities, levees, BSNP structures, bridges, pipelines, underwater cable crossings, and wharf and dock facilities are identified and described by river segment.

3.5.4.1 St. Joseph Segment

One sand plant is located in the St. Joseph area. One company dredges the area around St. Joseph from that sand plant and dredges the lower portion of the St. Joseph segment from a sand plant situated in the Kansas City segment. A second company has proposed a new sand plant and dredging operation in the lower end of the St. Joseph segment. Several locations downstream of the City of St. Joseph have experienced river bed degradation greater than 3 feet (USACE 2009b).

Water Intake Facilities

Table 3.5-3 lists the six water intake facilities identified in the St. Joseph segment. Two of these intake facilities provide cooling and process water for two power plants, and four facilities withdraw water for public water supply.

Table 3.5-3 Water Intake Facilities – St. Joseph Segment

Facility Name[a]	River Mile
St. Joseph Water[b]	452.2
St. Joseph Power & Light	445.9
Atchison Water	423.3
Atchison Water Department	422.5
Iatan Power Plant	411.1
Leavenworth Water Company	398.0

[a] Names of water intake facilities were obtained from the Missouri River Navigation Charts and may not correspond to the current facility name or operating utility.

[b] A water intake facility for St. Joseph Water is shown on the Missouri River navigation charts; however, water supply for the area around St. Joseph is currently provided by Missouri American Water and its system of wells.

Intake Systems for Power Plant Cooling and Process Water

The intake system at RM 411.1 provides cooling and process water for the Iatan Power Plant. The Iatan Power Plant is comprised of two coal-fired power stations operated by Kansas City Power & Light (KCP&L). Iatan Plant 1 opened in 1980 and has a 651-MW capacity. Iatan Plant 2 is scheduled to open in 2010 and will generate 850 MW. The Iatan Power Plant is the largest coal-burning power plant in Missouri and generates 25 percent of the power that KCP&L generates and provides to more than 820,000 customers in 47 northwestern Missouri and eastern Kansas counties. The KCP&L also operates a 100-MW coal-fired plant in St. Joseph (the Aquila Lake Road Power Station) that relies on an intake system located at RM 445.9 (Burse pers. comm.).

Intake Systems for Public Water Supply

Missouri American Water owns a water intake facility for St. Joseph Water at RM 452.2; however, according to the current owner/operator, the intake has not been in service since 2000 when the company converted to an all-well water supply system (Fuerman pers. comm. [a]).

The Leavenworth Water Company operates north and south plants that rely on the intake facility at RM 398. The intake grate is set on bedrock, and the operations of the plant are not affected by silt. Each winter, the intake facility is inoperable because of low flows and ice, requiring use of alternate sources; this condition has persisted for the past 20 years (Kowalewski pers. comm.).

The City of Atchison operates two water supply intake facilities within this segment (RM 423.3 to RM 422.5). The capacity of the City's system is 10 million gallons per day (gpd), supplying water to over 4,000 accounts and five rural water districts (City of Atchison 2005).

Water Supply Wells

Several notable water supply wells systems are located along this segment. Missouri American Water operates a collector well and seven vertical wells at approximately RM 454.75. The company is concerned that dredging in this area will decrease the yield of their wells by introducing finer material and reducing the permeability of the aquifer, as well as increasing the risk of microbial contamination by reducing the effectiveness of river bed filtration (Fuerman pers. comm. [b]). The Leavenworth Water Company operates groundwater wells near RM 398.0. No problems with well production have been reported to date (Kowalewski pers. comm.).

Levees

Table 3.5-4 lists the 94.4 miles of federal levees in the St. Joseph segment. These levees are concentrated primarily along the LOMR mainstem and on several major tributaries approximately 30 river miles upriver and downriver of the City of St. Joseph (Figure 3.4-2, Sheet 1).

In the St. Joseph area between RM 456.5 and RM 437.6, the federal Levee Units R-471-460 and L-455 alone protect 20,000 acres of industrial, commercial, residential, and agricultural land uses; approximately 5,469 residents; and approximately $2.2 billion in investment. Another concentration of federal levees begins near Leavenworth, Kansas and extends downriver for approximately 15 miles. These two areas represent the second largest concentration of federal levees outside of the Kansas City segment. Together, the federal levees in this segment protect approximately 101,598 acres of urban, commercial/industrial, residential, and agricultural land use; a population of approximately 5,930; and approximately $2.4 billion in investment, primarily in and around the communities of St. Joseph, Elwood, and Atchison (USACE 2010b).

Non-federal levees are more evenly distributed along the St. Joseph segment than federal levees. Approximately 32 miles of levees in eight separate units protect over 55,000 acres of primarily agricultural uses along the mainstem LOMR and major tributaries (Figure 3.4-2, Sheet 1).

Table 3.5-4 Federal Levee Units – St. Joseph Segment

Unit Name[a]	River Miles
Levee Unit R-513-512	497.5–495.0
Levee Unit R-500	484.5–480.0
Levee Unit 497	482.4–476.7
Levee Unit L-488	475.3–465.2
Levee Unit R-482	468.4–458.0
Levee Unit L-476	461.0–454.0
Levee Unit R-471-460	456.5–441.8
Levee Unit L-455	445.6–437.6
Levee Unit L 448-443	437.6–428.0
Levee Unit R-440	431.0–424.3
Levee Unit L-408	401.3–391.5
Levee Unit L-400	391.0–385.0

[a] R and L refer to right and left descending banks, respectively. The number is the river mile at the center point of the levee at the time it was authorized. The river miles do not match up exactly now, because of river cutoffs constructed since the levee was authorized.

Bank Stabilization and Navigation Project Facilities

The USACE maintains over 600 wooden pile and rock rip-rap dikes and more than 121 miles of rock revetments along the navigation channel in the St. Joseph segment as part of the BSNP (Figure 3.4-2, Sheet 1). The heights of all dikes and revetments within the St. Joseph segment are maintained by the USACE, as measured against the CRP.

Bridge, Pipeline, and Cable Crossings

Four vehicle bridges and three railroad bridges cross the Missouri River in the St. Joseph segment (Table 3.5-5). The vehicle bridges provide interstate connections for Route 159, US 36, US 59, and Route 92 (Figure 3.4-2, Sheet 1). These bridges are operated and maintained jointly by the KDOT and the MoDOT, except for the Rulo Highway Bridge (Route 159) which is operated and maintained jointly by the NDOR and the MoDOT. In 2009, the average annual daily traffic (AADT) volume was 1,006 on the Rulo Highway Bridge at RM 498.1, 8,849 on the St. Joseph Highway Bridge (US 36) at RM 447.9, 9,432 on the Atchison Highway Bridge (US 59) at RM 422.5, and 14,914 on the Leavenworth Highway Bridge (Route 92) at RM 397.6 (MoDOT 2009).

