Appendix D – 2014 Update to the Stevens Creek Basin Study Area No. 3

City of Lincoln, NE

Stevens Creek Basin Study Area No. 3

Updated Technical Memorandum

FINAL

February 2015

REGISTERED PROFESSIONAL ENGINEER
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STATE OF NEBRASKA

2/17/15

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903 E. 104th Street, Suite 320, Kansas City, MO 64131
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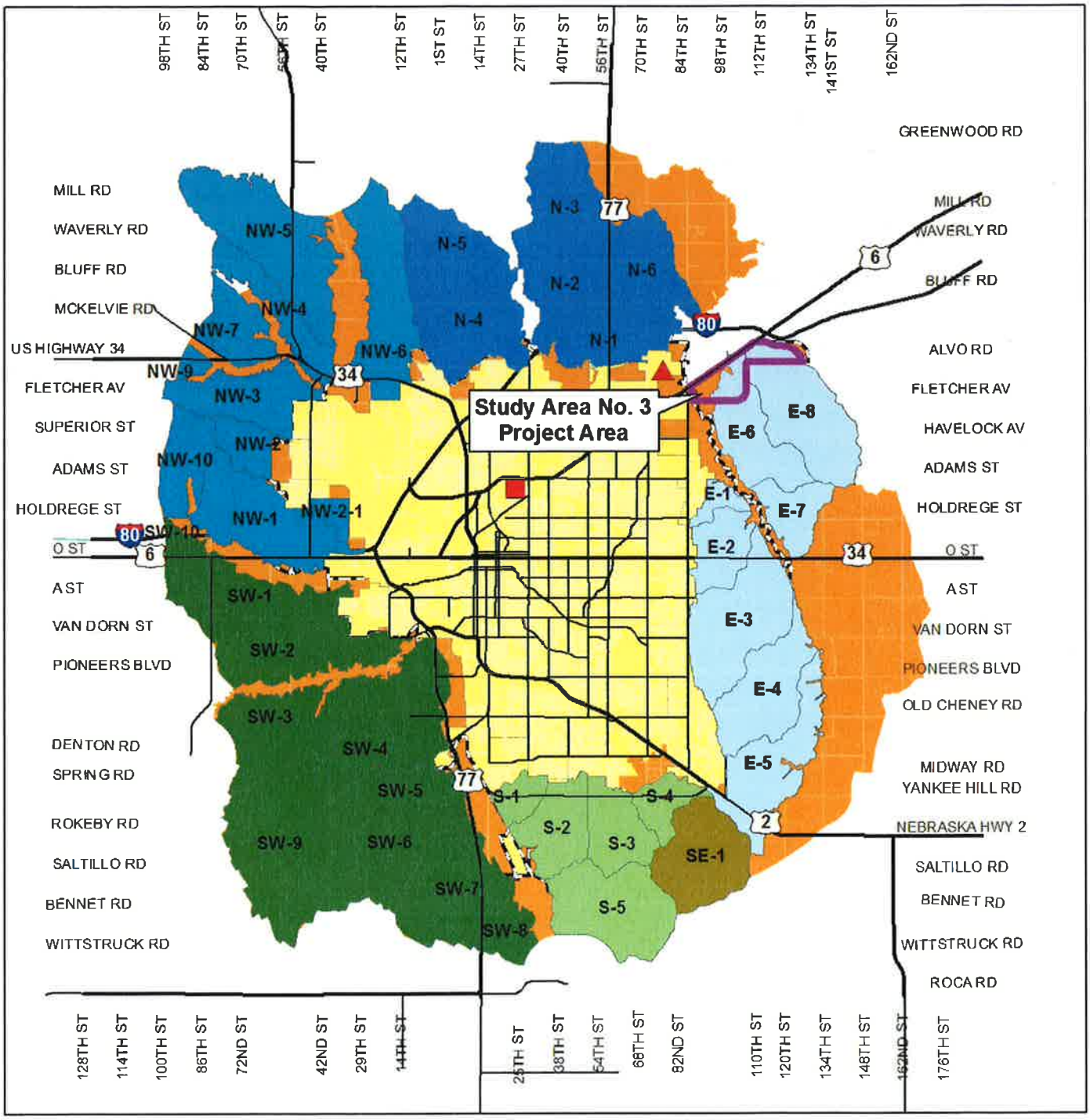

Legend

- Existing Service Area[1]
- Future Growth Areas
- 2040 Future Service Limit
- Study Area 3 Project Area

Utility Planning Zones

- East Zones
- North Zones
- Northwest Zones
- South Zones
- Southeast Zones
- Southwest Zones

Notes:
(1) Represents all land within City limits which includes Tier IA.

N W E S

0 0.5 1 2 3 4 5 Miles

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FIGURE 1 – PROJECT STUDY AREA – UTILITY PLANNING ZONES
STUDY AREA NUMBER 3
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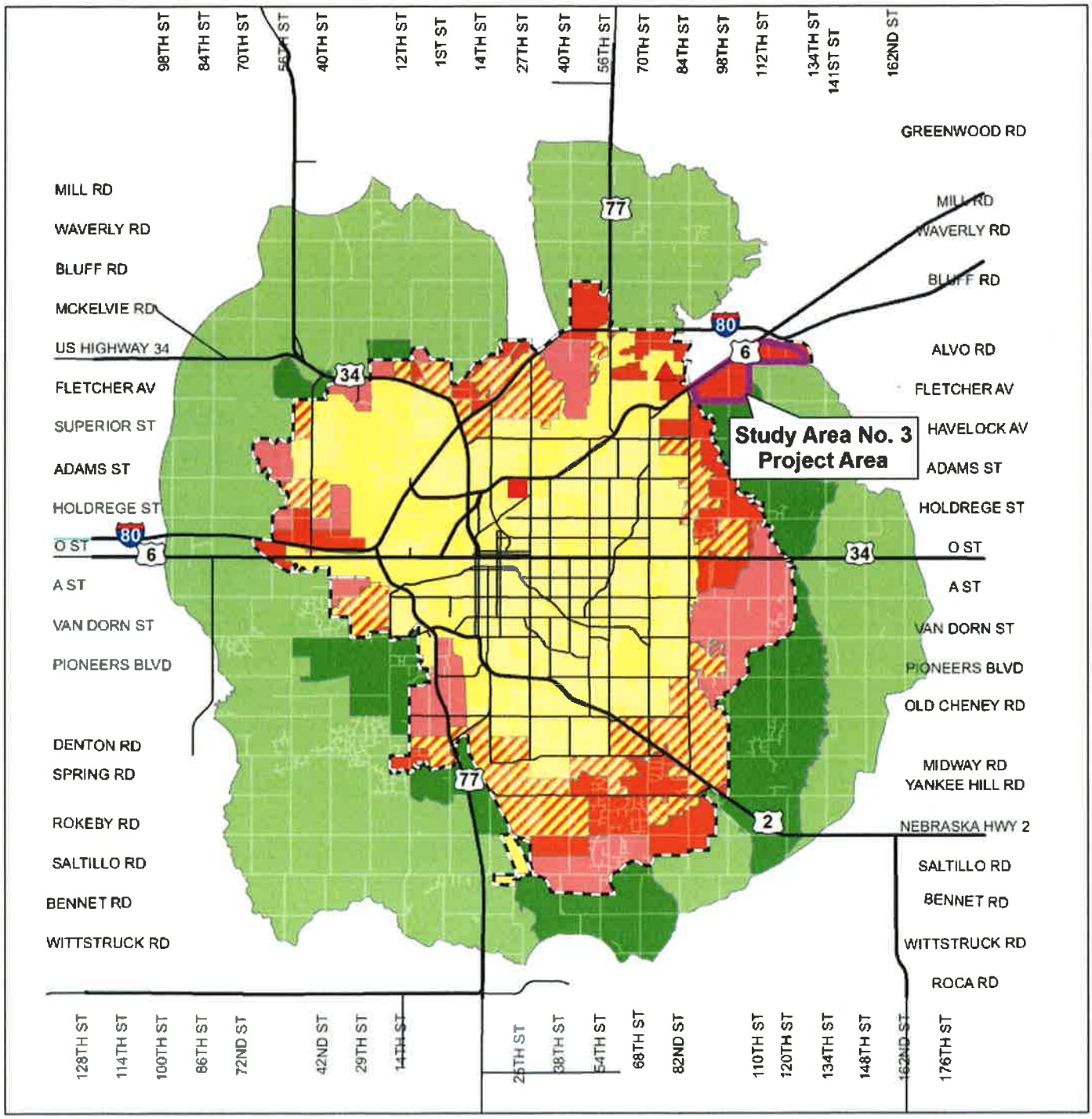

Legend

- Existing City
- Tier I Priority A (Developing)
- Tier I Priority B (2025)
- Tier I Priority C (2040
- Tier II (2060)
- Tier III
- 2040 Future Service Limit
- Theresa St. WWTP
- Northeast WWTP

0 0.5 1 2 3 4 5 Miles

Note: Tier I Priority A already included within City limits.

FIGURE 2 – PROJECT STUDY AREA – GROWTH TIERS
STUDY AREA NUMBER 3
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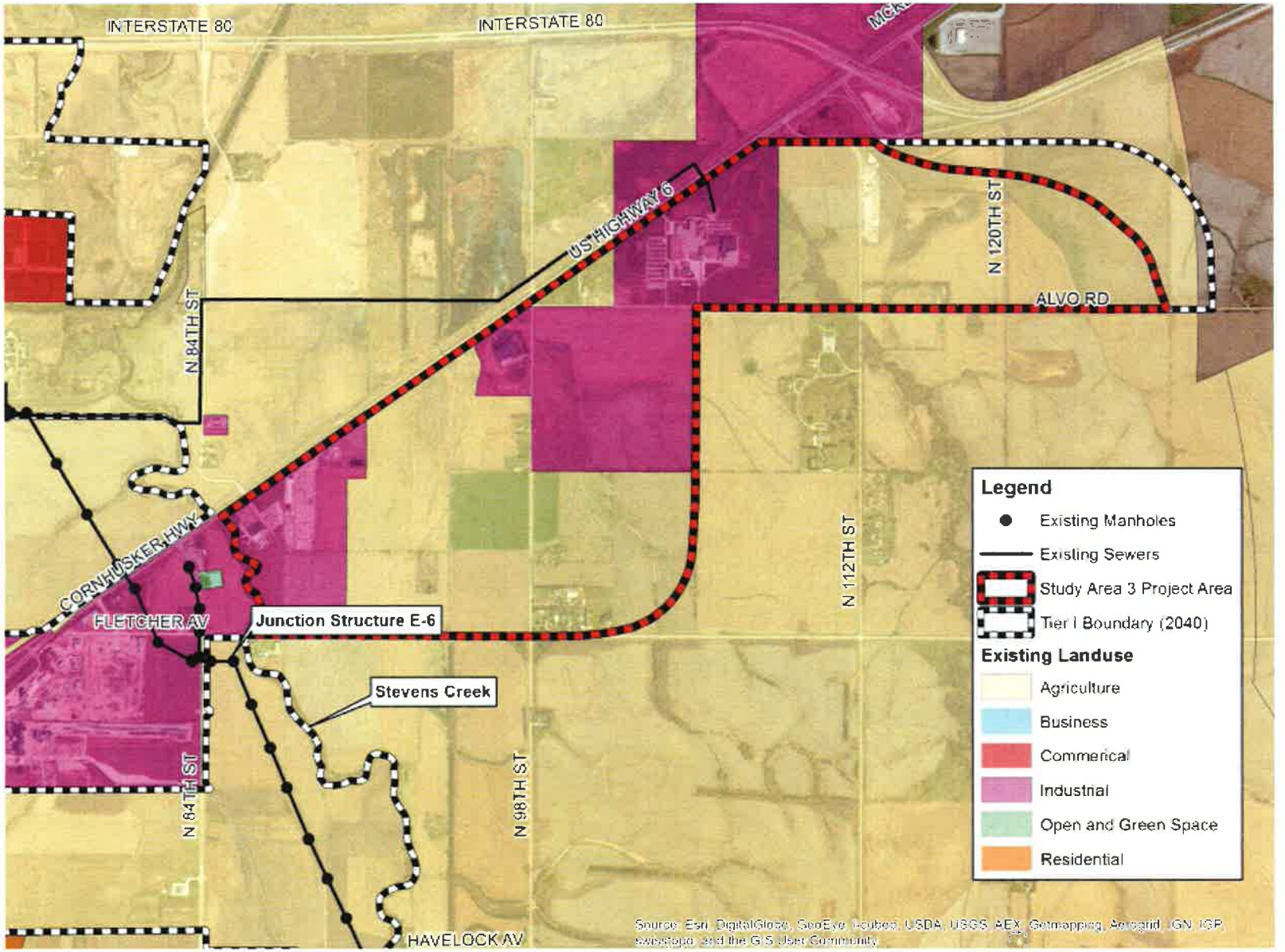

