

Beal Slough Relief Trunk Sewer Alignment Study Report

Findings and Evaluation of Alignment Selection Factors

3.0 Findings and Evaluation of Alignment Selection Factors

This section presents the findings and evaluation of alignment selection factors used to compare each alternative alignment. The evaluation to select a preferred alignment was based on the selection factors listed below. Each of the factors was placed into a matrix to evaluate a preferred alignment alternative.

- Length of Sewer
- Length of Tunnel Crossings
- Geotechnical
- Existing Utilities
- Railroad Impacts
- Pavement and Traffic Impacts
- Proposed Road Improvements
- Proposed Stormwater Improvements
- Connections with Existing Sewers
- Public Relations
- Impacts and Disruptions to Existing Businesses
- Wetlands
- Hazardous Substances
- Cultural Resources
- Construction Techniques
- Hydraulic Design
- Constructibility Requirements
- Construction Impacts on Existing Sewer
- Potential Risks During Construction
- ROW and Land Acquisition
- Permits and Approvals

Multiple field reconnaissance trips were conducted by Black & Veatch personnel with assistance from Olsson Associates to determine topographic features and define alignment alternatives. A reconnaissance trip was also conducted with LWWS staff and other City department staff to review alignment issues. The opinion of probable project cost for each alignment is provided in the Project Costs for Alternatives section.

3.1 Length of Sewer

As presented in Section 2 – Description of Proposed Alignment Alternatives, Table 3-1 indicates the lengths of sewer pipeline required for each proposed Beal Slough Relief Trunk Sewer alignment.

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Table 3-1: Length of Sewer for Each Alignment

Alignment	Phase	Length (feet)
Alignment No. 1	Phase I	10,287
	Phase II	11,286
	Total Length (feet)	21,573
Alignment No. 2	Phase I	9,411
	Phase II	11,694
	Total Length (feet)	21,105
Alignment No. 3	Phase I	8,853
	Phase II	11,315
	Total Length (feet)	20,168

Alignment No. 1 has the longest length, since it is routed along the north side of Highway 2 from 14th Street to 56th Street. Alignment No. 2 is routed along the east side of Fleming Foods, extending the alignment 600 feet away from the Beal Slough at this location, to avoid the LES substation along Beal Slough. The additional length is the result of deviating the alignment away from Beal Slough and proceeding back to the southeast from 33rd Street to 40th Street. Alignment No. 3 has the shortest length since it follows the south side of the Beal Slough from its connection with the Salt Valley Relief Trunk Sewer east to 56th Street in nearly a straight line.

The selection factor for length of sewer favors Alignment No. 3, although the difference in sewer length is within 5% for all alternatives.

3.2 Length of Tunnel Crossings

Railroad companies, utility agencies, and public works entities were contacted to determine locations that would require tunneling for the sewer alignments. The tunnel locations and lengths are shown in Figures 2-1 through 2-5 and are indicated in Table 3-2. The total number of tunnel crossings is also indicated in Table 3-2 for each alignment.

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Table 3-2: List of Tunnels and Length for Alignments

Alignment	Phase	Tunnel No.	Tunnel Location	Length (feet)
Alignment No. 1	Phase I	1	BNSF Railroad Line	110
	Phase I	2	BNSF Railroad Line	110
	Phase I	3	14 th Street/Highway 2	380
	Phase I	4	18 th Street	135
	Phase I	5	Highway 2/BNSFRR at 14 th Street	310
	Phase I	6	Highway 2/BNSFRR at 27 th Street	310
	Phase II	7	27 th Street/Pedestrian Hill	660
	Phase II	8	Highway 2/Pioneers Blvd Access Roads	135
	Phase II	9	33 rd Street	80
	Phase II	10	40 th Street	210
	Phase II	11	48 th Street	85
			Total Length	2,525
Alignment No. 2	Phase I	1	BNSF Railroad Line	110
	Phase I	2	BNSF Railroad Line	105
	Phase I	3	14 th Street	110
	Phase I	4	115 KVA LES Transmission Main	50
	Phase I	5	Southwood Street	60
	Phase I	6	Beal Slough/BNSFRR/27 th Street	380
	Phase II	7	Highway 2/40 th Street	205
	Phase II	8	48 th Street	85
			Total Length	1,105
Alignment No. 3	Phase I	1	BNSF Railroad Line	110
	Phase I	2	BNSF Railroad Line	105
	Phase I	3	Hill on Correctional Services Land	980
	Phase I	4	14 th Street	125
	Phase I	5	Southwood Street	60
	Phase I	6	Pedestrian Walkway on Old Railroad Grade/LES Easement and 27 th Street	725
	Phase II	7	40 th Street	175
	Phase II	8	48 th Street	85
			Total Length	2,365

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Alignment No. 1 has 11 tunnels with a total length of 2,525 feet. The major tunnel that impacts this alignment is the 660 foot tunnel to cross beneath 27th Street and the pedestrian hill with the hiking-biking trail. The tunnel is required at the pedestrian hill because of the excessive depth for open cut excavation.

Alignment No. 2 has eight tunnels with a total length of 1,105 feet. The tunnels cross beneath the BNSF railroad lines, roadways, and the LES 115 KVA transmission main. All of the tunnels have relatively short lengths and will not require special tunneling methods.

Alignment No. 3 has eight tunnels with a total length of 2,365 feet. The major tunnels that impact this alignment include the 980 foot tunnel on Correctional Services property and the 725 foot tunnel under the hiking-biking trail/LES easement/27th Street. The tunnel on Correctional Services property is required because of excessive trenching at the hill south of Beal Slough. The 27th Street tunnel extends west to the hiking-biking trail because of excessive trenching at this location. The alignment through the LES easement is directly beneath the overhead transmission lines and, therefore, requires tunneling.