Table 3.5-5 Bridge Crossings – St. Joseph Segment

Crossing Name (Route Number)	River Mile	Pile Cap Elevation	River Bed Elevation
Rulo Highway (US 159)	498.1	Unknown	Unknown
Burlington Northern	498.1	Unknown	Unknown
Union Pacific Railroad	448.2	Unknown	Unknown
St. Joseph Highway (US 36)[a]	447.9	Unknown	Unknown
Atchison Railroad	422.8	Unknown	Unknown
Atchison Highway (US 59)	422.5	Unknown	Unknown
Leavenworth Highway (Route 92)	397.6	Unknown	Unknown

[a] Includes separate westbound and eastbound spans.

All highway bridges across the Missouri River are regularly inspected, and if necessary, reinforced against scour. While river bed degradation may be occurring in certain areas, routine inspections have determined that the foundations are stable, with footings or piles secured to bedrock material. The Leavenworth Highway Bridge (Route 92) is supported by concrete spread footings 30 feet deep. Surveys by the KDOT show negligible degradation at this bridge crossing. The new Atchison Highway Bridge (US 59) is supported by drilled shafts founded 85 feet below the streambed (Orth pers. comm.). The three railroad bridges—one each for the Atchison Railroad, the UPRR, and the BNSF—are located at RM 422.8, RM 448.2, and RM 498.1, respectively. No information on the condition of these bridges was available.

More than six pipelines transporting liquid petroleum, natural gas, and water are located in the St. Joseph segment (Table 3.5-6). Two communication cable crossings also are located in this segment. Cable crossings are typically encased in steel pipes for protection. No issues related to river bed degradation at these crossing locations have been reported.

Table 3.5-6 Pipeline and Cable Crossings – St. Joseph Segment

Crossing Name	Utility Type	River Mile
Michigan and Wisconsin Pipelines	Pipeline	497.3
Williams Brothers Oil	Pipeline	455.5
City of St. Joseph (water)	Pipeline	450.4
Platte Pipeline Co.	Pipeline	437.3
AT&T	Cable	431.2
AT&T	Cable	431.1
Hydrocarbon Pipeline Transport, Inc.	Pipeline	414.1
Mid-America	Pipeline(s)	406.7

Wharf and Dock Facilities

There are 43 wharf and dock facilities in the St. Joseph segment (Table 3.5.7). These facilities service commerce and recreation. In addition to loading and unloading facilities, boat ramp access is scattered throughout the segment. The segment is served by one marina (Island Marina) at RM 462.6.

3.5.4.2 Kansas City Segment

Two existing sand plants are located in the Kansas City segment, and one dredging company is actively mining in this portion of the river. The Kansas City segment has experienced the greatest amount of river bed degradation. Individual locations have degraded from 2 to 7 feet since 1990 (USACE 2009b).

Water Intake Facilities

Eight water intake facilities are located in the Kansas City segment (Table 3.5-8). Four of these intake facilities provide cooling and process water for power plants, three provide public water supply, and one provides industrial process water for asphalt production. The KCP&L, the Kansas City (Kansas) Board of Public Utilities, the Kansas City (Missouri) Water Services Department, and WaterOne rely on these intake facilities.

Table 3.5-7 Wharf and Dock Facilities – St. Joseph Segment

Facility Name	Facility Type	River Mile
Rulo Boat Dock	Dock	498.0
Rulo Boat Club	Ramp	497.7
Unlabeled	Ramp	495.6
Unlabeled	Ramp	495.4
White Cloud Grain Co.	Grain loading dock	488.0
Buffalo Hollow Quarry	Rock loading dock	478.0
Paynes Landing Access	Ramp	477.1
Wolf Creek Rock Quarry	Dock	474.5
Mount Vernon Quarry	Rock loading dock	473.6
Mount Vernon Ranch Quarry Dock	Dock	468.9
unnamed	Ramp	468.3
Island Marina	Gas, docking, food	462.6
Nodaway Island Recreation Facility	Ramp	462.2
Studer (Westlake) Quarry	Dock	456.9
St. Joseph boat ramp	Ramp	452.1
D.L.W., Inc.	Ramp	452.0
Spirit of St. Joseph	Landing	449.0
Holliday Sand and Gravel Co.	Sand and gravel unloading dock	447.6
Bartlett and Company, Inc.	Grain loading dock	446.6
AG Processing	Dock, derrick, grain conveyor	446.1
Farmland Industries, Inc.	Dock	445.5
Chemical Operations	Chemical unloading dock	445.4
Flathead Fishing Club	Ramp	444.6
St. Joseph Outboard Motor and Yacht Club	Ramp and dock	444.0
Wathena Boat Ramp	Ramp	440.9
Scholz (Roundy) (Westlake) Quarry	Dock	432.8
Bromely & Sons Quarry	Dock	423.9
Maczuk, Inc.	Fertilizer unloading dock	423.2
Elders Grain, Inc.	Grain loading conveyor	423.1
Atchison Municipal Dock	Loading dock	423.0
Atchison Independent Park	Ramp	423.0

Table 3.5-7 Wharf and Dock Facilities – St. Joseph Segment

Facility Name	Facility Type	River Mile
Atchison Dock	Loading and unloading dock	421.1
Atchison County Co-Op Association	Grain unloading dock	420.9
Boldridge Quarry	Dock	418.5
Oak Mills Quarry	Dock	413.5
Westlake Quarry	Dock	413.0
West Bend State Park	Ramp	403.1
Hull Quarry	Dock	403.0
Leavenworth Park	Ramp	397.6
U.S. Coast Guard (Leavenworth)	Transfer of government materials dock	397.3
Leavenworth Boat Club	Ramp	396.8
Leavenworth Municipal Dock	Dock	396.1
Missouri Valley Steel Shipyard	Dock	395.6
Smoot Grain Co.	Grain loading dock	386.5
Cargill Inc.	Molasses unloading dock	386.4
Holliday Sand and Gravel Co.	Sand and gravel unloading dock	386.2
Massman Construction Co., Inc.	Construction materials and rock loading dock	385.0

Intake Systems for Power Plant Cooling and Process Water

The intake facility located at RM 378.7 provides cooling and process water to the 261-MW Nearman Bottoms coal-fired power plant operated by Kansas City Board of Public Utilities. The publicly owned utility serves approximately 65,000 electric customers in Wyandotte and Johnson Counties, Kansas.