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FIGURE 3 – PROJECT STUDY AREA – EXISTING LAND USE
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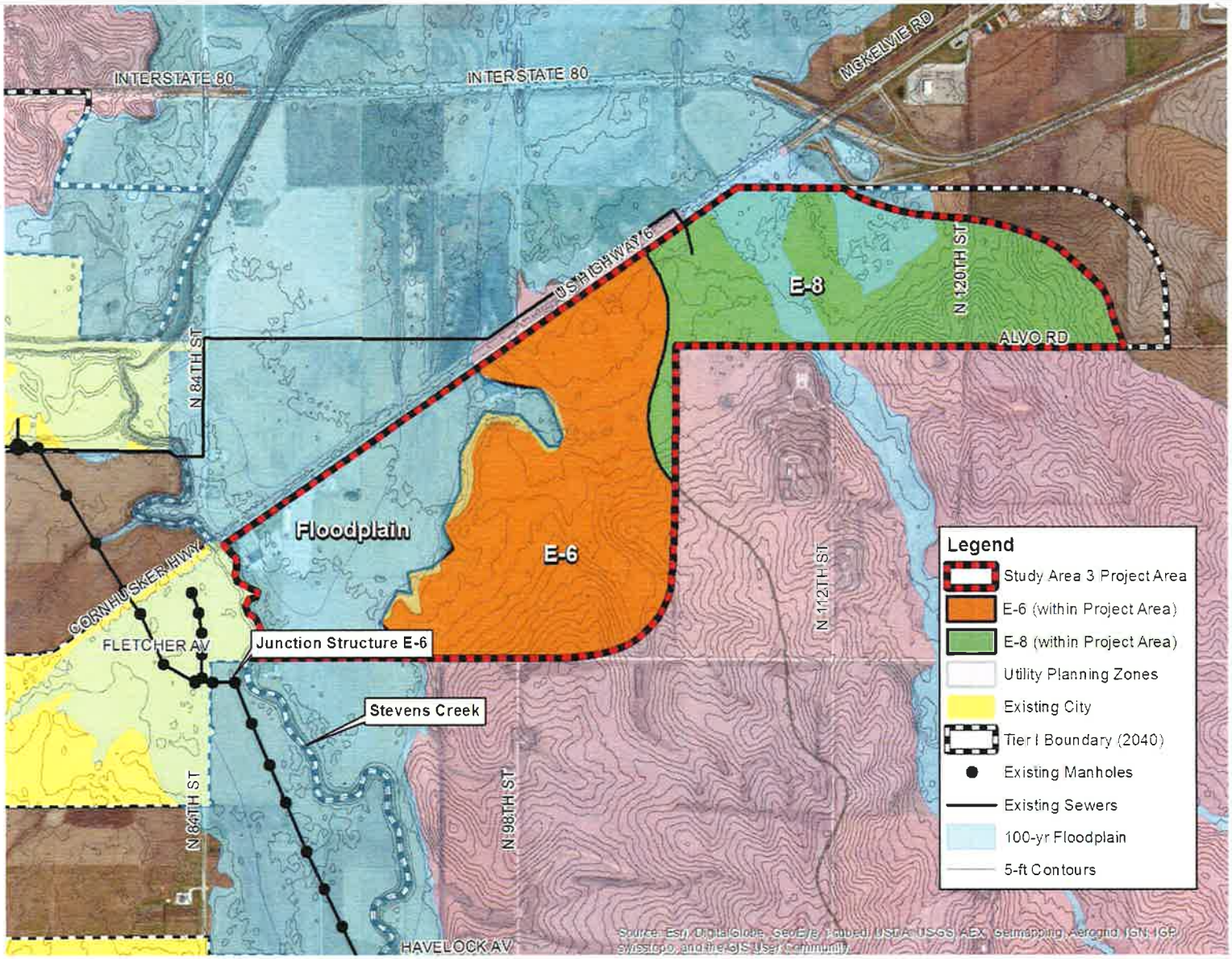

Note: Tier I Priority A included within Existing City limits.

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FIGURE 4 – PROJECT STUDY AREA - OVERVIEW
STUDY AREA NUMBER 3
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2.0 EXISTING SEWER IMPROVEMENTS

Since the original Study Area No. 3 evaluation was completed, the construction of the first 4 phases of the Stevens Creek Basin Trunk Sewer have been constructed. The Stevens Creek Basin Trunk Sewer flows uphill from the Northeast Wastewater Treatment Plant (NE WWTP) to the near Holdredge Avenue and Stevens Creek. Near Stevens Creek and Fletcher Avenue the trunk sewer reduces in size from 72-inch to 66-inch in diameter at Junction Structure E-6. This junction structure was designed with a 36-inch pipe stub to the north, as well as a 36-inch pipe stub to the east to accommodate flows from the east side of Stevens Creek. The invert of the 36-inch pipe stubs are 1162.82.

During the design of the Stevens Creek Phase I Project, the flowline of Stevens Creek at the Highway 6 bridge was surveyed. At that time, the invert of the creek was determined to be approximately 1117.7 feet, - or near the same elevation as the invert of the 36-inch pipe stubs at Junction Structure E-6. At the time Junction Structure E-6 was designed it was unknown if a pump station or siphon would be utilized to serve Basin E-6 and other areas on the east side of the Creek.

2.1 Existing Four-Inch Force Main

A privately owned and operated lift station and 4-inch diameter PVC force main that serves an industry located on the south side of Highway 6 is currently in operation within the evaluated study area. This force main discharges into a junction structure upstream of the NE WWTP.

During the initial evaluation (2006) for the study area, it was assumed that the 4-inch force main could possibly be used to convey collected flows from Study Area No. 3 to the NE WWTP. However, the available capacity in the existing force main would not be adequate to accommodate flows from the study area. Thus, it would be better if the privately owned lift station and force main are abandoned and waste flows from the industry are collected and conveyed as part of the new facilities that will serve the study area.

3.0 STUDY AREA FLOWS

3.1 Determination of Flows in the 2006 Study Area No. 3 Work

The 2006 study was completed prior to the City implementing a flow monitoring program. Therefore, the flows for Study Area No. 3 and Basin X that were used in that study were based on the use of the City's peak flow equation shown below. The area used to determine the flows were based on available GIS data.

$Q = 0.01726 * A^{0.8} + 0.003 * A$.

Where, Q = the peak hourly design flow in cfs,

and A = the developable land area in the basin/subbasin.

Based on this area and the City's peak flow equation, the flows from these two areas were determined, as shown in Table 1 below.

Table 1 Study Area No 3 Flows (2006)
2014 Study Area No. 3 Technical Memorandum
City of Lincoln, NE

Basin	Area	Flow (cfs)	Flow (mgd)
Study Area 3	1,024	7.5 cfs	4.84
Basin X	4,503	28 cfs	18.0

3.2 2007 Wastewater Facilities Master Plan Update

The sanitary sewer model that was set up as part of the 2007 Master Plan Update was also completed before the City began its flow metering program. The flows that were used in that modeling effort were generated based on the City's design equation. As part of that work it was noted that the modeled peak flows entering the wastewater treatment facilities were higher than the actual flows measured by the influent meters at the WWTP. To correlate the modeled flows with the actual flows, a correction factor of 0.75 (75%) was applied to the flow equation values so that the model could be calibrated.

3.3 Current Flows and Modeling

Since the 2007 Master Plan Update the City has implemented a flow monitoring program. This program has collected flow data from several populated basins within the City. However, since there is currently very little flow in the Stevens Creek Basin and points east, the collected flow metering data does not specifically apply to this study area.

During the 2014 Wastewater Facilities Master Plan update, the collection system model was updated with hydrographs generated from the City's flow metering program. The results of this effort revealed that the peak instantaneous flows from the City's design equation with the 75 percent flow factor applied is approximately the same as the newly generated basin specific hydrographs as shown in Figure 5. Since the peak flows from the two methods are approximately the same, the City's design equation (with the 75% flow factor) will be used to determine the peak flows used to size the sanitary sewers for the study area. By doing so, the sum of the cumulative total flows may not be equal to total peak flow as calculated using the design equation.

$$Q = \{(0.01726 * A^{0.8}) + (0.003 * A)\} * 0.75.$$

Where, Q = the peak hourly design flow in cfs,

0.75 = flow factor used in the 2007 modeling effort,

and A = the developable land area in the basin/subbasin.

It is recommended that a more detailed analysis that includes future land use planning and other site-specific parameters be performed initially as part of the final design of any sewer improvements.

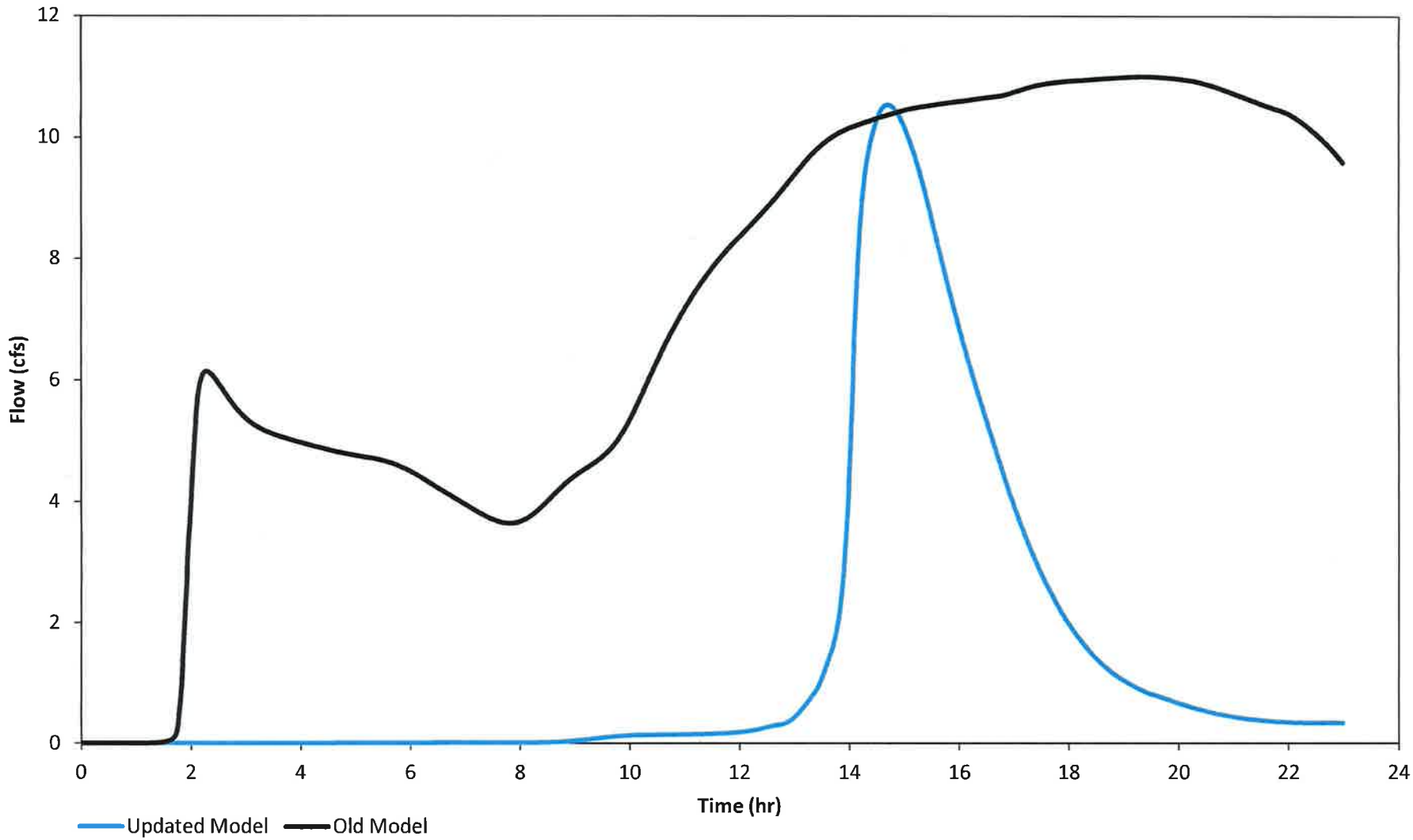

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FIGURE 5 – UPDATED MODEL HYDROGRAPH
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3.3.1 Study Area No. 3 Peak Flows

Based on updated base mapping, the areas for Study Area No. 3, including portions of Basin E-8 have been re-calculated. Study Area No. 3 is generally divided into three sub-areas, - including Basins E-6 and E-8. The westerly area, located south of Highway 6 and east of Stevens Creek, has an area of 265 acres but is excluded from the analysis for the study area because it consists solely of floodplain. It is assumed that no future growth will occur in this floodplain area. The middle area consists of the northerly reaches of Basin E-6 with an area of 465 acres. The easterly area of the study area is the northerly reaches of Basin E-8 which has an area of 395 acres. The peak flows from these areas have been calculated as shown in Table 2 below.

Table 2 Study Area No. 3 Flows (2014)
2014 Study Area No. 3 Technical Memorandum
City of Lincoln, NE

Basin	Area (ac)	Flow (cfs)	Flow (mgd)
Westerly Area	265	--(1)	--(1)
Middle Area	465	2.81 cfs	1.82
Easterly Area	395	2.45 cfs	1.58
Totals	1125		

Note:
(1) This area consists of floodplain. It is assumed no growth or flow will be generated from this area.

3.3.2 Basin E-8

As described above, in addition to Study Area No. 3, the City would like to know the future flows from Basin E-8. Based on the updated mapping, the gross area of Basin E-8 is 3,954 acres. Of this total area, 395 acres is located within Study Area No. 3, which results in a net area of 3,559 acres. Using the modified City design equation results in flows from this area to be 17 cfs (10.98 mgd)

3.3.3 Basin E-6

According to the 2005 Stevens Creek Basin Preliminary Design Report, the flows from Basin E-6 will flow downhill and westerly toward Stevens Creek, where it will be collected by a future Basin E-6 sewer and routed separately to Junction Structure E-6. This sewer will direct the flows to Junction Structure E-6. Based on the flows identified in the preliminary design report total flows from this Basin E-6 are approximately 25 cfs. These flows were calculated based on a gross area of 4,040 acres. Subsequent work completed in the 2007 and 2014 Wastewater Facilities Master Plan Updates has reduced the contributing area from the basin by eliminating contributions from flood plains and the area north of Highway 6. This has resulted in a reduction in peak flow from Basin E-6 from 25 cfs to approximately 11 cfs.

4.0 ALTERNATIVES ANALYSIS

Each alternative will be analyzed using a common set of design criteria, summarized below:

- Sewers sized to convey the peak flows as determined by using the modified flow equation discussed previously.
- Associated lift stations were sized to accommodate the sum of flows calculated for the incoming sewers.
- The slopes and diameters of the proposed gravity sewers were varied to maintain velocities close to 3.0 ft/s for design flows assuming full pipe flow conditions. This was selected to maintain scour velocities to ensure grit and other solids do not settle out along the sewers.
- Force mains were sized to maintain velocities less than 10 ft/s at design flows to limit head loss through the system.
- Minimize ground cover and limit depth of pipes to approximately 20 feet if possible.
- Assumed a minimum cover of 5 feet for stream crossings (measured from the bottom of the stream).

Additionally, each alternative includes two sub-alternatives (except for alternative four). These sub-alternatives will be evaluated to determine if it is feasible at this time to install a sewer system sized to accommodate the future growth that is projected for Basin E-8. Thus, the two sub-alternatives include evaluating each alternative to serve only Study Area No. 3 (Alternative #A), or to serve Study Area No. 3 and Basin E-8 (Alternative #B), in which case, the piping and lift station sizes would be larger to accommodate future flows from E-8. Costs estimated for the lift stations in the "B" alternatives include construction of a larger structure to accommodate the ultimate projected capacity, with pumping equipment sized only to handle current flows from Study Area No. 3. Also, the location of the alignment for all of the alternatives was the same. This means that only the pipe sizes, slopes, sewer type (gravity vs. force main), and lift station location were modified for each alternative.

Included in each alternative are the estimated project costs in the first quarter of 2015 dollars. The assumptions utilized for these cost estimates can be seen in Table 3. A detailed summary of the costs for each alternative are included in Appendix A.

