Linton – Beaver Creek Alternatives Report

Emmons County, North Dakota

SWC Project #558
December 2018

North Dakota
State Water Commission

Beaver Creek Alternatives Report

Linton, North Dakota, Emmons County

SWC Project #558
North Dakota State Water Commission
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Prepared for:
Emmons County Water Resource District

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1. Introduction

This report documents the alternatives analyzed for reducing flood risk along Beaver Creek at Linton, ND. The alternatives were created as part of a Section 22 Planning Assistance to States study agreement between the U.S. Army Corps of Engineers (Omaha District) and the Emmons County Water Resource District (District), and pursuant to an investigation agreement between the District and the North Dakota State Water Commission (SWC). The purpose of the Section 22 study is to investigate flood risk management alternatives for Linton, ND.

The purpose of this report is to analyze impacts on water surface elevations based on developed alternatives for Linton, ND. Alternatives analyzed as part of this report include bridge removals, removal of an earthen levee, and the creation of temporary emergency levees. These alternatives were analyzed using the Beaver Creek Hydraulics Model developed as part of this study (North Dakota State Water Commission, 2018). This report does not include an examination of upstream storage alternatives, as this methodology was screened out of consideration in the Beaver Creek Hydrology Report that was completed as part of the study (North Dakota State Water Commission, 2016).

This report includes electronic appendices A, B, C, D, and E which provide more information on the Linton structure survey, the hydraulic model used to evaluate each alternative, bridge removal alternatives, Old Town levee removal alternative, and temporary emergency levee alignments, respectively.

2. Site Location

The Beaver Creek reach included in the alternative analysis (**Figure 1**) is located in Emmons County, near the City of Linton, ND. The figure illustrates the boundary of the two-dimensional hydraulic model used in the alternative analysis and identifies key features of the model.

Old Town, which can be seen in **Figure 1**, lies between Spring Creek and Beaver Creek. Old Town sustained considerable damage during the 2009 event and is the most flood prone portion of the community.

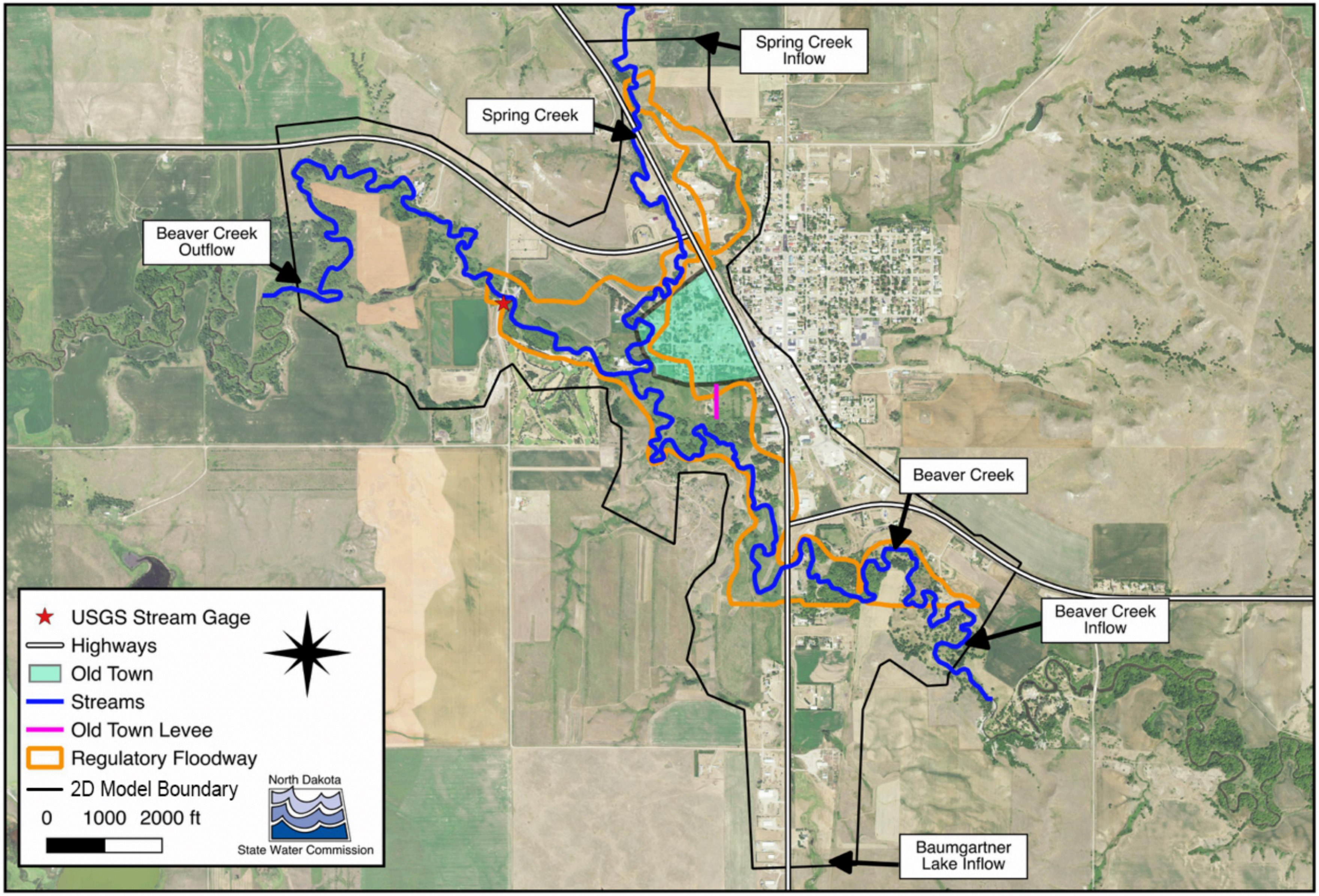

Figure 1. Site location

3. Bridge Removal Alternatives

During a visit to the City of Linton with Omaha District representatives and District members, it was mentioned that there was some concern that bridges downstream of Old Town were impeding flow and contributing to the flooding in 2009. For this reason, bridge removal alternatives were evaluated.

3.1 6th Avenue Southeast Bridge Removal

The 6th Ave SE Bridge (**Figure 2**) is located approximately half of a mile downstream of the City of Linton, directly downstream of the USGS gage. Over the years, citizens have raised concerns that 6th Avenue SE Bridge restricts the flow of Beaver Creek and contributed to damage during the 2009 event. The bridge was constructed after the flood of 1952, which at the time was the flood of record, and did not produce the amount of damage that occurred in 2009. The 1952 event was considerably smaller than the 2009 event (**Figure 3**), but removal of the 6th Avenue SE Bridge was examined to determine what impacts this structure may have on the community.

Figure 2. 6th Avenue SE Bridge (downstream end)

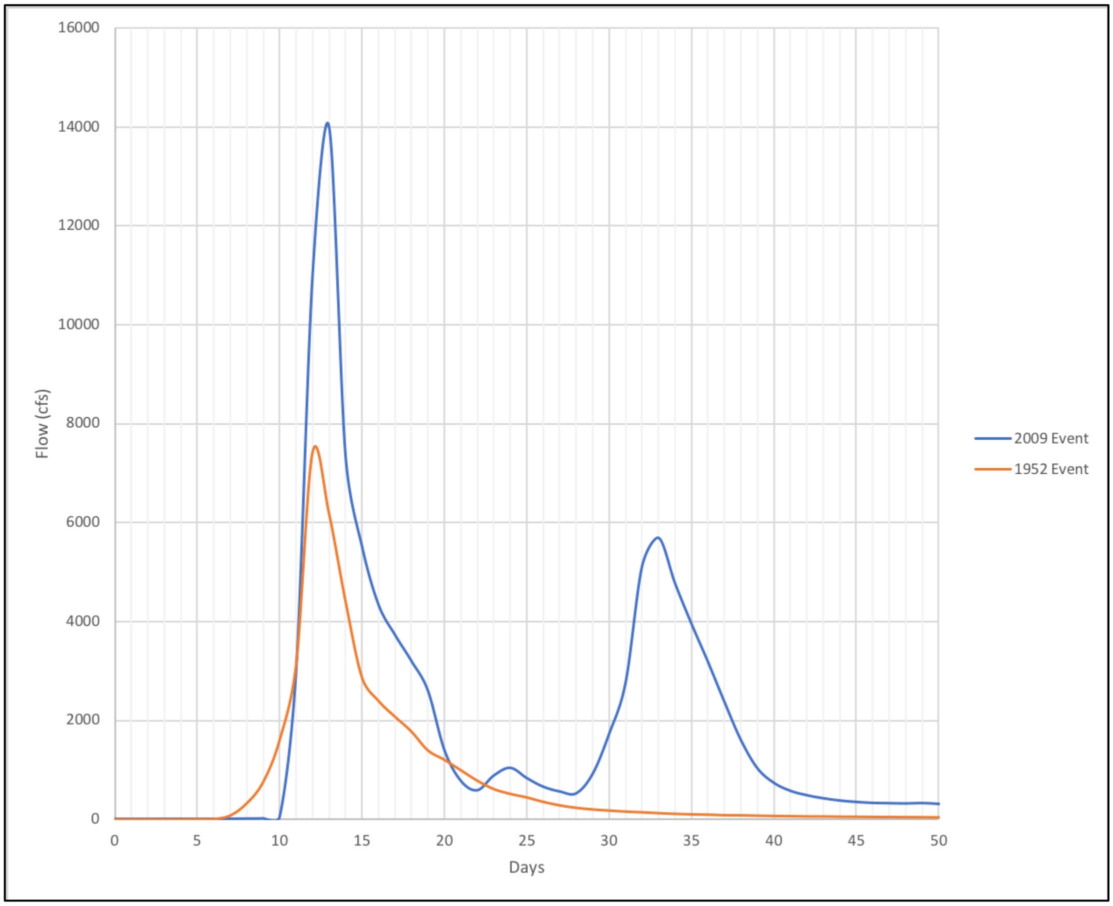

Figure 3. 1952 and 2009 event hydrograph comparison

In order to determine the effects the 6th Avenue SE Bridge has on Old Town, the bridge was removed from the hydraulics model. Modeling the removal of the bridge required the removal of both the main bridge opening, as seen in **Figure 2**, the secondary opening further to the north, and a section of roadway. This required editing the Light Detection and Ranging (LiDAR) data used by the hydraulic model and the hydraulically modeled bridges to reflect the removal of the section displayed in **Figure 4**. **Figure 5** provides a comparison of the LiDAR pre- and post-removal of the 6th Avenue SE Bridge.

The 6th Avenue SE bridge removal was evaluated against the 2009 snowmelt event to assess the potential benefits of removing the bridge. This was done to identify if the bridge caused adverse impacts in the City of Linton, specifically Old Town. **Figure 6** illustrates the maximum water surface difference at peak flow for the 2009 snowmelt event between existing conditions and removal of the 6th Avenue SE Bridge. Water surfaces for the entire comparison can be viewed in **Appendix B** for each of the 2D cells displayed in **Figure 6**.