A water intake facility located at RM 373.4 provides cooling and process water to the 239-MW coal-fired Quindaro Station operated by the Kansas City Board of Public Utilities. The Kansas City Board of Public Utilities abandoned one pump intake at this location and installed two new intakes to replace the original (USACE 2010c).

Table 3.5-8 Water Intake Facilities – Kansas City Segment

Facility Name[a]	River Mile
Johnson Co. Water District No. 1 (WaterOne)	380.0
Nearman Bottoms Power Plant (KCBPU)	378.7
Mid-Continent Asphalt & Paving	378.4
Kansas City, KS Water Co. (KCBPU)	373.5
Kansas City, KS Power & Light (KCBPU)	373.4
Kansas City, MO Water Department	371.0
Kansas City Power & Light Co. (KCP&L)	365.8
Kansas City Power & Light Co. (KCP&L)	358.2

[a] Names of water intake facilities were obtained from the Missouri River Navigation Charts and may not correspond to the current facility name or operating utility.

The intake facility located at RM 365.8 is used to withdraw water for the Trigen-Kansas City plant that provides heating and cooling for approximately one-third of the buildings in downtown Kansas City, Missouri and for a major industrial facility in North Kansas City.

The water intake facility at RM 358.2 provides cooling and process water to the Hawthorn Generating Station operated by the KCP&L. The plant can generate up to 565 MW of electricity, approximately 26 percent of the company's total production capacity. The KCP&L has installed new circulating water pumps and modified its intake structures in response to ongoing river bed degradation (of more than 5 feet) near these intake facilities (Heidtbrink pers. comm.).

Intake Systems for Public Water Supply

WaterOne operates an intake facility at RM 380.0 that currently supplies 125 million gpd of the District's 180-mgd total (Schrempp pers. comm. [b]). The facility was retrofitted in early 2004 with supplemental pumps to draw from lower elevations, at a cost of approximately $2 million, in order to guarantee service to 402,000 persons. The supplemental pump system lacks the intake capacity of the original design main pumps. When the Nearman Power Plant shuts down because of intake issues, the power supply to the WaterOne pumps is limited, which reduces the maximum pumping rate (Schrempp pers. comm. [c]).

The Kansas City Board of Public Utilities operates an intake facility at RM 373.5. The utility operates a collector well and treatment plant providing up to 45 mgd of water to approximately 51,000 water customers in Wyandotte and Johnson Counties, Kansas.

The Kansas City, Missouri Water Services Department (WSD), Water Supply Division processes drinking water for Kansas City residents and 33 wholesale customers in the greater Kansas City area. The division treats an average of 113 million gpd and supplies approximately 44 billion gallons of water annually (City of Kansas City, MO. 2010). A WSD intake facility is located at RM 371.0. One intake at this location was abandoned in the 1990s. The current intake facility operates six individual pumps. During periods of low flow, river bed degradation requires installation of four supplemental pumps that, combined, provide 50-percent capacity of the current intake system (Klender pers. comm.).

Water Supply Wells

The Kansas City Board of Public Utilities operates two horizontal collector wells in this segment that are capable of producing more than 80 million gallons of source water per day. These wells are the only water source for the Nearman Water Treatment Plant, which serves over 145,000 residents in Kansas City, Kansas and Wyandotte County. The State of Kansas has approved water rights for these wells based on scientific data demonstrating that the wells acquire 90 percent of their water from surface water (the Missouri River) and the remainder from groundwater. Within the next 2 years, these two wells will become the utility's sole source for water (Uden pers. comm.).

In March, 2010 WaterOne began operating a new horizontal collector well located on the Missouri River at approximately RM 385.5. The well includes approximately twelve 250-foot long radial collectors located approximately 90 feet below the ground surface, several of which are located approximately 50 feet below the river bed. The well is capable of producing 30 million gallons per day (Schrempp pers. comm. [d]).

Levees

Approximately 24 miles of federal levees are located along the LOMR in the Kansas City segment (Table 3.5-9). The Kansas City's Levee system is comprised of seven separate federal levee units: Fairfax-Jersey, North Kansas City, Central Industrial District, East Bottoms, Birmingham, Armourdale, and Argentine. The Armourdale and Argentine units are located on the Kansas River, but function as part of the Kansas City's Levee system. Levee Unit L-385 near the community of Riverside, Missouri was completed in 2005 and is located just upriver from the Kansas City's Levee system.

Together, the Kansas City's levee system and Levee Unit L-385 protect 154,566 acres of industrial, commercial, manufacturing, warehouse, retail, and residential land uses—including critical facilities such as power plants and water treatment plants. The levees protect approximately $19 billion of investment, including businesses and industries that provide nearly 100,000 jobs. Approximately 24,000 residents live behind these levees (USACE 2010b). Additional details on Levee Unit L-385 and the Fairfax-Jersey, North Kansas City, and East Bottoms Levee Units is presented below

Table 3.5-9 Federal Levee Units – Kansas City Segment

Unit Name	River Miles
Levee Unit L-385[a]	372.1–375.9
Levee Unit Fairfax-Jersey	374.0–367.5
Levee Unit North Kansas City	370.5–363.5
Levee Unit Central Industrial District	367.4–365.7
Levee Unit East Bottoms	365.7–357.5
Levee Unit Birmingham	360.3–354.0
Levee Unit Armourdale	Kansas River 2.1–6.5
Levee Unit Argentine	Kansas River 4.5–9.5

[a] L refers to left descending bank. The number is the river mile at the center point of the levee at the time it was authorized. The river miles do not match up exactly now, because of river cutoffs constructed since the levee was authorized.

Levee Unit L-385 (Riverside-Quindaro Bend)

The Riverside-Quindaro Bend Levee (Levee Unit L-385) consists of 4.7 miles of earthen levee along the left descending bank of the Missouri River at Riverside, Missouri. The levee system averages approximately 20 feet in height, varying from 15 feet to 23 feet, and provides 500-year floodplain protection to approximately 1,200 acres of land in the Missouri River valley, including undeveloped property, farm land, and a border area of light industrial development. The project was planned and implemented by the Quindaro Bend Drainage District and the USACE at a cost of over $87 million dollars. The undeveloped property in this flood-protected area includes the site of the Horizons Projects. The site is bounded by Interstate 635, has railroad access, and is near downtown Kansas City. The master plan calls for mixed-use development incorporating "new urbanism" design concepts. Levee Unit L-385 is the first levee in Missouri to integrate a trail for walking and running atop the levee. The Missouri Riverfront Trail winds through trees, past wetlands and bluffs, and connects with several

parks including E. H. Young Riverfront Park in Riverside, Missouri and English Landing Park in neighboring Parkville, Missouri (City of Riverside 2010).