The length of tunnel crossings significantly favors Alignment No. 2, followed by Alignment No. 1, and Alignment No. 3. The tunnel lengths for Alignment Nos. 1 and 3 are approximately 110% and 115% longer, respectively, than Alignment No. 2.

3.3 Geotechnical

Geotechnical considerations include the types and properties of the soils underlying the proposed alignments along with the potential amounts of groundwater. Geotechnical borings were reviewed for the Beal Slough drainage basin in the vicinity of the proposed alignments. A generalized description of the anticipated subsurface conditions includes a layer of silty clay ranging from one to 20 feet with a layer of lean clay from 20 to 40 feet in depth, overlaying the alluvial sands. Groundwater is present in each alignment with a water table depth ranging from 13 to 25 feet along the alignments. Rock was not encountered within 50 feet of the surface on the soil explorations.

Analysis of the geotechnical considerations does not favor a particular alignment, therefore, each alignment should be considered equivalent.

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3.4 Existing Utilities

Alignment selection factors for the presence of existing utilities along the alignments included evaluating the impacts of both underground and overhead utility installations. Diggers Hotline of Nebraska was contacted to determine the utilities in the Beal Slough area. Each utility listed below was provided preliminary alignment drawings for review. Information was obtained from each utility pertaining to their existing and planned utilities.

3.4.1 Lincoln Water System

Water maps indicating the existing water mains were obtained from the City of Lincoln GIS System. A summary of the water mains crossed and paralleled for each alignment is as follows:

Alignment No. 1 (Brown Alignment) –

- A 24 inch main is crossed at 27th Street
- An 8 inch main is crossed at 33rd Street
- A 16 inch main is crossed at 40th Street
- A 6 inch main is crossed at 48th Street

Alignment No. 2 (Red Alignment) –

- An 8 inch main is crossed at 14th Street
- A 16 inch main is paralleled from 17th Street to 19th Street along Pioneers Blvd, but will be greater than 10 feet from the sewer.
- A 16 inch main is crossed at 19th Street
- A 16 inch main is crossed at Southwood Blvd
- A 24 inch main is crossed at 27th Street
- A 16 inch main is crossed at 40th Street
- A 6 inch main is crossed at 48th Street

Alignment No. 3 (Green Alignment) –

- An 8 inch main is crossed at 14th Street
- A 16 inch main is paralleled from 17th Street to 18th Street
- A 16 inch main is crossed at 19th Street
- A 16 inch main is crossed at Southwood Blvd
- A 24 inch main is crossed at 27th Street

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Alignment No. 3 (Green Alignment) continued–

- A 16 inch main is crossed at 40th Street
- A 6 inch main is crossed at 48th Street

Alignment No. 3 may require relocation of the 16 inch main from 17th to 18th Streets. Alignment Nos. 1 and 2 should not require relocations; therefore, these are the favored alternatives.

3.4.2 Storm Sewers

Storm sewer maps indicating the existing storm sewers were obtained from the City of Lincoln GIS System. Curbs, gutters, and inlets are present along Highway 2 and other paved streets. A summary of the storm sewers crossed and paralleled for each alignment is as follows:

Alignment No. 1 (Brown Alignment) –

- A 15 inch line is crossed at 14th Street
- A 24 inch line is crossed at 14th Street
- A 24 inch line is crossed at 14th Street
- A 36 inch line is crossed at 16th Street
- A 42 inch line is crossed at 17th Street
- A 30 inch line is crossed at 20th Street
- A 60 inch line is crossed at Dunn Ave
- A 60 inch line is crossed at Dunn Ave
- A 36 inch line is crossed at 27th Street
- A 36 inch line is paralleled at 27th Street for 90 feet
- A 24 inch line is crossed at 27th Street
- A 72 inch line is crossed at 36th Street
- A 60 inch line is crossed at 37th Street
- A 60 inch line is paralleled at 40th Street for 200 feet
- A 48 inch line is crossed at 48th Street
- A 60 inch line is crossed at 48th Street

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Alignment No. 2 (Red Alignment) –

- A 12 inch line is crossed south of the State Penitentiary
- A 12 inch line is crossed south of the State Penitentiary
- An 8 inch line is crossed south of the State Penitentiary
- A 36 inch line is crossed at 14th Street
- A 36 inch line is crossed at 17th Street
- A 36 inch line is crossed at 27th Street
- A 48 inch line is crossed at 27th Street
- An 8x8 box culvert is crossed at 27th Street
- A 48 inch line is crossed at 48th Street
- A 60 inch line is crossed at 48th Street

Alignment No. 3 (Green Alignment) –

- A 24 inch line is crossed at 14th Street
- A 30 inch line is crossed at 14th Street
- A 48 inch line is crossed at 18th Street
- A 24 inch line is crossed at Southwood Blvd
- A 24 inch line is crossed at 23rd Street
- A 30 inch line is crossed at 24th Street
- A 36 inch line is crossed at 27th Street
- A 36 inch line is crossed at 33rd Street
- A 24 inch line is crossed at 35th Street
- A 30 inch line is crossed at 40th Street
- A 48 inch line is crossed at 48th Street
- A 60 inch line is crossed at 48th Street

Each alignment crosses between 10 and 16 storm sewers; therefore, each alignment is considered equal.

3.4.3 Lincoln Electric System (LES)

Two separate electric transmission main systems are located along or across the proposed alignments. The first line is an underground 115 KVA transmission main which proceeds north from the substation at 20th

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Street and Pioneers Blvd to the BNSFRR right-of-way and then proceeds east to 27th Street approximately 8 feet south of the BNSFRR right-of-way. The transmission main then proceeds northeast along the hiking/biking trail under Highway 2 and then further north out of the project area. This line is located approximately five feet below the surface and is surrounded by thermal sand and a concrete cap on top of the line. According to LES, activities near this line should stay a minimum of three feet away from the line. Crossing this main should be accomplished by tunneling to avoid replacing the concrete cap and thermal sand. The construction schedule should be modified to complete this tunneling between October 1st and May 1st to allow the line to be taken out of service. Paralleling of this transmission main would require all trenching to stay out of the 15 foot easement along the south side of the BNSFRR right-of-way.