Table 3	Cost Estimate Assumptions Study Area No. 3 City of Lincoln, NE	
Parameter	**Unit Cost ($)**	**Unit**
Standard Pipeline, depth <10 ft	10.00	in-dia/lf
Standard Pipeline, depth 10-20 ft	15.00	in-dia/lf
Standard Pipeline, depth >20 ft	27.00	in-dia/lf
Jack & Bore Pipeline	137.50	in-dia/lf
Force Main	12.00	in-dia/lf
Creek Crossing	150.00	per LF
Easement Acquisition	40.00	per LF
Lift Station Structure	0.63	per gpd
Submersible Pumps	3000.00	per MGD

Note:
(1) Contingencies included as part of unit costs.

4.1 Alternative 1 - Gravity Sewer Along Highway 6

The first alternative was evaluated to convey the flows using gravity sewers only. Besides the gravity sewer, the only other major design element is the siphon required to convey the flows beneath Stevens Creek to the existing junction structure. Given that this alternative is comprised completely of gravity sewers, the piping profiles were back-calculated from the existing junction structure based on the assumed pipe sizes and slopes which can be seen in Figure 6 and Figure 7 for Alternatives 1A and 1B, respectively. The piping profiles, using 2-foot contours, were generated for the alignment which are illustrated in Figure 8 and Figure 9 for Alternatives 1A and 1B, respectively. However, it can be seen in Figure 8 and Figure 9 that these alternatives are not feasible given that the sewers would not have enough ground cover as illustrated by the pipe profile projecting above the ground surface profile. Thus, neither of these alternatives were evaluated further.

Table 4	Proposed Sewers for Alternatives 1A and 1B Study Area No. 3 City of Lincoln, NE					
Reach	**Diameter (in)**	**Length (ft)**	**Slope (ft/ft)**	**Pipe Capacity (cfs)**	**Full Pipe Velocity (ft/sec)**	**Projected Peak Flows (cfs)(1)**
Alternative 1A						
1	18	6,100	0.0025	5.3	3.0	2.44
2	24	11,400	0.0017	9.4	3.0	4.82
Alternative 1B						
1	36	6,100	0.0010	21.2	3.0	18.66
2	36	11,400	0.0010	21.2	3.0	20.62

Note:
(1) Peak flows for proposed infrastructure were calculated based upon total contributing area using the peak flow equation as defined previously.

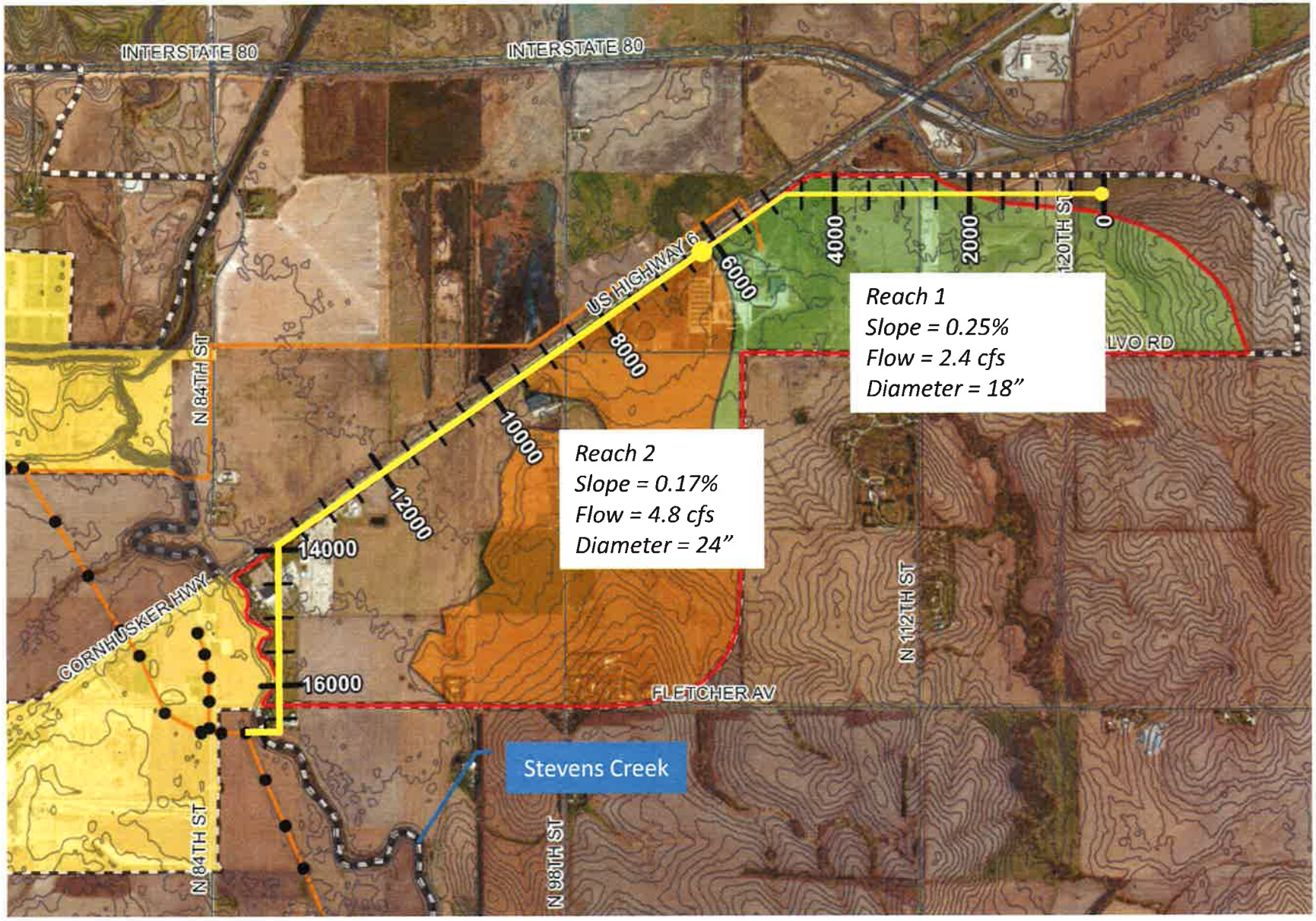

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FIGURE 6 – ALTERNATIVE 1A - PLAN
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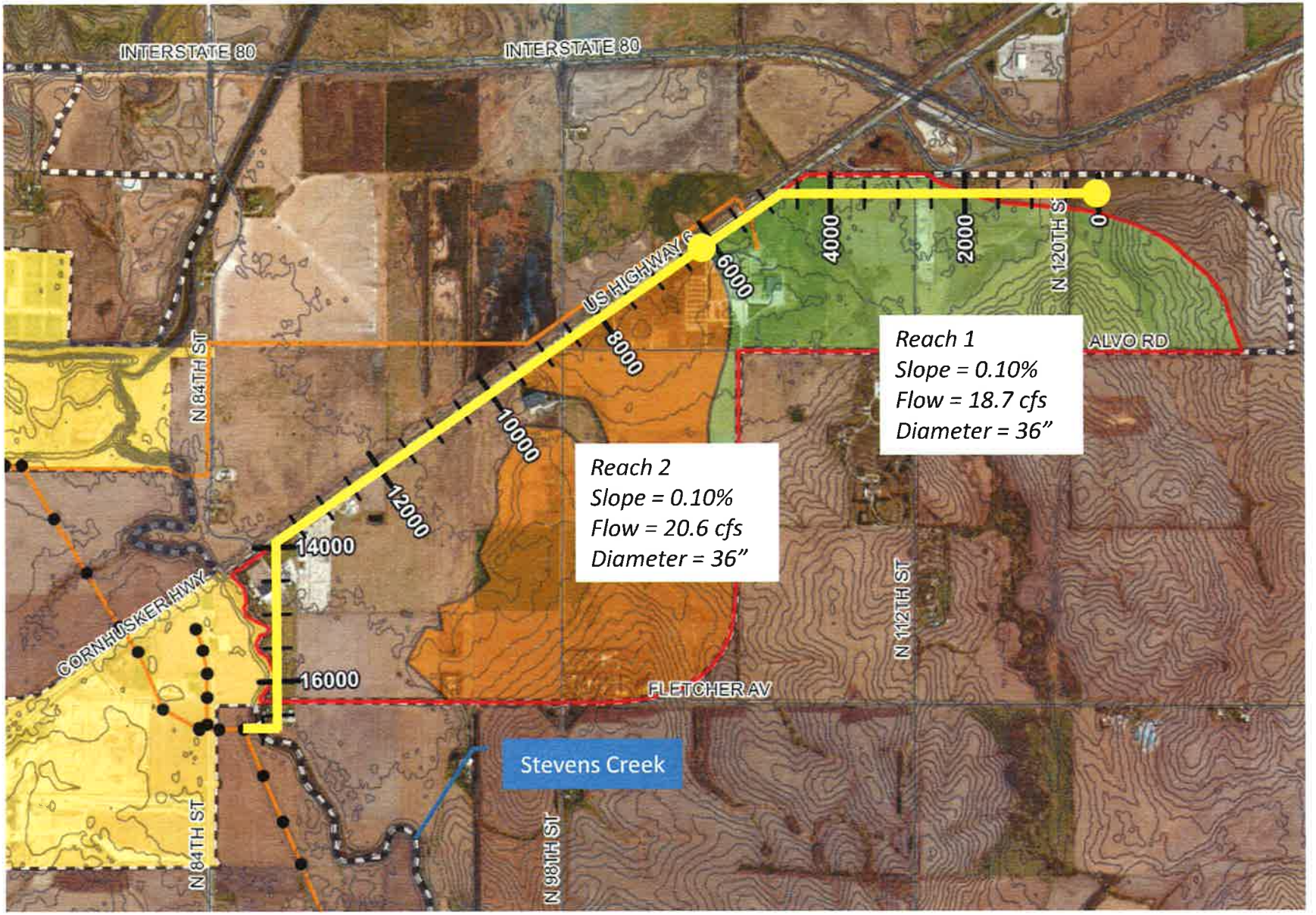

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FIGURE 7 – ALTERNATIVE 1B - PLAN
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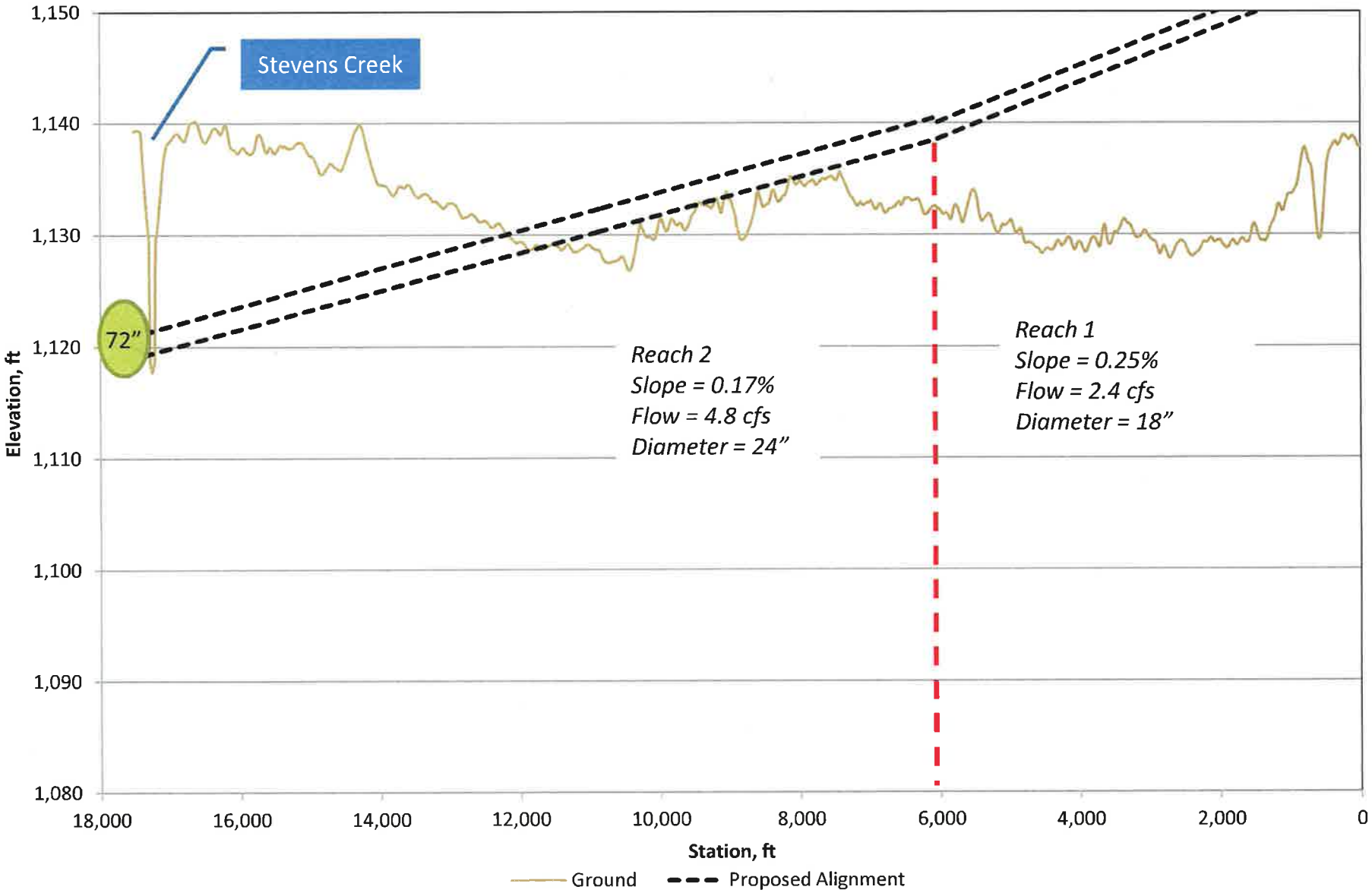