North Kansas City Levee Unit

The North Kansas City Levee Unit protects a left bank area across the Missouri River from downtown Kansas City, Missouri. The protected area, which is essentially the city of North Kansas City, Missouri, includes nearly 1,100 residential units—home to almost 4,900 residents—and almost 500 businesses and facilities, including Kansas City's Charles B. Wheeler Downtown Airport. The BNSF and Norfolk Southern railroad yards are protected, in addition to a significant retail sector, numerous small businesses, warehouses, and industrial sites. Approximately 26,700 people work in North Kansas City. The levee unit's estimated protected investment is almost $3.5 billion, based on October 2008 prices. The existing condition of the river bed at RM 370.1, near the Charles B. Wheeler Downtown Airport, is estimated to have dropped 24 feet, resulting in loss of rock fill toe protection at one storm sewer outlet (USACE 2009a).

Fairfax-Jersey Levee Unit

The Fairfax-Jersey Levee Unit protects a right bank industrial area in Kansas City, Kansas. The protected area includes approximately 350 businesses and facilities, with a total estimated investment of almost $3.5 billion. A General Motors assembly plant anchors the area, which also includes large commercial, industrial, and public facilities such as Owens-Corning, Weyerhauser, and Certainteed. The area has no residents; however, the area's workforce exceeds 11,100 people. Analysis of the existing river bed condition at RM 367.8 indicates that a drop of 20 feet in the river bed already has occurred and is threatening a slide in the riverside bank (USACE 2009a).

East Bottoms Levee Unit

The East Bottoms Levee Unit protects a right bank industrial area of Kansas City, Missouri. The protected area contains approximately 750 businesses and homes with a total estimated value of approximately $5.4 billion. The industrial structure includes manufacturing, transportation, and major warehouse storage, as well as retail businesses. The approximately 500 companies and facilities in the area include a KCP&L plant, a water treatment plant, a Sears distribution center, Cargill, the Isle of Capri Casino, General Mills, and Bayer Corporation. Approximately 250 residential units also are protected. More than 3,200 residents live in the area, and more than 20,100 people are employed in East Bottoms businesses. At RM 364.5, a 15-foot drop in the river bed already has occurred (USACE 2009a).

Non-Federal Levees

Non-federal levees in the Kansas City segment are concentrated primarily upriver from Kansas City. Approximately 10 miles of levees in four separate units protect over 5,200 acres of primarily agricultural use along the mainstem LOMR (Figure 3.4-2, Sheet 2).

Bank Stabilization and Navigation Project Facilities

The USACE maintains 149 wooden pile and rock rip-rap dikes and approximately 42 miles of rock revetments along the navigation channel in the Kansas City segment as part of the BSNP (Figure 3.4-2, Sheet 2). The Kansas City reach has required installation of additional dikes to manage the sediment load from the Kansas River. The dike system has resulted in a reach of river that is very efficient at "cleaning" and maintaining the low-flow channel (USACE 2009a). As in other segments, the height of the dikes and revetments are maintained by the USACE, as measured against the CRP.

Bridge, Pipeline, and Cable Crossings

Eight vehicle bridges and three railroad bridges cross the Missouri River in the Kansas City segment (Table 3.5-10). Vehicle bridges carry large volumes of automobile and truck traffic in and through the Kansas City metropolitan area.

Table 3.5-10 Bridge Crossings – Kansas City Segment

Crossing Name (Route Number)	River Mile
Wolcott Highway Bridges (Interstate 435)	383.3
Kansas City Highway Bridge (Interstate 635)	374.1
Fairfax Highway Bridges (US 69)	372.6
Broadway Avenue Bridge	366.2
Hannibal Railroad Bridge	366.1
A.S.B. Railroad Bridge	365.6
Heart of America Bridge (Route 9)	365.5
Paseo Bridge (Interstate 29 & 35)	364.8
Chouteau Highway (Route 269)	362.3
Interstate 435 Bridge	360.3
Harry S. Truman Railroad Bridge	359.3

Highway bridges connecting Kansas and Missouri are jointly operated and maintained by the KDOT and the MoDOT. The Broadway Avenue Bridge is operated and maintained by the Kansas City, Missouri Department of Public Works. In 2009, the average AADT volume was 14,705 on the Fairfax Highway Bridges (US 69), 24,500 on the Wolcott Highway Bridges (Interstate 435), 46,640 on the Kansas City Highway Bridge (Interstate 635), 72,782 on the Paseo Bridge (Interstate 29 and 35), and 83,379 on the Interstate 435 Bridge (MoDOT 2009).

The Wolcott Highway Bridges carrying Interstate 435 over the Missouri River at RM 383.3 are founded on deep-drilled shafts 62 feet below the streambed (Orth pers. comm.). The Wolcott Highway Bridges are currently being monitored by the MoDOT for scour. If necessary, the MoDOT will use countermeasures to control river bed degradation and scour by installing spur dikes (finger dikes that project out into the river to direct water back toward the channel) or by placing gabions (large rectangular wire baskets containing rock) or dumping rock around bridge footings (Stotlemeyer pers. comm.).

The three railroad bridges in the Kansas City segment are located in the urban/industrial portions of Kansas City at RM 366.1, RM 365.6, and RM 359.3. Kansas City is the second largest rail hub in the United States, and is a major distribution and intermodal center. No information on the condition of these bridges was available.

The natural gas, liquid petroleum, water and sewer, and telecommunication lines in the Kansas City segment are concentrated in the urbanized areas approximately 10 miles upriver and downriver from the heart of Kansas City (Table 3.5-11). Williams Brothers Pipeline Company (RM 372.5) owns and operates six pipelines in the area. AT&T operates one telecommunication line, and the City of Kansas City, Missouri operates water and sewer lines in this area. An inspection report completed in February 1999 reported that pipelines in this area were exposed and sensitive to changes in river bed elevations (West Consultants 1999). No additional inspection data have been obtained.

Wharf and Dock Facilities

There are 35 wharf and dock facilities in the Kansas City segment (Table 3.5-12). These facilities service commerce and recreation. In addition to loading and unloading facilities, boat ramp access is scattered throughout the segment. The segment is served by one fuel dock at RM 364.1.