The second transmission main is an overhead system which proceeds from 6th and Calvert southwest to the Beal Slough then east along the Beal Slough to near 54th Street. This transmission main has 60 foot and 80 foot easements along the entire route with transmission towers intermittently spaced along the route. At 38th Street, a connection is provided to the LES substation north of Highway 2. When de-energized, all construction activities shall remain outside of a 10 foot diameter from the lines. When energized, construction activities shall remain outside of a 20 foot diameter from the lines. Permitting for crossing and paralleling the transmission mains within the easements requires a “Letter of Understanding” between the contractor and LES.

Alignment No. 1 crosses beneath the overhead transmission line near 7th Street and Pioneers Blvd, 38th Street and Highway 2, and at 40th Street and Highway 2. The alignment parallels the easement from 40th Street to 54th Street.

Alignment No. 2 crosses beneath the overhead transmission line near 7th Street and Pioneers Blvd, 38th Street and Highway 2, and at 40th Street and Highway 2. The alignment parallels the north side of the easement from approximately 7th Street to 18th Street and the south side of

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the easement from 40th Street to 54th Street. It crosses the underground 115 KVA transmission main at 20th Street and Pioneers Blvd.

Alignment No. 3 crosses the easement four times and parallels the easement from southwest of the State Penitentiary to near 40th Street. The four crossings are located at approximately 7th Street south of the Beal Slough, near the existing Salt Valley Trunk Sewer, near 20th Street, and in Tierra Briarhurst Park. The alignment is located inside the easement directly beneath the power lines from the pedestrian trail east to 27th Street for approximately 750 feet.

3.4.4 Alltel

Alltel has fiber optic lines extending along 14th Street and 27th Street. Each alignment will cross beneath these lines; therefore, no alignment was favored.

3.4.5 MCI

MCI has fiber optic lines paralleling the BNSF railroad lines along 6th Street. Each alignment will cross beneath these lines; therefore, no alignment was favored.

3.4.6 Qwest

Qwest has fiber optic lines paralleling the BNSF railroad lines along 6th Street. Each alignment will cross beneath these lines; therefore, no alignment was favored.

3.4.7 Aquila

A 24 inch gas main with, a max allowable pressure of 74 naop, extends along the north side of Highway 2 from 56th Street to 33rd Street. The main is located approximately 100 feet north of the centerline of Highway 2 in the right-of-way and buried 5 to 10 feet below ground. This main is one of the most critical supply lines for the City of Lincoln and would be difficult to remove from service. An 8 inch gas main is located along 40th Street at a depth of approximately 5 feet. Additional 4 inch and

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2 inch distribution gas mains are located throughout the project area and are concentrated at the major street intersections with Highway 2 at 14th Street, 33rd Street, 40th Street, 48th Street, and 56th Street.

Construction of the recent sewer along 56th Street impacted the gas main requiring additional shoring of the gas main for support. Evaluation of alignments near 56th Street should include provisions for preventing interference with the existing gas main.

Two fiber optic lines proceed along 14th Street and 56th Street which will cross each of the alignments. These lines are connected to the new high schools in south Lincoln. Each line has three 1-1/4 inch conduits.

Alignment No. 1 would parallel the 24 inch gas main from 33rd Street to 56th Street. Alignment No. 2 would parallel the 24 inch gas main from 40th Street to 56th Street. The analysis of the alignments indicates sufficient clearance from the 24 inch gas main along the north side of Highway 2.

3.5 Railroad Impacts

The Burlington Northern Santa Fe Railroad (BNSFRR) has three lines that will require permitting with the sewer alignments. The first line is located on the east side of the abandoned Union Pacific railroad grade at approximately 6th Street. Each of the three alignments will tunnel beneath the railroad for a connection to the Salt Valley Relief Trunk Sewer Phase IV. A second line is located along the existing Salt Valley Trunk Sewer, which will also require tunneling for each of the three alignments. A third line runs east-west from 14th Street to 56th Street. This line transfers ownership from BNSFRR to Omaha Public Power District (OPPD) 150 feet west of the 56th Street and Old Cheney intersection. No crossings of the OPPD railroad line are required.

Alignment No. 1 will cross beneath the BNSFRR line at 14th Street. Alignment No. 2 will parallel the railroad line outside the easement from 18th Street to west of 27th Street. At 27th Street the alignment will cross beneath the railroad line and then parallel north side of the railroad line adjacent to the right-of-way from 27th Street to just west of 40th Street. Alignment No. 3 will parallel the railroad line from 40th Street to 56th Street inside of the right-of-way.

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The Utility Accommodation Policy for BNSFRR was reviewed to determine the requirements for paralleling and crossing beneath the railroad lines. When work is within twenty-five feet of the centerline of the track, railroad flagging will be required. Flagging services shall be performed by BNSF employees and the total cost borne by the Utility Owner at a rate of \$500 per day billed monthly. Utilities greater than 500 feet in length installed within the outside 10 feet of the easement will be considered a parallel line. BNSFRR must approve any parallel installation over one mile. If pipeline is located 40 feet or less from centerline of track, the pipeline shall be encased or specifically constructed to AREMA Standard and be approved by BNSF. No pipeline may be installed closer than twenty-five feet from centerline of track.

Alignment No. 1 would have the least impact to the railroad. Alignment No. 2 would have some impact as the pipeline may be installed on the edge of the right-of-way from 27th Street to 40th Street. Alignment No. 3 would have the most impact as it would be installed within the railroad right-of-way from 40th Street to 56th Street and would be considered as a parallel line.