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FIGURE 8 – ALTERNATIVE 1A - PROFILE
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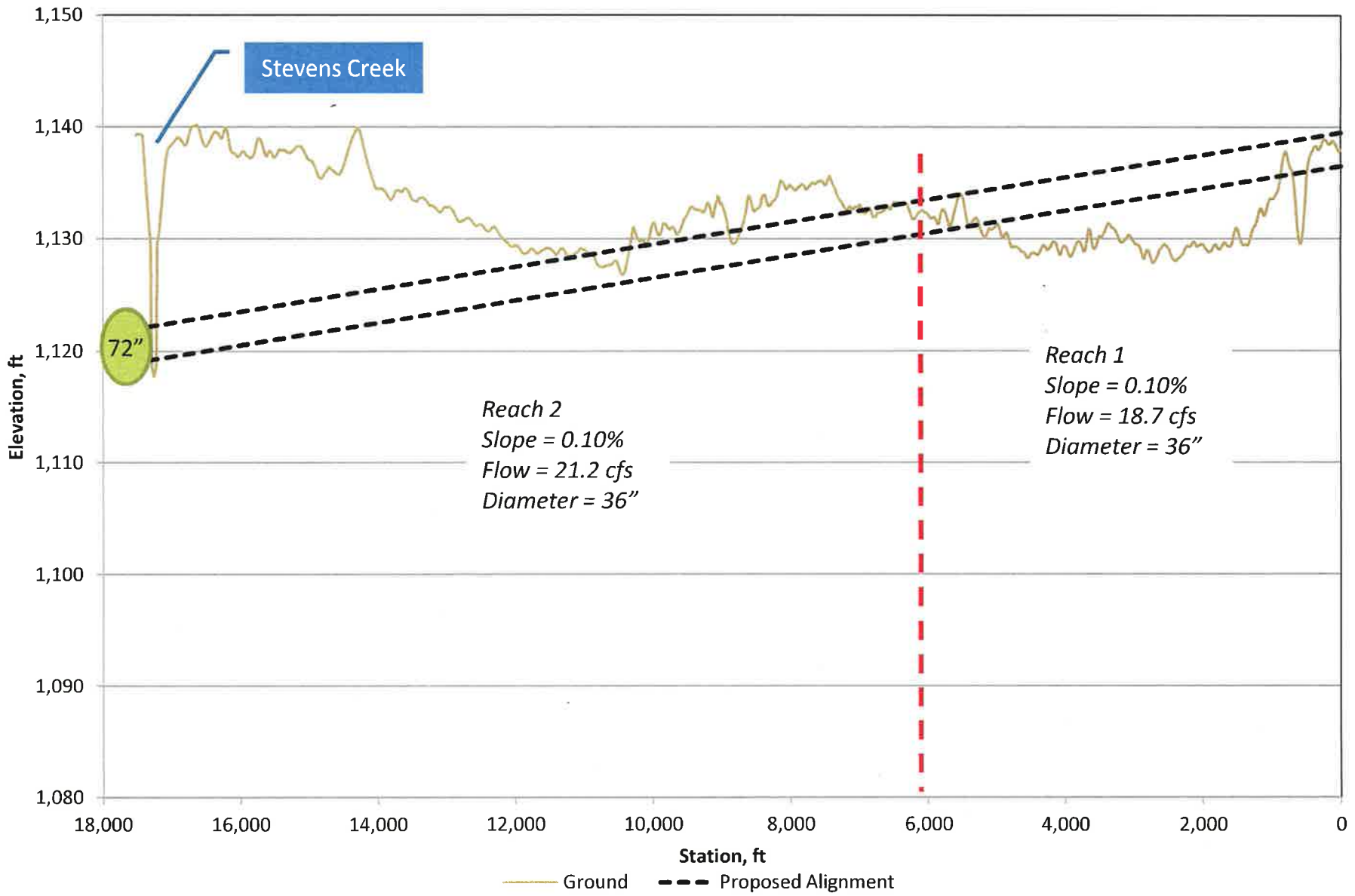

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FIGURE 9 – ALTERNATIVE 1B - PROFILE
STUDY AREA NUMBER 3
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4.2 Alternative 2 - Lift Station near Fletcher Avenue

The second alternative was evaluated to convey the flows using gravity sewers to Fletcher Avenue then pumping the flows underneath Stevens Creek by building a new lift station near Fletcher Avenue. This alternative is the same as Alternative 1 except that the new lift station will convey the flows under Stevens Creek instead of a siphon. Given that there are no downstream elevation constraints for this alternative, eliminated by the lift station, the profile for this alternative was dictated by maintaining the 5 feet of minimum cover underneath the stream crossing near station 500. Based on this, the proposed sewers are summarized in Table 5. The plans for Alternatives 2A and 2B can be seen in Figure 10 and Figure 11, respectively. The piping profiles were, again, generated using the 2-foot contours for Alternatives 2A and 2B and can be seen in Figure 12 and Figure 13, respectively. It can be seen in the figures that Alternative 2A pushes the lift station deeper than Alternative 2B. This is due to the steeper slopes required in Alternative 2A to convey the lower design flows while still maintaining the required minimum velocities.

Table 5 Proposed Sewers for Alternatives 2A and 2B
Study Area No. 3
City of Lincoln, NE

Reach	Diameter (in)	Length (ft)	Slope (ft/ft)	Pipe Capacity (cfs)	Full Pipe Velocity (ft/sec)	Projected Peak Flow (cfs)(1)
Alternative 2A						
1	18	6,100	0.0025	5.3	3.0	2.44
2(2)	24	3,400	0.0017	9.4	3.0	4.82
3	24	6,496	0.0017	9.4	3.0	4.82
Force Main	10	1,504	-	5.5	10.0	4.82
Alternative 2B						
1	36	6,100	0.0010	21.2	3.0	18.66
2	36	3,400	0.0010	21.2	3.0	20.62
3	36	6,496	0.0010	21.2	3.0	20.62
Force Main	24	1,504	-	31.4	10.0	20.62

Note:

(1) Peak flows for proposed infrastructure were calculated based upon total contributing area using the peak flow equation as defined previously.

(2) Pipe upsized to accommodate flows from the portion of E-6 included in the study are as there is no dedicated sewer to serve this area.

For the purpose of determining the estimated project costs, the following assumptions were utilized for costing out the lift station:

- The lift station and force main will be capable of handling the estimated peak flows from the study area of 4.8 cfs from Study Area No. 3 only (Alternative 2A), or 20.6 cfs for Study Area No. 3 plus Basin E-8 (Alternative 2B).
- The lift station would be constructed north of Fletcher Avenue near Steven's Creek.
- The lift station would incorporate a concrete wetwell utilizing submersible pumps.
- A prefabricated electrical building would be provided.

Based on the information provided in Table 5, the assumptions listed above, and similar projects the probable opinion of estimated project costs for alternatives 2A and 2B are approximately $12,182,800 and $20,664,900, respectively as outlined in Table 6 and Table 7 below.

Table 6 Alternative 2A - Probable Opinion of Estimated Project Costs
Study Area No. 3
City of Lincoln, NE

Element	Estimated Cost
Lift Station	$1,956,700
Gravity Sewer	$8,058,100
Force Main	$180,500
Stevens Creek Siphon Crossing	$180,000
Right of Way	$700,000
Subtotal(1)	$11,075,300
Engineering, Legal, Administrative (10%)	$1,107,500
Estimated Total	$12,182,800

Note:
(1) Contingencies included as part of unit costs.

Table 7	Alternative 2B - Probable Opinion of Estimated Project Costs Study Area No. 3 City of Lincoln, NE
Element	**Estimated Cost**
Lift Station	$8,189,200
Gravity Sewer	$9,283,900
Force Main	$433,100
Stevens Creek Siphon Crossing	$180,000
Right of Way	$700,000
Subtotal	$18,786,200
Engineering, Legal, Administrative (10%)	$1,878,600
Estimated Total	$20,664,900

Note:
(1) Contingencies included as part of unit costs.

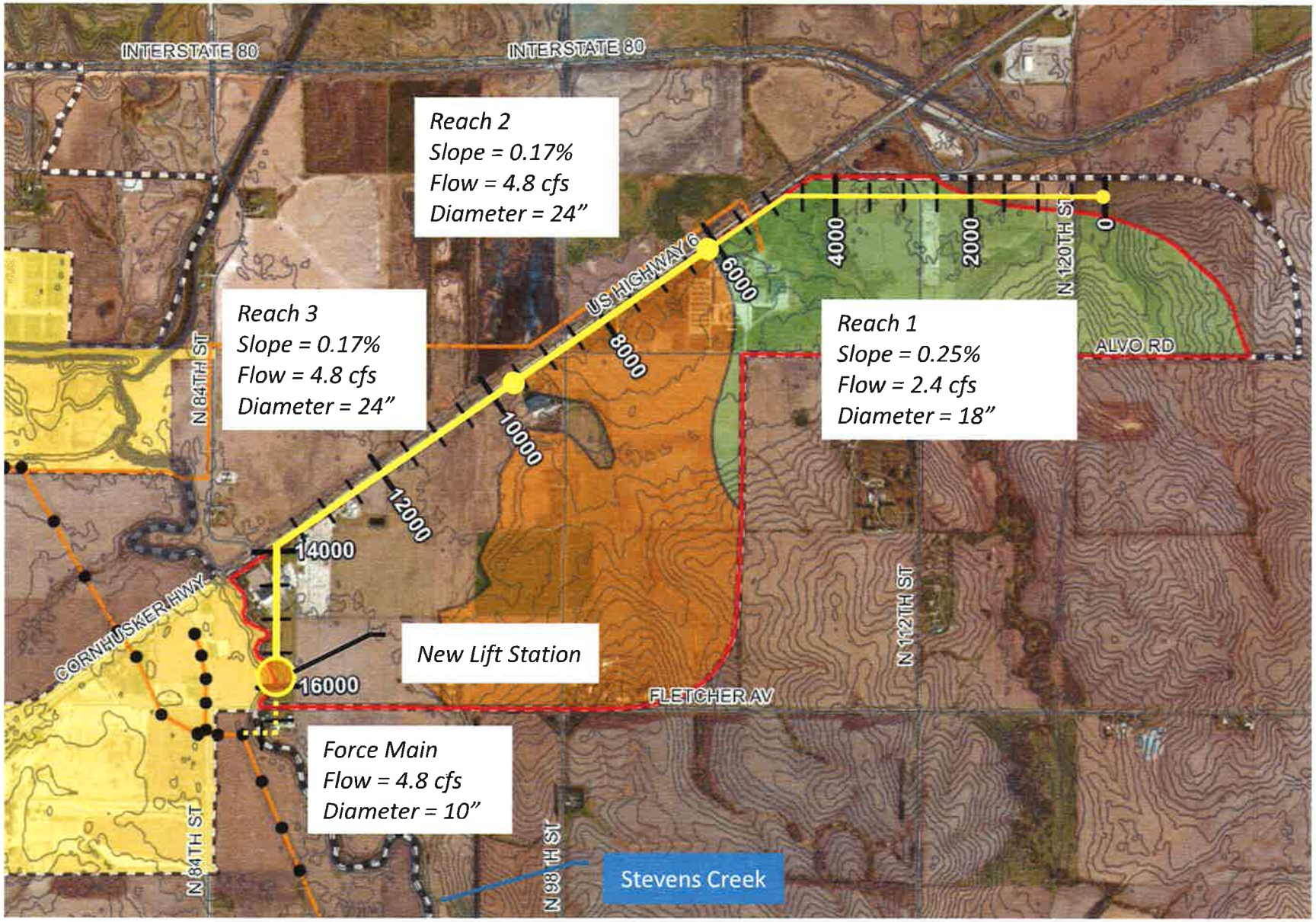

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FIGURE 10 – ALTERNATIVE 2A - PLAN
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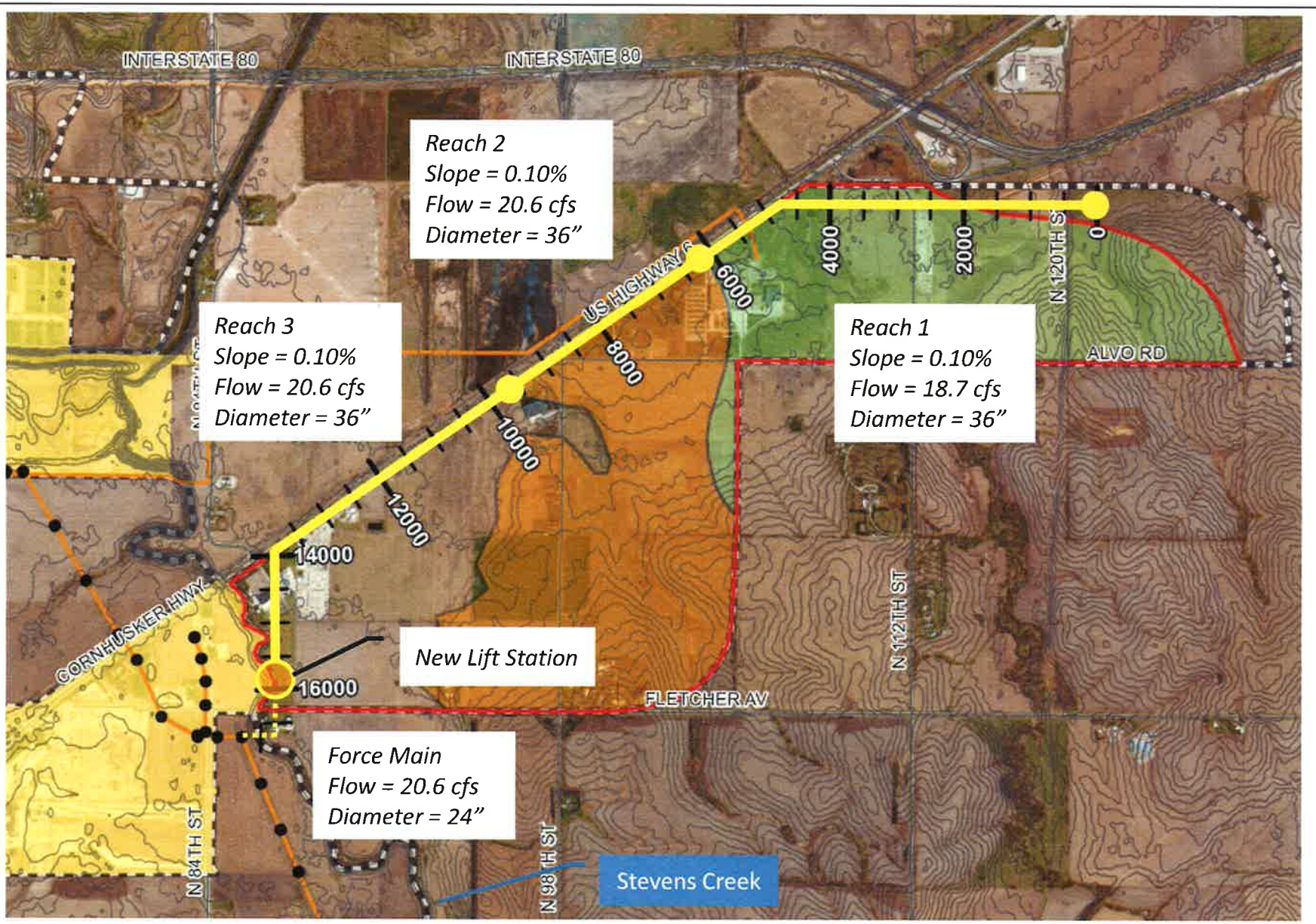

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FIGURE 11 – ALTERNATIVE 2B - PLAN
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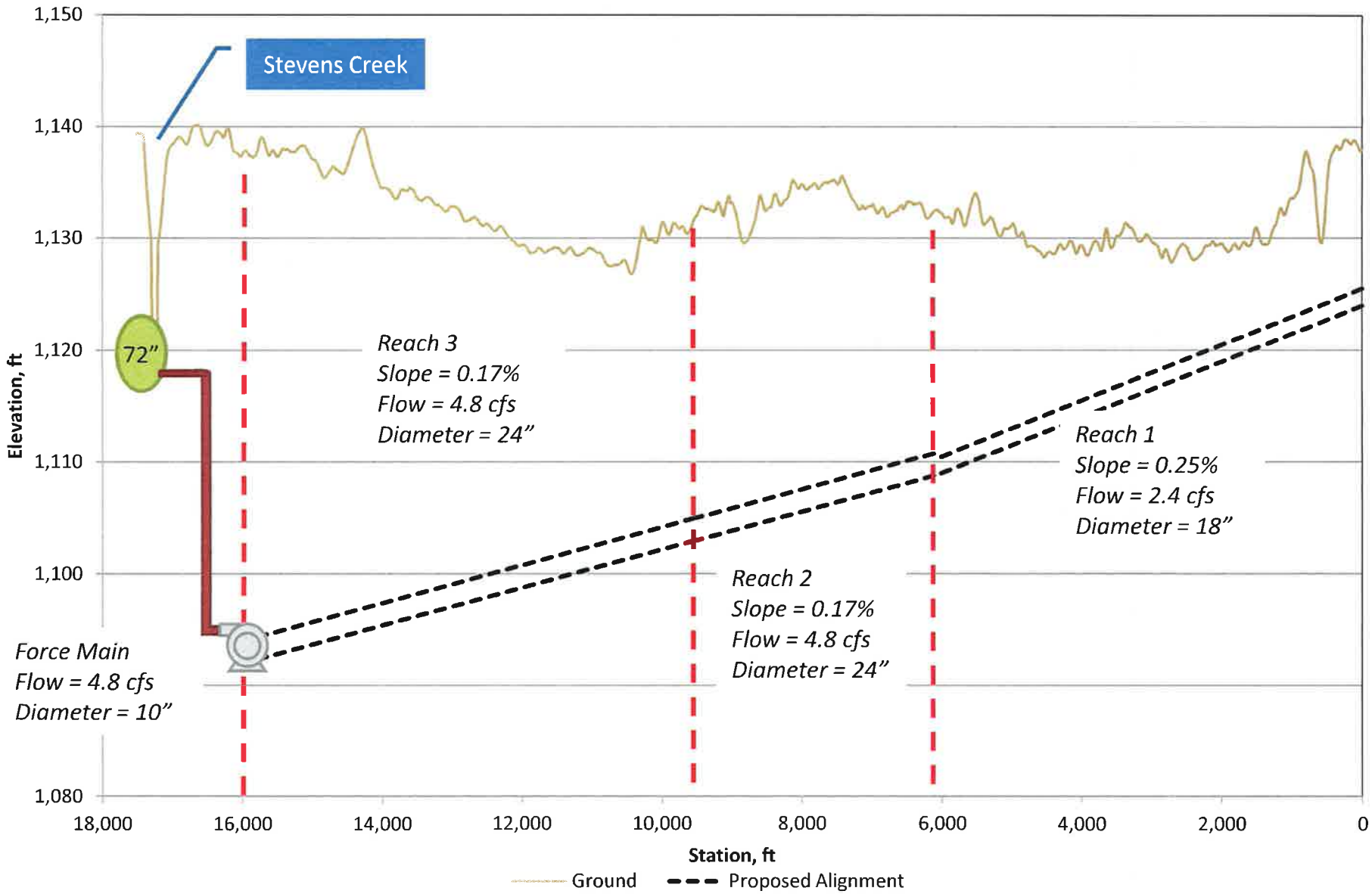

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FIGURE 12 – ALTERNATIVE 2A - PROFILE
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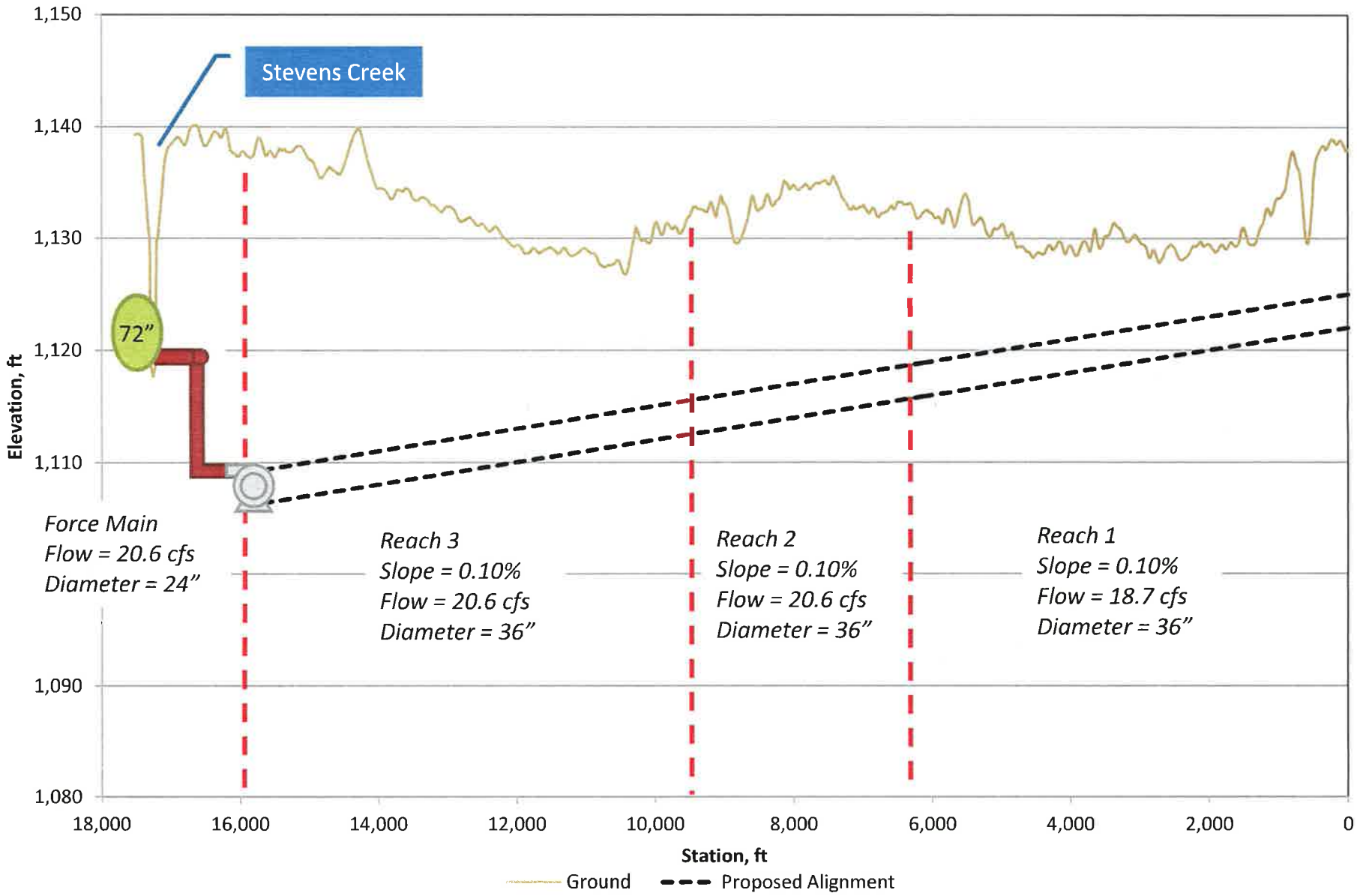

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FIGURE 13 – ALTERNATIVE 2B - PROFILE
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CITY OF LINCOLN, NEBRASKA

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4.3 Alternative 3 - Lift Station near Alvo Road

The third alternative is similar to alternative 2 in that a lift station will be used to convey the flows underneath Stevens Creek. However, in this alternative the lift station will be located farther to the east near Alvo Road. This alternative was analyzed to evaluate the potential costs savings of installing a longer force main as opposed to a longer gravity sewer. The costs savings include reduced costs due to the force main having a lower cost per LF of pipe because of its smaller diameter and minimizing excavation depths. However, because of the longer force main, a gravity sewer is proposed to convey flows from the portion of basin E-6 within the study area back to the new lift station. Again, given that there are no downstream elevation constraints for this alternative due to the lift station, the profile for this alternative was dictated by maintaining the 5 feet of minimum cover underneath the stream crossing near station 500. Based on this, the proposed sewers are summarized in Table 8. The plans for Alternatives 3A and 3B are shown in Figure 14 and Figure 15, respectively. The piping profiles were generated using 2-foot contours for Alternatives 3A and 3B and can be seen in Figure 16 and Figure 17, respectively. Additionally the profile for the proposed gravity sewer to serve the western portion of the study area (E-6) can be seen in Figure 18. It should be noted that this sewer is the same for both alternatives. Again, it can be seen in the figures that Alternative 3A pushes the lift station deeper than in Alternative 3B. This is due to the steeper slopes required in Alternative 3A to convey the lower design flows while still maintaining the required minimum velocities.

Table 9	Alternative 3A - Probable Opinion of Estimated Project Costs Study Area No. 3 City of Lincoln, NE
Element	**Estimated Cost**
Lift Station	$1,956,700
Gravity Sewer	$4,644,200
Force Main	$1,020,000
Stevens Creek Siphon Crossing	$180,000
Right of Way	$916,000
Subtotal	$8,716,900
Engineering, Legal, Administrative (10%)	$871,700
Estimated Total	$9,588,500

Note:
(1) Contingencies included as part of unit costs.

Table 10	Alternative 3B - Probable Opinion of Estimated Project Costs Study Area No. 3 City of Lincoln, NE
Element	**Estimated Cost**
Lift Station	$8,219,100
Gravity Sewer	$5,745,700
Force Main	$2,447,900
Stevens Creek Siphon Crossing	$180,000
Right of Way	$916,000
Subtotal	$17,508,700
Engineering, Legal, Administrative (10%)	$1,750,900
Estimated Total	$19,259,600

Note:
(1) Contingencies included as part of unit costs.