Table 3.5-11 Pipeline and Cable Crossings – Kansas City Segment

Crossing Name	Utility Type	River Mile
Williams Natural Gas	Pipeline	375.2
AT&T	Cable	374.0
Williams Brothers	Pipeline	374.0
Skelly Pipeline	Pipeline	373.9
Williams Brothers	Pipeline(s)	372.5
Williams Brothers	Pipeline	369.5
Kansas City, MO Water	Tunnel	366.1
Kansas City, MO Sewer	Pipeline(s)	361.2
American Oil	Pipeline	356.5

Table 3.5-12 Wharf and Dock Facilities – Kansas City Segment

Facility Name	Facility Type	River Mile
Smoot Grain Co.	Grain loading dock	386.5
Cargill, Inc.	Molasses unloading dock	386.4
Holliday Sand and Gravel Co.	Sand and gravel unloading dock	371.8
Massman Construction Co., Inc.	Construction materials and rock loading dock	385.0
Holliday Sand and Gravel Co.	Sand and gravel unloading dock	378.3
English Landing Park	Ramp	377.3
Texaco Oil Co.	Bulk petroleum storage	376.3
Intercontinental Engineering and Manufacturing Co.	Loading and unloading dock	375.6
Union Equity Co-Op	Grain loading dock	373.0
Bennett Rogers Pipe Coating, Inc.	Bulk and liquid unloading dock	372.4
William Brothers Pipeline Fertilizer	Liquid fertilizer solutions unloading dock	368.2
Bartlett and Company Inc.	Grain loading dock	367.7
Kansas City, KS Public Terminal	Loading and unloading dock	367.7
Missouri River Queen	Loading and unloading dock	367.4

Table 3.5-12 Wharf and Dock Facilities – Kansas City Segment

Facility Name	Facility Type	River Mile
Holliday Sand and Gravel Co.	Sand and gravel unloading dock	371.8
Midwest Term. Warehouse Co.	Grain loading dock and warehouse	367.1
Kansas City, MO Public Terminal	Loading and unloading dock	367.1
American Compressed Steel Co.	Scrap and steel loading dock	366.9
Kansas City, MO	Warehouse, dock, and platform	365.9
Kansas City, MO	Loading dock	365.4
Cargill Grain, Inc.	Grain loading dock	364.2
Brochers Fuel	Fuel dock	364.1
Kansas City River Access	Ramp	363.0
Continental Grain Co.	Grain loading dock	361.6
K.C. Terminal Elevator Co.	Grain loading dock	361.0
Chemtech Corp.	Chemical loading and unloading dock	360.6
La Moth Landing	Coke loading and unloading dock	360.4
Midwest Precote Quarry	Dock	359.9
Armco Steel Co.	Scrap steel unloading dock	357.6
Amoco Oil Co. (Distribution Center)	Unloading dock	356.6
Chevron Chemical Co.	Fertilizer unloading dock	355.8
Kansas City River Terminal	Fertilizer unloading dock	355.8
Mo. Portland Cement Co.	Cement loading dock	354.8
La Benite Recreation Park	Ramp	352.6
Eton Tower (Wake) Quarry	Dock	350.4

3.5.4.3 Waverly Segment

Two dredging sand plants are located in the Waverly segment, and two dredging companies are actively mining in the segment. The Waverly segment has experienced an average of approximately 1 foot of aggradation between 1998 and 2007, and 1.7 feet of aggradation between 1998 and 2009.

Water Intake Facilities

Five water intake facilities are located in the Waverly segment (Table 3.5-13). Two of these intake facilities provide cooling and process water for power plant processes. The City of Independence, the Sibley Power Station, U.S. Water Company, and Higginsville Municipal Utilities rely on these intake facilities.

Intake Systems for Power Plant Cooling and Process Water

In the Waverly segment, the intake system at RM 345.2 provides cooling and process water for the 46-MW coal-fired Independence Power Plant owned and operated by Independence Power & Light (IPL). IPL is a non-profit, municipally owned electric utility serving more than 50,000 consumers in Independence, Missouri. A water intake system for the Sibley Power Plant is located at RM 336.5. The Sibley plant is a 524-MW coal-fired power plant owned and operated by the KCP&L. The KCP&L services more than 820,000 customers in 47 northwestern Missouri and eastern Kansas counties with 15 generating facilities that generate over 6,100 MW. The Sibley plant generates approximately 8.6 percent of the company's electric power.

Table 3.5-13 Water Intakes – Waverly Segment

Facility Name[a]	River Mile
Independence Power Plant	345.2
Sibley Power Plant	336.5
U.S. Water Company	322.0
U.S. Water Company	317.0
Higginsville Water Department	307.0

[a] Names of water intake facilities were obtained from the Missouri River Navigation Charts and may not correspond to the current facility name or operating utility.

Intake Systems for Public Water Supply

Two intake facilities on the LOMR in the Waverly segment (at approximately RM 322 and RM 317) are owned and operated by the U.S. Water Company. These intakes supply a single water filtration plant that serves approximately 2,300 customers (Luehrs. pers. comm.). Average consumption is 560,000 gpd, with peak consumption at 700,000 gpd.

The Higginsville Water Department operates a movable pump intake system at RM 307. The intake hose is laid along the river bottom and is used to supplement water supply in a city-owned lake located

approximately 2 miles east of Higginsville, Missouri. When water levels at the lake are low, the intake system withdraws water that is pumped 11 miles to the lake (MDNR 2002). The intake location is underlain with rock, but sand and silts have buried this area, requiring increased maintenance and frequent replacement of the pump shaft (Urfer pers. comm.). The intake requires constant maintenance and adjustment due to sediment accumulation at the facility, as it is located in an area where the river bed is aggrading. The Higginsville system can produce up to 2.5 million gpd and supplies the citizens of Higginsvillle, three other communities, and a rural water district. It also has sufficient excess capacity to meet the needs of new large industrial customers.

Water Supply Wells

The City of Independence, Missouri operates a horizontal collector well that collects water from beneath the Missouri River at RM 353.5. This well produces 6,940 gallons per minute which accounts for a significant percentage of the water provided to the City's customers (Kelly. 2010).

Levees

Only one federal levee unit is located in the Waverly segment. Levee Unit R-351 extends approximately 10.3 miles from RM 350.0 to RM 339.7. The levee protects a large agricultural area located on the right bank (south side) of the river. Levee Unit R-351 protects approximately 8,861 acres of rural agricultural land use, a population of approximately 265, and approximately $15 million in investment (USACE 2010b).