3.6 Pavement and Traffic Impacts

This factor includes construction related impacts to existing pavement and traffic. These impacts are considered separately from the general disruptions to neighborhoods and businesses.

Alignment No. 1 would open-cut an asphalt access road and a portion of the concrete parking lot at the State Penitentiary. Additional street crossing which will be open-cut include Brower Road and 20th Street. These streets are concrete with finished curb and gutter. Additional paving will be required for replacement of the hiking/biking trail along Highway 2.

Alignment No. 2 would open-cut the gravel access road along the south side of the State Penitentiary. Concrete business drives at Budget Self Storage, Cambell Ind, and the LES Substation would be open-cut requiring temporary access drives to the businesses. Portions of Pioneers Blvd. may be open-cut, but half of the street must remain open at all times to provide access to the three businesses as previously identified. The asphalt parking lot at Peterson Park may require total replacement based on the exact location of the sewer. The Parks and Recreation Department has indicated that insufficient parking is available at this location, and they may want to contribute input

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into the replacement of the parking lot. Additional paving will be required for replacement of the hiking/biking trail along Highway 2.

Alignment No. 3 would open-cut the gravel drive south of the Correctional Services bridge over the Beal Slough. Additional concrete and gravel drives behind Weaver's and Pegler/Sysco would also be open-cut for installation of the sewer. Stephanos Drive may be open-cut provided access is always available from either the east or west.

Alignment No. 2 would require the most disturbances to existing paving because of the disturbances along Pioneers Blvd. near Budget Self Storage, Cambell Ind, the LES substation, and Peterson Park. Alignments No. 1 and No. 3 are nearly equivalent; therefore, they are the favored alignments.

3.7 Proposed Road Improvements

Nebraska Department of Roads (NDOR) and the City were consulted to determine future road improvements near the proposed alignments. NDOR indicated that they will relinquish control of Highway 2 to the City upon completion of the planned southern bypass project, therefore, NDOR doesn't have any major projects planned for Highway 2. The City indicated that Highway 2 would be expanded in the future to include an additional lane in either direction. A current planned improvement for Highway 2 is the addition of extra turning lanes at 27th Street. An HDR study indicated a dual grade intersection at 14th Street and Highway 2. Neither NDOR nor the City had any intention of continuing with this project.

The City indicated that Pioneers Blvd. would be expanded from two lanes to either three lanes or five lanes in the future to provide an alternative route into Lincoln from Highway 77. This expansion would include an additional 60 feet of right-of-way equally divided on the north and south sides of the road. Alignment No. 1 is shown extending through this additional 30 foot right-of-way on the south side of Pioneers Blvd. A safety project is being conducted by the City-PWU at 27th Street in 2004. Construction of the sewers should be coordinated with this project.

The alignments for each alternative have been adjusted to coordinate the future road improvements and, therefore, this factor does not favor one alignment over another.

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3.8 Proposed Stormwater Improvements

Lincoln Watershed Management and the Lower Platte South Natural Resources District have been consulted to identify concerns pertaining to locating the sewers along Beal Slough. Proposed improvements to Beal Slough are reflected on the drawings and include the installation of grade checks, tie-back levees, bridge replacements, by-pass channels, channel improvements, supplemental culverts, and an off-channel storage facility. Intuition and Logic is conducting a study on Beal Slough from 27th Street to near 40th Street. Portions of these improvements were also included.

Alignment No. 1 would be located upstream of the proposed grade check on Beal Slough and cross below the bed of the channel and may not require an additional grade check. The sewer would cross Beal Slough again in the bioengineered channel section west of 40th Street. It should be further examined to determine if the channel should be open-cut or tunneled at this location. South of the baseball field at 40th Street, a by-pass channel would be constructed over the sewer.

Alignment No. 2 would cross the Beal Slough east of the BNSF railroad line from the south to the north. A grade check installed at the stream crossing would prevent future stream bed erosion. This grade check would also protect the BNSF railroad bridge and the Correctional Services access bridge. A second grade check would be located on the west side of the BNSFR bridge. Erosion south of the State Penitentiary has been experienced along the south bank, but additional provisions for bank stabilization along the north bank should be investigated. The alignment south of the State Penitentiary and Fleming Foods would have a tie-back levee installed adjacent to the sewer in the future. The levee would be approximately four feet high and have a keyway below it to prevent sliding. See Beal Slough Stormwater Master Plan Figure SG1-PC for additional information. At the 40th Street and Highway 2 intersection, the alignment crosses northeast and would not be influenced by the proposed by-pass channel or supplemental culvert south of Highway 2. The proposed by-pass channel on the north side of Highway 2 would cross over the sewer.

Alignment No. 3 would not be impacted by future Beal Slough Stormwater Master Plan projects, but would require streambank stabilization from 14th Street to Southwood Blvd to stabilize the embankment and replace the trees removed during installation of the sewer. Additional streambank stabilization would be required along

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the sewer from 35th Street to 40th Street to prevent the stream channel from meandering further into the sewer alignment.

Alignment No. 2 would require the most coordination with entities for installation of the grade checks, but this would also prove to be an opportunity for a joint project to fix a problem with the streambed erosion. Alignment No. 3 would require coordination for the streambank stabilization and Alignment No. 1 would require the least coordination. The benefits associated with Alignment No. 2 make it the favored alternative.