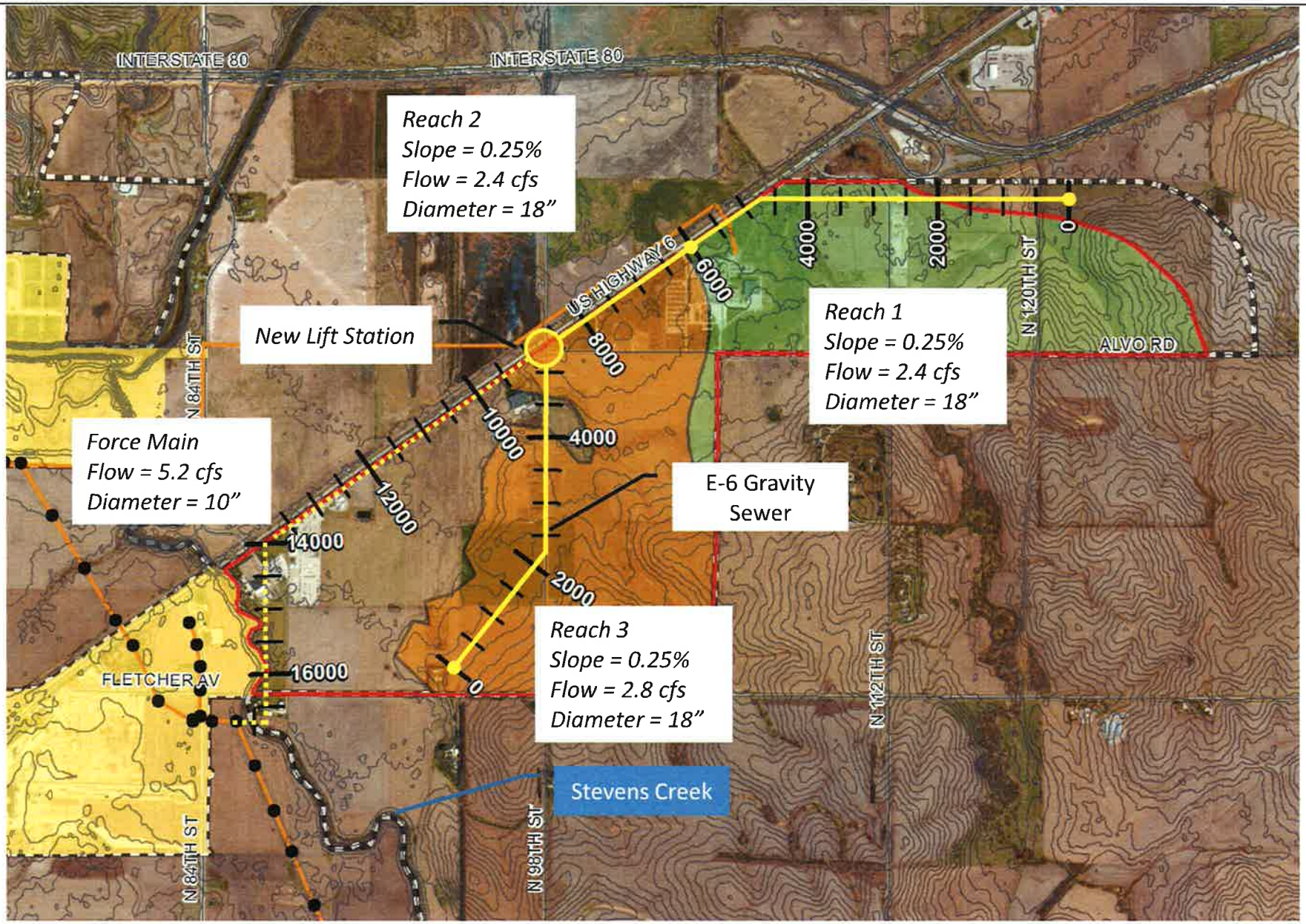

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FIGURE 14 – ALTERNATIVE 3A - PLAN
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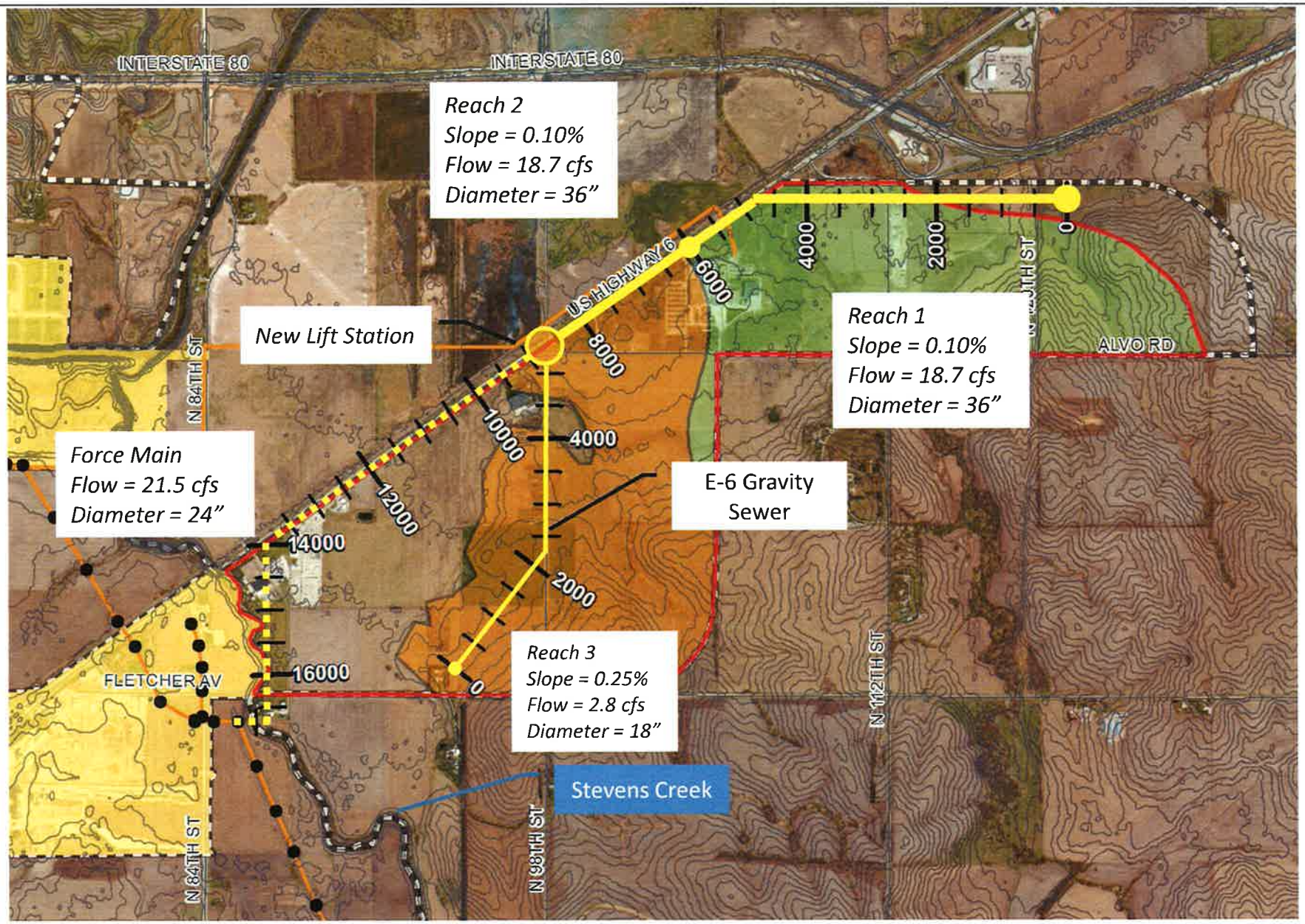

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FIGURE 15 – ALTERNATIVE 3B - PLAN
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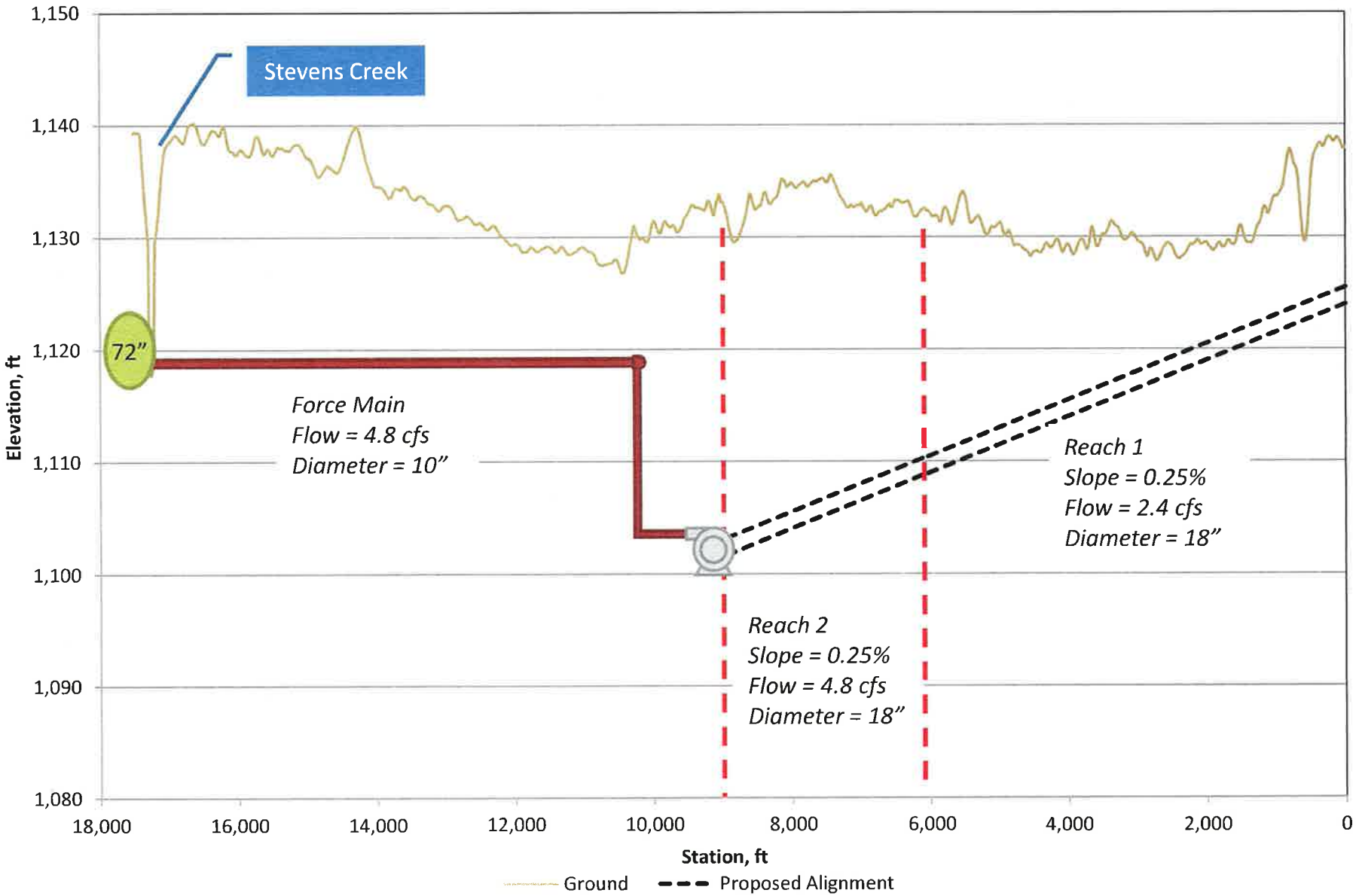

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FIGURE 16 – ALTERNATIVE 3A - PROFILE
STUDY AREA NUMBER 3
CITY OF LINCOLN, NEBRASKA

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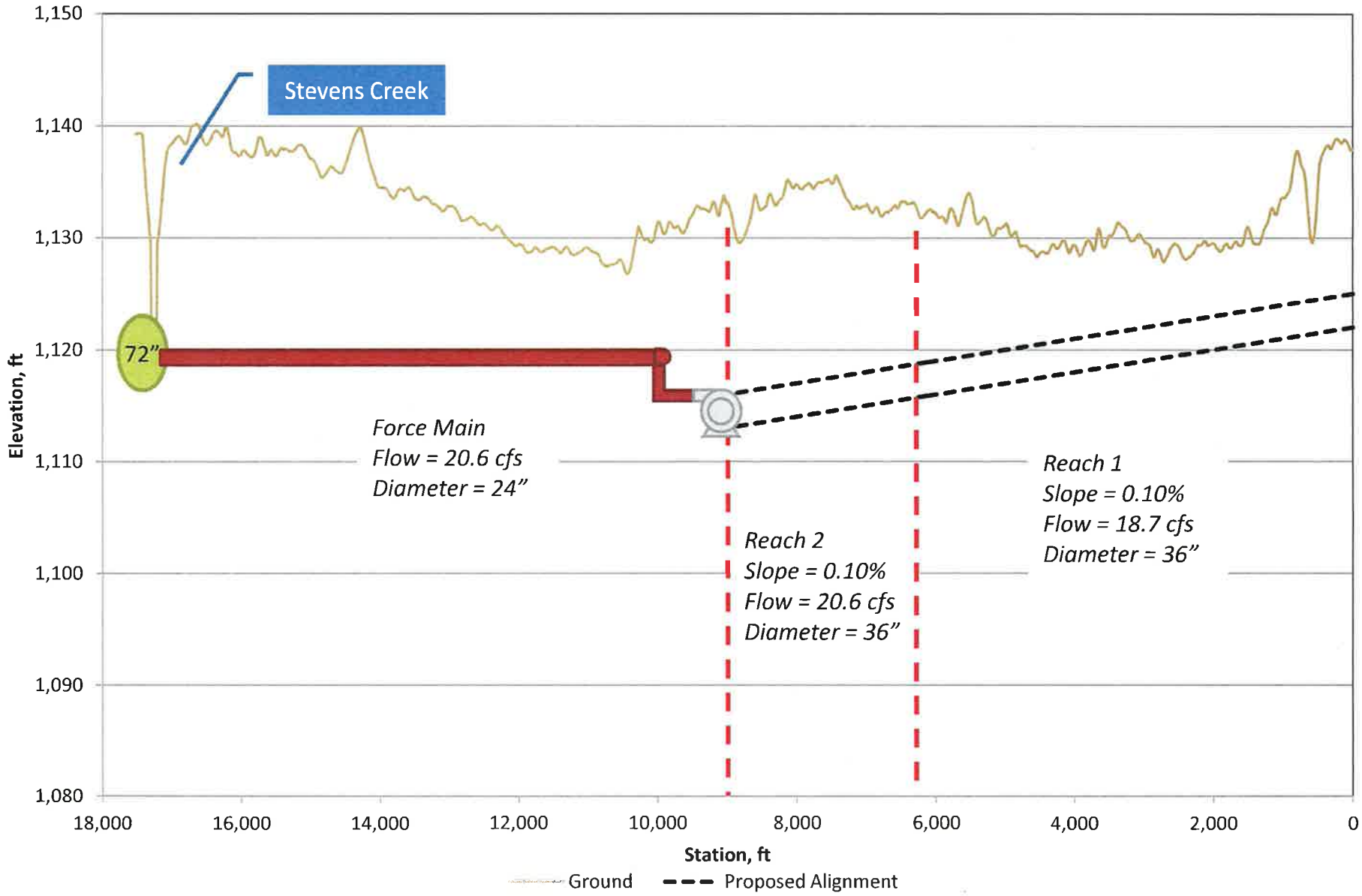

CITY OF LINCOLN NEBRASKA

FIGURE 17 – ALTERNATIVE 3B - PROFILE
STUDY AREA NUMBER 3
CITY OF LINCOLN, NEBRASKA

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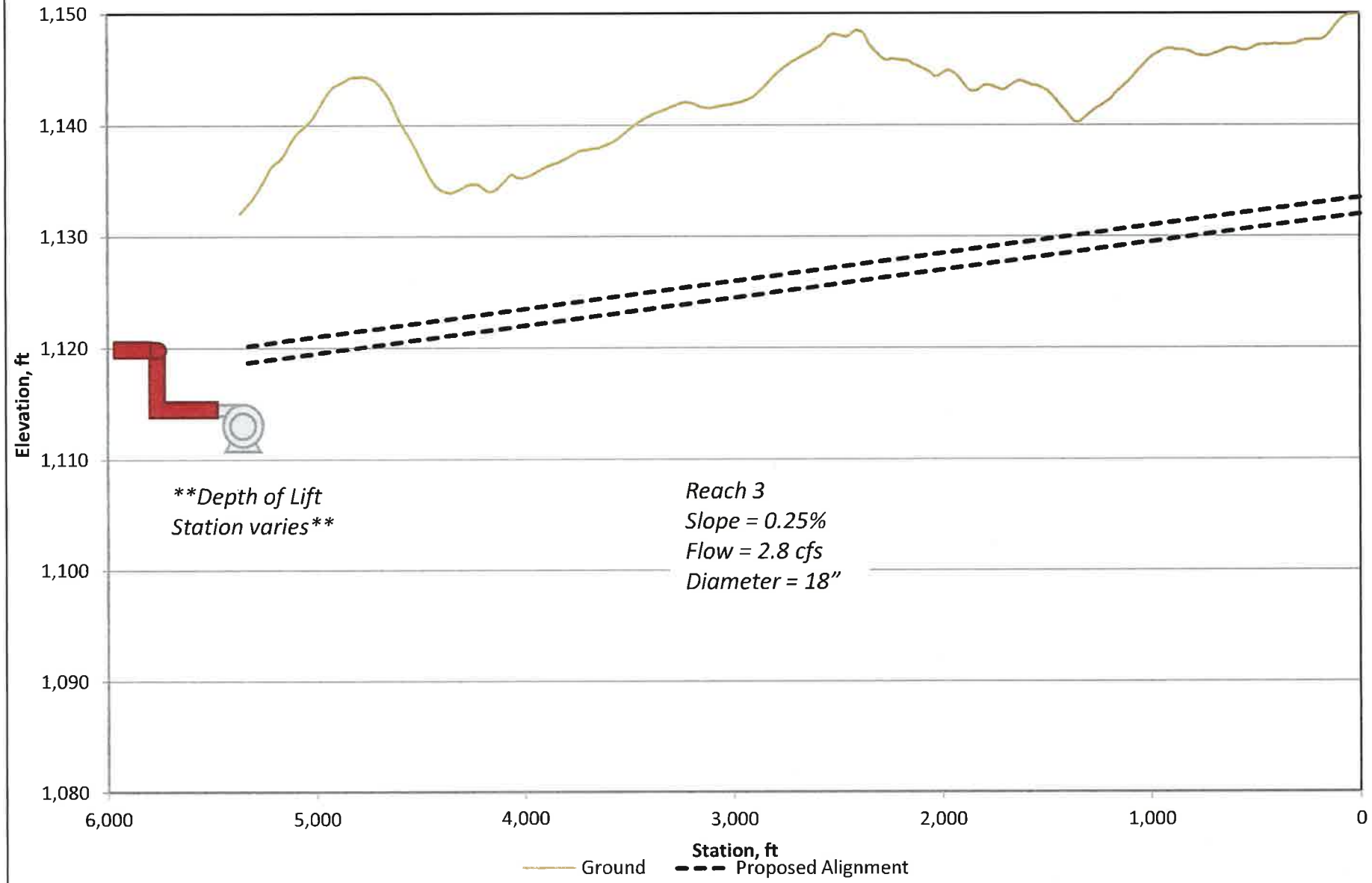

CITY OF LINCOLN NEBRASKA

FIGURE 18 – E-6 GRAVITY SEWER - PROFILE
STUDY AREA NUMBER 3
CITY OF LINCOLN, NEBRASKA

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4.4 Alternative 4 - Lift Station near Alvo Road with Parallel Sewers

The fourth alternative is similar to alternative 3A except that a parallel pipe will is proposed which will serve basin E-8 as well. Therefore, this alternative will include infrastructure to serve Study Area No. 3 in the near term (just as in alternative 3A), and to serve basin E-8 in the future through the addition of a parallel gravity sewer and an upsized lift station. This alternative was analyzed to evaluate the potential for serving E-8 with parallel infrastructure rather than ultimately sizing the infrastructure in the near term. Again, given that there are no downstream elevation constraints for this alternative due to the lift station, the profile for this alternative was dictated by maintaining the 5 feet of minimum cover underneath the stream crossing near station 500. Based on this, the proposed sewers are summarized in Table 11. The plan for alternative 4 can be seen in Figure 19. The profiles for the main alignment, E-8 parallel gravity sewer, and the E-6 gravity sewer can be seen in Figure 20, Figure 21, and Figure 18, respectively. For the parallel gravity sewer to serve basin E-8, it is envisioned that there will be two separate trunk sewers which will convey flows to the parallel sewer due to a ridge line which divides basin E-8. These trunk sewers are planned to tie into the beginning of reach four and five for the east, and west portions of basin E-8, respectively. Again, all piping profiles were generated using 2-foot contours.

Table 11 Proposed Sewers for Alternative 4
Study Area No. 3
City of Lincoln, NE

Reach	Diameter (in)	Length (ft)	Slope (ft/ft)	Pipe Capacity (cfs)	Full Pipe Velocity (ft/sec)	Projected Peak Flow (cfs)(1)
1	18	6,100	0.0025	5.3	3.0	2.44
2	18	2,900	0.0025	5.3	3.0	2.44
3	18	5,400	0.0025	5.3	3.0	2.81
4	18	1,100	0.0025	5.3	3.0	2.37
5	36	3,900	0.0010	21.2	3.0	16.99
6	36	2,400	0.0010	21.2	3.0	16.99
Force Main	24	8,500	-	31.4	10.0	20.62

Note:
(1) Peak flows for proposed infrastructure were calculated based upon total contributing area using the peak flow equation as defined previously.

For the purpose of determining the estimated project costs, the following assumptions were utilized for costing out the lift station:

- The lift station and force main will be capable of handling the estimated peak flow from the study area of 20.6 cfs.

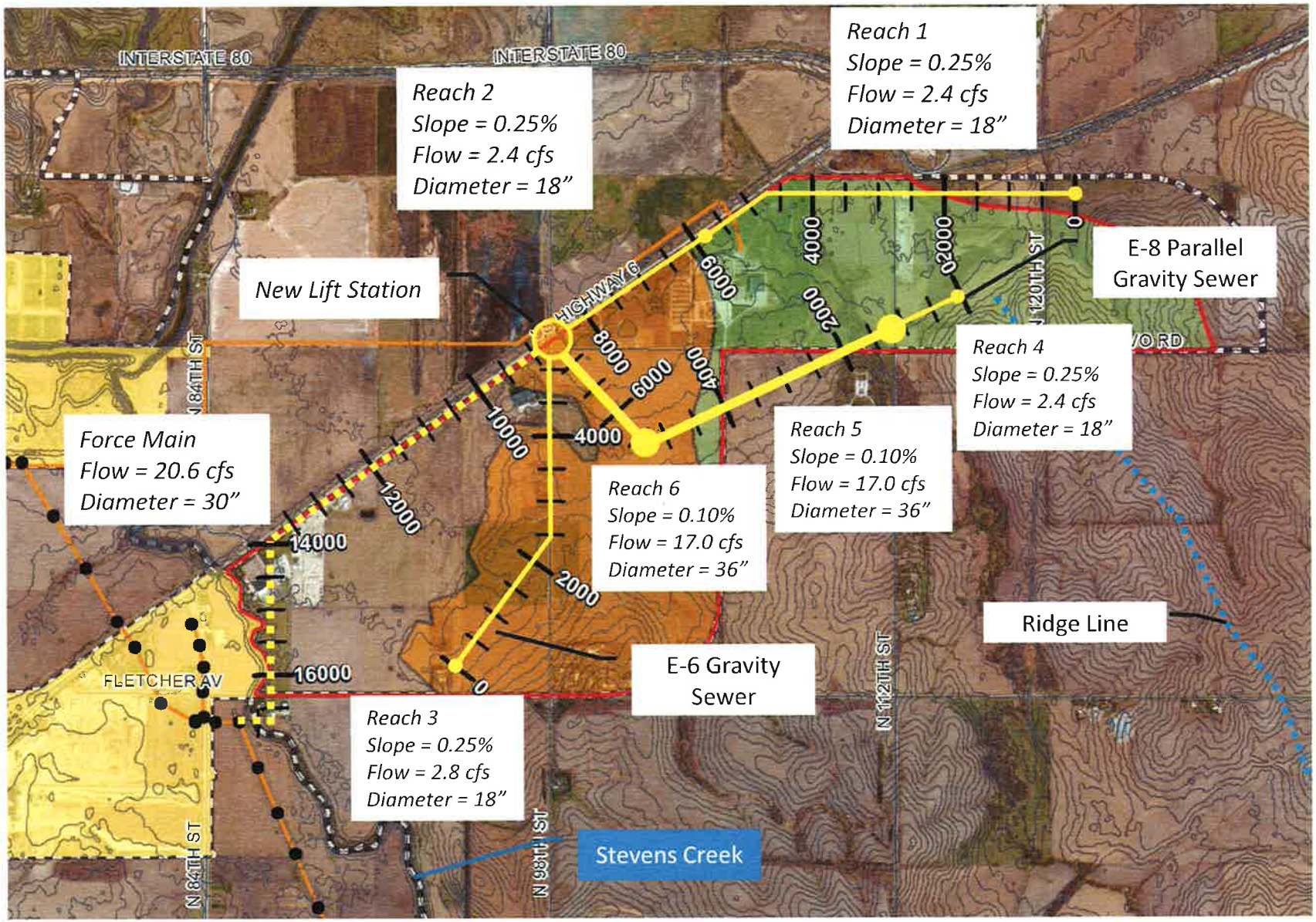
- The lift station would be constructed near the intersection of Alvo Road and 98th Street.
- The lift station would incorporate a concrete wetwell utilizing submersible pumps.
- A prefabricated electrical building would be provided.

Based on the information provided in Table 11, the assumptions listed above, and similar projects, the probable opinion of estimated costs for alternative 4 is approximately $22,738,100 as outlined in Table 12 below.

Table 12 Alternative 4 - Probable Opinion of Estimated Project Costs
Study Area No. 3
City of Lincoln, NE

Element	Estimated Cost
Lift Station	$8,219,100
Gravity Sewer	$8,612,000
Force Main	$2,448,000
Stevens Creek Siphon Crossing	$180,000
Right of Way	$1,212,000
Subtotal	$20,671,000
Engineering, Legal, Administrative (10%)	$2,067,100
Estimated Total	$22,738,100

Notes:
(1) Contingencies included as part of unit costs.



CITY OF LINCOLN NEBRASKA

FIGURE 19 – ALTERNATIVE 4 - PLAN
STUDY AREA NUMBER 3
CITY OF LINCOLN, NEBRASKA

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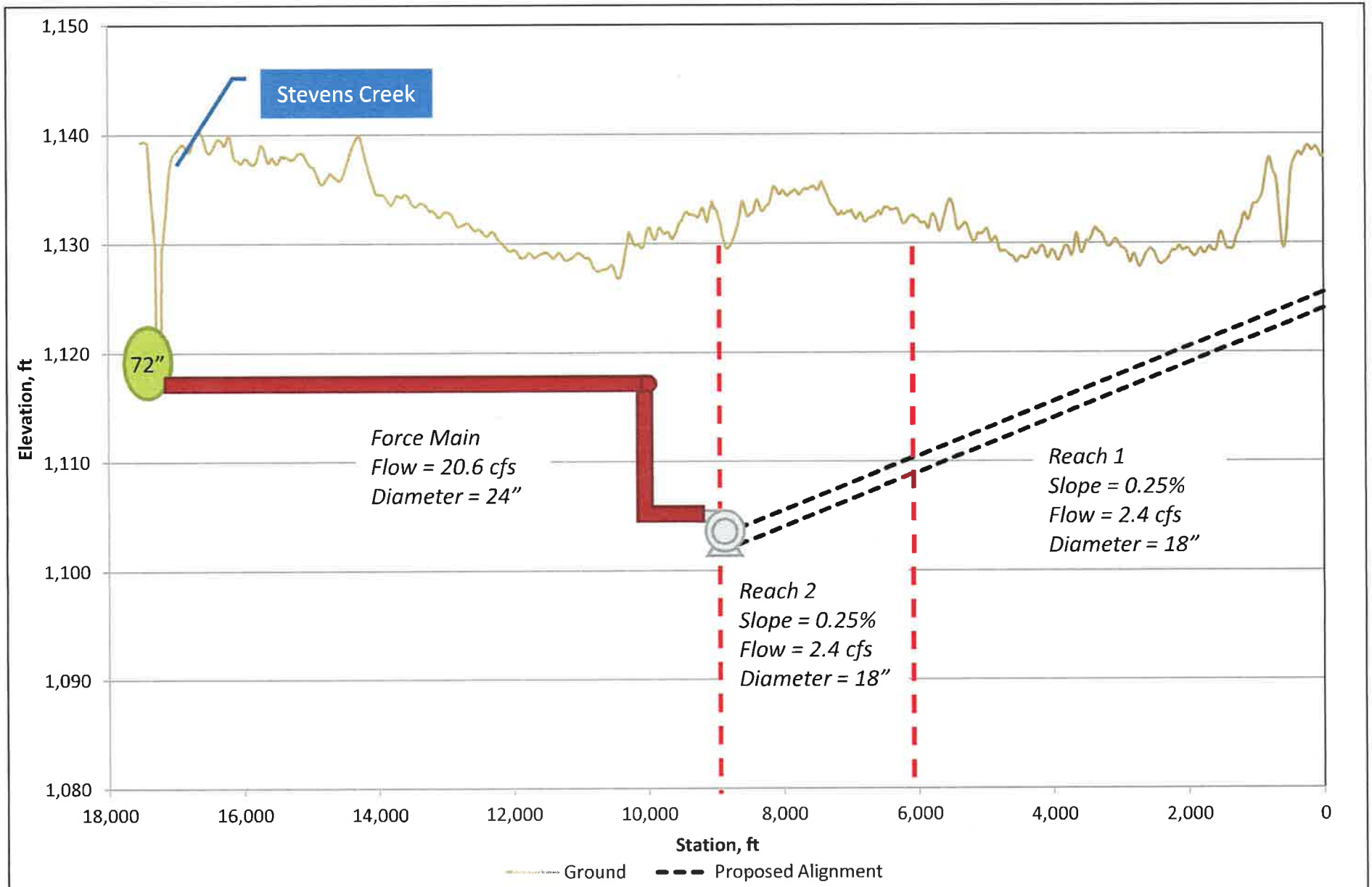

CITY OF LINCOLN NEBRASKA

FIGURE 20 – ALTERNATIVE 4 - PROFILE
STUDY AREA NUMBER 3
CITY OF LINCOLN, NEBRASKA

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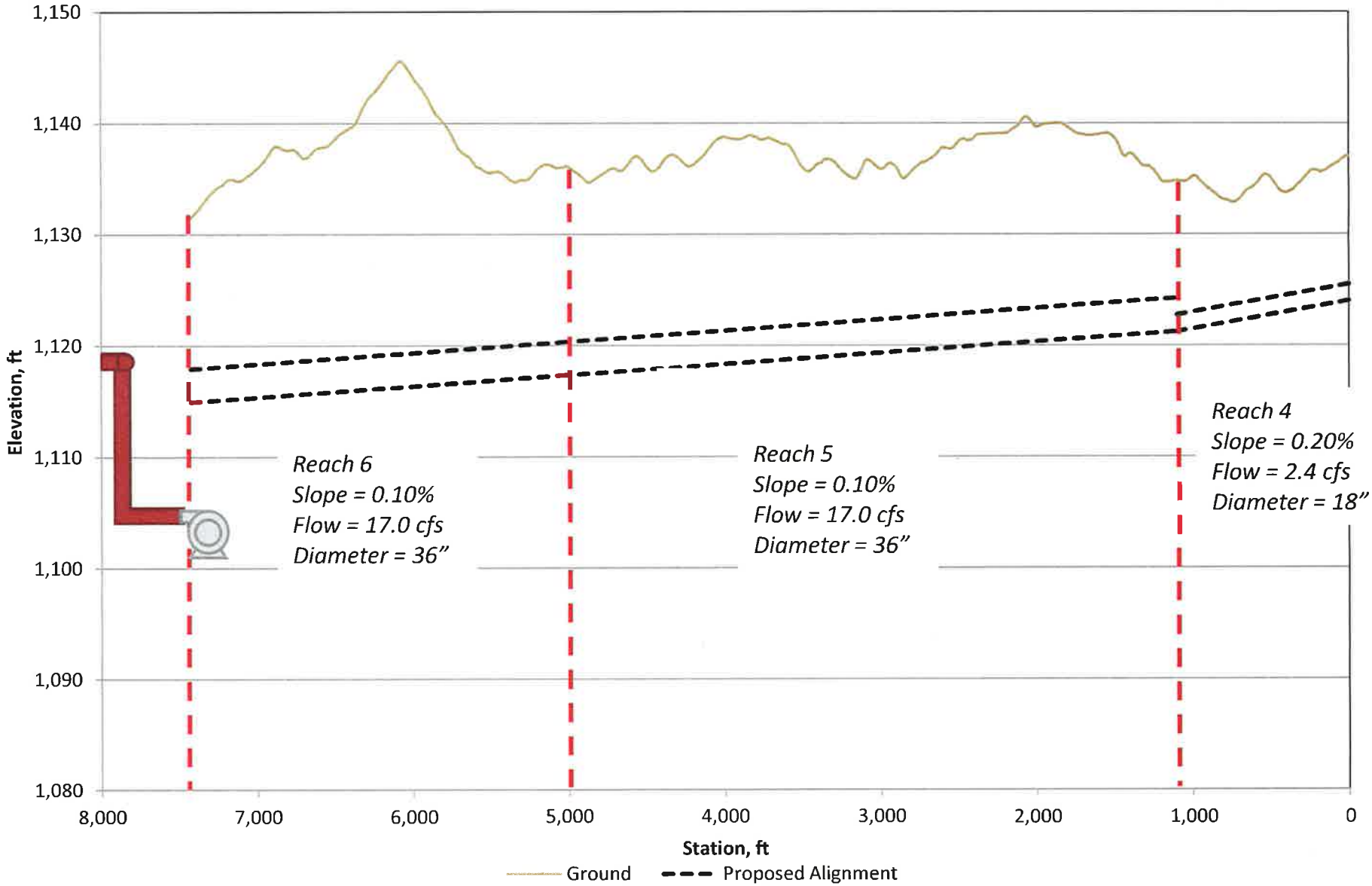

CITY OF LINCOLN NEBRASKA

FIGURE 21 – E-8 PARALLEL GRAVITY SEWER - PROFILE
STUDY AREA NUMBER 3
CITY OF LINCOLN, NEBRASKA

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5.0 SUMMARY

Four different alternatives were evaluated as part of this study. Three of these alternatives looked at both the costs to serve only Study Area No. 3 flows (designated as 'A'), and to serve the flows from both Study Area No. 3 and Basin E-8 (designated as 'B'). The fourth alternative included both Study Area No. 3 and Basin E-8 flow. The summary of the estimated costs are presented in Table 13 below.

Table 13 Proposed Sewers for Alternative 4
Study Area No. 3
City of Lincoln, NE

Alternative	Serve Study Area No. 3	Serves Basin E-8	Estimated Costs
1A	Yes		NA (1)
1B	Yes	Yes	NA (1)
2A	Yes		$12,182,800
2B	Yes	Yes	$20,664,900
3A	Yes		$9,588,500
3B	Yes	Yes	$19,259,600
4	Yes	Yes	$22,738,100

Note:
(1) These alternatives were a gravity only options, which did not work due to the topography of the area.

As shown in the table above Alternative 1A and 1B, which was a gravity only alternative will not work, and therefore was not further considered. Alternative 2A and 2B had higher costs than the 3A and 3B alternatives respectively. Based solely on costs, Alternative 3A would be the most affordable to serve only Study Area No. 3, and likewise Alternative 3B would be the most cost effective alternative to serve both areas. It should be noted that Alternative 4 provides the City with more options relating to phasing and construction sequencing. Based on the above, it is recommended that Alternative 3A be pursued if the City only desires to serve Study Area No. 3. However, if there is a desire to potentially serve Basin E8 in the future, both Alternatives 3B and 4 should be considered.

With Alternative 4, the smaller sewers needed to serve Study Area No. 3 could be built in phases. The lift station should be designed and constructed to be expandable. An example of the phasing follows.

- First Phase – Design and construct the lift station to be expandable. Design and construct force main for initial flows. Design and construct initial Study Area No. 3 sewers. This would result in a lower first cost then alternative 3B.

- Additional phases of the sewer could be constructed as the demand for sewers increases.

- As flows increase, expansions to the lift station should be constructed to match the anticipated flows.

It should also be noted that the flows from the majority of Basin E6, that are not included in Study Area No. 3, are planned to be collected and directed to the existing junction structure E6 using a siphon under Stevens Creek. Although not included in the estimated costs for the alternatives evaluated as part of this study, the siphon to serve Basin E6 could be sized, designed and constructed to serve the areas included in this study as well as Basin E6. Doing so would result in a larger up front costs, but would eliminate the need to cross Stevens Creek in the future.

It should be noted that the actual cost of the selected project will depend on many factors that have not necessarily been fully identified or resolved as of the date of this study. These include but are not limited to the following:

- The actual location of the pipelines and or lift station.
- The actual cost of the right of way for the facilities.
- The actual requirements for crossing Stevens Creek
- The depth of the gravity sewers and/or lift station wetwell.

The preliminary opinion of estimated costs developed and outlined in this study represent an order of magnitude cost estimate. All of the cost estimates presented are based on the first quarter of 2015 values. An order of magnitude estimate is considered a reconnaissance level estimate. The estimated costs are approximate because they are developed without detailed engineering data. Order of magnitude costs may be estimated using cost-capacity curves, scaling factors, ratios, and information from other projects. An order of magnitude cost would be expected to have an associated accuracy of +50 to - 30 percent.

These improvements describe the facilities needed for buildout flows for Study Area 3 using the City's peak flow equation. Opportunities may present themselves to downsize these improvements based on two general parameters:

- The actual peak flow from the planned industrial developments may be less than the estimated peak flows determined by the City's peak flow equation. This would results in the size of the improvements decreasing.
- Depending on the actual planned development of this area there may be opportunities to construct the improvements in phases which will lower the initial project costs.

Appendix A – Alternative Cost Estimates

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Subject: Project Flows
Project: Study Area 3 - UPDATE
Client: City of Lincoln, NE

Job Number: 7498C.00

Date: 17-Oct-14
By: RR

Checked: MJT/BDC
Date: 11/6/2014

UNIT COSTS	Base Unit Cost	Unit	Contingency Factors	Unit Cost
Standard Pipeline (Y), depth<10 ft =	$ 10.00	in-dia/lf	1.00	$ 10.00
Standard Pipeline (Y), depth 10-20 ft =	$ 12.00	in-dia/lf	1.25	$ 15.00
Standard Pipeline (Y), depth>20 ft =	$ 18.00	in-dia/lf	1.50	$ 27.00
Jack & Bore Pipeline (Z) =	$ 55.00	in-dia/lf	2.50	$ 137.50
Force Main =	$ 8.00	in-dia/lf	1.50	$ 12.00
Creek Crossing =	$ 75.00	per LF	2.00	$ 150.00
Easement Acquistion =	$ 40.00	per LF	-	$ 40.00
Lift Station Structure =	$ 0.50	per gpd	1.25	$ 0.63
Submersible Pumps =	$ 3,000.00	per MGD	-	$ 3,000.00

Project Name	Lift Station Capacity (MGD)	Total Length (ft)	Length Buried <10 ft	Length Buried 10-20 ft	Length Buried >20 ft	Stream Crossing Length (ft)	Conduit Shape	New Conduit Diameter (in)	Stream Crossing Cost (2015 dollars)	Estimated Construction Cost (2015 dollars)
Alternative 2A										
Reach 1	-	6,100	1,764	3,730	606	175	Circ	18	$ 26,250	$ 1,645,265
Reach 2	-	3,400	0	0	3,400	0	Circ	24	$ -	$ 2,203,201
Reach 3	-	6,496	0	0	6,496	0	Circ	24	$ -	$ 4,209,651
Force Main	-	1,504	0	0	0	1,200	Circ	10	$ 180,000	$ 360,466
Easement	-	17,500	-	-	-	-	-	-	$ -	$ 700,000
Pump Station	3.12	-	-	-	-	-	-	-	$ -	$ 1,956,700
									Subtotal:	**$ 11,075,283**
									ELA (10%):	**$ 1,107,528**
									Total:	**$ 12,182,811**
Alternative 2B										
Reach 1	-	6,100	4,054	2,046	0	175	Circ	36	$ 26,250	$ 2,590,411
Reach 2	-	3,400	0	3,400	0	0	Circ	36	$ -	$ 1,836,001
Reach 3	-	6,496	0	3,373	3,124	0	Circ	36	$ -	$ 4,857,500
Force Main	-	1,504	0	0	0	1,200	Circ	24	$ 180,000	$ 613,118
Easement	-	17,500	-	-	-	-	-	-	$ -	$ 700,000
Pump Station	13.09	-	-	-	-	-	-	-	$ -	$ 8,189,200
									Subtotal:	**$ 18,786,229**
									ELA (10%):	**$ 1,878,623**
									Total:	**$ 20,664,852**

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Subject: Project Flows
Project: Study Area 3 - UPDATE
Client: City of Lincoln, NE

Job Number: 7498C.00

Date: 17-Oct-14
By: RR

Checked: MJT/BDC
Date: 11/6/2014

UNIT COSTS	Base Unit Cost	Unit	Contingency Factors	Unit Cost
Standard Pipeline (Y), depth<10 ft =	$ 10.00	in-dia/lf	1.00	$ 10.00
Standard Pipeline (Y), depth 10-20 ft =	$ 12.00	in-dia/lf	1.25	$ 15.00
Standard Pipeline (Y), depth>20 ft =	$ 18.00	in-dia/lf	1.50	$ 27.00
Jack & Bore Pipeline (Z) =	$ 55.00	in-dia/lf	2.50	$ 137.50
Force Main =	$ 8.00	in-dia/lf	1.50	$ 12.00
Creek Crossing =	$ 75.00	per LF	2.00	$ 150.00
Easement Acquistion =	$ 40.00	per LF	-	$ 40.00
Lift Station Structure =	$ 0.50	per gpd	1.25	$ 0.63
Submersible Pumps =	$ 3,000.00	per MGD	-	$ 3,000.00

Project Name	Lift Station Capacity (MGD)	Total Length (ft)	Length Buried <10 ft	Length Buried 10-20 ft	Length Buried >20 ft	Stream Crossing Length (ft)	Conduit Shape	New Conduit Diameter (in)	Stream Crossing Cost (2015 dollars)	Estimated Construction Cost (2015 dollars)
Alternative 3A										
Reach 1	-	6,100	1,764	3,730	606	175	Circ	18	$ 26,250	$ 1,645,265
Reach 2	-	2,900	0	0	2,900	0	Circ	18	$ -	$ 1,409,582
Force Main	-	8,500	0	0	0	1,200	Circ	10	$ 180,000	$ 1,199,986
Reach 3	-	5,400	0	4,792	608	0	Circ	18	$ -	$ 1,589,328
Easement	-	22,900	-	-	-	-	-	-	$ -	$ 916,000
Pump Station	3.12	-	-	-	-	-	-	-	$ -	$ 1,956,700
									Subtotal:	**$ 8,716,861**
									ELA (10%):	**$ 871,686**
									Total:	**$ 9,588,547**
Alternative 3B										
Reach 1	-	6,100	4,056	2,044	0	175	Circ	36	$ 26,250	$ 2,590,170
Reach 2	-	2,900	0	2,900	0	0	Circ	36	$ -	$ 1,566,203
Force Main	-	8,500	0	0	0	1,200	Circ	24	$ 180,000	$ 2,627,892
Reach 3	-	5,400	0	4,792	608	0	Circ	18	$ -	$ 1,589,328
Easement	-	22,900	-	-	-	-	-	-	$ -	$ 916,000
Pump Station	13.09	-	-	-	-	-	-	-	$ -	$ 8,219,100
									Subtotal:	**$ 17,508,693**
									ELA (10%):	**$ 1,750,869**
									Total:	**$ 19,259,562**

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Subject: Project Flows
Project: Study Area 3 - UPDATE
Client: City of Lincoln, NE

Job Number: 7498C.00

Date: 17-Oct-14
By: RR

Checked: MJT/BDC
Date: 11/6/2014

UNIT COSTS	Base Unit Cost	Unit	Contingency Factors	Unit Cost
Standard Pipeline (Y), depth<10 ft =	$ 10.00	in-dia/lf	1.00	$ 10.00
Standard Pipeline (Y), depth 10-20 ft =	$ 12.00	in-dia/lf	1.25	$ 15.00
Standard Pipeline (Y), depth>20 ft =	$ 18.00	in-dia/lf	1.50	$ 27.00
Jack & Bore Pipeline (Z) =	$ 55.00	in-dia/lf	2.50	$ 137.50
Force Main =	$ 8.00	in-dia/lf	1.50	$ 12.00
Creek Crossing =	$ 75.00	per LF	2.00	$ 150.00
Easement Acquistion =	$ 40.00	per LF	-	$ 40.00
Lift Station Structure =	$ 0.50	per gpd	1.25	$ 0.63
Submersible Pumps =	$ 3,000.00	per MGD	-	$ 3,000.00

Project Name	Lift Station Capacity (MGD)	Total Length (ft)	Length Buried <10 ft	Length Buried 10-20 ft	Length Buried >20 ft	Stream Crossing Length (ft)	Conduit Shape	New Conduit Diameter (in)	Stream Crossing Cost (2015 dollars)	Estimated Construction Cost (2015 dollars)
Alternative 4										
Reach 1	-	6,100	1,764	3,730	606	175	Circ	18	$ 26,250	$ 1,645,265
Reach 2	-	2,900	0	0	2,900	0	Circ	18	$ -	$ 1,409,582
Force Main	-	8,500	-	-	-	1,200	Circ	24	$ 180,000	$ 2,627,966
Reach 3	-	5,400	0	4,792	608	0	Circ	18	$ -	$ 1,589,328
Reach 4	-	1,100	315	785	0	0	Circ	18	$ -	$ 268,667
Reach 5	-	3,900	0	3,900	0	0	Circ	36	$ -	$ 2,105,746
Reach 6	-	2,400	0	1,713	688	0	Circ	36	$ -	$ 1,593,376
Easement	-	30,300	-	-	-	-	-	-	$ -	$ 1,212,005
Pump Station	13.09	-	-	-	-	-	-	-	$ -	$ 8,219,100
									Subtotal:	**$ 20,671,034**
									ELA (10%):	**$ 2,067,103**
									Total:	**$ 22,738,137**