Non-federal levees in the Waverly segment are more common than in all the other segments combined. Over 130 miles of levees in approximately 25 separate units protect over 362,000 acres of primarily agricultural lands, small towns, and farms along the mainstem LOMR (Figure 3.4-2, Sheet 3).

Bank Stabilization and Navigation Project Facilities

The USACE maintains approximately 558 wooden pile and rock rip-rap dikes and approximately 127 miles of rock revetments along the navigation channel in the Waverly segment as part of the BSNP (Figure 3.4-2, Sheet 3). As in other segments, the height of dikes and revetments are maintained by the USACE, as measured against the CRP.

Bridge, Pipeline, and Cable Crossings

Four vehicle bridges and one railroad line cross the Missouri River in the Waverly segment (Table 3.5-14). The highway bridges are operated and maintained by the MoDOT. In 2009, the AADT

volume was 22,313 on Independence Liberty Highway (US 291), 4,579 on Lexington Highway (Route 224), 3,736 on Waverly Highway (US 65), and 2,140 on Miami Highway (Route 41). These numbers show a clear decline in traffic volumes the farther one travels east of Kansas City (MoDOT 2009). The MoDOT has not reported any major scour problems at these bridges.

Table 3.5-14 Bridge Crossings – Waverly Segment

Crossing Name (Route Number)	River Mile
Independence Liberty Highway (US 291)	352.7
Sibley Railroad	336.2
Lexington Highway (Route 224)	317.3
Waverly Highway (US 65)	293.4
Miami Highway (Route 41)	262.2

The BNSF owns and operates the Sibley Railroad Bridge at RM 336.2. No information on the condition of this bridge was available.

Multiple pipeline crossings occur in the Waverly segment (Table 3.5-15). Based on the identified ownership, these pipelines were assumed to be transporting liquid petroleum products. No issues have been reported with these crossings.

Table 3.5-15 Pipeline Crossings – Waverly Segment

Crossing Name	Utility Type	River Mile
Sinclair Refining	Pipeline(s)	333.9
Service Co.	Pipeline	297.8
Amoco	Pipeline(s)	296.0

Wharf and Dock Facilities

Twenty wharf and dock facilities are located in the Waverly segment (Table 3.5-16). These facilities service commerce and recreation. In addition to loading and unloading facilities, boat ramp access is scattered throughout the segment.

Table 3.5-16 Wharf and Dock Facilities – Waverly Segment

Facility Name	Facility Type	River Mile
Missouri Rock Quarry	Unloading dock	345.7
Independence Power Plant	Unloading dock	345.3
Little Blue Recreation Park	Ramp	339.4
Fort Osage	Ramp	337.2
Sibley Power Plant	Coal unloading	336.7
Orrick (Jefferies) Quarry	Rock loading	333.5
U.S. Army Corps of Engineers	Transfer of government materials dock	328.6
M.F.A. Central Co-Op	Grain loading	318.2
Raymond Driver Sand Co.	Sand unloading	317.9
Green Quarries	Sand unloading	317.1
Battle of Lexington State Park	Ramp	316.4
Port of Waverly Recreation Area	Ramp	293.5
Alma Farmers Co-Op Association	Grain loading	293.3
Bartlett and Company, Inc.	Grain loading	293.0
Green Quarries	Sand unloading	286.9
Blue Mound (Green) Quarry	Dock	269.8
Malan Quarry	Dock	263.2
Snake Bluff Recreation Park	Ramp	262.8
Slater Cooperative Association No. 1	Grain loading	262.7
Brunswick River Terminal, Inc.	Bulk fertilizer unloading	256.3

3.5.4.4 Jefferson City Segment

Five dredging sand plants are located in the Jefferson City segment, and three dredging companies are actively mining in the segment. Several miles of river bed in the segment have aggraded as much as 2 feet since 1990. However, just downstream of this aggradation, the dredging locations correlate to a reversal in river bed trends. Downstream of Booneville, the river bed has degraded as much as 4 feet (USACE 2009a).

Water Intake Facilities

Three municipal water intake facilities are located in the Jefferson City segment (Table 3.5-17). The City of Glasgow, the Boonville Public Works Department, and the Missouri-American Water Company rely on these intakes.

Table 3.5-17 Water Intake Facilities – Jefferson City Segment

Facility Name[a]	River Mile
Glasgow Waterworks	226.8
Boonville Water Company	197.5
Jefferson City Water Company	144.0

[a] Names of water intake facilities were obtained from the Missouri River Navigation Charts and may not correspond to the current facility name or operating utility.

The water intake at RM 226.8 provides water to the small town of Glasgow, Missouri (population 1,199 in 2008). The MDNR reports that the pump capacity at this intake system is 500 gallons per minute (gpm) (720,000 gallons per day) (MDNR 2010).

A similar intake serving the town of Boonville (population 8,770 in 2008) is located at RM 197.5. The intake structure was reconstructed approximately 15 years ago to improve performance and reduce maintenance. There is adequate armoring around the intakes, and no erosion problems are known (Cauthon pers. comm.). The MDNR reports that the pump capacity for this intake system is 20,000 gpm (28,000,000 gallons per day) (MDNR 2010).

The Missouri American Water Company operates an intake system at RM 144.0 that supplies a water treatment plant in Jefferson City. The MDNR reports that the pump capacity for this intake system is 4,875 gpm (7,020,000 gallons per day) (MDNR 2010).

Water Supply Wells

No horizontal collector wells have been identified in the Jefferson City segment.

Levees

Two federal levee units are located in the Jefferson City segment (Table 3.5-18). These levees extend for approximately 22.5 miles along the left bank of the Missouri River from the town of Brunswick on the

Grand River to the town of Glasgow. These levees protect approximately 44,200 acres of agricultural lands, homes, and businesses; a population of approximately 233; and approximately $67 million in investments (USACE 2010b).

Non-federal levees along the LOMR and its major tributaries are distributed throughout the Jefferson City segment. Nearly 100 miles of levees in approximately 25 separate units protect over 91,000 acres of primarily agricultural lands, small towns, and farms along the mainstem LOMR (Figure 3.4-2, Sheet 4).

Table 3.5-18 Levee Units – Jefferson City Segment

Unit Name	River Miles
Levee Unit L-246[a]	250.0–239.0
Levee Unit L-234/Lower Chariton	238.8–227.3

[a] L refers to left descending bank. The number is the river mile at the center point of the levee at the time it was authorized. The river miles do not match up exactly now, because of river cutoffs constructed since the levee was authorized.

Bank Stabilization and Navigation Project Facilities

The USACE maintains approximately 735 wooden pile and rock rip-rap dikes and over 121 miles of rock revetments along the navigation channel in the Jefferson City segment as part of the BSNP (Figure 3.4-2, Sheet 4). As in other segments the height of dikes and revetments are maintained by the USACE, as measured against the CRP.

Bridge, Pipeline, and Cable Crossings

Four vehicle bridges and two railroad lines cross the Missouri River within the Jefferson City segment (Table 3.5-19). The highway bridges are operated and maintained by the MoDOT. In 2009, the AADT volume was approximately 1,149 on the Glasgow Highway (Route 240), 6,670 on the Boonville Highway (Routes 5 and 87), 31,421 on the Rocheport Highway (Interstate 70), and 29,832 on the Jefferson City Highway (US 63 and US 54) (MoDOT 2009). The MoDOT has reported that Jefferson City Highway (US 63 and US 54) is currently being monitored for scour problems (Stotlemeyer pers. comm.).

The M.K.T. railroad bridge located at RM 197.1 crosses the Missouri River near the town of Boonville. This bridge is no longer in operation, and the movable span has been left in the elevated, non-passable

position. The Chicago, Missouri & Western Railroad located at RM 226.3 crosses the river in the town of Glasgow. No information on the condition of these bridges was available.

Table 3.5-19 Bridge Crossings – Jefferson City Segment

Crossing Name (Route Number)	River Mile
Chicago, Missouri & Western Railroad	226.3
Glasgow Highway (Route 240)	226.3
M.K.T. Railroad	197.1
Boonville Highway (Routes 5 and 87)	196.6
Rocheport Highway (Interstate 70)	185.0
Jefferson City Highway (US 63 and US 54)	143.9

There are eight pipeline crossings and three cable crossings in the Jefferson City segment (Table 3.5-20). One of the cable crossings is operated by Missouri River Light and Power, and another by Columbia Power. The third cable crossing is an AT&T communication line. Panhandle Eastern maintains two pipeline crossings near Boonville (RM 198.3 and RM 199.3). Currently, the pipelines are buried and threatened only by potential flooding. Pipelines are inspected by divers every 3 years (Howard pers. comm.). Divers investigate river channel bottoms along pipeline alignments to determine whether pipelines are exposed. If pipelines are exposed, they are also inspected for signs of damage.

Wharf and Dock Facilities

There are 25 wharf and dock facilities in the Jefferson City segment (Table 3.5-21). These facilities serve commerce and recreation. In addition to loading and unloading facilities, boat ramp access is scattered throughout the segment.

Table 3.5-20 Pipeline and Cable Crossings – Jefferson City Segment

Crossing Name	Utility Type	River Mile
Sinclair Refining	Pipeline	242.5
Panhandle Eastern	Pipeline	199.3
Panhandle Eastern	Pipeline	198.3
Panhandle Eastern	Pipeline	197.4
AT&T	Cable	186.5
Columbia Power	Cable	182.2
Texas Empire	Pipeline	175.2
Williams Brothers	Pipeline	174.6
Texas Empire	Pipeline	174.5
Missouri River Light and Power	Cable	143.8
City of Jefferson City Sewer	Pipeline	143.5

Table 3.5-21 Wharf and Dock Facilities – Jefferson City Segment

Facility Name	Facility Type	River Mile
Franklin (Woods) Quarry	Dock	245.1
Glasgow Co-Op Association	Grain loading	226.4
U.S. Army Corps of Engineers	Loading platform	226.4
Capitol Sand Co.	Sand and gravel unloading dock	226.2
Stump Island Recreation Park	Ramp	226.1
Glasgow Quarries	Rock loading dock	219.0
Sites Quarry	Dock	207.0
Missouri River Sand and Gravel Co.	Sand and gravel unloading dock	197.0
Interstate Marine Terminal	Fertilizer, grain, and molasses	196.4
Howard-Cooper Co. Port Authority	Loading and unloading dock	196.4
Franklin Island Access	Ramp	195.5
Columbia (Missouri River) Sand Co.	Sand and gravel unloading dock	186.3
George Russell Quarry	Dock	185.6
Taylors Landing Recreation Park	Ramp	185.1
Capitol Sand Co.	Sand and gravel unloading dock	181.6
Hunts Quarry	Dock	181.5

Table 3.5-21 Wharf and Dock Facilities – Jefferson City Segment

Facility Name	Facility Type	River Mile
Murrell Quarry	Dock	177.1
Sandy Hook Quarry	Dock	164.2
Wilton Boat Club	Ramp	161.0
Marion Access	Ramp	158.0
Marion Quarry	Dock	157.6
Amoco Oil Co.	Unloading dock	148.7
U.S. Army Corps of Engineers	Transfer of government materials dock	143.6
Jefferson City River Terminal Co.	Loading and unloading dock	143.3
Capitol Sand Co.	Sand and gravel unloading dock	143.2

3.5.4.5 St. Charles Segment

Eight dredging sand plants are located in this segment, and five dredging companies are actively mining. River bed degradation for the entire segment has ranged from 2 to 5 feet since 1990, and the greatest degradation is near the most intense dredging for gravel extraction (USACE 2009b).

Water Intake Facilities

Nine water intake facilities are located in this segment (Table 3.5-22). The St. Charles segment services a highly urbanized portion of the LOMR. Three intake facilities provide cooling and process water for power plants, while the remainder serve as municipal water supply intakes. The City of St. Louis Water Division, the Ameren Callaway Nuclear Power Plant, the Ameren Labadie Power Plant, and the Central Electric Power Cooperative rely on these intake facilities.

Intake Systems for Power Plant Cooling and Process Water

The water intake structure at RM 117.0 provides cooling and process water to the Chamois Power Plant owned and operated by the Central Electric Power Cooperative, headquartered in Jefferson City, Missouri. The electric generation and transmission cooperative and is an independent, locally-owned business. The 68-MW Chamois Power Plant is coal-based and delivers power to eight distribution cooperatives covering a 22,000-square-mile area in central Missouri.

Table 3.5-22 Water Intake Facilities – St. Charles Segment

Facility Name[a]	River Mile
Chamois Power Plant	117.0
Callaway Power Plant	115.4
Labadie Power Plant	57.7
City of St. Louis Waterworks[b]	37.0
St. Louis County Waterworks	36.3
St. Louis County Waterworks	36.2
St. Louis County Waterworks	20.5
St. Louis County Water Dept.	20.2

[a] Names of water intake facilities were obtained from the Missouri River Navigation Charts and may not correspond to the current facility name or operating utility.