3.9 Connections with Existing Sewers

Sanitary Sewer maps indicating the existing sanitary sewers were obtained from the City of Lincoln GIS System. A summary of the sanitary sewers crossed and paralleled for each alignment is as follows:

Alignment No. 1 (Brown Alignment) –

- The 36 inch Salt Valley Trunk Sewer is crossed along Pioneers Blvd
- The 36 inch Salt Valley Trunk Sewer is paralleled for 600 feet from Pioneers Blvd to the BNSF railroad across Correctional Services property.
- An 8 inch line is crossed at 14th Street
- An 8 inch line is crossed at 30th Street
- An 8 inch line is crossed at 33rd Street
- A 10 inch line is crossed at 37th Street
- A 12 inch line is crossed at 38th Street
- The 24 inch Beal Slough Sewer is paralleled from 40th Street to 56th Street
- An 8 inch line is crossed at 48th Street
- A 12 inch line is crossed at 48th Street
- A 10 inch line is crossed at 52nd Street
- An 8 inch line is crossed at 53rd Street

Alignment No. 2 (Red Alignment) –

- The 24 inch Salt Valley Trunk Sewer is crossed southwest of the State Penitentiary north of the existing siphon
- A 6 inch line is crossed south of the State Penitentiary
- A 15 inch line is crossed at 14th Street

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Alignment No. 2 (Red Alignment) continued –

- An 8 inch line is crossed at Southwood Blvd
- The 24 inch Beal Slough Sewer is paralleled or within close proximity from 18th Street to 56th Street
- An 18 inch line is crossed at 27th Street
- An 18 inch line is crossed at 27th Street
- An 8 inch line is crossed at 39th Street
- An 8 inch line is crossed at 40th Street
- An 8 inch line is crossed at 48th Street
- A 12 inch line is crossed at 48th Street
- A 10 inch line is crossed at 52nd Street
- An 8 inch line is crossed at 53rd Street

Alignment No. 3 (Green Alignment) –

- The 24 inch Salt Valley Trunk Sewer is crossed southwest of the State Penitentiary south of the existing siphon
- A 16 inch line is crossed at 14th Street
- A 10 inch line is paralleled from 14th Street to 17th Street
- An 8 inch line is crossed at Southwood Blvd
- An 18 inch line is crossed at 27th Street
- An 18 inch line is crossed at 27th Street
- An 8 inch line is crossed at 30th Street
- An 8 inch line is crossed at Jasper Court
- An 8 inch line is crossed at 38th Street
- An 8 inch line is crossed at 40th Street
- An 8 inch line is crossed at 48th Street
- A 12 inch line is crossed at 48th Street

LWWS has indicated that the Beal Slough Relief Trunk Sewer would be utilized primarily to serve the southern portion of the Beal Slough drainage basin. To accomplish this goal, the 16 inch sanitary sewer at 14th Street and the two 18 inch sewers at 27th Street must be extended north to tie into Alignment No. 1 resulting in additional cost.

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Alignment Nos. 2 and 3 are both located south of the existing Beal Slough Sewer; therefore, no additional extensions for interconnection are required.

A hydraulic analysis of the existing crossings at 56th Street and Highway 2 indicate that the 18 inch and 24 inch sewers have a combined capacity of 15.5 mgd. The projected future flow through this crossing is 17.7 mgd. This hydraulic analysis included the additional 800 acres from the Pine Lake addition, which may account for the 2.2 mgd difference. Based on this small difference in the total drainage basin area, an additional crossing of Highway 2 was not provided.

Based on the hydraulic evaluation, Alignment No. 2 is the favored alignment as interconnections from sewers south of the existing sewer would be connected with only minor disruptions and the proximity of the relief sewer to the existing sewer would allow direct interconnects at many locations. Alignment No. 3 would be favored next, since it is located south of the existing sewer and interconnects would be connected with only minor disruptions. Alignment No. 1 would be last, since interconnects would need to be constructed at 14th Street and 27th Street.

3.10 Public Relations

Public Relations pertains to the potential impacts the three alignments may have on the public and the surrounding community. Public relations issues for consideration would include higher visibility of construction operations; objectionable effects of construction operations due to dust, noise and proximity to the public; interruptions of utility services to a neighborhood; and other factors which could cause disruptions to neighborhoods.

Alignment No. 1 has street crossings at Brower Road and 20th Street that might impact the neighborhoods for up to 2 weeks. The greatest impact of the alignment will be the construction in Parks and Recreation and Highway 2 right-of-way causing the closure of portions of the hiking/biking trail during construction. Homeowners from 17th Street to 27th Street will also be subject to pipe staging area activities and the noise of construction activities near their backyards.

Alignment No. 2 is routed across Peterson Park and will close the parking lot for the baseball fields and tennis court during construction. However, there is the opportunity to relieve the current problems with lack of parking by increasing the size of the parking lot. These facilities are primarily used between June 1st and August 15th. The

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sewer will require the temporary closure of the hiking/biking trail during construction from 40th Street to 56th Street. The playground equipment in the park would require removal and replacement with new equipment, because of updated safety standards.

Alignment No. 3 is routed through Peterson Park from 19th Street to 27th Street, and will be near the neighborhood to the south of the park. The sewer extends along the LES easement through Tierra Park and the adjacent subdivision with construction occurring near homes in the area.

Alignment No. 2 would have the least public relations impact since it is not routed directly adjacent to homeowners. Although there are negative impacts in Peterson Park, increasing the size of the parking lot would prove beneficial to the community. Alignment No. 1 and No. 3 would have similar impacts and are rated second and third.

3.11 Impacts and Disruptions to Existing Businesses

This factor involves potential impacts and disruptions to existing businesses due to construction operations. Alignment No. 1 crosses Correctional Services land around the State Penitentiary and will temporarily close the northeast entrance to the parking lot. As the sewer is routed along Highway 2, the State Patrol office parking lot may be temporarily closed during construction in the area.