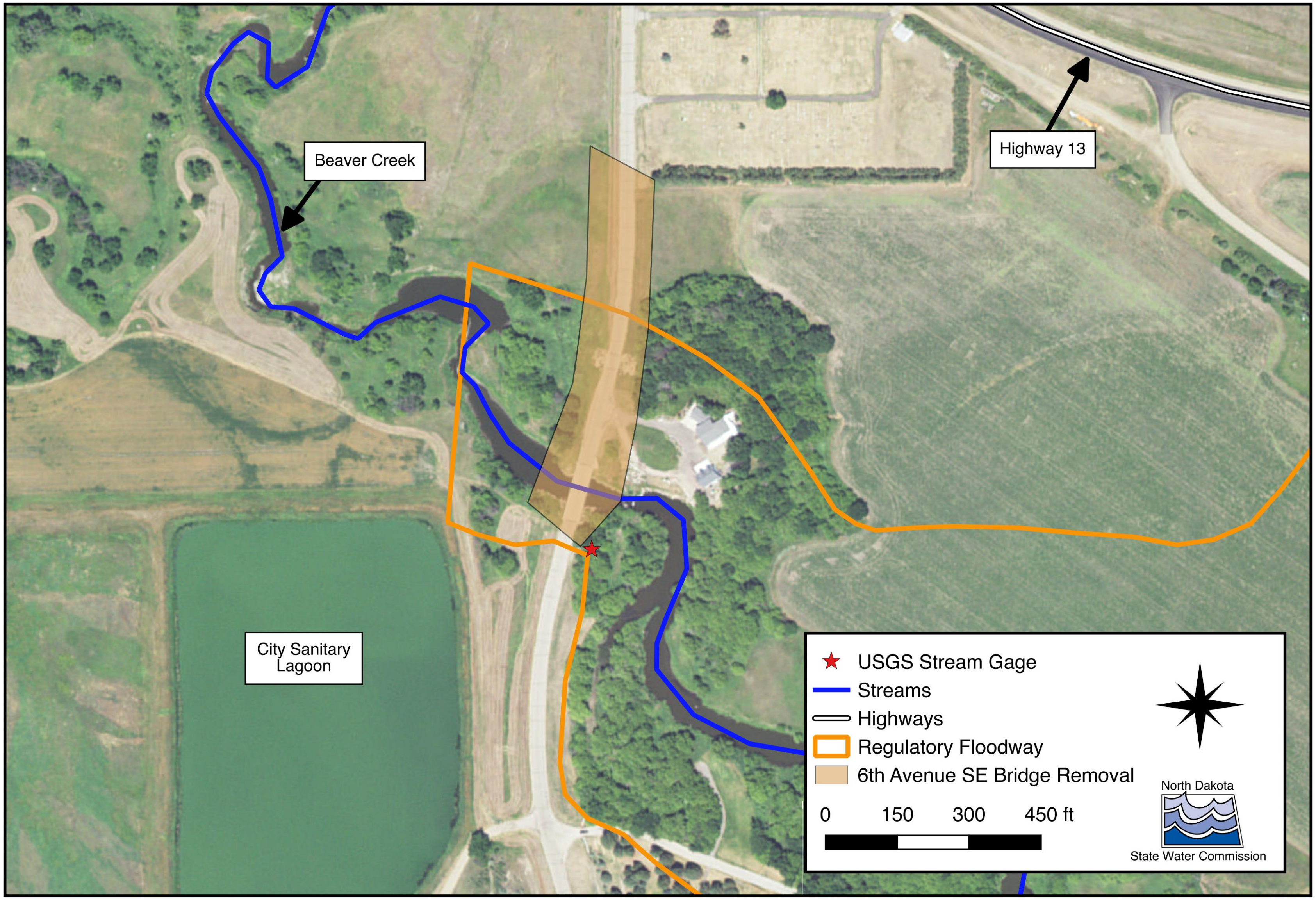

Figure 4. 6th Avenue SE Bridge removal

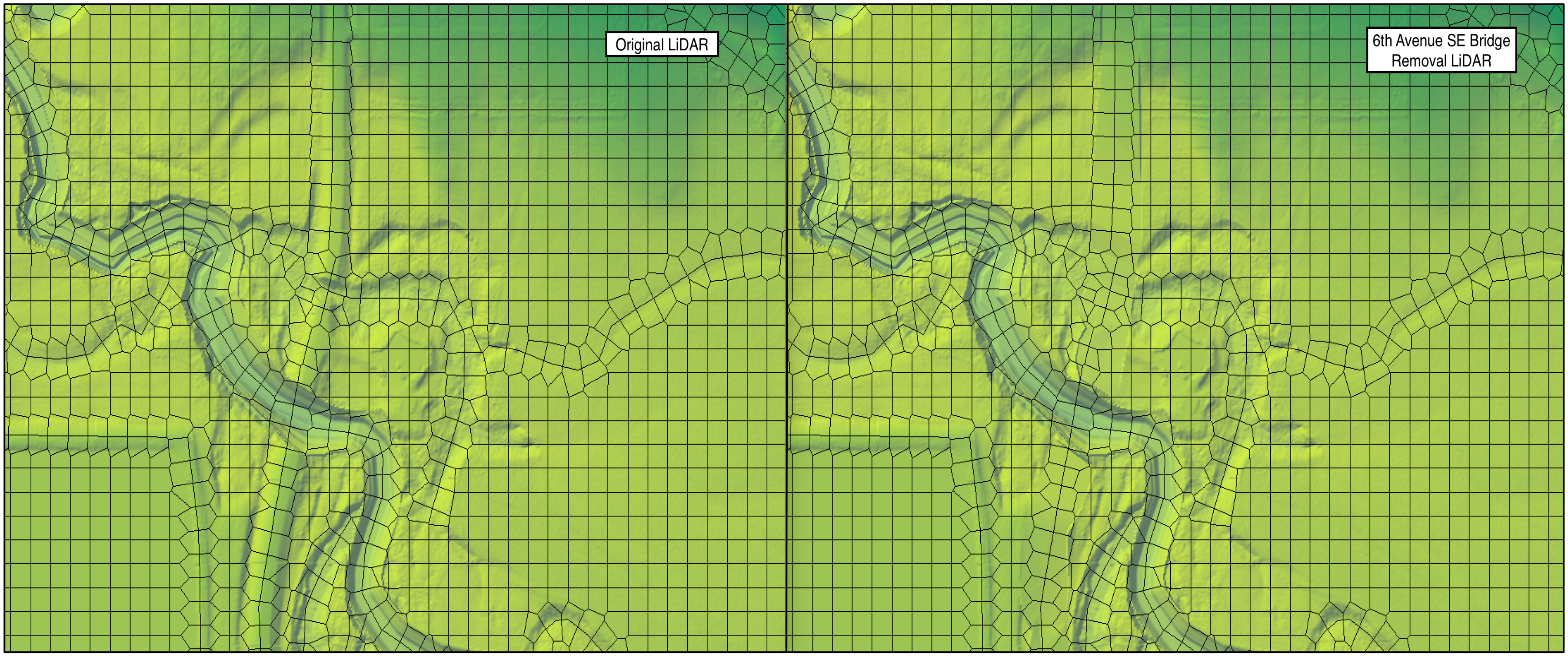

Figure 5. LiDAR comparison for the 6th Avenue SE Bridge removal

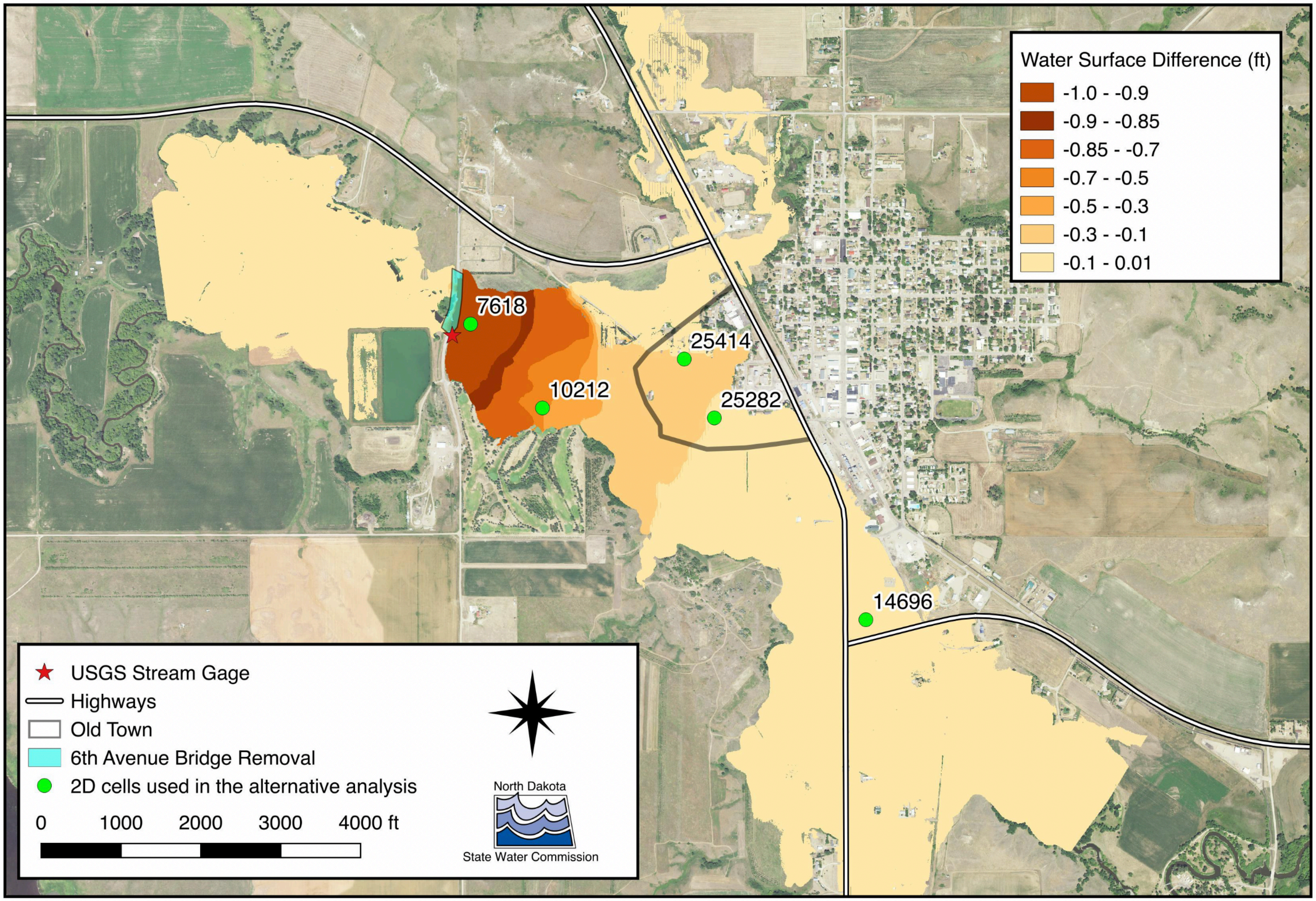

Figure 6. Maximum water surface difference at peak flow for the 2009 snowmelt event between existing conditions and removal of the 6th Avenue SE Bridge

3.2 Golf Course Bridge Removal

The Golf Course Bridge (**Figure 7**) is located approximately 1,000 feet downstream of Old Town (**Figure 8**). The bridge appears to be undersized, which could obstruct Beaver Creek's lower flows. The Golf Course Bridge allows players to access the green for hole 3 and the tee box for hole 4. In order to determine the effects the Golf Course Bridge has on Old Town, the bridge was removed from the hydraulics model. Modeling the removal of the bridge required the removal of the main bridge opening.

Figure 7. Golf Course Bridge (looking upstream)

This alternative was evaluated against the 2-year frequency event to assess the potential benefits of removing the bridge. It was assessed against this event to identify if the bridge caused adverse impacts to the City of Linton, specifically Old Town, in lower flows. Hydraulically, the bridge only obstructs the channel, for this reason only low flow events were used to evaluate the removal of the bridge. **Figure 9** provides the maximum water surface difference at peak flow for the 2-year frequency event between existing conditions and removal of the Golf Course Bridge. Removing the structure decreased the water surface directly upstream of the bridge, but does not contribute to a significant reduction. Reduction in the water surface upstream of the bridge was less than a tenth of a foot.

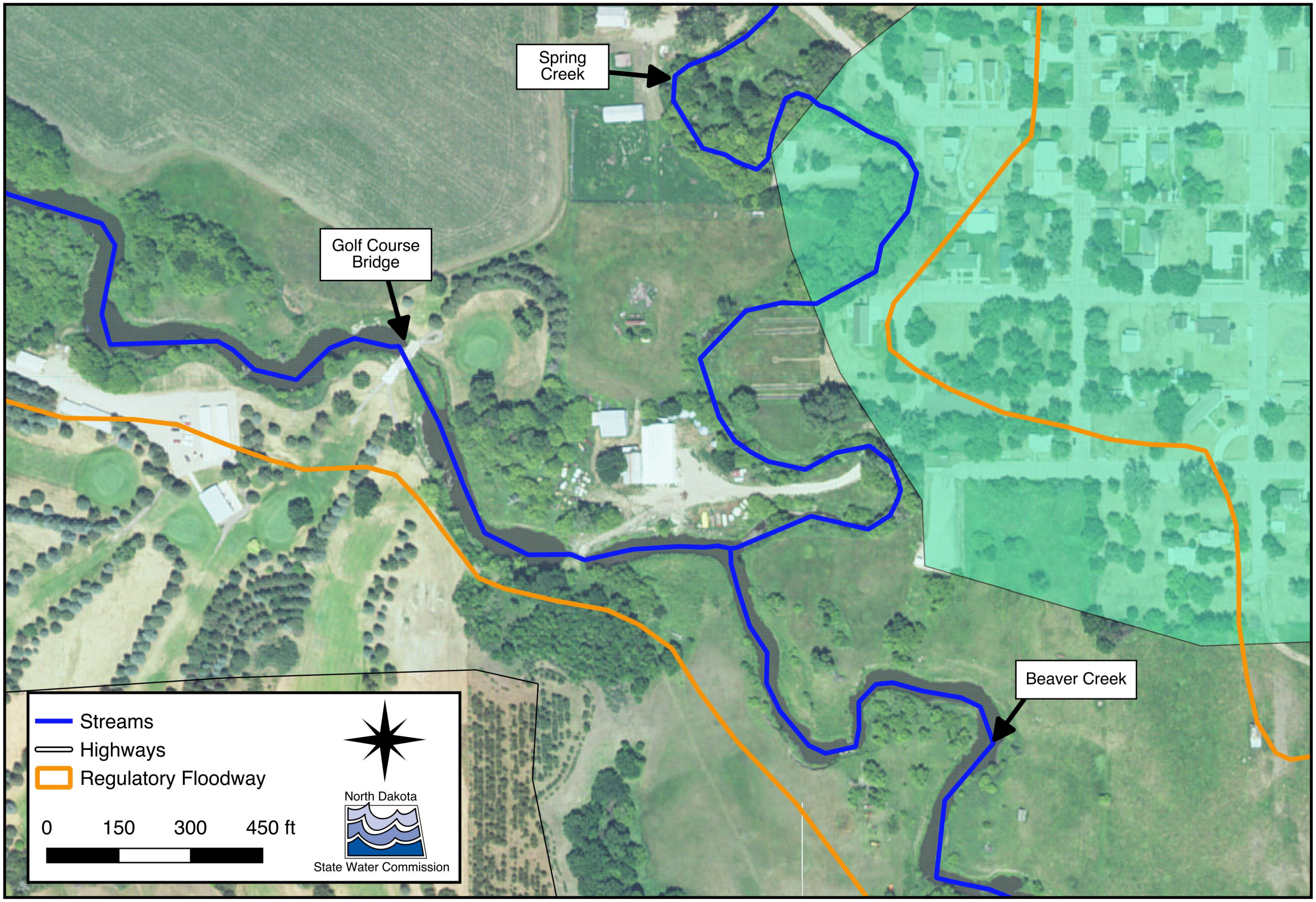

Figure 8. Golf Course Bridge location

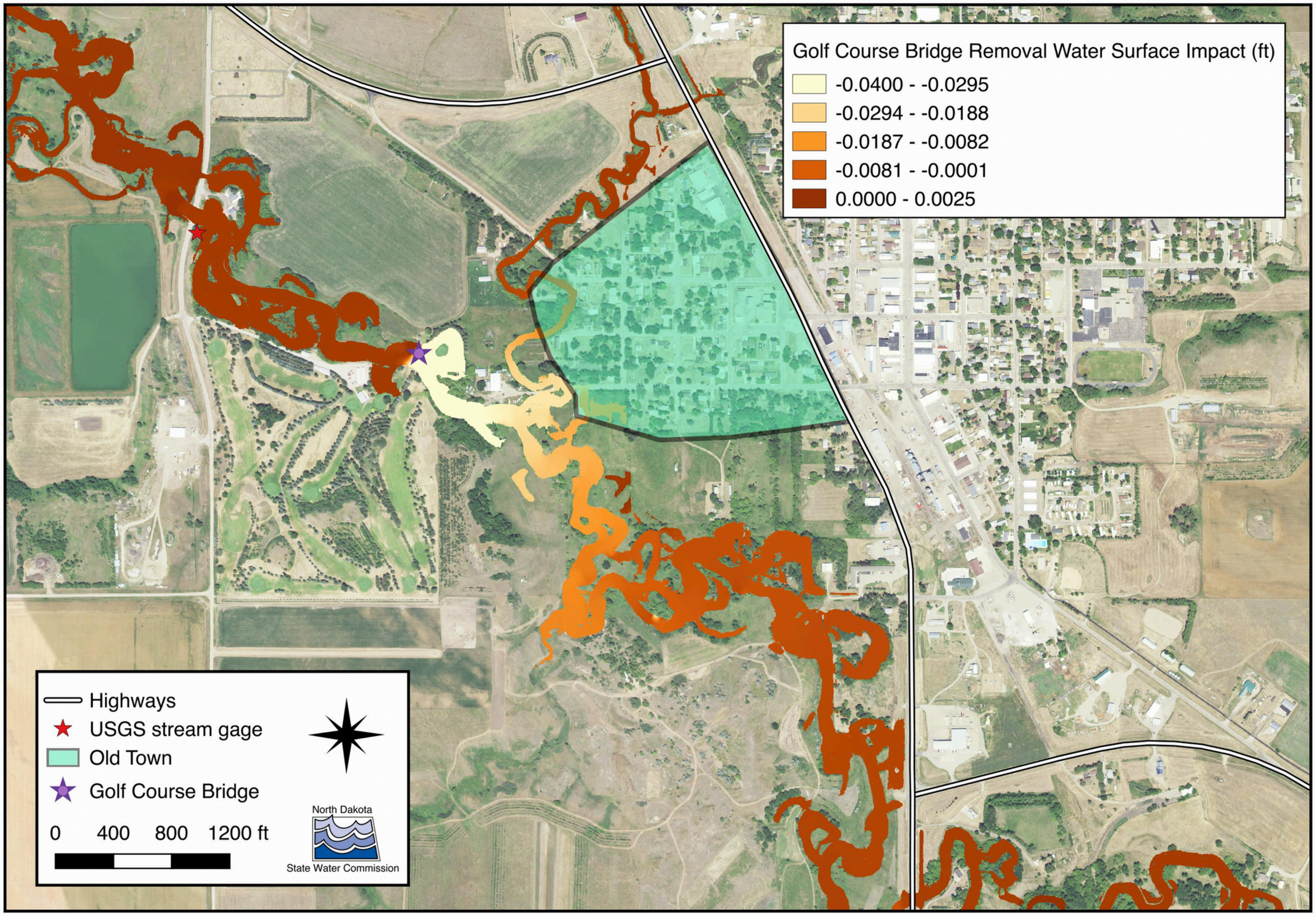

Figure 9. Maximum water surface difference for the 2-year frequency event between the Golf Course Bridge removal and existing conditions.

4. Old Town Levee Removal

The Old Town Levee (**Figure 10**) lies on the right overbank of Beaver Creek and runs perpendicular to the flow of the creek (**Figure 11**). During the flood of 2009, a water resource district board member described watching the water move northward along the levee, directing the water into Old Town. For this reason, the removal of the Old Town Levee was included in the alternative analysis. In order to determine the effects the levee has on Old Town, it was removed from the hydraulics model by editing the LiDAR. **Figure 12** provides a comparison of the LiDAR pre- and post-removal of the Old Town Levee.

Figure 10. Old Town Levee

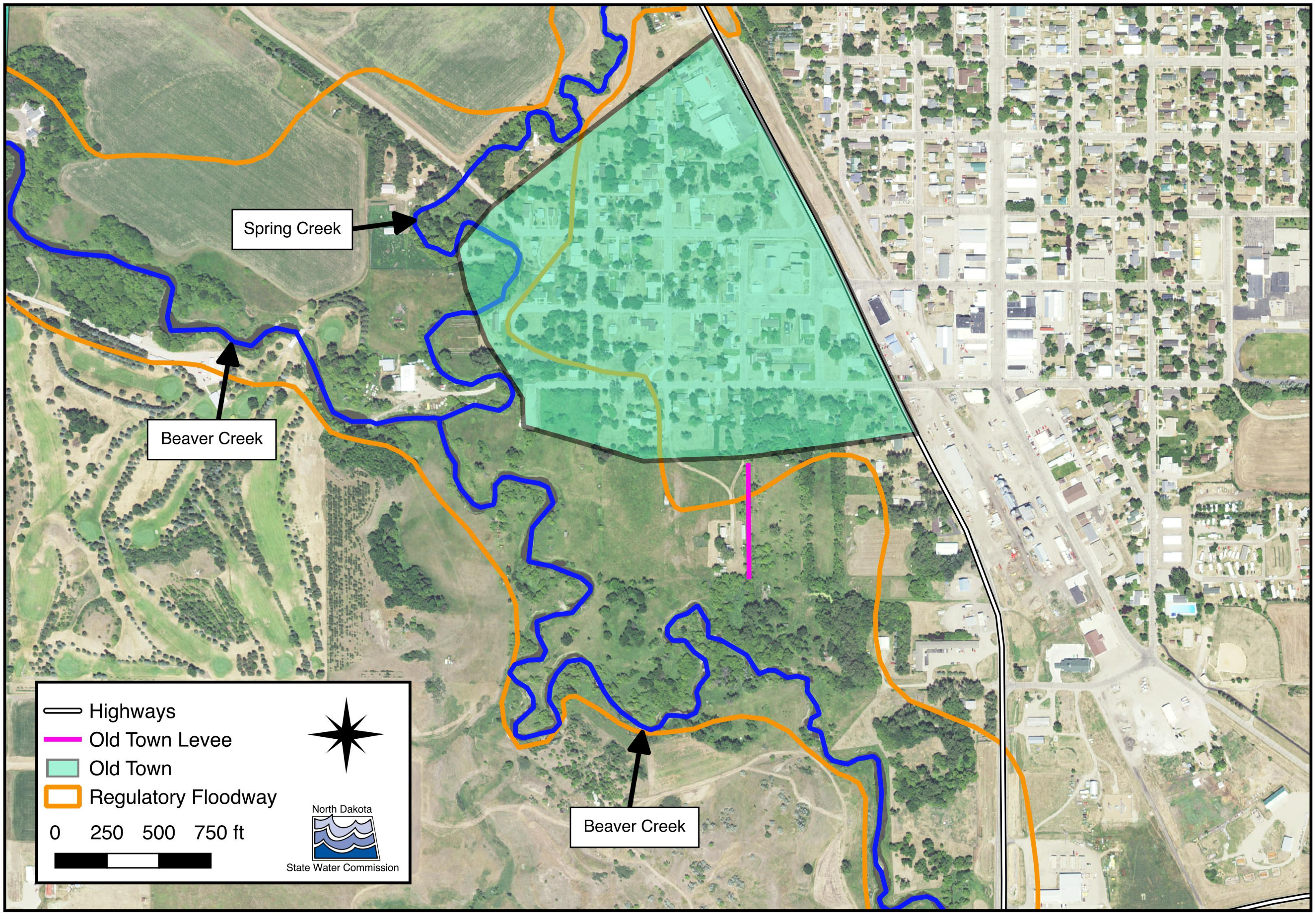

Figure 11. Old Town Levee location

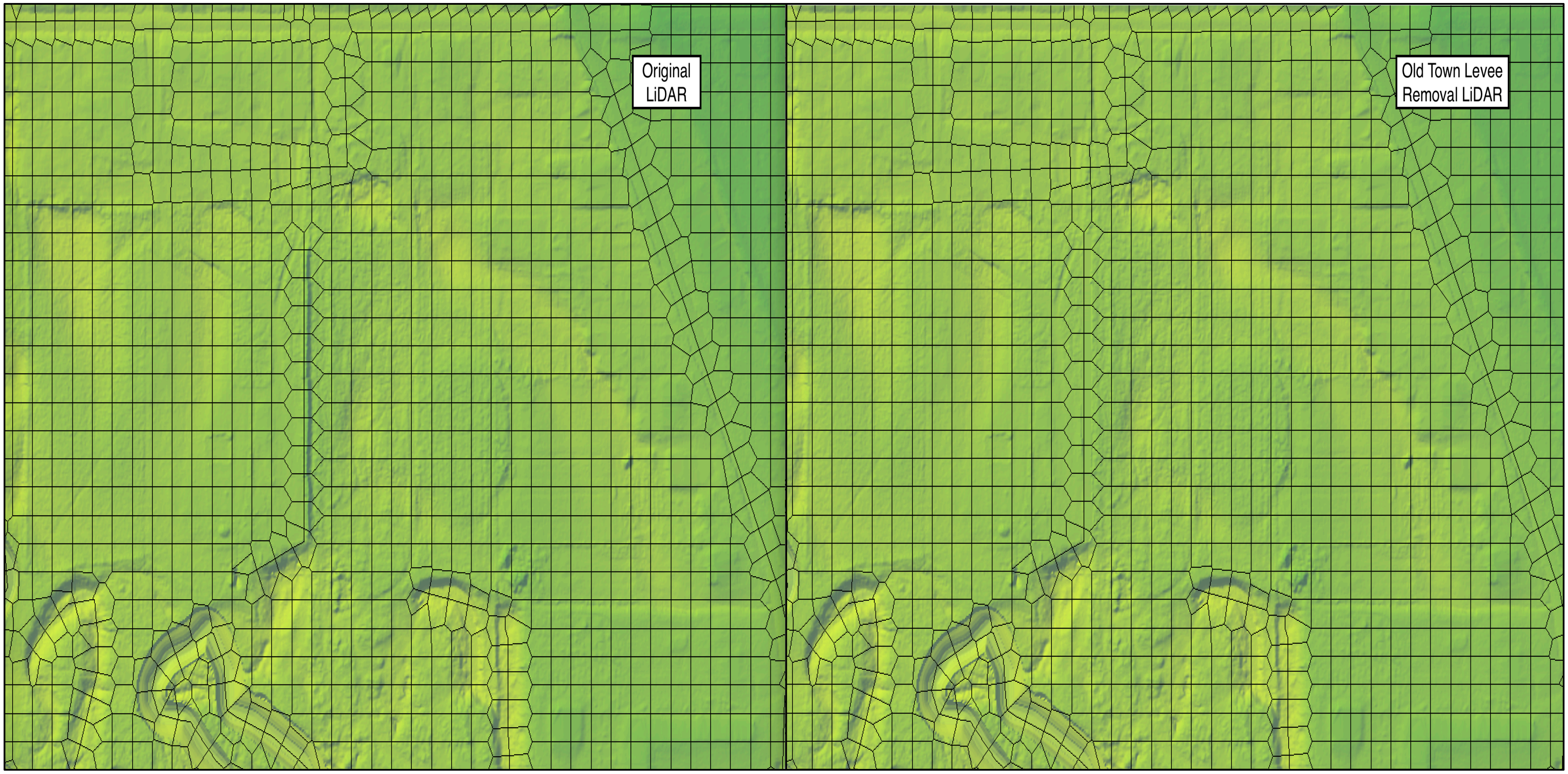

Figure 12. LiDAR comparison for Old Town Levee removal

HEC-RAS allows a user to view the computational outputs for each timestep in a movie format allowing the user to view changes in inundation area, velocity, and depth throughout a simulation. The 2009 event was examined near the Old Town Levee in order to assess the impacts the levee had on the surrounding area and verify the observations witnessed by the water resource district board member. It appears that the levee provides negligible benefit. Model simulations show that flow follows a natural low spot along both upstream and downstream of the Old Town Levee before the levee is actually inundated (**Figure 13**). The levee appears to impede flow during floods where the entire floodplain is inundated, thus blocking a portion of the overbank.

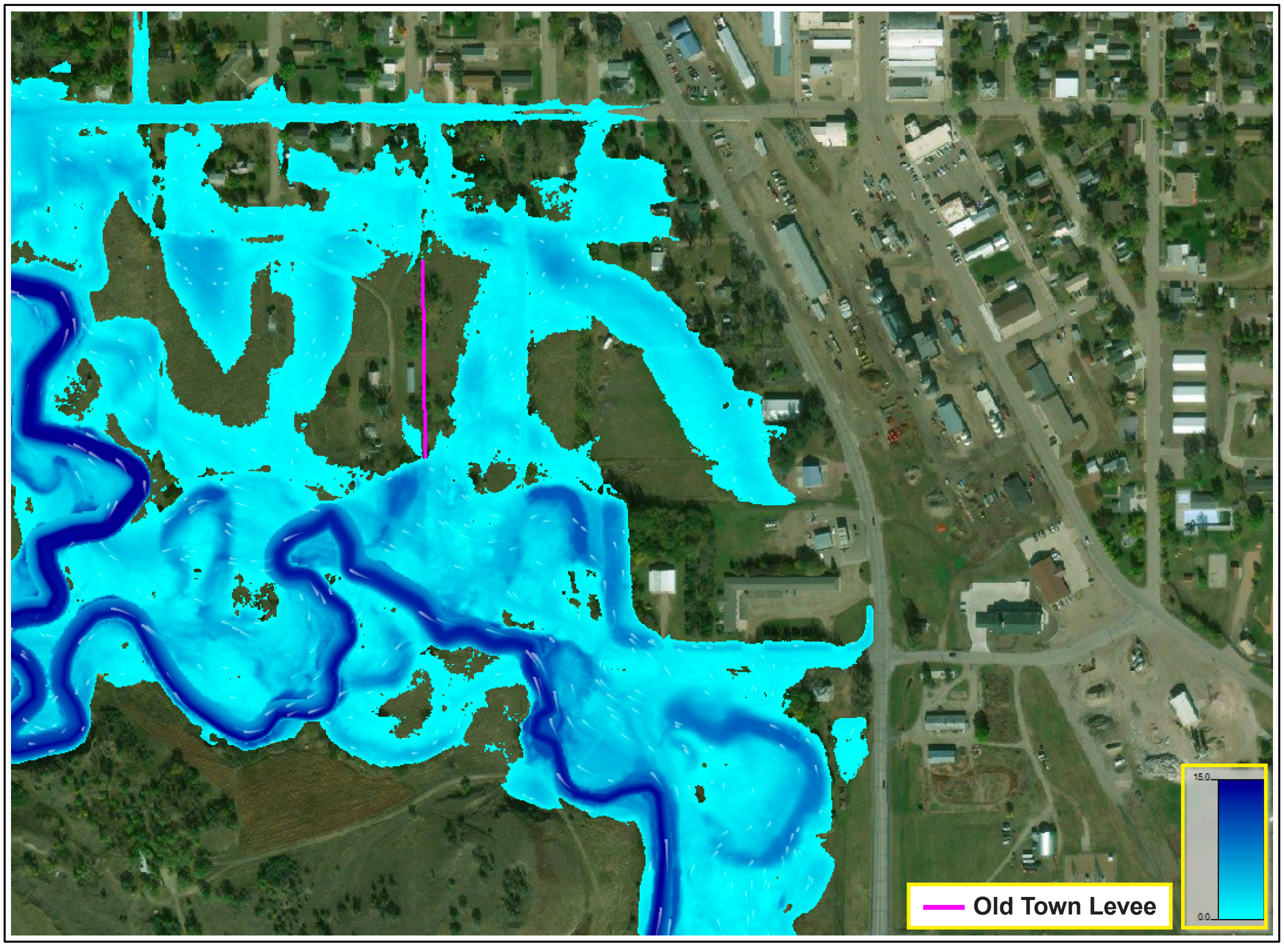

Figure 13. Old Town Levee lower flow path

The maximum water surface profile for the 2009 event for existing conditions and without the Old Town Levee were compared. **Figure 14** provides a comparison of the maximum water surface profile with and without the Old Town Levee. The water surface directly upstream of the levee only experienced a small drop in the water surface, less than 0.2 feet.

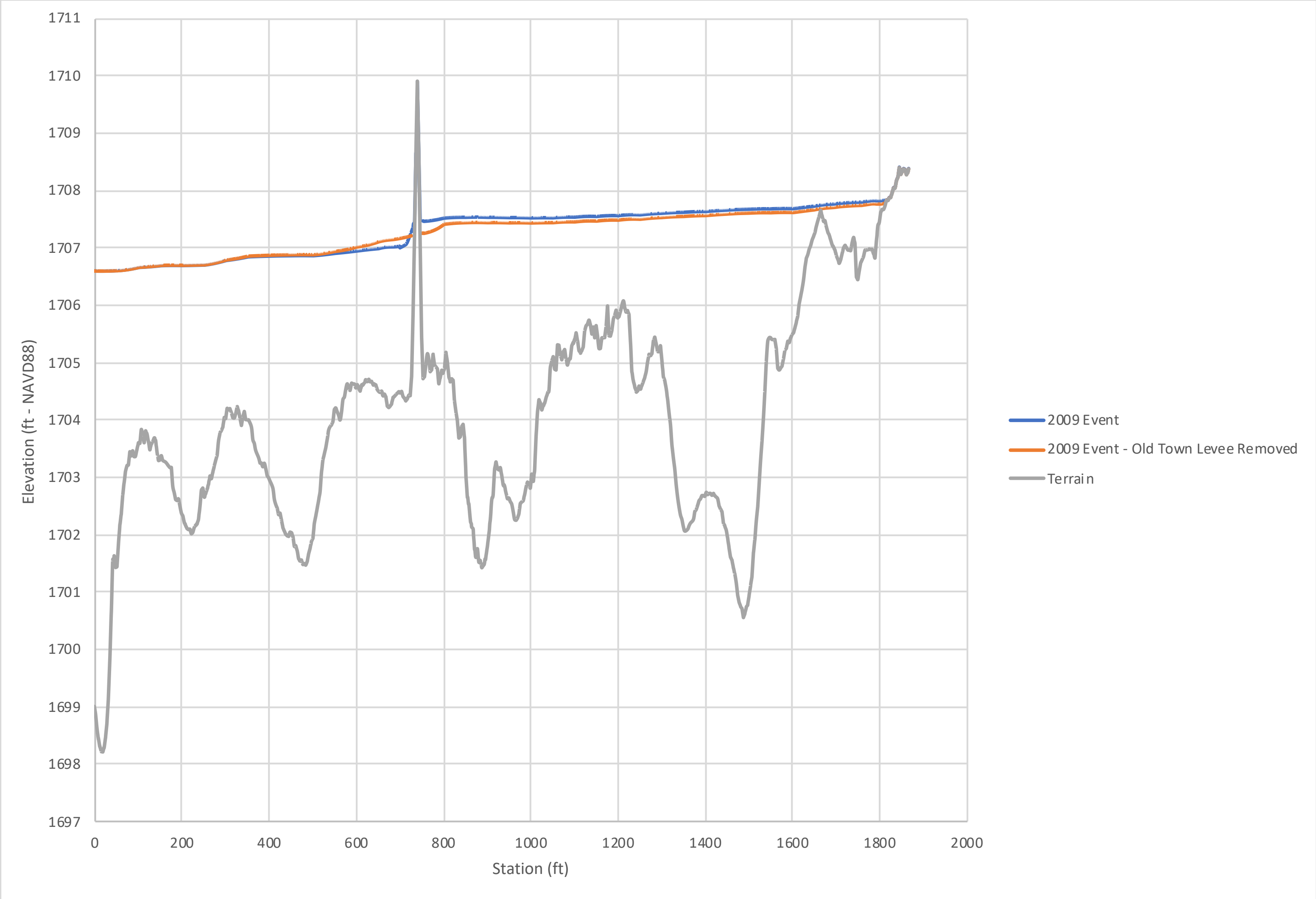

Figure 14. Maximum water surface comparison across the Old Town Levee

5. Temporary Emergency Levee Alternatives

As part of the Section 22 agreement, two alignments for temporary levee configuration were identified by the SWC because of interest from the City of Linton after the 2009 event. Temporary emergency levees were favorably viewed due to their lack of continuous maintenance. As part of emergency flood protection, temporary emergency levees require a permit from the Office of the State Engineer. A description of the permitting requirements for temporary flood measures is described in a letter from the North Dakota Office of the State Engineer (**Appendix E**).

Alternative 2 provides the most protection, but presents the most challenges with floodway restrictions, demolition of structures, and private property encroachment**.** Alternative 1 provides moderate protection and is more easily constructed. Both alternatives have limitations due to the space required to place the levees. Summaries for each option are provided in **Table 1**.

Each levee alternative was screened using the same criteria, listed below.

- 3-feet of freeboard for the 100-year event
- 10-foot top width
- 3-horizontal to 1-vertical side slopes
- Protect as many structures as possible
- No encroachment on the regulatory floodway

Temporary emergency levee alignments for the City of Linton were determined using 1-ft resolution aerial photography from the North Dakota Department of Emergency Services, 1-m resolution LiDAR, and a two-dimensional hydraulic model of Beaver Creek, which was created as part of this study (North Dakota State Water Commission, 2018). The levees were compared with quasi steady flow events to reduce model runtimes. The goal of the levee alignments was to protect as many structures as possible during the 100-year flood event, without encroachment into the Federal Emergency Management Agency's (FEMA) regulatory floodway. Many homes are within or near the regulatory floodway, and protection of these homes with a levee was infeasible. The 100-year flood event of 17,500 cfs, which was determined with the hydrology model produced for this study (North Dakota State Water Commission, 2016), was primarily used to evaluate the levee alignments. Additional flood events, from the 2-year to 500-year, were simulated for these alternatives, the results of which are located in **Appendix E**. **Figure 15** provides the alignments of Levee Alternatives 1 and 2 showing the coverage of their protection and their location relative to the regulatory floodway.

Table 1. Summary of temporary levee alternative alignments

Levee Name	Length, ft	HESCO Length, FT	Max Height, ft	Average Height, ft	Max Width, ft	Average Width ft	Volume, cy	Clearing and Grubbing, acres	Plastic Sheeting Area, SY	Approximate Homes/Businesses Protected	Non-Dwelling Structures Demolished	Potential Floodway Conflict	Constructability
Alignment 1	4,000	1,600	10.9	7.4	75	54	36,000	1.0	11,677	36	0	N	More Difficult
Alignment 2	8,180	1,600	12.4	6.7	84	50	66,000	1.0	21,984	51	2	N	Most Difficult

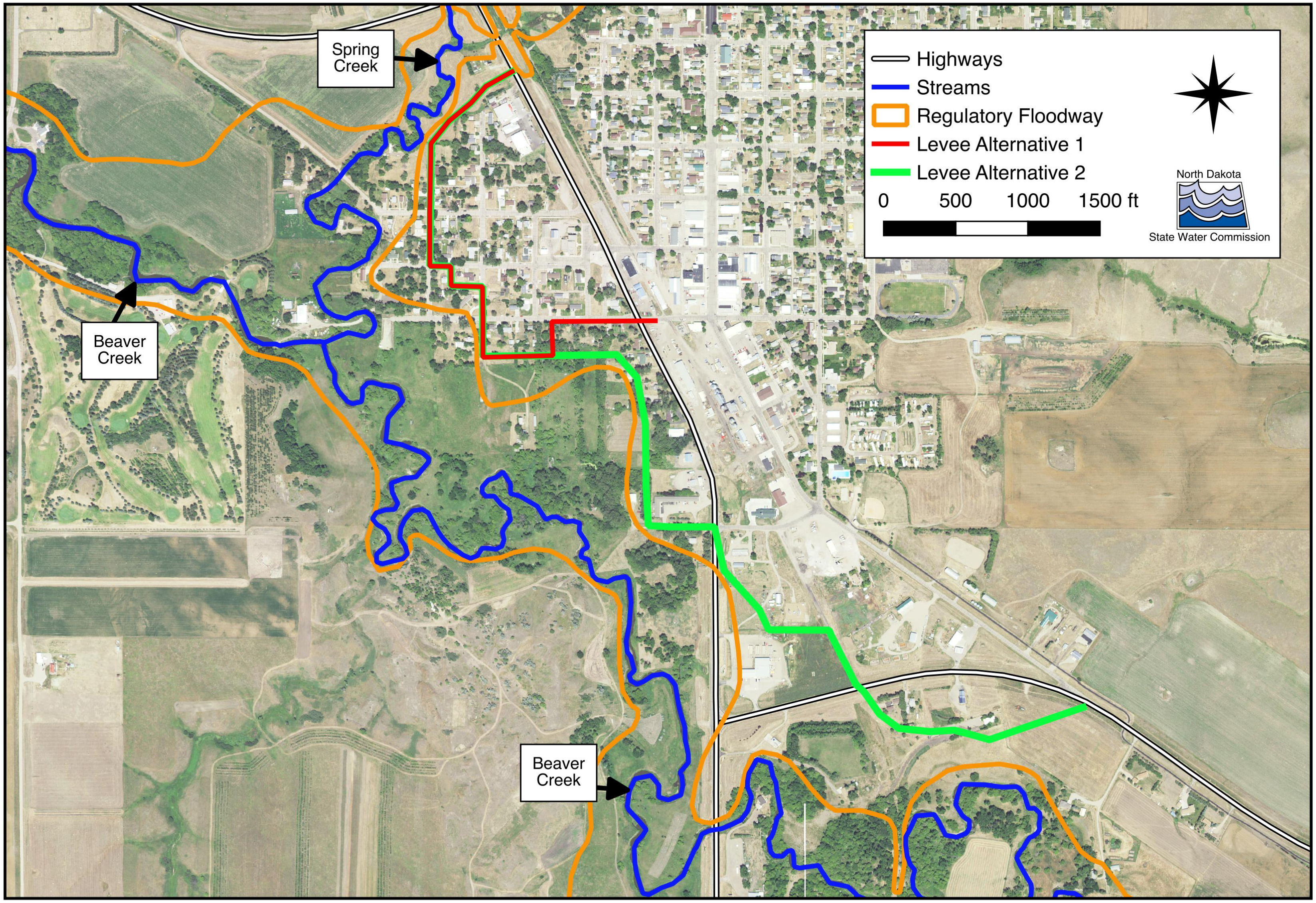

Figure 15. Levee Alternatives 1 and 2 alignments

5.1 Temporary Emergency Levee - Alternative 1

Temporary Emergency Levee Alternative 1 was designed for the 100-year event by creating a two-dimensional connection in the hydraulic model. The connection was arbitrarily raised along the alternative's alignment to show the impacts of increased water surfaces along the levee and allow the levee to be designed to the proper elevation. An offset line was digitized on the wet-side of the levee to develop the levee's profile and to evaluate various water surface profiles along the alignment, with the levee included. **Figure 16** illustrates the 100-year event inundation area for this alternative. Additional flood event inundation areas are provided in **Appendix E**.

Alternative 1 provides 100-year flood protection for the region incorporating Old Town. This alternative's footprint is substantial due to the depth of flooding that occurs in Old Town. Due to the physical constraints, building a levee to protect against events greater than the 100-year would require the buyout of additional homes, reducing the benefits received from the levee. **Figures 17** and **18** provide Alternative 1's footprint for a 100-year event. The figures also illustrate levee sections where the footprint could be reduced by including 3-foot HESCO barriers. **Figure 19** shows the water surface impacts created by Alternative 1. **Figure 20** illustrates the water surfaces along Alternative 1, with the zero-station located at the north tie-in to high ground and the 4050-station located at the south tie-in to high ground. The contributing drainage areas on the dry side of the levee and potential locations for internal drainage pumps are provided in **Appendix E**.

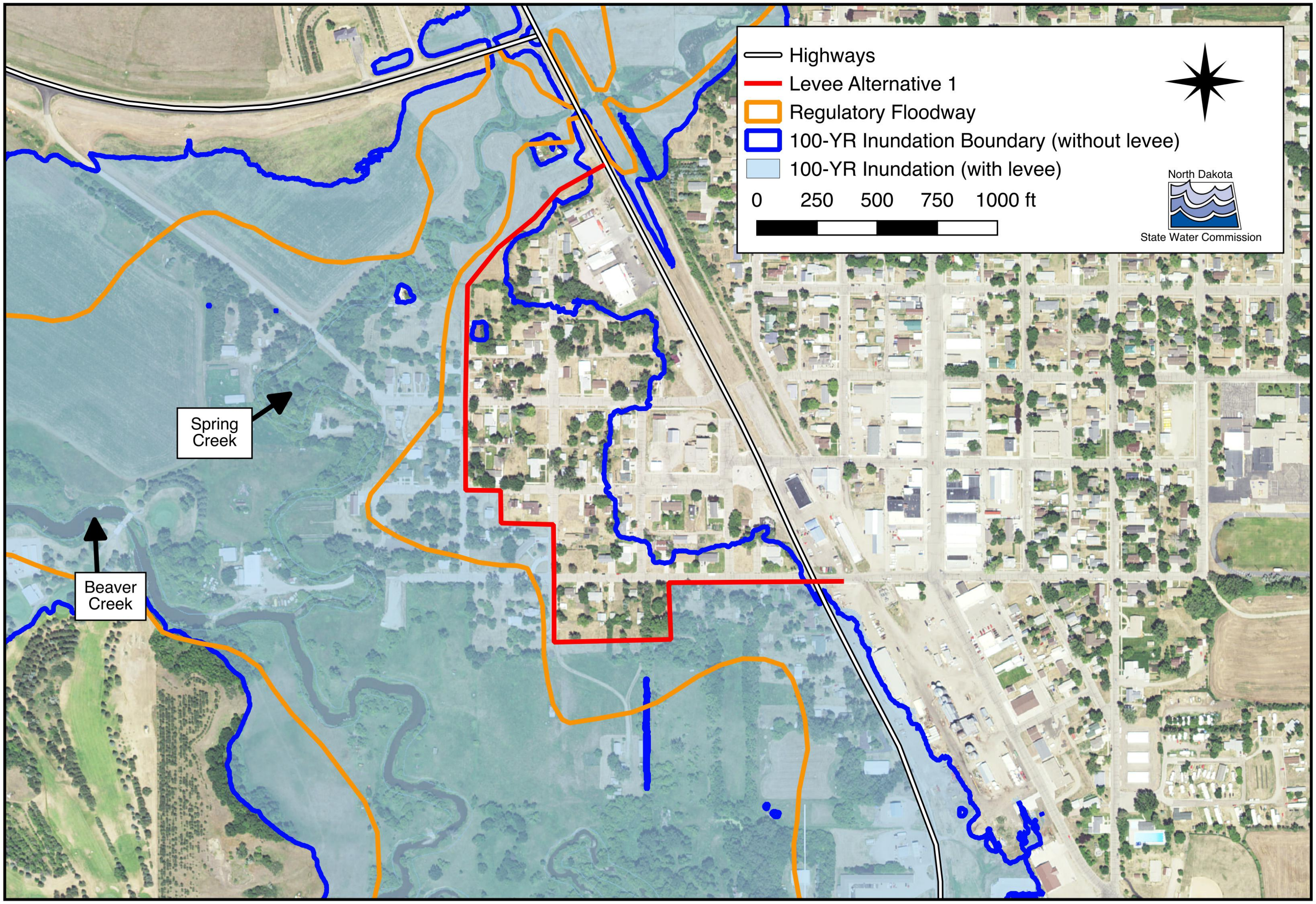

Figure 16. 100-year inundation area for Temporary Emergency Levee Alternative 1

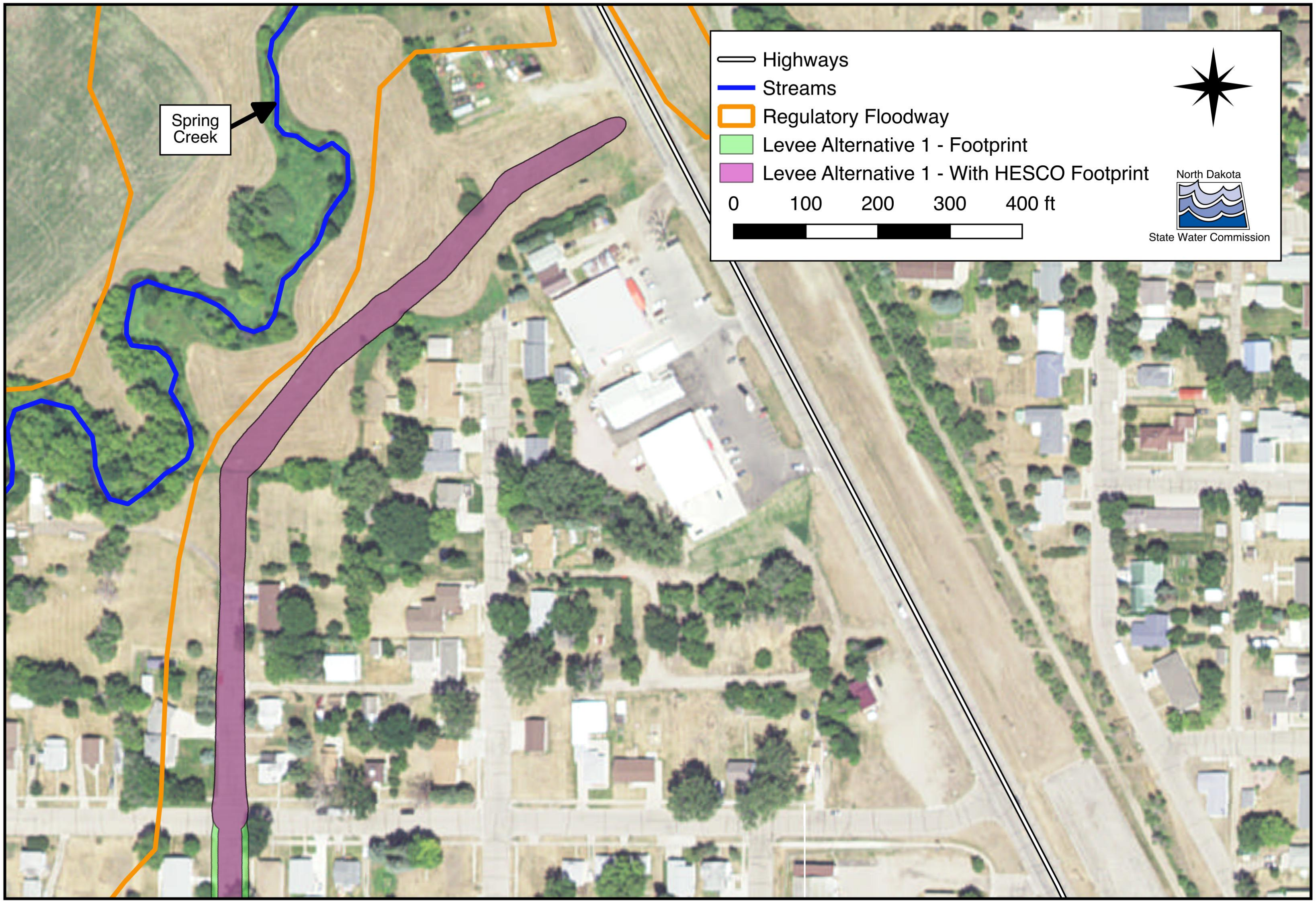

Figure 17. Temporary Emergency Levee Alternative 1 footprint - Map 1

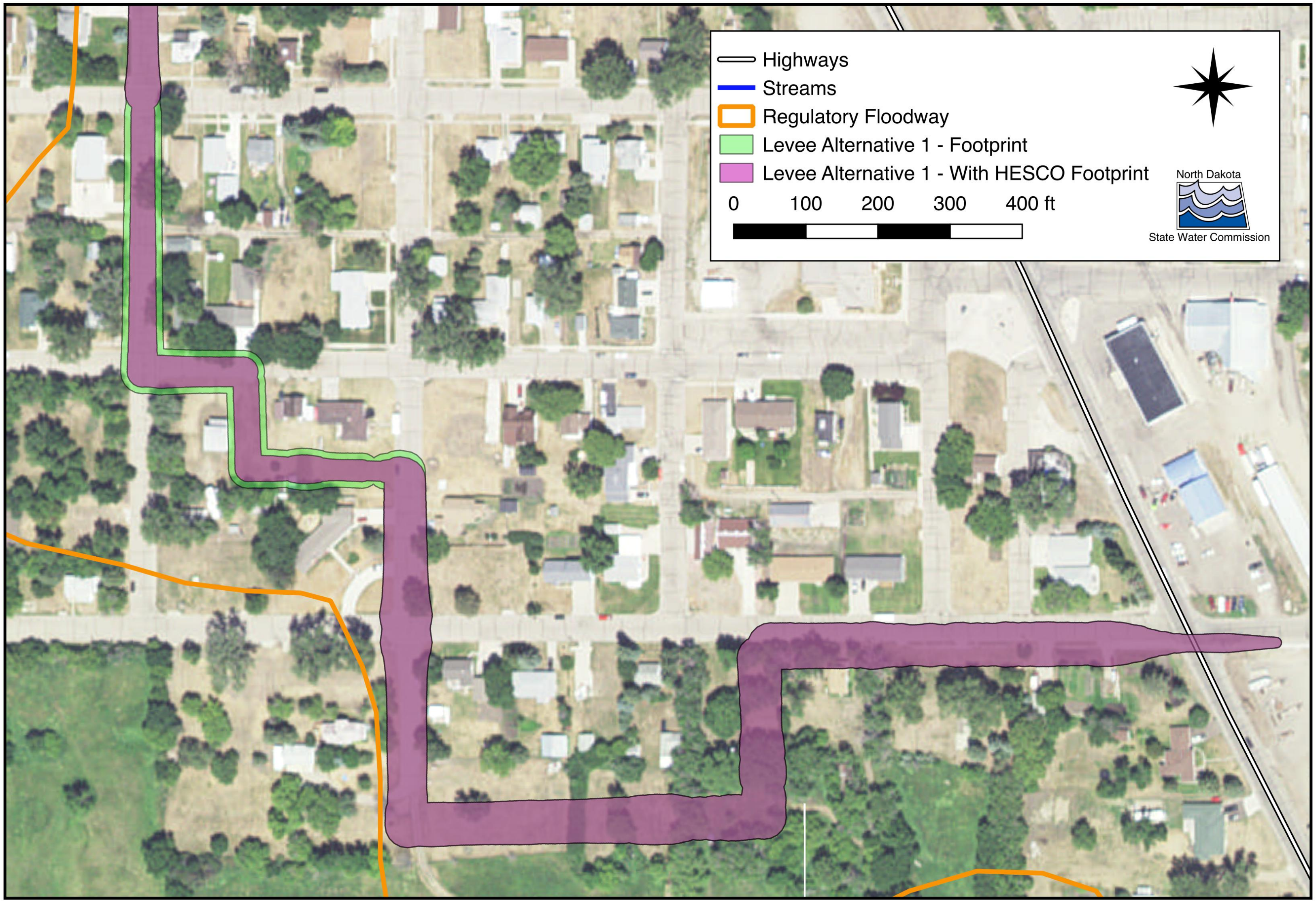

Figure 18. Temporary Emergency Levee Alternative 1 footprint - Map 2

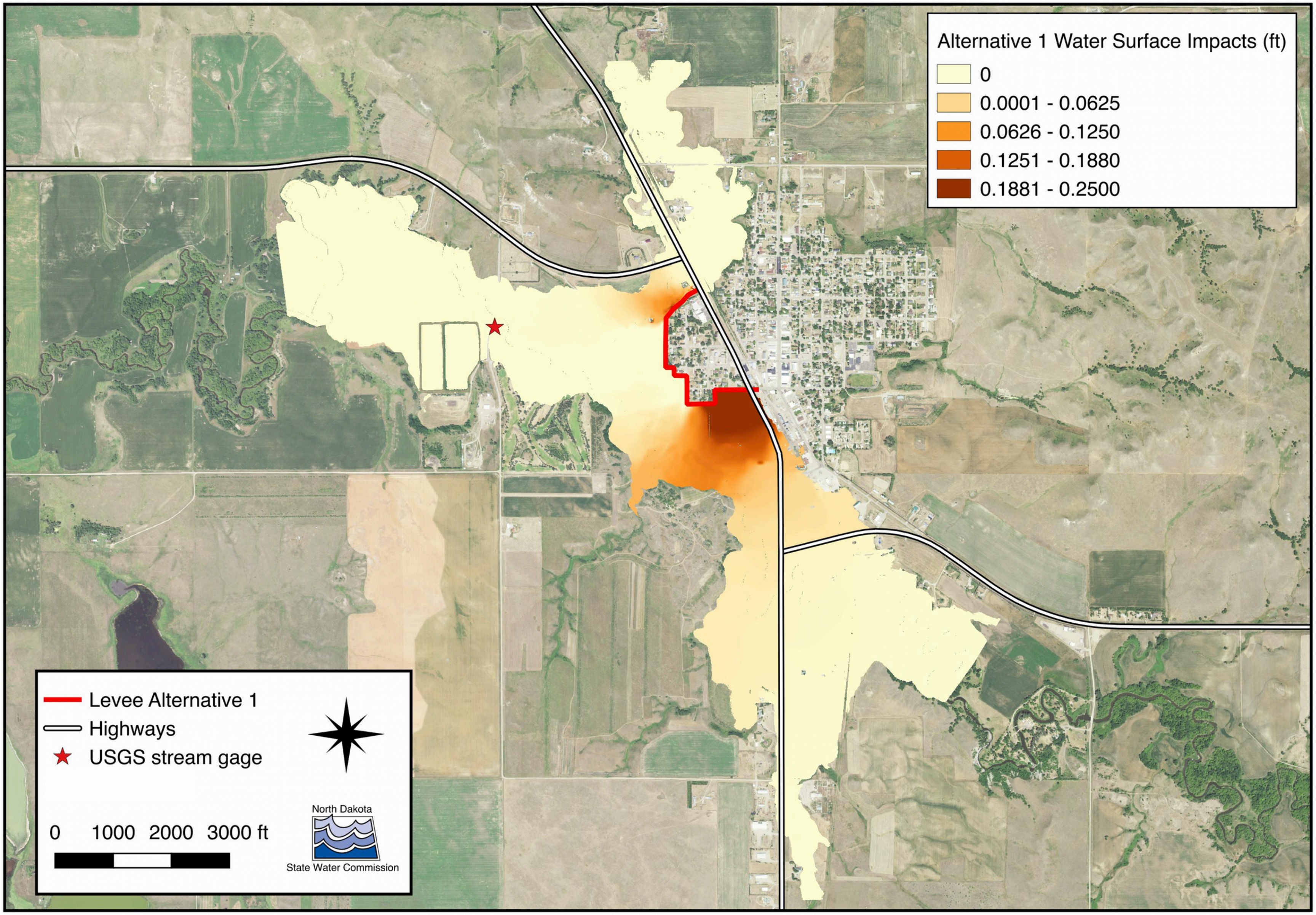

Figure 19. Temporary Emergency Levee Alternative 1 Water Surface Impacts

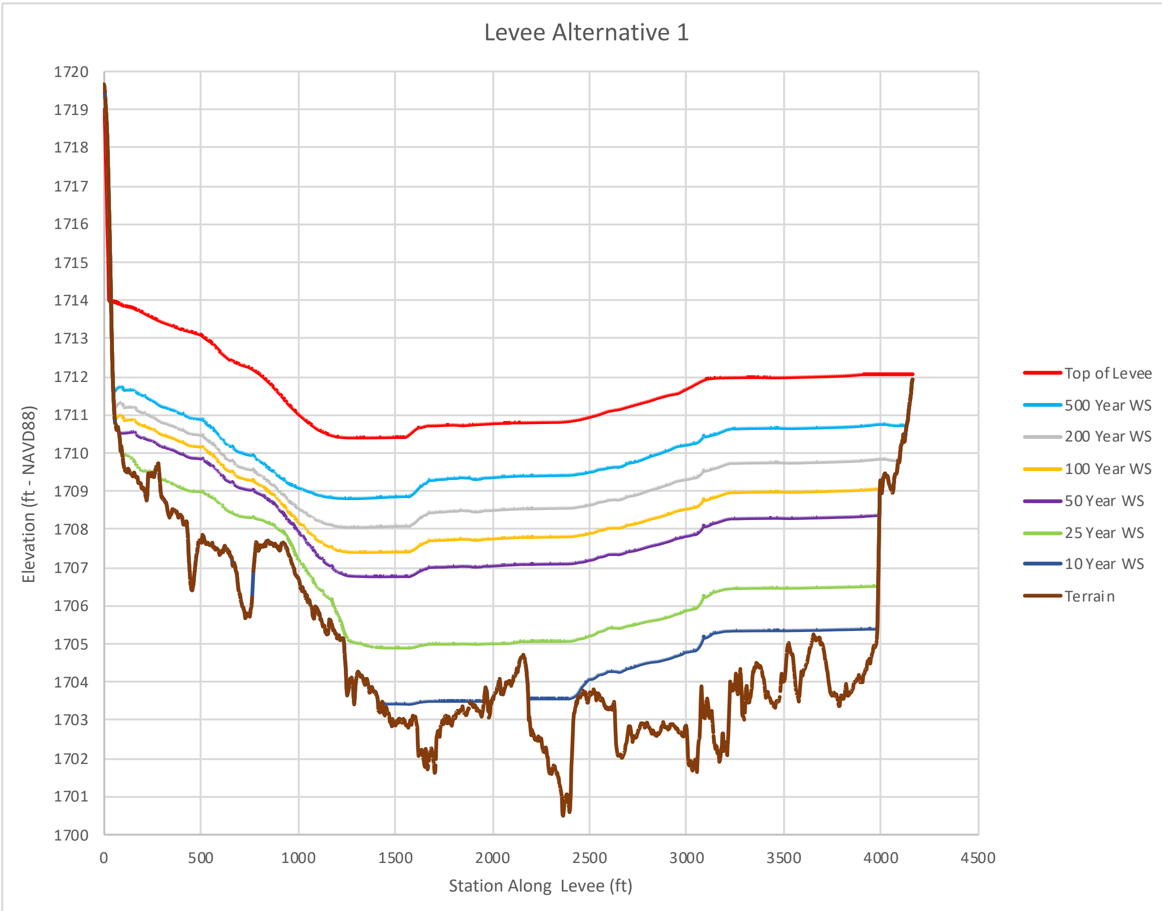

Figure 20. Water surface profiles along Temporary Emergency Levee Alternative 1

5.2 Temporary Emergency Levee – Alternative 2

Temporary Emergency Levee Alternative 2 was designed using the same methodology as Alternative 1. Alternative 2 is an extension of Alternative 1 and is meant to provide the greatest amount of protection for the community. **Figure 21** illustrates the 100-year event inundation area for Alternative 2. Additional flood event inundation areas are provided in **Appendix E**.

Alternative 2 provides 100-year flood protection for the region incorporating Old Town and the area near Highway 13. Alternative 2's footprint includes the same footprint as Alternative 1, which limits the amount of protection a levee can provide. Due to the physical constraints, building a levee to protect against events greater than the 100-year would require the buyout of additional homes, reducing the benefits received by the levee. **Figures 22** through **26** provide the footprint of Alternative 2 for a 100-year event. The figures also illustrate levee sections where the footprint could be reduced by including 3-foot HESCO barriers. **Figure 27** shows the water surface impacts created by Alternative 2. **Figure 28** illustrates the water surface profiles along Alternative 2, with the zero-station located at the north tie-in to high ground and the 8500-station located at the south tie-in to high ground. The contributing drainage areas on the dry side of the levee and potential locations for internal drainage pumps are provided in **Appendix E**.

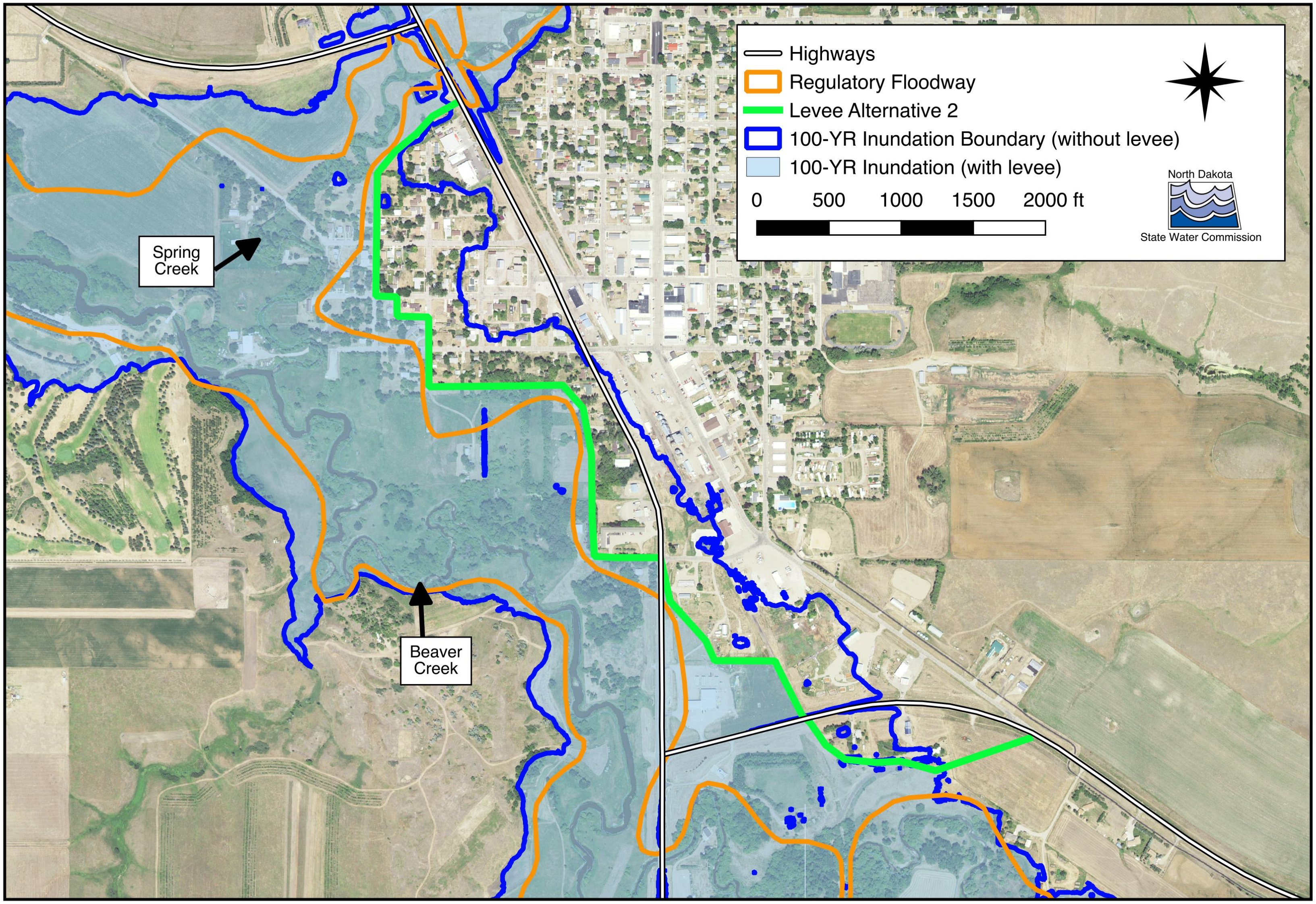

Figure 21. 100-year inundation area for Temporary Emergency Levee Alternative 2

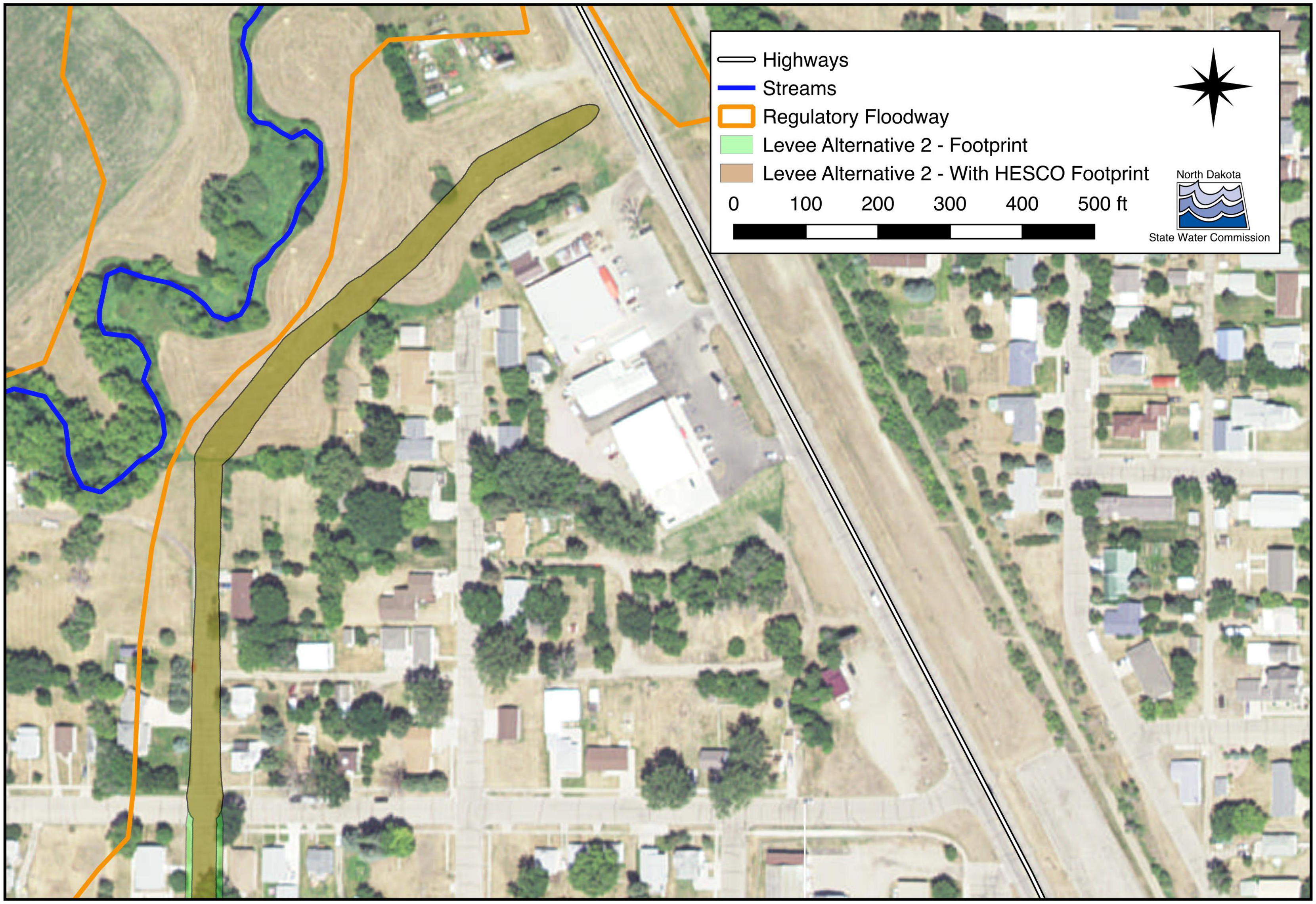

Figure 22. Temporary Emergency Levee Alternative 2 footprint - Map 1

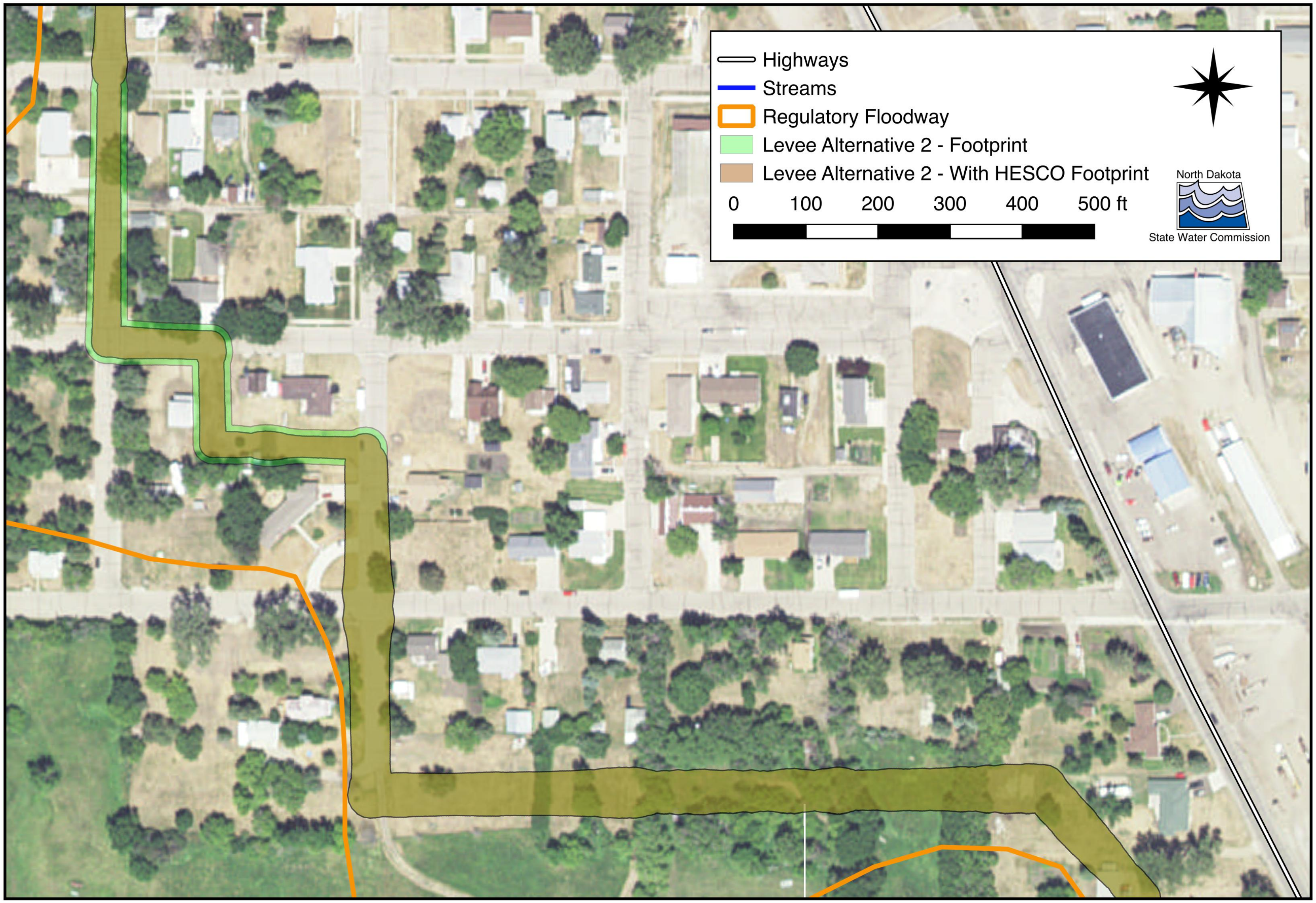

Figure 23. Temporary Emergency Levee Alternative 2 footprint - Map 2

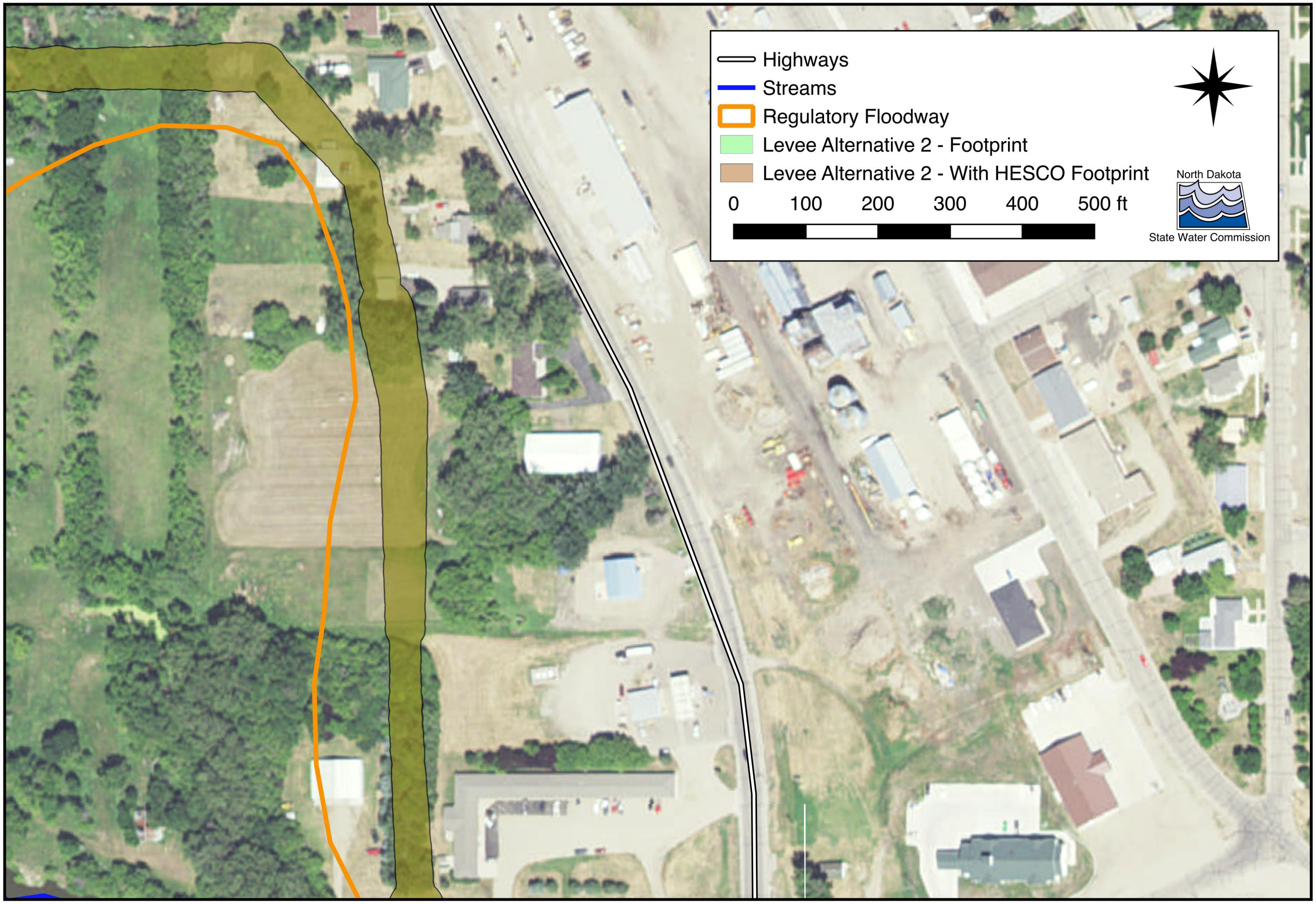

Figure 24. Temporary Emergency Levee Alternative 2 footprint - Map 3

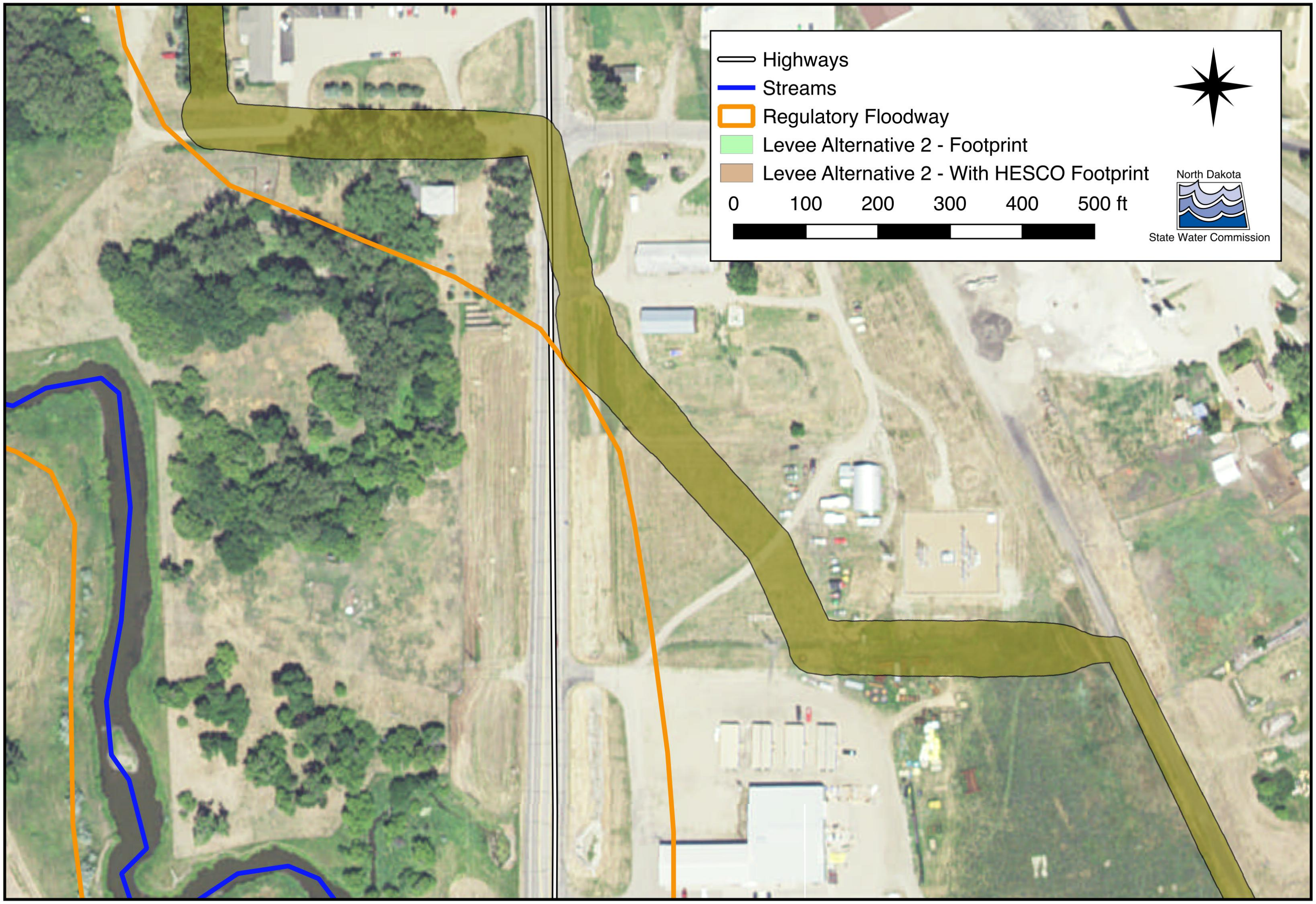

Figure 25. Temporary Emergency Levee Alternative 2 footprint - Map 4

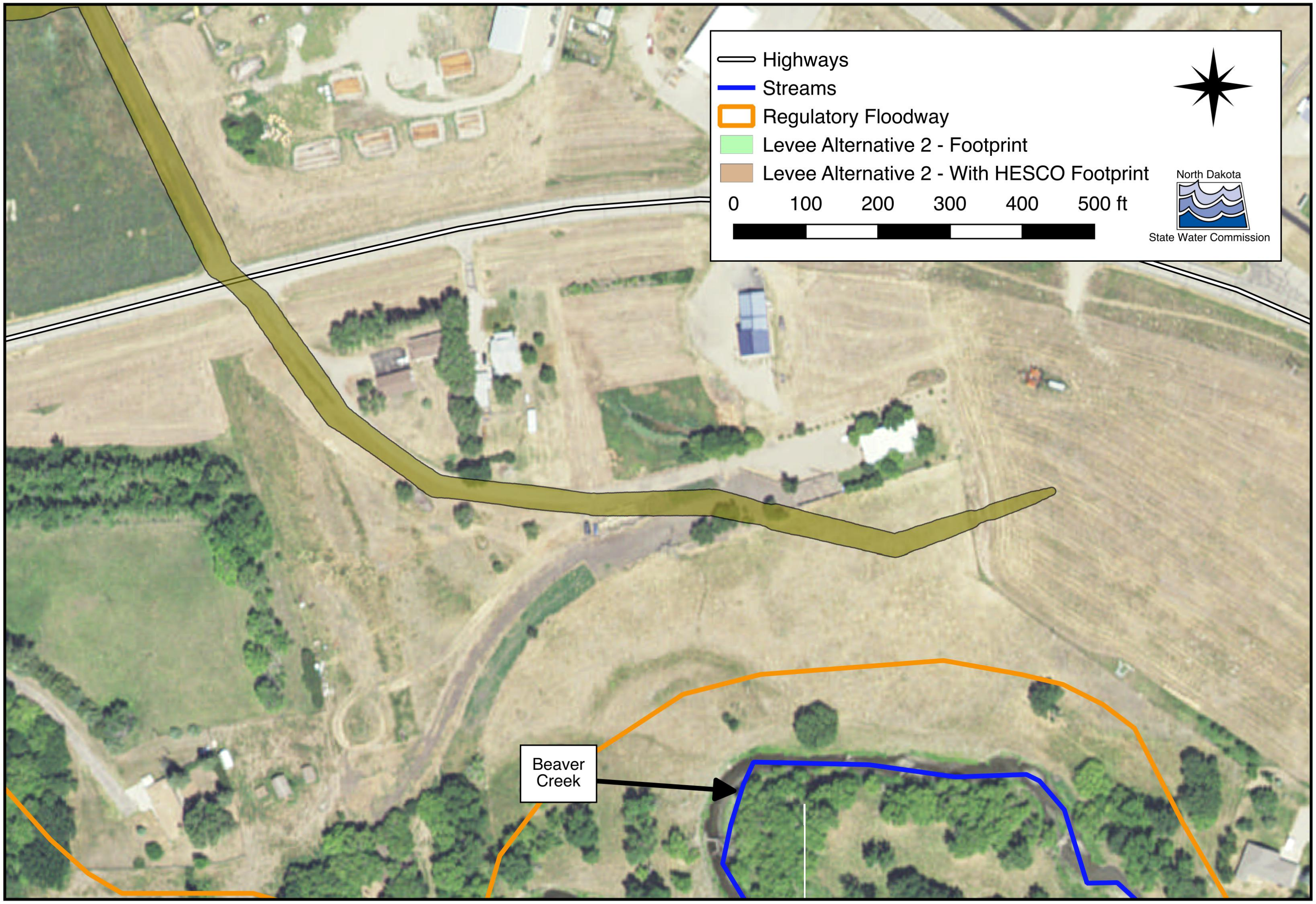

Figure 26. Temporary Emergency Levee Alternative 2 footprint - Map 5

North Dakota State Water Commission

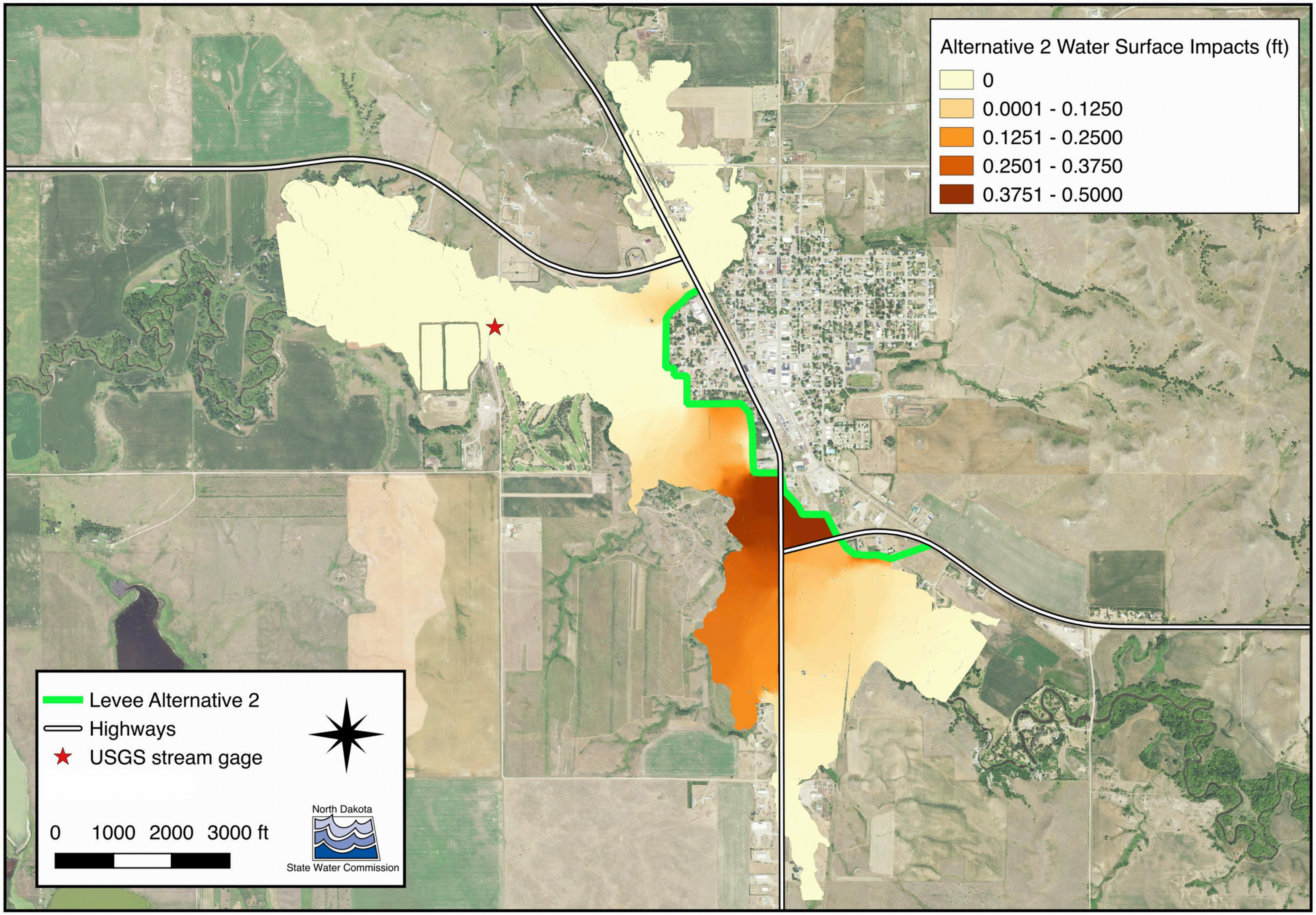

Figure 27. Temporary Emergency Levee Alternative 2 Water Surface Impacts

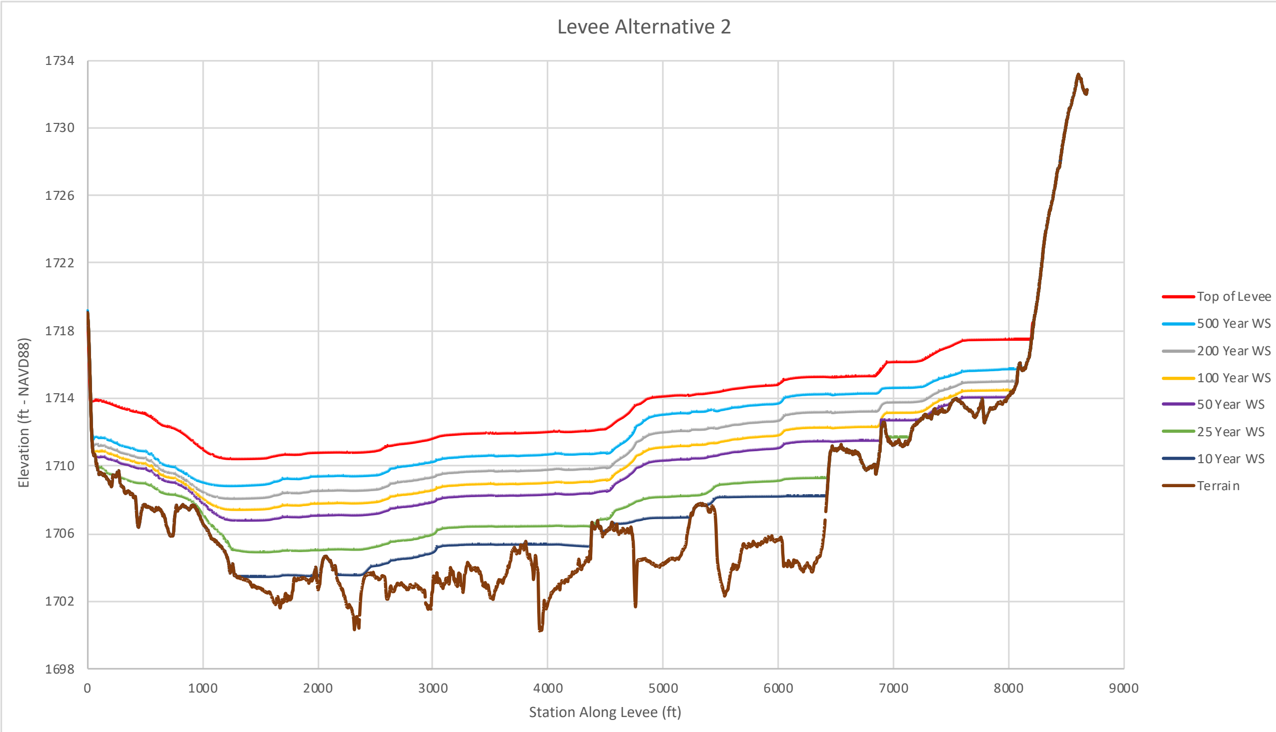

Figure 28. Water surface profiles along Temporary Emergency Levee Alternative 2

6. Summary

Alternatives for protecting the City of Linton from the impacts of Beaver Creek and Spring Creek flooding were evaluated as part of this study. Alternatives included two temporary emergency levee options, removal of bridges, and removal of the Old Town Levee. They were evaluated using the 2009 flood event and a series of synthetic flow events, created as part of this study (North Dakota State Water Commission, 2016).

This report provides preliminary options for the community and District to consider to reduce or prevent flood damage within the City of Linton. This is an interim report that will be used by the Omaha District to further screen and develop alternatives. A future report prepared by the Omaha District will detail the cost evaluation of these alternatives.

7. References

North Dakota State Water Commission, 2018. Linton - Beaver Creek Hydraulic Model Report, