4.2 Surface Water

This section describes the analysis of potential impacts to surface water from construction and operation of the proposed Port MacKenzie Rail Extension. Section 4.2.1 describes the surface water study area, Section 4.2.2 describes the methods employed to analyze impacts to surface water, Section 4.2.3 describes the affected environment (existing conditions), Section 4.2.4 describes potential environmental consequences (impacts), and Section 4.2.5 describes unavoidable environmental consequences of the proposed action to surface water from the proposed rail line.

4.2.1 Study Area

The proposed Port MacKenzie Rail Extension would be northwest of Anchorage on the west side of the Knik Arm. The area is within the Matanuska-Susitna Borough (MSB or Borough) Susitna River valley, bounded by the Susitna River on the west, Knik Arm of Cook Inlet on the south and east, and Parks Highway and the existing Alaska Railroad Corporation (ARRC or the Applicant) main line on the north. The Susitna River watershed is approximately 20,752 square miles; it is the fifth largest basin in Alaska, comprising more than half of the Cook Inlet drainage basin (USGS, 1999). Surface drainage in the area is generally to the west and south. Subsequently, areas drain into Cook Inlet, Knik Arm, or the Susitna River, which then discharge into Cook Inlet (ARRC, 2008). The study area for surface waters is the area within the proposed rail line footprint and 200-foot ROW.

4.2.2 Analysis Methodology

The Applicant performed a hydrologic review of the study area to identify surface water resources. The Applicant identified stream, river, and lake crossings from field surveys and orthoimagery. After the Applicant's analysts identified crossing locations, they delineated crossing-location drainage areas with the Environmental Systems Research Institute (ESRI) ArcHydro computer program. After computing flow directions based on a U.S. Geological Survey 2 arc-second (30-meter) digital elevation map, analysts obtained a flow accumulation grid for the study area and then used ArcHydro to delineate the catchment of each crossing location based on the flow direction and accumulation patterns.

The study area was then divided into catchments using ArcHydro based on available hydrological data. Streams and lakes were associated with each sub-catchment in Geological Information System (GIS) analysis, and then networked by designating points of connection (nodes) between all stream segments, lakes, ponds, and potential railroad crossings. Catchments, streams, and lakes were evaluated using ESRI Spatial Analyst (2009) extensions. Catchments were examined in GIS to determine their surface area, perimeter, elevation, average slope, rugosity, and present storage (surface area of lakes and ponds versus surface area of the catchment). Lakes and ponds were examined in GIS to determine their perimeter, surface area, and elevation. Streams were examined to determine their length, slope, and stream order in the network (Strahler, 1952). This geomorphic information was used to estimate flow exceedances for each catchment using U.S. Geological Survey methods (Curran et al, 2003), and subsequently to support the fisheries and Essential Fish Habitat analysis.

Analysts subsequently checked and refined the computer-generated delineations using U.S. Geological Survey digital topographic quadrangle maps, aerial imagery, and field survey information. Several minor refinements to crossing locations resulted from Office of Environmental Analysis (OEA) field studies in 2008. Analysts calculated the design flow used to size hydraulic structures for mapped streams for the 100-year flood event, as recommended by the American Railway Engineering and Maintenance-of-Way Association.

Crossing structures would consist of bridges, culverts, natural bottom plate or pipe arches, and other drainage structures. Crossing structures identified as "drainage structures" would be determined by the Applicant during the final design process and could include multi-plate culverts, pre-cast arches, and single or multiple short-span bridges. In addition, the Applicant would extend existing culverts and construct new bridges for rail sidings proposed along the existing ARRC main line where any of the alternatives would connect to the main line. The Applicant's hydrologic review report is a preliminary analysis that determined the approximate locations of crossings and types of conveyance structures; final locations, conveyance structures, and structure sizes would be determined during final design and permitting. OEA conducted an independent review of the Applicant's methodology and hydrologic review report.

OEA used the results of the Applicant's hydrologic review report to qualitatively analyze potential impacts to surface water from the proposed rail line. The analysis incorporated review of existing ARRC project descriptions, ARRC's voluntary proposed mitigation measures, and further review of waterbodies using GIS. OEA collected stream-characteristic and water-quality data at ARRC-proposed stream crossing locations in the summer of 2008 (Noel *et al.*, 2008) and considered these data in the analysis of potential impacts to surface water. OEA's surface water impact analysis focuses on general impacts to water quality and hydrology, which are based on rail line construction activities and conveyance structures proposed at each crossing. This section also addresses potential impacts to water quality during rail line operation. Other parts of this EIS address potential impacts to other resources associated with or that depend on surface waters, such as fisheries (Section 5.4 and Appendix F), floodplains (Section 4.4), navigation (Chapter 12), wetlands (Section 4.5 and Appendix C), Essential Fish Habitat (Section 5.4 and Appendix G), and subsistence (Chapter 7).

4.2.3 Affected Environment

4.2.3.1 Hydrologic Environment

Surface water in the study area includes streams and rivers, lakes, and wetlands. Smaller streams join to form larger streams; the continued joining eventually forms rivers that ultimately flow into lakes, wetlands, or Cook Inlet. The interconnected system of moving waterbodies is a watershed. Watersheds are defined by the drainage basins or drainage divides, and can be discussed on small, local scales or on large scales. One watershed or basin can be comprised of multiple sub-watersheds or sub-basins.

The proposed rail line would lie within the following 9 watersheds (see Figure 4.2-1):

- Little Willow Creek watershed (172 square miles) includes Rogers Creek and many unnamed tributaries in the Talkeetna Mountains. Little Willow Creek begins at its headwaters in the Talkeetna Mountains and flows approximately 43 miles through the MSB before discharging into the Susitna River. Six miles of the Willow Segment would transect this watershed.
- Willow Creek watershed (254 square miles) includes many small tributaries in the Talkeetna Mountains. Willow Creek begins at its headwaters in the Talkeetna Mountains and flows approximately 40 miles through the MSB before discharging into the Susitna River. One mile of the Willow Segment would transect this watershed.
- The Susitna River watershed is extensive (6,160 square miles) and includes many major river tributaries. The Lower Susitna River sub-basin includes Little Willow Creek, Willow Creek, Rolly Creek, Fish Creek, and other small unnamed creeks before discharging into Cook Inlet. Approximately 8 miles of the Willow Segment would transect this watershed.
- Rolly Creek watershed (13 square miles) includes North Rolly Lake and many minor tributaries. Rolly Creek flows approximately 7 miles through the MSB before discharging into the Susitna River. Four miles of the Willow Segment would transect this watershed.
- Fish Creek watershed (111 square miles) includes Lynx Creek and many small creeks in the Red Shirt Lake area. Fish Creek flows approximately 30 miles through the MSB before discharging into Flat Horn Lake and then into the Susitna River. Eight miles of the Willow Segment would transect this watershed.
- The Little Susitna River watershed (373 square miles) includes Lake Creek and other small unnamed tributaries. The Little Susitna River begins in the Talkeetna Mountains at Hatcher Pass and flows approximately 122 miles through the MSB and discharges into Cook Inlet (Wasilla SWCD, 2009). All of the rail line segments would transect this watershed, ranging from 2 miles for the Big Lake Segment to 10 miles for the Houston Segment.
- Big Lake Drainage Area watershed (120 square miles) includes Meadow Creek, Little Meadow Creek, Lucile Creek, Big Lake, and Fish Creek. The waterbodies of the Big Lake Drainage Area flow approximately 52 miles through the MSB before discharging into the Knik Arm. Fourteen miles of the Big Lake Segment would cross this watershed.
- Goose Creek watershed (43 square miles) includes Stephens Lake and many small unnamed tributaries in the study area. Goose Creek flows for approximately 14 miles before discharging into Knik Arm. Six miles of the Big Lake Segment would transect this watershed.
- East Susitna Flats watershed (66 square miles) is a nearly flat drainage system of many small unnamed streams discharging into Cook Inlet. About 8 miles of the Mac East Segment, 7.5 miles of the Mac East Variant Segment, and 9 miles of the Mac West Segment would transect this watershed.

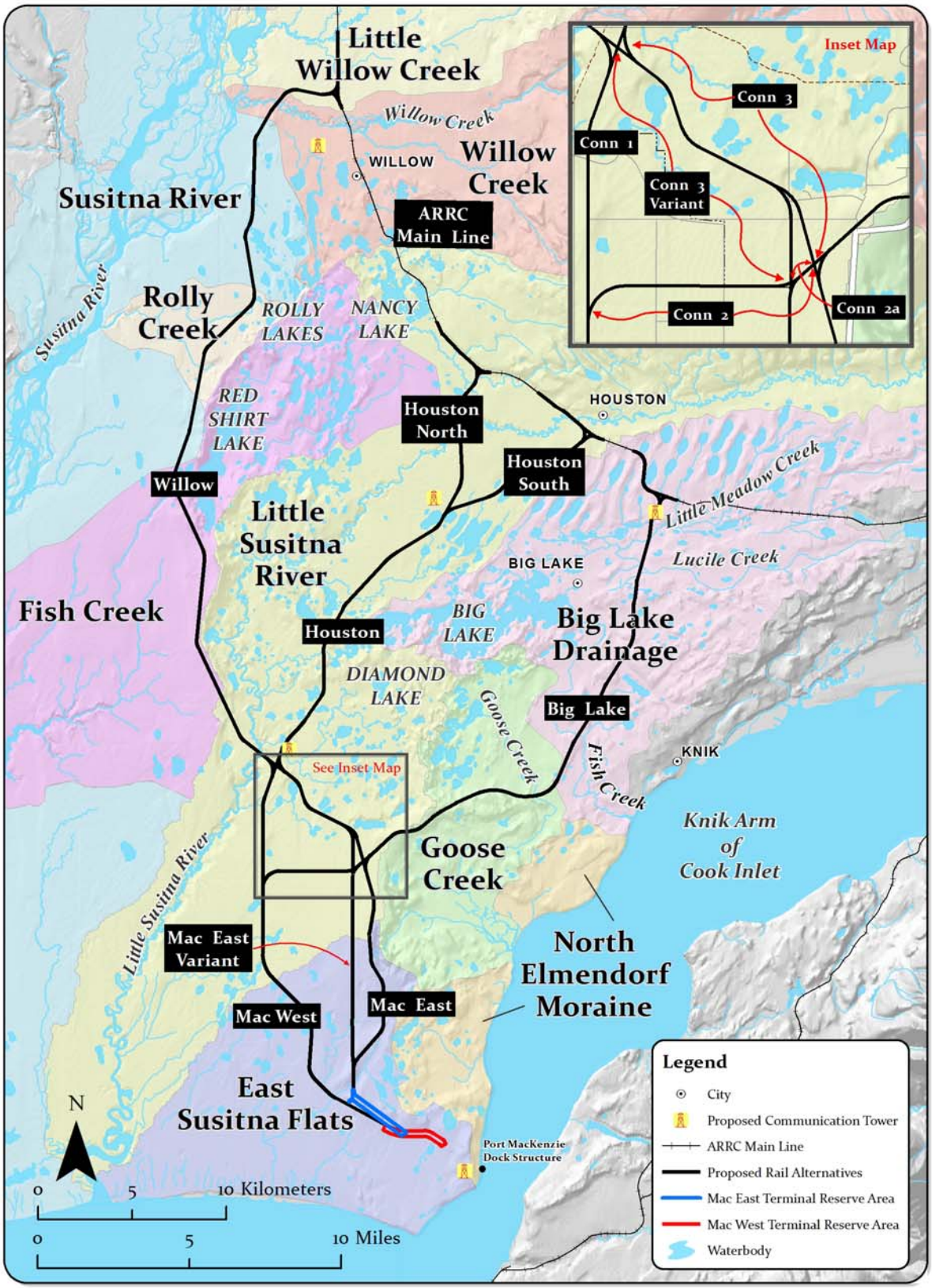

Figure 4.2-1. Watersheds in the Proposed Port MacKenzie Rail Extension Study Area

These watersheds can contain several distinct hydrologic regimes comprised of high-gradient, high-elevation mountainous areas and low-gradient, low-elevation areas with lakes and wetlands. The Talkeetna Mountains, north of the Little Susitna River in the upper drainage area of the Little Susitna River, Willow Creek, and Little Willow Creek, have greater relief and better-developed drainage patterns. This is due to the differential glacial erosion that took place in this area; however, drainage is still complicated by post-glacial surface morphology. For example, in the lower drainage area of the Little Susitna River and all of the study area south of the Little Susitna River, the landscape is dominated by hundreds of small, irregular lakes.

Most of these lakes formed in kettle moraines where the land surface was shaped primarily by retreating glacial ice. They are not usually associated with stream systems. There are also a large number of drainage and outlet lakes, typically found in the central areas of watersheds, where main streams or tributaries flow through or out of the lakes. The abundance of these lakes indicates that the water inputs to area lakes by precipitation, surface runoff, and groundwater inflow are typically greater than water losses through evaporation and groundwater outflow (ARRC, 2008).

High- and low-gradient geomorphic areas have differing effects on the 9 principal watersheds the proposed rail line alternatives would intersect. Four of these watersheds, Susitna, Little Susitna, Willow Creek, and Little Willow Creek, have their headwaters in the Talkeetna Mountains. More than half of the Willow Creek and Little Willow Creek watersheds consist of mountainous terrain; their stream flow is dominated by high-elevation snow fields and rapid response to summer storms. The Susitna and Little Susitna watersheds have a smaller portion of their area in the Talkeetna Mountains; a larger portion of their watersheds are dominated by low-lying, low-gradient areas that moderate the water flow influence of the mountainous terrain. The Fish Creek, Rolly Creek, East Susitna Flats, Goose Creek, and Big Lake Drainage Area watersheds exclusively contain low-lying, low-gradient landforms that tend to retard runoff and reduce stream flow. All of the watershed areas can be characterized by increasing flows from spring ice breakup beginning in mid April and snowmelt runoff continuing from May to July, rainfall runoff from May to September, and fall freeze-up and stream flow recession from October through April (ARRC, 2008).

4.2.3.2 Water Quality Conditions

Federal and state water quality standards are designed to maintain the beneficial uses of state water. Beneficial use can be defined based on the purpose for using the water and based on non-wasteful use of the water. Beneficial uses include aquatic life, agricultural, drinking, recreational, and other uses. Typical baseline water quality elements include color, dissolved oxygen, total dissolved solids, petroleum hydrocarbons, pH, residues, temperature, turbidity (suspended solids), and others.

Maintenance of the Federal and state water quality standards is required in all land use actions in Alaska. The proposed rail line could impact waters that Federal and state agencies have designated as “fresh water aquatic life.” The Alaska Department of Environmental Conservation (ADEC) document “Water Quality Standards (Alaska Admin. Code 18 § 70)” (ADEC, 2008a) and U.S. Environmental Protection Agency (USEPA) document “Quality Criteria for Water, 1986” (EPA, 1986) describe water quality standards for fresh water aquatic life. Table 4.2-1 lists and describes some of the Federal and State of Alaska water quality standards. OEA field crews

Table 4.2-1
Federal and Alaska Water Quality Standards for Fresh Water in Natural Environments[a]
(page 1 of 2)

Parameter	Criteria
Alkalinity	Alkalinity is a measure of the pH-buffering capacity of water or waters' resistance to changes in pH (such as the capacity of water to neutralize acids). This capacity is caused by the waters' content of carbonate, bicarbonate, hydroxide, and occasionally borate, silicate, and phosphate. Alkalinity is expressed in milligrams per liter of equivalent calcium carbonate. Alkalinity less than 20 milligrams per liter of calcium carbonate can be harmful to aquatic life.
Color	Color can indicate dissolved organic material, inadequate treatment, high disinfectant demand, or possible excessive production of disinfectant by-products or inorganic contaminants, including metal. Color points begin at 0. A point is the equivalent of a milligram of the substance in question per liter. Color or apparent color may not reduce the depth of the compensation point (the point at which there is just enough light for a plant to survive) for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life. For all waters without a seasonally established norm for aquatic life, color or apparent color may not exceed 50 color units or the natural condition, whichever is greater.
Dissolved Oxygen	Dissolved oxygen is the amount of gaseous oxygen dissolved in the water. Oxygen enters water through aeration (rapid movement) diffused from the surrounding air or as a waste product of photosynthesis. Dissolved oxygen must be greater than 7 milligrams per liter in water used by anadromous or resident fish. In no case may dissolved oxygen be less than 5 milligrams per liter to a depth of 20 centimeters in the interstitial waters (water occupying interstices or pore volumes in rock) of gravel used by anadromous or resident fish for spawning. For water not used by anadromous or resident fish, dissolved oxygen must be greater than or equal to 5 milligrams per liter but may not exceed 17 milligrams per liter. In no case may dissolved oxygen be greater than 17 milligrams per liter. The concentration of total dissolved gas may not exceed 110 percent of saturation at any point of sample collection. Dissolved oxygen below 1 to 2 milligrams per liter or beyond 110 percent can be harmful to aquatic life.
Total Dissolved Solids	Total dissolved solids are the combined content of all inorganic and organic substances in a molecular, ionized, or micro-granular suspended form. Total dissolved solids are measured only in fresh water because the salinity of sea water comprises ions that are counted as total dissolved solids. Total dissolved solids may not exceed 1,000 milligrams per liter. Water may not exceed a certain level of total dissolved solids if that concentration causes or reasonably could be expected to cause an adverse effect to aquatic life. Most aquatic ecosystems can tolerate total dissolved solids levels of 1,000 milligrams per liter. Total dissolved solids levels can be inferred from conductivity.
Petroleum Hydrocarbons	Petroleum hydrocarbons are contaminants with the potential to impact human and environmental health (because they could be carcinogenic, mutagenic, or teratogenic). Total aqueous hydrocarbons in the water column (the water from the top of the substrate to the surface of the water) may not exceed 15 micrograms per liter. Total aromatic hydrocarbons in the water column may not exceed 10 micrograms per liter. There may be no concentrations of petroleum hydrocarbons, animal fats, or vegetable oils in shoreline or bottom sediments that cause deleterious effects to aquatic life. Surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration.

Table 4.2-1
Federal and Alaska Water Quality Standards for Fresh Water in Natural Environments[a]
(page 2 of 2)

pH	pH is the measure of acidity or alkalinity and is a logarithmic scale measure of hydrogen ions. "Pure water" has a neutral pH, equal to 7.0 on the logarithmic scale. pH levels below 7 are considered acidic and greater than 7 are basic or alkaline. The water quality standard requires that pH not be less than 6.5 or greater than 8.5 or vary more than 0.5 pH unit from natural conditions.
Residues	Residues are floating solids, debris, sludge, deposits, foam, scum, or any other material or substance that occurs in water as a result of human activity. Residues may not, alone or in combination with other substances, be present in concentrations or amounts that form objectionable deposits that are undesirable or a nuisance to aquatic or other species.
Temperature	Water temperature may not be caused to exceed 20 degrees Celsius (°C) at any time. The following maximum temperatures may not be exceeded, where applicable: (1) migration routes, 15°C; (2) spawning areas, 13°C; (3) rearing areas, 15°C; and (4) egg and fry incubation, 13°C. For all other waters, the weekly average temperature may not exceed site-specific requirements needed to (1) preserve normal species diversity and (2) prevent the appearance of nuisance organisms (i.e., must be such that the nuisance organisms are prevented from appearing).
Turbidity	Turbidity is the cloudiness or haziness of fluid caused by suspended solids generally invisible to the naked eye. Turbidity may not exceed 25 nephelometric turbidity units above natural conditions. For all lake waters, turbidity may not exceed 5 nephelometric turbidity units above natural conditions.

[a] Sources: ADEC, 2008a; EPA, 1986.

collected baseline surface water quality data during August 2008 at proposed crossing sites along the proposed rail line (Noel *et al.*, 2008). Crews collected data via visual observation from a helicopter and from on-the-ground testing and observations. Crews did not collect on-the-ground data from crossings that were inaccessible due to lack of adequate and safe road access or landing zones for the helicopter, or from crossings where the aerial survey indicated there was no waterbody and a ground visit was not warranted.

Table 4.2-2 summarizes water quality values collected at sampling sites along the proposed rail line segments and compares the data to Federal and state water quality standards. These sampling points coincide with proposed waterbody crossing points along the proposed rail line segments. The records included in the table reflect sampling locations where water was present. Figure 4.2-2 shows the sample locations in relation to the proposed crossing sites.

The 2008 field data suggests that water quality at the proposed crossings met the current Federal and state water quality standards during the collection dates. Turbidity values ranged from 0 to 130 nephalometric turbidity units, and these one-time values cannot be used to determine standard compliance. Unlike other water quality parameters, turbidity does not have a fixed value for its standard; the water quality standard for turbidity is site specific and may not be 25 nephalometric turbidity units or more above the natural conditions of the site because of human activities.

Table 4.2-2
Summary of Water Quality Data in Streams Collected in 2008[a,b]

Segment and Crossing Mile Post	Date Collected	Flow (m/s)	Dissolved Oxygen (mg/L)	Temperature (°C)	Turbidity (NTUs)	Total Dissolved Solids (mg/L)	pH (s.u.)	Conductivity (µS/cm)
Water Quality Standard			7 - 17	≤ 20	≤ 25[c]	≤ 1000	6.5 - 8.5	≤ 500[d]
Big Lake								
B-16.6	8/12/2008	No Data	12.5	14.1	67	80	7.7	115
B-15.9	8/12/2008	No Data	10.6	11.2	2	130	6.7	199
B-15.2	8/12/2008	No Data	12.0	10.2	22	150	7.5	230
B-9.0	8/12/2008	No Data	12.0	15.0	1.0 to 2.0	100	7.4	150
B-6.4	8/13/2008	0.5	7.1	16.8	0	90	7.5	135
Connector 1								
C1-2.6	8/14/2008	No Data	9.9	13.8	4	130	7.6	201
Houston								
H-9.6	8/14/2008	0.4	8.0	18.0	29	30	7.1	40
H-6.3	8/14/2008	No Data	10.5	13.8	4	50	7.8	87
H-4.3	8/14/2008	No Data	10.4	13.4	3	60	7.1	94
H-0.8	8/14/2008	No Data	11.9	16.7	120	120	7.5	179
Houston North								
MP-179.9	8/15/2008	< 1	12.6	11.7	12	60	7.4	101
MP-179.4	8/15/2008	< 1	12.8	11.0	11	60	7.5	100
MP-179.0	5/15/2008	0.5 to 1	11.2	12.2	3	40	7.2	55
MP-178.5	8/15/2008	No Data	11.8	13.6	5	70	7.3	114
HN-4.8	8/16/2008	0.4	10.1	10.7	10	80	7.1	130
HN-4.4	8/16/2008	8 to 10	7.4	18.4	71	80	7.0	117
HN-3.2	8/15/2008	No Data	12.9	13.2	100	60	7.6	97
Houston South								
MP-175.0	8/16/2008	0	9.8	12.4	3	90	7.6	140
MP-174.3	8/15/2008	No Data	12.5	11.3	100	60	7.7	90
HS-1.0	8/16/2008	< 0.5	9.7	15.8	130	70	7.6	68
Mac East and Mac East Variant[e]								
ME-4.5	8/13/2008	0.5	11.0	13.6	5	90	7.7	144
Mac West								
MW-11.0	8/13/2008	No Data	10	14.7	92	140	7.1	200
MW-10.1	8/13/2008	1.5	12.3	6.2	15	160	6.9	240
MW-4.6	8/13/2008	0.5 to 1	9.7	12.8	4	100	7.5	160
Willow								
MP-190.3	8/16/2008	No Data	11.9	15.6	64	80	7.2	127
MP-189.0	8/16/2008	No Data	10.1	13.6	27	60	6.8	80
W-24.0	8/16/2008	No Data	11.8	11.4	12	50	6.2	70
W-20.9	8/14/2008	No Data	11.5	11.9	27	80	7.3	118
W-16.7	8/17/2008	No Data	7.2	13.7	9	80	6.9	120
W-10.0	8/14/2008	0.9	10.7	18.9	54	60	7.1	90
W-0.6	8/15/2008	No Data	12.3	14.1	5	70	7.6	110

[a] Sources: ADEC, 2008a; EPA 1986; Noel *et al.*, 2008
[b] m/s = meters per second; mg/L = milligram/liter; °C = degrees Celsius; NTU = nephalometric turbidity units; pH = measure of acidity or alkalinity of a solution; u. = standard units; µS/cm = micro-siemens per centimeter; < = less than; ≤ = less than or equal to.
[c] Turbidity may not be 25 NTUs above natural conditions
[d] Conductivity is not a water quality standard, but acceptable range for aquatic life. TDS levels can be inferred from conductivity.
e Mac East Variant would cross upstream of ME-4.5; data were considered applicable to both Mac East and Mac East Variant segments.

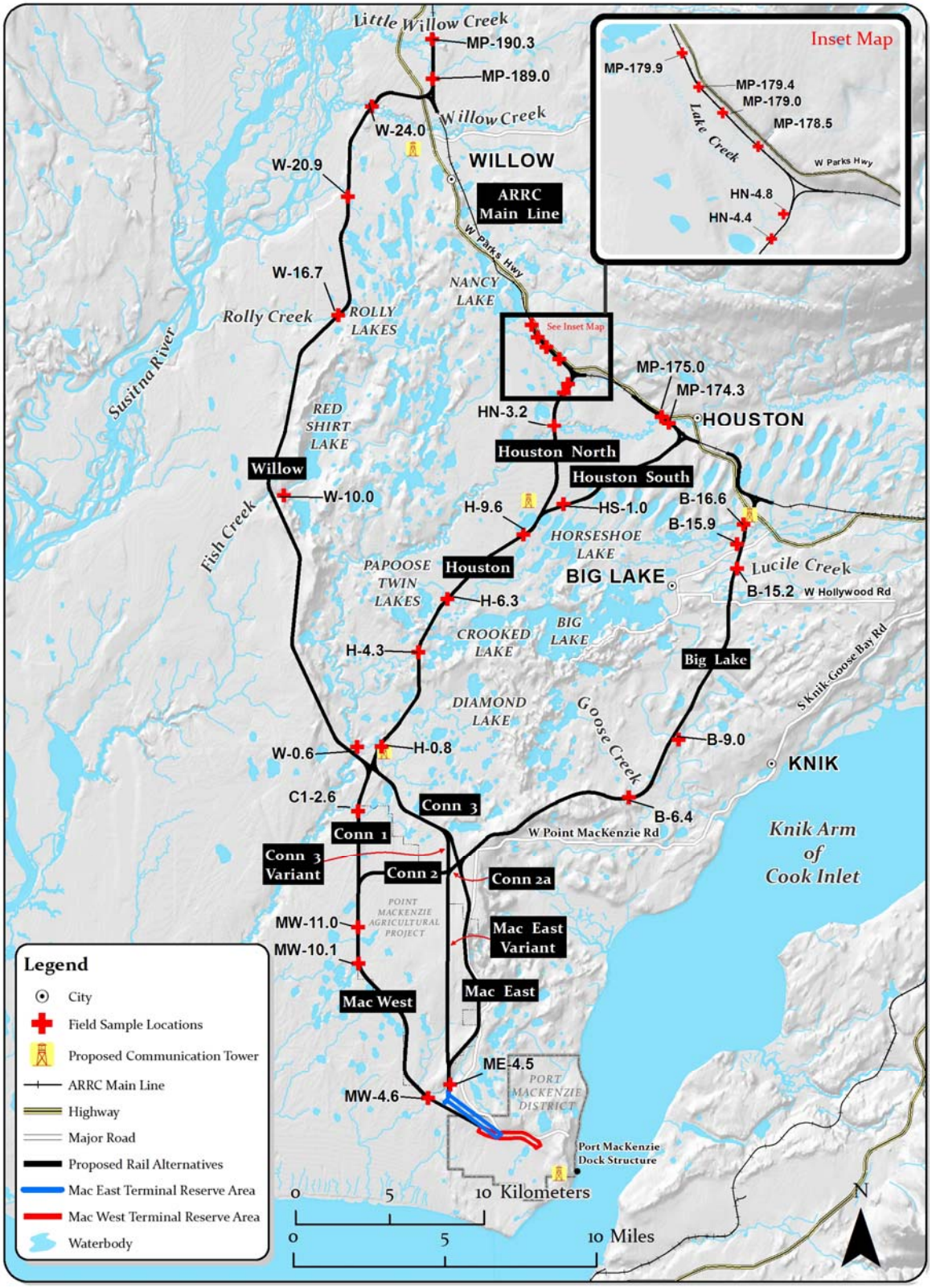

Figure 4.2-2. Sample Locations and Proposed Crossing Sites

There are no U.S. Geological Survey water quality monitoring sites within the rail line footprint or downstream of any rail line segment crossings. Three U.S. Geological Survey water quality stream gauges are upstream of the project area on the Little Susitna River, the Susitna River, and Willow Creek. All 3 stations are upstream of the developed areas of the MSB, and the nearest station to a rail line segment (Willow Creek station) is more than 8 miles upstream of the Willow Segment crossing. In addition, most of the available data were collected between 1952 and 1986, prior to the substantial growth the MSB experienced in recent years. However, it is noteworthy that during the period of record, all water quality parameters met Federal and State of Alaska water quality standards, except iron concentrations at the Little Susitna River station.

The Wasilla Soil and Water Conservation District collected water temperature data for the Little Susitna River at Houston. This data collection location is where ARRC proposes a bridge for the rail siding on the Houston South Segment. Most of the temperature samples were less than or equal to 10 degrees Celsius (°C), and 2 samples were 14°C, all well below the standard of 20°C.

According to ADEC, 1 waterbody in the study area is listed on the section 303(d) list of impaired waters (Big Lake in Wasilla). The proposed rail line would not cross Big Lake. Waterbodies are placed on the list if (1) the water quality standard(s) are exceeded, (2) the waterbody is impaired for 1 or more designated uses by a pollutant(s), and (3) the water body requires a total maximum daily load limitation or waterbody recovery plan to attain state water quality standards (Alaska Admin. Code 18 § 70).

Big Lake (approximately 2.2 miles from the Houston Segment and 1.9 miles from the Big Lake Segment; see Figure 4.2-2) is on the section 303(d) list of impaired waters for non-attainment of the petroleum hydrocarbon water quality standard. ADEC collected water quality information at Big Lake beginning in the open water months of 2004 and 2005. Petroleum hydrocarbon concentrations appear to be influenced by the use of motorized watercraft. The area of impairment is estimated to be 1,250 acres (ADEC, 2008b).

4.2.4 Environmental Consequences

This section describes potential impacts to surface water hydrology and water quality as a result of the construction activities, conveyance structures proposed at each crossing, and proposed rail line operation. Section 4.2.4.1 describes potential impacts under the proposed action; Section 4.2.4.2 describes potential impacts under the No-Action Alternative. The impacts description provides a general guideline for understanding the potential effects of the proposed project because the location and/or design characteristics of some temporary construction facilities and rail line structures would be determined only during final design and permitting. Other parts of this Final EIS address potential impacts to other resources associated with or that depend on surface waters, such as fisheries (Section 5.4 and Appendix F), floodplains (Section 4.4), navigation (Chapter 12), wetlands (Section 4.5 and Appendix C), Essential Fish Habitat (Section 5.4 and Appendix G), and subsistence (Chapter 7).

4.2.4.1 Proposed Action

Common Construction Impacts

Construction activities associated with the proposed rail line could result in short-term impacts to the flow and quality of surface water. The following paragraphs describe potential construction-related impacts that OEA anticipates would be common to all alternatives.

Construction of the Rail Line and Unpaved Access Road

Construction of the rail line and unpaved access road would result in negligible impacts to water quality except in areas were the rail line footprint would be near, adjacent to, or span waterbodies. In these areas, construction of the rail line, which would include clearing, grading, and construction of the proposed rail line and access road within the ROW, would expose soil to the erosive forces of wind, rain, and surface runoff during construction until temporarily disturbed areas were revegetated. The resulting impacts to water quality could include the following:

- Increased erosion and sediment availability/transport to watercourses during spring ice breakup, snowmelt, or rainstorms
- Nutrient loading associated with sediments that could contribute to changes in water quality
- Small petrochemical leaks from construction equipment that could enter a waterbody, either directly as equipment crossed a waterbody or with surface runoff

If sediments were disturbed and entrained, the effect would be short term and temporary, lasting only during the construction period. Any turbid waters that could result from construction would return to background conditions once the fine material settled. OEA would not expect long-term impacts to water quality from rail construction activities.

Excavation of Borrow Areas

ARRC might obtain subballast and fill material from borrow areas established within the rail line ROW. Borrow areas would be identified by the Applicant during final design and permitting, but local shallow-water areas (former borrow areas) could be targeted areas for further extraction. Removal of material could disrupt these shallow-water areas, including disturbing sediment, increasing turbidity, and generally degrading water quality. If sediment were disturbed and entrained, the effect would be temporary and would last only during the construction and extraction period. Turbidity levels would return to background conditions after the fine material settled. OEA would expect no long-term impacts to water quality. Potential new borrow areas might also be identified in surface-water areas. ARRC has not established the location, timing, or duration of borrow activity. Depending on the annual and seasonal variation of flood stage and hydraulics of the waterbodies at the borrow areas, there could be impacts to water quality. Impacts could include short-term impacts, such as erosion of the borrow area, and flooding, increased erosion, and sediment transport within the waterbodies. If borrow areas were developed in a floodplain and near to a waterbody, excavation could alter the hydraulics and conveyance of the watercourse during flood storage, which could lead to a short-term increase in

flood storage or an alteration of the channel alignment through rapid channel separation into the borrow areas.

Construction of Staging Areas

The proposed rail line could require construction of staging areas for temporary storage of equipment and materials. According to the Applicant, the objective would be to place staging areas within the proposed ROW at relatively flat, previously disturbed areas with established access to existing public roads. If the Applicant placed a staging area in or near a waterbody or floodplain, grading and filling associated with re-contouring and staging-area construction could disrupt natural drainage patterns during flooding episodes of major streams during high runoff periods along seasonal drainages or along shallow overland flow paths. Blockages or diversions to areas with insufficient flow capacity could result in seasonal or semi-permanent impoundments. Also, redirected surface flows could increase stream velocities at isolated locations where there could be increased bank scour or overbanking.

Clearing, grading, and filling associated with the construction of staging areas would temporarily expose soil to the erosive forces of wind, rain, and surface runoff during construction until temporarily disturbed areas were revegetated. If near a waterbody, this ground disturbance could mobilize sediment and increase turbidity, which could result in an overall degradation of water quality. The effect would be temporary and would last only during the construction period. Turbidity levels would return to background conditions after the fine material settled. In addition, small petrochemical leaks from construction equipment could enter a waterbody either directly or with surface runoff. OEA would not expect long-term impacts to water quality from the construction of staging areas.

Construction and Installation of Bridges and Culverts

Common impacts that could result from the culvert and bridge construction and installation within the ROW would include the following:

- Sloughing, sheet rilling, and erosion of streambanks and riparian areas
- Increased stages and velocities of flood water (due to temporary constrictions) possibly concurrent with increased backwater flooding
- Increased channel scour, bank erosion, and downstream sedimentation
- Blockage, convergence, or changes to natural drainage during construction in the channel
- Communication between surface water and groundwater in geotechnical boreholes that would be drilled to determine the suitability of the substrate at the crossing

Culvert construction and installation could result in impacts to water quality from localized disturbance of the streambank to gain access to the channel and from disturbance of the channel bed during culvert placement. In addition, if a culvert occupied only a small portion of the channel and ARRC covered the remaining channel width in fill, there would be additional stream bank and channel disturbances and loss of channel area. These activities could result in increases in turbidity and sediment loads and changes to natural drainage. Bed and bank disruption could

also lead to increased sediment load downstream of the crossing; this impact, however, would generally be short term and temporary, and conditions would return to background levels after ARRC finished construction. The extension of existing culverts along the ARRC main line could affect water quality through disturbance of the existing rail embankment by exposing soils to erosive forces, which could increase sedimentation and turbidity. OEA would not expect culvert extensions to significantly affect existing flow conditions at the culverts.

Construction and installation of proposed bridges could result in impacts to water quality and flow, the level of impact depending on (1) the proposed bridge design (full or partial span), (2) the amount of in-channel work necessary for construction of piers and abutments, and (3) the angle of the bridge in relation to the river/stream (perpendicular or oblique). Consequently, the degree of bank and channel disturbances could vary substantially and, at some sites, could alter waterbody flow, bank erosion, and sedimentation processes. Based on the design and the need to work either in-channel to construct piers and footings or along the stream banks to construct abutments, there could be impacts. In general, bridges typically result in fewer impacts to streams than culverts because they are able to maintain stream structure and flow characteristics better than culverts, maintain transport of bedload, and provide less restriction to flow than culverts.

Common Operation Impacts

Rail line operation could affect both the hydrology and quality of surface water. Operation impacts to surface water would consist of long-term impacts that could result from the presence of the rail line and access road embankment, conveyance structures, and movement of trains along the rail line. The following paragraphs describe operation-related impacts that OEA anticipates would be common to all of the build alternatives.

Bridges and Culverts

The presence of bridges and culverts in or over a channel could alter channel hydraulics, which could increase channel scour and erosion processes (lateral migration, channel reorientation, bank undercutting) that could lead to an increase in sediment transport loads and downstream sedimentation. The approach direction (perpendicular or oblique), size of culvert, and the length of affected stream bank and channel width would vary. Therefore, the degree of bank and channel infringement could also vary substantially, as would the extent of erosion and sedimentation. Culverts would likely result in greater potential impacts to flow and water quality due to the potential of culverts to constrict and alter flows more than bridges.

The presence of bridges could affect water quality as a result of altered flow hydraulics that could increase scour, erosion, and sedimentation. The level of impact would depend on the number of in-channel piers used to support the bridge and whether the proposed bridge was a full or partial span. The approach direction (perpendicular or oblique) and type of bridge construction (single partial span, single clear span, multiple-pier partial span, multiple-pier clear span), placement of abutments and/or in-channel piers, and the length of affected stream bank and channel width would vary by structure. Therefore, the degree of bank and channel infringement could also vary substantially, as would the extent of erosion and sedimentation. Bridges typically result in fewer impacts to streams than culverts because they are able to

maintain stream structure and flow characteristics better than culverts, maintain transport of bedload, provide less restriction to flow than culverts, and generally require less instream maintenance over time than culverts.

Rail Line and Unpaved Access Road Operations

In general, use of the rail line and unpaved access roads would result in negligible impacts to rivers and streams except in areas where the rail line and roads would be near waterbodies. When the rail line or roads would be near or adjacent to waterbodies, the potential consequences to water quality during spring ice break-up, snowmelt, or rainstorms could include increased transport of fine-grained sediments and increased concentrations of pollutants that could alter waterbody chemistry and pH. In addition, fugitive dust, generated by rail operation and vehicles using gravel access roads, and chemicals, used for access road maintenance, could affect water quality. The relative degree of water quality degradation would vary depending on stream type, location, and habitat value. Small petrochemical leaks from trains or vehicles using the access road could also affect water quality if the pollutant entered a waterbody directly or via surface runoff.

Impacts by Segment and Segment Combination

This section describes potential impacts associated with specific rail line segments by building on the common impacts to hydrology and water quality (see previous section) where project design information and environmental data are available to reasonably distinguish between the rail line segments. Factors used to differentiate between segments could include the number of waterbody crossings, number of major waterbody crossings, number of new bridges and culverts, number of culvert extensions, acreage of wetlands and waters within the rail line footprint, presence of highly erodible soils, and multiple- or single-span bridges.

For waterbody crossings where the Applicant has not made a preliminary determination of whether a culvert or a bridge would be constructed (when “drainage structure” is the designed type of crossing structure), this discussion of potential impacts to surface waters only includes a count of those crossing as part of the comparison of potential impacts. In addition, the Applicant has indicated additional culverts might be needed for equalization across wetlands or for drainages that have not been identified at this time. Because these culverts might or might not be installed and the actual numbers or locations have not been determined, they are not included in the following description of potential impacts.

Table 4.2-3 details waterbody crossings by rail line segments and includes crossing identification numbers so readers can match each crossing to corresponding figures.

Southern Segments and Segment Combinations

Table 4.2-4 provides summary details of waterbody crossings for each southern segment and Figure 4.2-3 shows the crossing locations.

Table 4.2-3
Waterbody Crossings by Segment [a] (page 1 of 4)

	Mile Post	Waterbody Type[b]	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[d]
Southern Segments				
Mac West	MW-12.0	Unidentified	Culvert	48
	MW-11.0	Unidentified stream	Culvert	36
	MW-10.1	Unidentified stream; inlet to Horseshoe Lake	Culvert	48
	MW-9.3	Wetland	Culvert	48
	MW-8.8	Wetland	Culvert	48
	MW-8.3	Unidentified	Culvert	48
	MW-7.8	Unidentified	Culvert	48
	MW-7.2	Unidentified	Culvert	48
	MW-6.8	Unidentified	Culvert	48
	MW-6.3	Unidentified	Culvert	48
	MW-5.2	Unidentified	Culvert	48
	MW-4.6	Unidentified stream; drains to Cook Inlet	Culvert	48
	MW-3.7	Wetland	Culvert	48
	T-1.2	Wetland	Culvert	48
	T-0.9	Unidentified	Culvert	48
Mac East	ME-7.4	Wetland	Culvert	48
	ME-4.5	Unidentified stream; drains to Cook Inlet	Bridge	28
	ME-2.5	Wetland	Culvert	48
Mac East Variant	MEV-7.4	Wetland	Culvert	48
	MEV-4.5	Unidentified stream; drains to Cook Inlet	Bridge	28
	MEV-2.5	Wetland	Culvert	48
Connector 1	C1-3.0	Wetland	Culvert	48
	C1-2.6	Unidentified stream; tributary to the Little Susitna River	Bridge	56
	C1-2.3	Wetland	Drainage structure	ND
	C1-1.1	Wetland	Culvert	48
	C2-1.9	Unidentified	Culvert	48
	C2-1.7	Unidentified	Culvert	48
	C2-0.2	Wetland	Culvert	48
Connector 3	C3-3.6	Wetland	Culvert	36
	C3-3.0	Wetland	Culvert	48
	C3-2.2	Wetland	Culvert	24
	C3-1.5	Unidentified	Culvert	36
Connector 3 Variant	C3V-3.6	Wetland	Culvert	36
	C3V-3.0	Wetland	Culvert	48
	C3V-2.2	Wetland	Culvert	24
	C3V-1.5	Unidentified	Culvert	36

Table 4.2-3
Waterbody Crossings by Segment[a] (page 2 of 4)

	Mile Post	Waterbody Type[b]	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[d]
Northern Segments				
Willow	MP-190.3	Unidentified stream; tributary to Little Willow Creek	Bridge	ND
	MP-189.6	Wetland	Culvert	36
	MP-189.3	Wetland	Culvert	36
	MP-189.0	Rogers Creek	Bridge	ND
	MP-188.2	Wetland	Culvert	48
	W-25.6	Wetland	Culvert	48
	W-25.5	Wetland	Culvert	48
	W-24.8	Wetland	Culvert	48
	W-24.0	Willow Creek	Bridge	ND
	W-23.1	Wetland	Drainage structure	ND
	W-22.7	Unidentified	Culvert	48
	W-21.4	Unidentified	Culvert	48
	W-20.9	Unidentified stream; tributary to the Susitna River	Natural Bottom Plate Pipe/ Arch	8 to10 feet
	W-19.6	Wetland	Drainage structure	ND
	W-16.7	Unidentified stream; tributary to Rolly Creek	Culvert	72
	W-16.4	Unidentified stream; tributary to Rolly Creek	Culvert	48
	W-15.8	Unidentified	Culvert	48
	W-14.4	Unidentified stream; tributary to Rolly Creek	Culvert	36
	W-13.8	Unidentified	Culvert	48
	W-10.0	Fish Creek	Drainage structure	ND
	W-8.6	Unidentified	Culvert	36
	W-2.4	Unidentified	Culvert	48
	W-0.6	Little Susitna River	Bridge	ND
Houston South	MP-175.0	Unidentified stream	Culvert	48
	MP-174.3	Little Susitna River	Bridge	~80
	MP-173.3	Wetland	Culvert	48
	HS-1.9	Wetland	Culvert	48
	HS-1.4	Unidentified stream; tributary to Little Horseshoe Lake	Culvert	48
	HS-1.0	Stream; tributary to Little Horseshoe Lake	Culvert	36
	HS-0.8	Wetland	Culvert	48

Table 4.2-3
Waterbody Crossings by Segment[a] (page 3 of 4)

	Mile Post	Waterbody Type[b]	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[d]
Northern Segments (cont'd)				
Houston	H-9.6	Outflow Muleshoe Lake; inflow Colt Lake	Culvert	48
	H-9.4	Unidentified	Culvert	48
	H-8.3	Wetland	Culvert	48
	H-7.1	Wetland	Culvert	48
	H-6.3	Unidentified stream; tributary to the Little Susitna River	Drainage structure	ND
	H-5.8	Wetland	Culvert	36
	H-4.3	Unidentified stream; tributary to the Little Susitna River	Culvert	72
	H-2.8	Wetland	Culvert	48
	H-1.9	Wetland	Culvert	48
	H-1.2	Wetland	Culvert	24
	H-0.8	Unidentified stream; outlet of Diamond Lake	Drainage structure	ND
Houston North	MP-179.9	Unidentified stream	Culvert	48
	MP-179.8	Unidentified	Culvert	48
	MP-179.7	Unidentified	Culvert	36
	MP-179.6	Unidentified	Culvert	36
	MP-179.5	Unidentified	Culvert	48
	MP-179.4	Unidentified stream	Culvert	60
	MP-179.1	Unidentified	Culvert	48
	MP-179.0	Unidentified stream	Culvert	36
	MP-178.9	Unidentified	Culvert	36
	MP-178.5	Unidentified stream; tributary to Lake Creek	Culvert	48
	MP-178.1	Unidentified	Culvert	48
	MP-177.8	Unidentified	Culvert	36
	MP-177.5	Unidentified	Culvert	48
	HN-4.8	Unidentified stream; tributary to Lake Creek	Bridge	28
	HN-4.4	Lake Creek	Drainage structure	ND
	HN-3.2	Little Susitna River	Bridge	ND
	HN-2.7	Wetland	Culvert	48
	HN-1.2	Wetland	Culvert	48

Table 4.2-3
Waterbody Crossings by Segment[a] (page 4 of 4)

	Mile Post	Waterbody Type[b]	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[d]
Northern Segments (cont'd)				
Big Lake	MP-170.7	Unidentified	Culvert	48
	MP-170.5	Unidentified stream	Culvert	60
	MP-170.1	Unidentified stream; outlet of Cheri Lake	Culvert	60
	B-18.3	Unidentified stream	Drainage structure	ND
	B-17.5	Unidentified stream; inlet to Long Lake	Drainage structure	ND
	B-16.6	Unidentified stream; inlet to Long Lake	Drainage structure	ND
	B-15.9	Little Meadow Creek	Drainage structure	ND
	B-15.8	Unidentified	Culvert	48
	B-15.2	Lucile Creek	Drainage structure	ND
	B-15.1	Unidentified stream; tributary to Lucile Creek	Culvert	36
	B-14.8	Wetland	Culvert	36
	B-14.5	Wetland	Culvert	48
	B-14.3	Wetland	Culvert	24
	B-13.5	Wetland	Culvert	48
	B-12.7	Wetland	Culvert	48
	B-11.9	Wetland	Culvert	24
	B-9.9	Wetland	Culvert	24
	B-9.0	Fish Creek	Drainage structure	ND
	B-8.4	Wetland	Culvert	24
	B-7.2	Wetland	Culvert	36
	B-6.4	Goose Creek	Drainage structure	ND
	B-5.9	Wetland	Culvert	24
	B-4.1	Unidentified	Culvert	48

[a] Source: ARRC, 2008; Noel *et al.*, 2008.
[b] Unidentified designates an unmapped drainage area.
[c] Drainage structures would be determined during the final design process and could include multi-plate culverts, pre-cast arches, or bridges.
[d] ND = No data; to be determined during final permitting and design.

Table 4.2-4
Summary of Waterbody Crossings along the Southern Segments and Segment Combinations[a]

	Mac West-Connector 1	Mac West-Connector 2	Mac East-Connector 3	Mac East	Mac East Variant-Conn 2a	Mac East Variant-Conn 3 Variant
Numbers of Crossings						
Total Crossings	22	19	7	3	3	7
Types of Waterbodies						
Wetlands	10	5	5	2	2	5
Streams	4	3	1	1	1	1
Unidentified[b]	8	11	1	0	0	1
Types of Crossings						
Bridges	1	0	1	1	1	1
Drainage Structures[c]	1	0	0	0	0	0
Culverts	20	19	6	2	2	6
Culvert Extensions	0	0	0	0	0	0

[a] Source: ARRC, 2008; Noel *et al.*, 2008.
[b] Unidentified designates an unmapped drainage area.
[c] Drainage structures would be determined during the final design and permitting and could include multi-plate culverts, pre-cast arches, or bridges.

Mac West-Connector 1 Segment Combination

The Mac West-Connector 1 Segment Combination would cross 22 waterbodies with 1 bridge, 1 drainage structure (culverts or bridges, depending on permitting and final design), and 20 culverts (see Table 4.2-4). This segment combination would require more crossings than the other southern segments and segment combinations, which would increase the potential for impacts to water quality and hydrology during rail line construction and operation. In addition, this segment combination would have the most acreage of wetlands and waters of the United States (218 acres; see Section 4.5, Wetland Resources) within the rail line footprint, which would increase the potential for impacts to water quality and alteration of hydrology in those areas. This segment combination would involve the lowest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) across all southern segments and segment combinations; however, the number of crossings and in-water work that would be required would be greatest for this segment combination. This segment combination would not cross any major rivers or streams. Overall, OEA anticipates that this segment combination would result in the greatest impact to surface water when compared to the southern segments and segment combinations.

Mac West-Connector 2 Segment Combination

The Mac West-Connector 2 Segment Combination would cross 19 waterbodies with 19 culverts (see Table 4.2-4). This segment combination would require the second largest number of crossings compared to the other southern segments and segment combinations, which would give it a higher potential for impacts to hydrology and water quality. In addition, this segment combination would have the second largest acreage of wetlands and waters of the United States (200 acres; see Section 4.5, Wetland Resources) within the rail line footprint, which would increase the potential for impacts to water quality and alteration of hydrology. This segment combination would involve the second lowest percentage of highly or potentially highly erodible

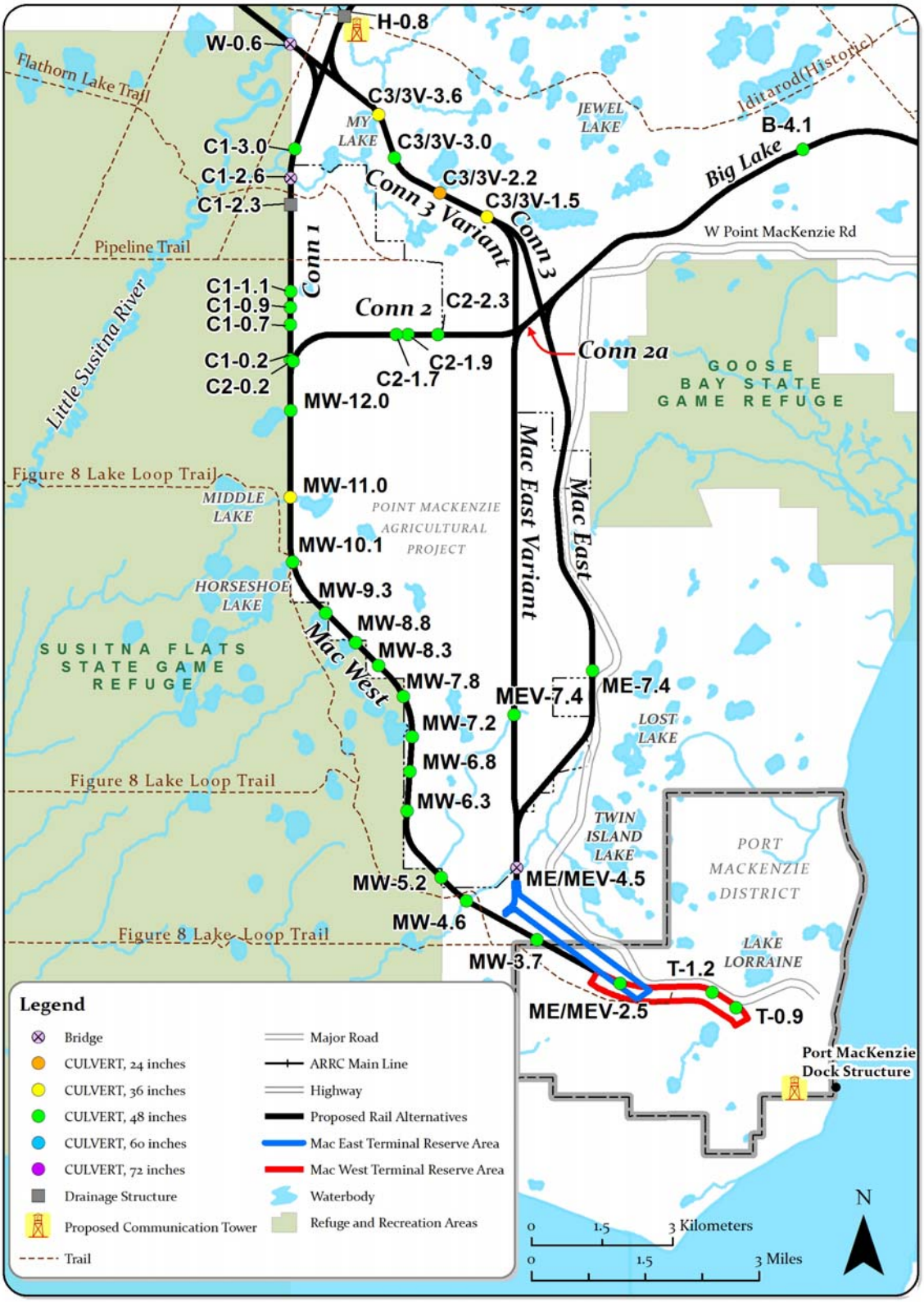

Figure 4.2-3. Mac East, Mac West, and Connector Segment Crossings Proposed Port MacKenzie Rail Extension

soils (see Section 3.4, Geology and Soils) across all southern segments and segment combinations. The Mac West-Connector 2 Segment Combination would not cross any major rivers or streams.

Mac East-Connector 3 Segment Combination

The Mac East-Connector 3 Segment Combination would cross 7 waterbodies with 1 bridge and 6 culverts (see Table 4.2-4). This segment combination, along with the Mac East-Connector 3 Variant Segment Combination, would involve the second smallest number of crossings compared to the other southern segments and segment combinations, which would give it a comparatively low potential for impacts to water quality and hydrology during rail construction and operation. In addition, this segment combination would involve the third lowest acreage of wetlands and waters of the United States (103 acres; see Section 4.5, Wetland Resources) within the rail line footprint, which would give it a lower potential for impacts to water quality and alteration of hydrology. This segment combination would involve the third highest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) of the southern segments and segment combinations. However, the smaller number of crossings and amount of in-water work that would be required compared to the Mac West-Connector 1 Segment Combination and the Mac West-Connector 2 Segment Combination would likely result in a lower direct impact to water quality. This segment combination would not cross any major rivers or streams.

Mac East Segment

The Mac East Segment would cross 3 waterbodies with 1 bridge and 2 culverts (see Table 4.2-4). This segment, along with Mac East Variant-Connector 2a, would involve the fewest crossings out of the southern segments and segment combinations. In addition, this segment, along with Mac East Variant-Connector 3 Variant segment combination, would involve the second lowest acreage of wetlands and waters (100 acres; see Section 4.5, Wetland Resources) within the rail line footprint, but not much lower than the Mac East-Connector 3 Segment Combination. With the second lowest acreage of wetlands and waters of the United States across all southern segments and segment combinations, OEA anticipates this segment would have a relatively low potential for impacts to water quality and alteration of hydrology in these areas. This segment combination would involve the greatest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils), exceeding the percentages for the other southern segments and segment combinations. This could increase the potential for impacts to water quality if ARRC did not implement appropriate best management practices and mitigation measures. This segment would not cross any major rivers or streams.

Mac East Variant-Connector 2a Segment Combination

The Mac East Variant-Connector 2a Segment Combination would cross 3 waterbodies with 1 bridge and 2 culverts (see Figure 4.2-3). This segment combination, along with the Mac East Segment, would involve the fewest crossings compared to the other southern segments and segment combinations. In addition, this segment combination would involve the lowest acreage of wetlands and waters (94 acres; see Section 4.5, Wetland Resources) within the rail line footprint, approximately 5 acres less than the Mac East Segment. With the smallest acreage of

wetlands and waters of the United States across all southern segments and segment combinations, OEA anticipates this segment would have a relatively low potential for impacts to water quality and alteration of hydrology in these areas. This segment combination would involve the third lowest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) of the southern segments and segment combinations. This segment combination would not cross any major rivers or streams. Overall, OEA anticipates that this segment combination would result in the lowest potential impact to surface waters across all southern segments and segment combinations.

Mac East Variant-Connector 3 Variant Segment Combination

The Mac East Variant-Connector 3 Variant Segment Combination would cross 7 waterbodies with 1 bridge and 6 culverts (see Table 4.2-4). This segment combination, along with the Mac East-Connector 3 Segment Combination, would involve the second smallest number of crossings compared to the other southern segments and segment combinations, which would give it a comparatively low potential for impacts to water quality and hydrology during rail construction and operation. In addition, this segment combination and the Mac East Segment would involve the second lowest acreage of wetlands and waters of the United States (100 acres; see Section 4.5, Wetland Resources) within the rail line footprint. This segment combination would involve the second greatest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) of the southern segments and segment combinations. With the second smallest acreage of wetlands and waters of the United States across all southern segments and segment combinations, OEA anticipates this segment would have a relatively low potential for impacts to water quality and alteration of hydrology in these areas. This segment would not cross any major rivers or streams.

Northern Segments and Segment Combinations

Table 4.2-5 provides summary details of waterbody crossings for each northern segment and segment combinations.

Willow Segment

The Willow Segment would cross 23 waterbodies with 4 bridges, 3 drainage structures, 12 culverts, 1 natural bottom plate pipe or arch structure, and 3 culvert extensions (see Table 4.2-5). This segment would involve the second largest number of crossings compared to the other northern segments and segment combinations, which would increase the potential for more impacts to water quality and hydrology (see Figure 4.2-4). This segment would have the smallest acreage of wetlands and waters of the United States (38 acres, see Section 4.5, Wetland Resources) within the rail line footprint compared to the other northern segments and segment combinations. Having the lowest acreage of wetlands and waters across all northern segments and segment combinations indicates this segment would have the least potential for impacts to water quality and alteration of hydrology in these areas. This segment would involve the second largest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) compared to the other northern segments and segment combinations, but the percentage for this segment is relatively low when compared to the segment combination with the highest

Table 4.2-5
Summary of Waterbody Crossings along the Northern Segments and Segment Combinations[a]

	Willow	Big Lake	Houston-Houston North	Houston-Houston South
Numbers of Crossings				
Total Crossings	23	23	29	18
Types of Waterbodies				
Wetlands	8	10	8	9
Streams	9	10	11	8
Unidentified[b]	6	3	10	1
Types of Crossings				
Bridges	4	0	2	1
Drainage Structures[c]	3	7	3	2
Culverts	12	13	11	13
Natural Bottom Plate Pipe/Arch Structure	1	0	0	0
Culvert Extensions	3	3	13	2

[a] Source: ARRC, 2008; Noel *et al.*, 2008.
[b] Unidentified designates an unmapped drainage area.
[c] Drainage structures would be determined during the final design and permitting and could include multi-plate culverts, pre-cast arches, or bridges.

percentage. This segment would cross Rogers Creek, Willow Creek, the Little Susitna River, and a tributary to Little Willow Creek with bridges. Multiple spans and in-water support piles would likely be required for Rogers Creek, Willow Creek, and the Little Susitna River because their channel widths all exceed ARRC's proposed bridge span length of 28 feet. Compared to other northern segments and segment combinations, this segment would involve the most bridge crossings and bridge crossings that would require in-water support piles. The tributary to Little Willow Creek would likely have a single-span bridge with no in-water support piles because the channel width is less than half of the 28-foot bridge span. The number of new culverts (12) proposed along this segment is not substantially different from the number of new culverts proposed along the other northern segment combinations. This segment would also involve one of the fewest numbers of culvert extensions along the main line.

Big Lake Segment

The Big Lake Segment would cross 23 waterbodies with 7 drainage structures, 13 culverts, and 3 culvert extensions (see Table 4.2-5). This segment would involve the same number of crossings as the Willow Segment, and impacts to water quality and hydrology would be similar to those for the Willow Segment (see Figure 4.2-5). In addition, this segment would have the second highest acreage of wetlands and waters of the United States (75 acres; see Section 4.5, Wetland Resources) within the rail line footprint compared to the other northern segments and segment combinations, which would increase the potential for impacts to water quality and alteration of hydrology in these areas.

This segment would have the largest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils), far exceeding the percentages for the other northern segments and segment combinations. This could increase the potential for impacts to water quality if ARRC did not implement appropriate best management practices and mitigation measures. This

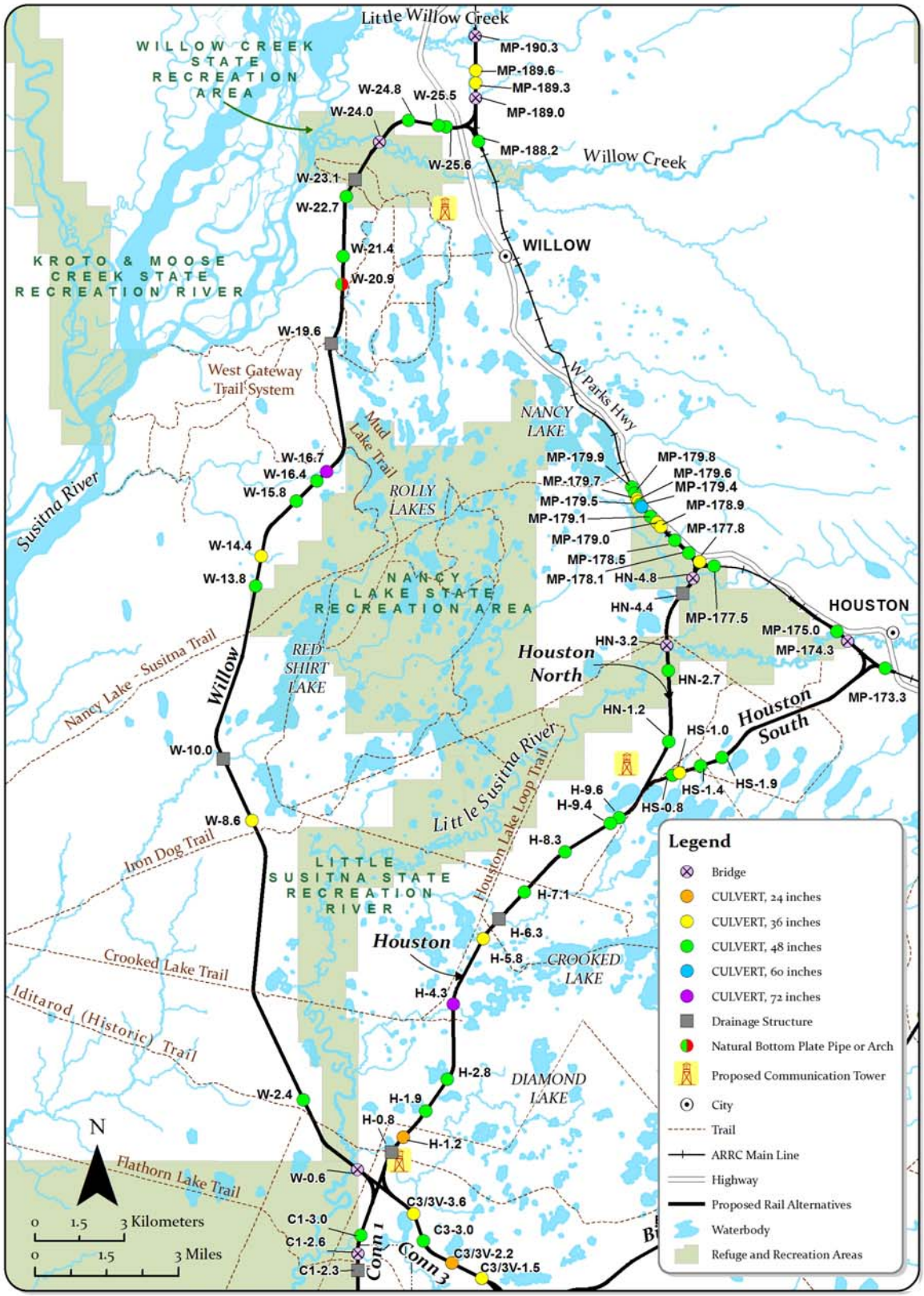

Figure 4.2-4. Willow, Houston, Houston North, and Houston South Segment Crossings Proposed Port MacKenzie Rail Extension

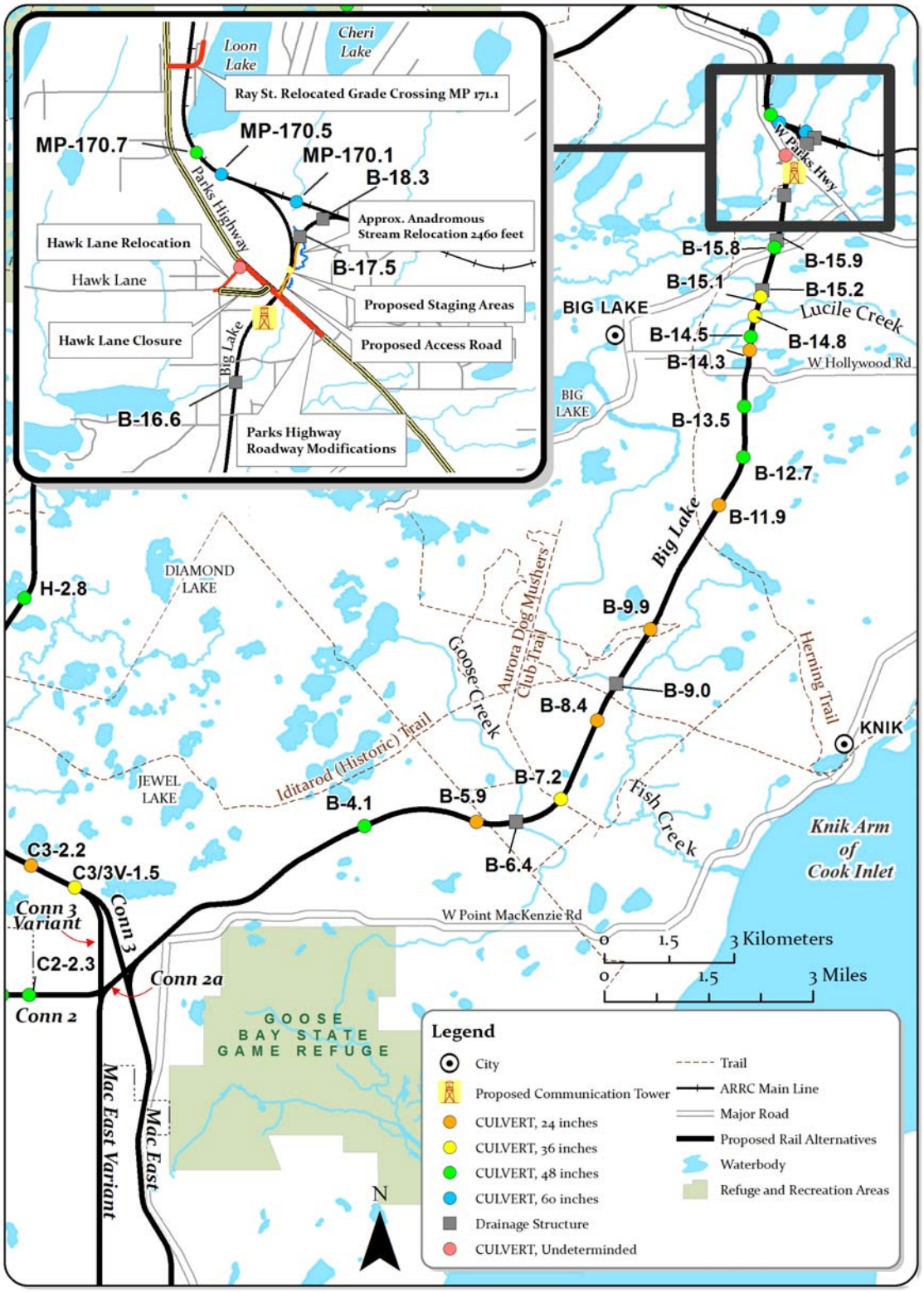

Figure 4.2-5. Big Lake Segment Crossings Proposed Port MacKenzie Rail Extension

segment would cross Little Meadow Creek, Lucile Creek, Fish Creek, and Goose Creek with drainage structures (culverts or bridges, depending on permitting and final design). This segment would also require the relocation of approximately 2,440 feet of stream channel from an unnamed anadromous fish stream adjacent to the rail line between Mile Post B-17.1 and Mile Post B-17.6 into two new sections of 2,460-foot-long channel.

There would be impacts to the specific stream reach involved and possible upstream and downstream effects. Several characteristics of a reach could be altered, including channel morphology, channel hydraulics, sediment erosion and deposition processes, and water quality. In addition, channel reconstruction could result in erosion and sedimentation. Many of the detrimental effects of stream relocation could be avoided, with little compromise in channel efficiency, by employing channel design guidelines that do not destroy the hydraulic and morphologic equilibria of natural streams. These guidelines include minimal straightening; promoting bank stability by leaving trees, minimizing channel reshaping, and employing bank stabilization techniques; and emulating the morphology of natural stream channels.

The number of new culverts (13) proposed along this segment is not substantially different from the number of new culverts proposed along the other northern segments and segment combinations. This segment would also require one of the smallest numbers of culvert extensions along the main line.

Houston-Houston North Segment Combination

The Houston-Houston North Segment combination would cross 29 waterbodies with 2 bridges, 3 drainage structures, 11 culverts, and 13 culvert extensions (see Table 4.2-5). This segment combination would involve the most crossings compared to the other northern segments and segment combinations (see Figure 4.2-4). However, this might exaggerate the level of potential impacts in relation to other segments and segment combinations because 13 of these 29 crossings would be extensions of existing culverts under the main line, and extensions to these culverts might not have the same level or intensity of impact as the installation of a new culvert. Sixteen of the 29 crossings would be new. This segment combination would have the largest acreage of wetlands and waters of the United States (101 acres; see Section 4.5, Wetland Resources) within the rail line footprint, compared to the other northern segment and segment combinations, which could increase the potential for impacts to water quality and alteration of hydrology. This segment combination would have one of the smallest percentages of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) compared to the other northern segments and segment combinations. This segment combination would cross Lake Creek and the Little Susitna River. Multiple spans and in-water support piles would likely be required for the Little Susitna River crossing because its channel width exceeds ARRC's proposed bridge span length of 28 feet. Compared to other northern segments and segment combinations, this segment combination would require the second largest number of bridge crossings. This segment combination would cross Lake Creek with a drainage structure that would be determined during final permitting and design.

The number of new culverts (11) proposed along this segment combination is not substantially different from the number of new culverts proposed along the other northern segments and

segment combinations. This segment combination would also require the largest number of culvert extensions along the main line.

Houston-Houston South Segment Combination

The Houston-Houston South Segment combination would cross 18 waterbodies with 1 bridge, 2 drainage structures, 13 culverts, and 2 culvert extensions (see Table 4.2-5). This segment combination would involve the fewest crossings compared to the other northern segments and segment combinations, and would have the least potential for impacts to water quality and hydrology during rail line construction and operation (see Figure 4.2-4).

This segment combination would have the second lowest acreage of wetlands and waters of the United States (61 acres; see Section 4.5, Wetland Resources) within the rail line footprint compared to the other northern segments and segment combinations. This segment would have a comparatively low potential for impacts to water quality and alteration of hydrology because it has one of the smallest acreages of wetlands and waters within the footprint across all northern segment combinations. This segment combination would have the smallest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) compared to the other northern segments and segment combinations, but the percentage for this segment combination is similar to that of the Willow segment and Houston-Houston North segment combination. This segment combination would cross the Little Susitna River with a bridge adjacent and identical to the existing main line railroad bridge over the Little Susitna River. Compared to other northern segments and segment combinations, this segment combination would have one of the smallest numbers of bridge crossings.

The new culverts (13) proposed along this segment combination is not substantially different from the number of new culverts proposed along the other northern segment combinations. This segment combination would have the smallest number of culvert extensions along the main line.

Summary of Potential Impacts by Rail Line Alternative

The primary factor to consider when comparing potential impacts to surface water among alternatives is the number of waterbody crossings, because it is this activity that could most directly affect water quality and hydrology during rail line construction and operation. The more in-water work that would result from a larger number of culverts and bridges during construction, the greater the potential for impacts to surface water. In addition, bridges generally would be expected to result in fewer hydrology impacts than culverts, because bridges are able to maintain stream structure and flow characteristics better than culverts, maintain transport of bedload, provide less restriction to flow, and generally require less instream maintenance over time. Other minor factors that can be considered when assessing potential impacts to surface water can include the presence of highly erodible soils, the extension of existing culverts versus the construction of new culverts, or the amount of wetlands and waters of the United States near the ROW that could be affected by water quality impacts during construction and operation. However, these potential impacts can be reduced and minimized through best management practices and mitigation measures and are not expected to be primary determining factors when comparing potential impacts to surface water among alternatives. Table 4.2-6 summarizes waterbody crossings associated with the 12 proposed rail line alternatives.

Table 4.2-6
Waterbody Crossings by Alternative[a]

	Alternative											
	Mac West-Conn 1-Willow	Mac West-Conn 1-Houston-Houston North	Mac West-Conn 1-Houston-Houston South	Mac West-Conn 2-Big Lake	Mac East-Conn 3-Willow	Mac East-Conn 3-Houston-Houston North	Mac East-Conn 3-Houston-Houston South	Mac East-Big Lake	Mac East Var-Conn 2a-Big Lake	Mac East Var-Conn 3 Variant-Willow	Mac East Var-Conn 3 Var-Houston-Houston North	Mac East Var-Conn 3 Var-Houston-Houston South
Numbers of Crossings												
Total Crossings	45	51	40	42	30	36	25	26	26	30	36	25
Types of Waterbodies												
Wetlands	18	18	19	15	13	13	14	12	12	13	13	14
Streams	13	15	12	13	10	12	9	11	11	10	12	9
Unidentified[b]	14	18	9	14	7	11	2	3	3	7	11	2
Types of Crossings												
Bridges	5	3	2	0	5	3	2	1	1	5	3	2
Drainage Structures[c]	4	4	3	7	3	3	2	7	7	3	3	2
Culverts	32	31	33	32	18	17	19	15	15	18	17	19
Natural Bottom Plate Pipe/Arch Structure	1	0	0	0	1	0	0	0	0	1	0	0
Culvert Extensions	3	13	2	3	3	13	2	3	3	3	13	2

[a] Source: ARRC, 2008; Noel *et al.*, 2008.
[b] Unidentified designates an unmapped drainage area.
[c] Drainage structures would be determined during the final design process and could include multi-plate culverts, pre-cast arches, or bridges.

The number of waterbody crossings would range from 25 along the Mac East-Connector 3-Houston-Houston South Alternative and Mac East Variant-Connector 3 Variant-Houston-Houston South Alternative to 51 along the Mac West-Connector 1-Houston-Houston North Alternative.

The Mac East-Connector 3-Houston-Houston South and Mac East Variant-Connector 3 Variant-Houston-Houston South alternatives would require the fewest crossings with the fewest number of drainage structures and culvert extensions, and one of the fewest number of culverts, which would result in the least in-water work and the smallest potential impact during operation. The Mac West-Connector 1-Houston-Houston North Alternative would require the most crossings, which would require the most in-water work. While this alternative would require less new culverts than 3 other alternatives, it would require 13 culvert extensions that would require in-water work. Any alternative that includes the Big Lake Segment also would involve the relocation of a nearly 0.5 mile segment of stream channel.

4.2.4.2 No-Action Alternative

Under the No-Action Alternative, ARRC would not construct and operate the proposed Port MacKenzie Rail Extension, and there would be no surface water impacts from the project.

4.2.5 Unavoidable Environmental Consequences of the Proposed Action

To avoid or minimize the potential environmental impacts to surface water from the proposed rail line as described above in Section 4.2.4.1, OEA is recommending that the Board impose 28 mitigation measures, including 10 measures volunteered by the Applicant (see Section 19.2). These measures include requiring: acquisition of appropriate Federal and state permits; mitigation of unavoidable impacts to surface water; avoidance and minimization of impacts to wetlands and waters of the United States; maintenance of natural water flow and drainage; design of bridges and culverts over fish-bearing waters to meet National Marine Fisheries Service (NMFS) requirements; limitation of construction in anadromous streams during low-flow conditions and following other Alaska Department of Fish and Game (ADF&G) timing recommendations to the extent practicable; utilization of best management practices imposed by the USACE; marking of stream channels prior to snowfall; removal of debris from waterbodies at rail line crossings; construction of project-related winter roads to avoid water quality degradation; consultation with the USACE on gravel mining within the limits of ordinary high water; and compliance with appropriate regulations governing hazardous substances and potential contamination.

Notwithstanding the recommended mitigation measures, there still would be potential unavoidable impacts to surface water from the proposed rail line. Potential impacts would include: potential changes to natural drainage and altered flood hydraulics near crossings; increased potential for debris jams and overbank flooding upstream of water crossings; reduced floodplain area; increased scour and bank erosion at crossings; and increased turbidity, sediment loads, and concentrations of pollutants during construction.

There is also some chance that there could be additional potential impacts due to culvert or bridge design or maintenance. Recommended mitigation would require water crossing structures to be designed to meet specific hydrologic criteria (such as the 100-year flood), but natural fluctuations in hydrology could create instances where culvert and bridge design cannot move flow effectively, potentially leading to an alteration in water flow through streams. For example, flooding levels exceeding the culvert design could result in impeded surface water flow. Culverts would result in greater potential impacts to flow than bridges due to the greater potential of culverts to constrict and alter flows than bridges.