Alignment No. 2 crosses the south side of the Correctional Services land and may require additional security by the State Penitentiary during construction along the outer fence. However, the addition of a grade check would benefit the State Penitentiary by minimizing stream degradation in the area. The Fleming Foods' south fence must be removed and replaced during construction, but this should not impact any business operations. On the east side of Fleming Foods, construction activities will temporarily require moving 10-20 trailers parked along the proposed easement during construction. Budget Self Storage, Cambell Ind, and the LES Substation will require a temporary entrance to their facilities during construction. Budget Self Storage will require a temporary security fence during construction.

Alignment No. 3 crosses the south side of the Beal Slough from 14th Street to 19th Street behind Weaver's and Pegler/Sysco. Although construction activity should not directly impact operations at these facilities, construction traffic will pose a burden on their property. Parking areas at the businesses may be required for a staging area as well. LES may be impacted during construction of this alignment due to the proximity of the

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overhead power lines. If damage were to occur to these lines, it could disrupt electrical services.

Alignment No. 2 will have the least impact on business operations, since it will not require closure of parking lots at businesses or disrupt business activities beyond creating temporary drives for businesses. Alignment No. 1 would be favored second followed by Alignment No. 3.

3.12 Environmental

Environmental factors were considered for compliance with existing regulations and to assess the potential for adverse impacts during construction which could result in additional costs and delays to the project. Environmental factors would include wetlands, hazardous substances, and cultural resources. The overall evaluation of the environmental factors favors Alignment Nos. 1 and 2, since they avoid the potential leaking underground storage tanks for Alignment No. 3 at Weaver's Potato Chip Factory and at Flemming Foods.

3.12.1 Wetlands

A preliminary wetlands evaluation was conducted for the proposed Beal Slough alignments to investigate possible permitting issues that could be encountered once a final alignment is selected. All the proposed alignments have wetland areas and permitting will be required. Wetland areas along all the potential alignments of Beal Slough would qualify for a Nationwide Permit # 12 (NWP). This is a utility line-crossing permit for temporary impacts with grade restored to pre-existing contours. No saline wetlands are in the project area.

The Beal Slough crossing west of 40th Street could have a different permitting issue depending on the construction method used (boring or grade structure). A Beal Slough grade check structure should qualify for a NWP #27, stream and wetland restoration activity, which would be consistent with the Beal Slough Master Plan. Boring under Beal Slough may not require a permit. Total impacts to wetland areas based on the current alignments options appear to be small at this time and no mitigation would be required. Any construction directly adjacent to or paralleling Beal Slough must incorporate best management practices (BPM's) and not disrupt the steam channel without a permit.

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3.12.2 Hazardous Substances

Examination for potential hazardous wastes along each of the three alignments included a review of an Environmental Data Resources, Inc. (EDR) report, dated May 22, 2003, and an evaluation of the proximity of the contaminants in relation to each alignment. A memorandum and figure discussing the analysis of the alignments are included in Appendix B. The findings of the EDR report indicate that there are four areas of concern for the alignment of the sewers as follows:

9th Street and Highway 2. This section has been listed as containing carbon tetrachloride and chloroform in groundwater. No future remedial action is currently planned for the site. Alignments for the sewer will not proceed along Calvert to 9th Street and Highway 2, thus avoiding this location.

South side of Beal Slough from 14th Street to 19th Street. This section has four leaking underground storage tanks located on properties owned by Weaver's Potato Chips Company, Pegler Sysco, and Fleet Maintenance. No remedial actions are currently planned for these sites and the state trust fund for remediation of leaking underground storage tanks has been exhausted. An alignment along the south side of Beal Slough would require further studies to determine the exact location of the storage tanks and the progression of contaminants in the soil and groundwater. Geotechnical exploration along this alignment should include sampling for volatile organics, semi-volatile organics, and RCRIA metals.

40th Street and Highway 2. A motor vehicle spill occurred at this intersection involving Fitch Trucking. Information pertaining to this spill should be obtained from the EDR and from the Nebraska Department of Environmental Quality to determine the contaminants and volume of the spill. Alignments for all three alternatives are located in this area and may require remediation activities. Geotechnical exploration along these alignments should include sampling for volatile organics, semi-volatile organics, and RCRIA metals.

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56th Street and Highway 2. Four motor vehicle spills have occurred at this intersection as indicated in the attached table. Also, three leaking underground storage tanks are located within one block of the intersection. A project was recently completed for the installation of a 24 inch sewer on the west side of 56th Street at Highway 2. This project should be examined to determine if any contaminants were encountered and if remediation was required. Alignments for all three alternatives are located in this area and may require remediation activities. Geotechnical exploration along these alignments should include sampling for volatile organics, semi-volatile organics, and RCRIA metals.

Each alignment will be impacted by potential hazardous wastes located at the intersections of 40th Street and Highway 2 and at 56th Street and Highway 2 as a result of automotive spills. Alignment No. 1 may be impacted by a leaking underground storage tank (LUST) at 14th Street and Highway 2 and two additional LUSTs at 33rd Street and Pioneers Blvd. Alignment No. 3 may be impacted by LUSTs at Weavers Potato Chip Factory, Pegler-Sysco Co, and Fleet Maintenance. Therefore, Alignment No. 2 is the favored alignment. Each alignment will require additional geotechnical analysis of the soil conditions and the groundwater to determine the extent of possible contamination.

3.12.3 Cultural Resources

Mr. Ed Zimmer from the Lincoln/Lancaster County Planning department was contacted regarding cultural resources for all the possible alignments for Beal Slough. Mr. Zimmer has investigated the areas and indicated there are no historic resources in the area. The State Historical Preservation Office recommended an archaeology survey from 15th Street west to 4th Street along Beal Slough. The cost of the survey for the recommended alignment is approximately \$2,000.

3.13 Construction Techniques

Evaluation of the potential construction techniques that would be utilized for each alignment was conducted. The analysis included factors that may negatively impact the

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selected alignment by requiring a higher degree of uncertainty in performance and ability to complete the work.