[b] This is the Howard Bend Plant which is capable of pumping 236 Million gallons per day and is protected from flooding by a flood wall.

The water intake facility at RM 115.4 provides cooling and process water to the Callaway Nuclear Generating Station located near Fulton, Missouri. The Callaway plant has generating capacity of 1,190 MW and is owned and operated by AmerenUE (AmerenUE 2010). According to the MDNR, the pumping capacity at the intake facility is 42,000 gpm (MDNR 2010).

AmerenUE also owns and operates the Labadie Power Station that withdraws cooling and process water from an intake facility located at RM 57.7. The Labadie coal-fired plant is capable of generating 2,389 MW of electricity (AmerenUE 2010). According to the MDNR, the pumping capacity at the intake facility is 1,021,064 gpm (MDNR 2010).

AmerenUE is Missouri's largest electric utility and provides electric service to approximately 1.2 million customers across central and eastern Missouri, including the greater St. Louis area. AmerenUE serves 57 Missouri counties and 500 towns; more than one-half (55 percent) of AmerenUE's electric customers are located in the St. Louis metropolitan area (AmerenUE 2010).

Intake Systems for Public Water Supply

Six additional water intakes located between RM 37.0 and RM 20.2 supply drinking water to more than 1 million people, including business and industry, within the greater St. Louis metropolitan area.

Water Supply Wells

No horizontal collector wells have been identified in the St. Charles segment.

Levees

One small federal levee (New Haven) is located on the right bank of the Missouri River in the St. Charles segment, between RM 81.7 and RM 81.4 in the town of New Haven. The levee protects 15 acres, 15 residents, and nearly $11 million in investment.

An extensive network of non-federal levees is located along this segment, extending from approximately RM 130 to RM 55. Nearly 90 miles of levees in approximately 20 separate units protect approximately 58,000 acres of primarily agricultural lands, small towns, and farms along the mainstem LOMR (Figure 3.4-2, Sheet 5). Additional non-federal levees are located between RM 55 and RM 0, but detailed information on these levees was not available.

Bank Stabilization and Navigation Project Facilities

The USACE maintains approximately 729 wooden pile and rock rip-rap dikes and over 129 miles of rock revetments along the navigation channel in the St. Charles segment as part of the BSNP (Figure 3.4-2, Sheet 5). As in other segments the height of dikes and revetments are maintained by the USACE, as measured against the CRP.

Bridge, Pipeline, and Cable Crossings

There are nine bridges crossing on the Missouri River in the St. Charles segment, seven highway crossings, and two railroad line crossings (Table 3.5-23). The MoDOT reports that the bridges in this segment have deep foundations secured to competent material. No information was available on the condition of the railroad bridges. Traffic volumes on the highway bridges range from approximately 5,325 AADT at the Hermann Highway Bridge crossing (Route 19) at RM 97.9 to approximately 166,242 AADT at the Interstate 70 crossing at RM 29.6 (MoDOT 2009).

There are seven pipeline crossings and three cable crossings in the St. Charles segment (Table 3.5-24). One of the cable crossings is operated by Union Electric Company and another by Central Electric Power. The third cable crossing is an AT&T communication line.

Table 3.5-23 Bridge Crossings – St. Charles Segment

Crossing Name (Route Number)	River Mile
Bellefontaine Highway (US 67)	8.1
Burlington Northern Inc. Railroad	8.2
Proposed New Highway (MO 115)	27.0
Norfolk & Southern Railroad	27.1
St. Charles Highway (MO 115)	28.2
Interstate 70 & US 40	29.6
Weldon Springs Highway (US 40 & 61)	43.9
Washington Highway (Route 47)	67.6
Hermann Highway (MO 19)	97.9

Table 3.5-24 Pipeline and Cable Crossings – St. Charles Segment

Crossing Name	Utility Type	River Mile
Laclede Gas Co.	Pipeline	8.0
Union Electric Co.	Cable	19.6
AT&T	Cable	26.5
St. Peters Water	Pipeline	34.5
Shell	Pipeline	44.2
Shell	Pipeline	44.5
Explorer	Pipeline	54.4
Ajax	Pipeline	66.0
Gulf Central	Pipeline	101.1
Central Electric Power	Cable	113.9

Wharf and Dock Facilities

There are 31 wharf and dock facilities in the St. Charles segment (Table 3.5-25). These facilities service commerce and recreation. In addition to loading and unloading facilities, boat ramp access is scattered throughout the segment. The segment is served by one marina (Olympic Marina and Harbor Services).

Table 3.5-25 Wharf and Dock Facilities – St. Charles Segment

Facility Name	Facility Type	River Mile
Central Stone Company	Loading dock	7.8
West Lake Quarry Material Co., Inc.	Rock loading, sand and gravel unloading	8.4
Masker Marine Railway	Dock	8.6
Sioux Passage Park	Ramp	10.4
Riverview Sand and Dredging Co.	Rock loading, sand and unloading	16.7
Tiemann Boat Ramp	Ramp	18.3
Blanchette Access	Ramp	27.2
St. Charles Sand Co.	Sand and gravel unloading dock	27.8
St. Charles Sand Co.	Sand, salt and lightweight materials unloading	28.1
Frontier Park	Ramp	28.5
St. Charles Quarry Co.	Rock loading, sand and gravel unloading	31.3
St. Charles Sand Co.	Sand and gravel unloading dock	43.9
Hamberg Quarry	Dock	47.3
Weldon Spring Access	Ramp	48.4
Daniel Boone Access Area	Ramp	55.5
Berg (Matson) Quarry	Dock & Ramp	56.2
Washington Sand Co.	Sand and gravel unloading dock	68.1
Washington Public Boat Ramp	Ramp	68.2
Washington Boat Club	Ramp	68.3
Olympic Marina and Harbor Services	Gas and oil	68.6
New Haven	Ramp	81.5
Maczuk Industries, Inc.	Loading dock	81.7
Meyer Quarry	Dock	85.4
Hermann Sand and Gravel, Inc.	Sand unloading	96.9
U.S. Army Corps of Engineers	Dock, harbor, and boatyard	104.4
Two Rivers Sand and Gravel	Dock	114.1
Chamois Power Plant	Coal unloading	117.1
Chamois Access Area	Ramp	118.0
Callaway County Sand Co.	Sand and gravel unloading dock	124.5
Mokane Access Area	Ramp	124.7
Massaman Quarry	Dock	126.2

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