Construction techniques anticipated for each alignment would include the use of trenchless technologies for railroad crossings, road crossings, and some utility crossings. The remainder of the project would utilize open-cut trenching techniques. No significant difference in construction technologies is anticipated between the alignments; therefore, each alignment is considered to be equivalent.

3.14 Hydraulic Design

A review was conducted of previous reports and documentation relating to the study area including engineering analysis, inventory databases, and maps provided by the City. Based on the City's design flow curve and historical flow data, unit-hydrographs were created for each point of entry, which included both existing and ultimate flow conditions. The existing sewer was then modeled utilizing Hydroworks to perform system hydraulic analyses on the existing trunk sewer system. This modeling determined for each line segment the peak flows, percentage of capacity used, and preliminary relief sewer size. Listed below are the criteria selected for hydraulic design of the Beal Slough Relief Trunk Sewer:

- Minimum Velocity (Full Pipe) = 3 ft/s
- Maximum Velocity = 12 ft/s
- Manning Coefficient = 0.013
- Minimum Slope = Based on Minimum Velocity
- Existing Sewer Allowable Flow/Capacity Ratio = 1.0
- New Relief Sewer Design Flow/Capacity Ratio = 0.90
- Minimum Depth of Cover = 10 ft

The manholes listed in Table 3-3 show the location of the incoming subsystem areas, as shown in Figure 1-2, to the existing Beal Sough Trunk Sewer. The calculated flow and the criteria listed above provide the information needed to properly size the new Beal Sough Relief Trunk Sewer.

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Table 3-3: Wastewater Model Flow Input Locations

Manhole	Subsystem	Area (acres)	Peak Flow (cfs)	Peak Flow (mgd)
3	BS21, 31A & 30	3607	22.920	14.818
13	BS20	51	0.554	0.358
14	BS19	275	2.369	1.531
17	BS17 & 18	304	2.584	1.671
42	BS16	130	1.238	0.800
43	BS15	55	0.591	0.382
44	BS14	259	2.244	1.451
99	BS14	259	2.244	1.451
101	BS13	91	0.910	0.588
186	BS12	165	1.521	0.983
193	BS11	46	0.507	0.328
272	BS7, 8, 9, 10, & 31B	4045	25.396	16.419
80	BS6	187	1.695	1.096
86	BS5	83	0.841	0.544
89	BS4	332	2.791	1.804
262		748	5.681	3.673
20A	BS2 & BS3	649	5.015	3.242
298	BS1	61	0.646	0.417

Based on the hydraulic analysis conducted, the Beal Slough Relief Trunk Sewer is 36 inches in diameter for Phase I, which is approximately from the Salt Valley Relief Trunk Sewer connection east to 27th Street. Phase II, from 27th Street to 56th Street is sized at 30 inches in diameter. The sizes will not differ between the proposed alignments; therefore, this factor does not favor a particular alignment.

3.15 Constructibility Requirements

Constructibility requirements include potential conditions along each alignment that may impact the construction of the relief sewer. As discussed in Construction Techniques, it is anticipated that similar construction techniques will be utilized for each alignment. Alignment No. 1 construction staging area will be reduced because of the close proximity of Highway 2 from 16th Street to 30th Street. Materials may have to be stored off-site during construction. Alignment No. 2 construction staging area will be reduced from 27th Street to 40th Street between the BNSF railroad line and Highway 2. Alignment No. 3 is primarily along the LES overhead power easement which causes safety considerations associated with these power lines. Also, the sewer from 14th Street

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to Southwood Blvd. would be constructed directly adjacent to the Beal Slough requiring stream bank restoration. Materials may have to be stored off-site during construction.

Each alignment location identified will require the contractor to exercise additional care in conducting operations, placing excavated materials, stockpiling embedment materials and pipe, and placing and compacting backfill materials. Evaluation of this factor would favor Alignment No. 2 because of the open areas along the alignment for construction staging areas and the smaller length of reduced areas for staging, followed by Alignment No. 1, then Alignment No. 3.

3.16 Construction Impacts on Existing Sewer

This factor relates to concerns about potential damage to the existing Beal Slough sewer from construction of the new relief sewer. Alignment No. 1 parallels the existing sewer from Pioneers Blvd to the BNSF railroad tracks and from 40th Street to 56th Street. Alignment No. 2 parallels the existing sewer from 20th Street to 56th Street. Alignment No. 3 briefly parallels the existing sewer for a minimal distance at 40th Street.

Evaluation of these locations indicates that Alignment No. 3 would have the least chance of disturbing the existing sewer, followed by Alignment No. 1 and Alignment No. 2.

3.17 Potential Risks During Construction

This factor considers risks associated with construction of the project and contrasts them for each alignment. The risks identified are related to potential catastrophic failures. Alignment No. 1 crosses beneath the pedestrian bridge near 27th Street and could potentially cause settlement damage to the structure. The tunnel at this location is also in excess of 600 feet and has a greater potential of failure. The total tunnel length for the 12 tunnels in Alignment No. 1 are in excess of 2,300 feet. Construction will occur near traffic along Highway 2 from 14th Street to 56th Street, increasing the potential risk.

Alignment No. 2 is located near the State Penitentiary south wall. Settlement associated with construction activities near this location could potentially damage this structure. Tunneling beside the support structures for the pedestrian bridge near 27th Street, and could potentially cause settlement damage to the structure.

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Alignment No. 3 is located adjacent to Weaver's Potato Chip factory and Pegler/Sysco facilities and could potentially cause settlement damage to the facilities. Also, construction along the LES easement could potentially damage the towers or power lines. This alignment has eight tunnels with a total length of 2,365 feet. The greater length of tunnels increases the potential for failure along the alignment.

This factor would favor Alignment No. 2, followed by Alignments No. 1 and No. 3.

3.18 Easement and Land Acquisition

This factor considers the potential difficulties in obtaining temporary and permanent easements for construction of the sewer. Temporary easements would be used during construction and would provide room for staging and construction activities. Permanent easement would allow the City to permanently install the new sewer at the alignment locations and also restricts the use of the land by the property owner. The preliminary widths anticipated for the new sewers are 30 feet for the permanent easement and an additional 70 feet for the temporary easement.

Staging areas for materials can be located on Correctional Facilities property and in Parks and Recreation property along each alignment. Private property, therefore, would not need to be utilized to obtain staging areas for the alignments.

Alignment No. 1 would require permanent easements across private land along the south side of Pioneers Blvd. to the Salt Valley Trunk Sewer, across the Correctional Facilities property, and along Parks and Recreation property and Highway 2 right-of-way to 56th Street. Easements associated with the Correctional Facilities property must be obtained from the State of Nebraska.

Alignment No. 2 would require easements across private land south of the Beal Slough; across the Correctional Facilities property; along Fleming Foods' property on the south and east sides; north of Budget Self Storage, Cambell Ind., and the LES Substation; through Peterson Park; in the BNSF railroad right-of-way from 27th Street to 40th Street; and along Highway 2 in the right-of-way.

Alignment No. 3 would require easements across private land south of Beal Slough; across the Correctional Facilities property; along Weaver's Potato Chip Factory, Fleming Foods' property on the south and east sides; north of Budget Self Storage,

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Cambell Ind., and the LES Substation; through Peterson Park; in the BNSF railroad right-of-way from 27th Street to 40th Street; and along Highway 2 in the right-of-way.

Alignment No. 1 would be the favored alternative since most of the alignment occurs along Highway 2, Correctional Services property, and Parks and Recreation property. Alignment No. 2 would be second, since the easements obtained from private owners are not in critical locations. Alignment No. 3 easements may be more difficult to obtain along residential homes and behind Weaver's Potato Chip Factory and Pegler/Sysco facilities.

3.19 Permits and Approvals

Permits will be required for crossing and paralleling the BNSF railroad lines in all locations. Construction along the Highway 2 right-of-way would require permits from the Nebraska Department of Roads. Lincoln Electric System requires a "Letter of Understanding" for crossing or paralleling within their easement or conducting any construction activities directly in the easement.

All the proposed alignments have wetland areas and permitting will be required. Wetland areas along all the potential alignments of Beal Slough would qualify for a Nationwide Permit # 12 (NWP). This is a utility line-crossing permit for temporary impacts with grade restored to pre-existing contours. This permit is not difficult to obtain.

The Beal Slough crossing west of 40th Street could have a different permitting issue depending on the construction method used. A Beal Slough grade check structure should qualify for a NWP #27, stream and wetland restoration activity, which would be consistent with the Beal Slough Master Plan. Boring under Beal Slough may not require a permit. Additionally, if a culvert needs to be placed in the channel for construction activities a NWP #33 (Temporary Construction Permit) would be required. Total impacts to wetland areas based on the current alignments options appear to be small at this time and no mitigation would be required. Any construction directly adjacent to or paralleling Beal Slough must incorporate best management practices (BPM's) and not disrupt the steam channel without a permit. NPDES and Floodplain permits will also be required for this project.

Obtaining permits and approvals for each alignment will require coordination from the same organizations and entities. Each entity has been contacted pertaining to

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the permits required for construction of the alignments; therefore, each alignment should be permitted. This factor does not favor any particular alignment; therefore, permits and approvals are considered equivalent for each alignment.

3.20 Ranking of Alignment Selection Factors

A summary of the relative ranking of alignment selection factors is provided in Table 3-4. The purpose of the table is to provide a rating score for basis of comparison between each of the alignments for the factors discussed in this section. The overall ratings were used to develop a ranking of each alignment alternative.

A rating scale from 1-5 was created to differentiate between each alternative for the given rating factors. A rating a “1” is least favorable compared to other alternatives, whereas a rating of “5” indicates an alternative is most favorable compared to other alternatives. An * was used to indicate when no difference between the three alignments exists.

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Table 3-4: Summary of Route Alignment Selection Factors

Description of Factors	Ranking of Factor (5=Most Favorable, 1= Least Favorable, * = No Difference)		
	Alignment No. 1	Alignment No. 2	Alignment No. 3
Length of Sewer	4	4	5
Length of Tunnel Crossings	1	5	2
Geotechnical	*	*	*
Existing Utilities	4	4	2
Railroad Impacts	5	4	3
Pavement and Traffic Impacts	4	3	4
Proposed Road Improvements	3	5	5
Proposed Stormwater Improvements	4	5	3
Connections with Existing Sewers	2	5	4
Public Relations	3	5	3
Impacts and Disruptions to Existing Businesses	4	5	3
Wetlands	*	*	*
Hazardous Substances	3	5	5
Cultural Resources	*	*	*
Construction Techniques	*	*	*
Hydraulic Design	*	*	*
Constructibility Requirements	3	5	2
Construction Impacts on Existing Sewer	4	2	4
Potential Risks During Construction	4	5	3
ROW and Land Acquisition	3	5	2
Permits and Approvals	*	*	*
TOTALS	51	67	43

The table indicates that Alignment No. 2 is the most favored alternative with a score of 67 for the factors discussed in this section. Alignment No. 1 is second with a score of 51, and Alignment No. 3 is third with a score of 43. These scores reflect both non-cost and cost issues that may impact each alignment, but do not include the project cost for each alignment. The project cost for each alternative is discussed in Section 4 – Project Costs for Alternatives. The ranking of alignment selection factors is very useful for differentiating alternatives that may have similar project costs.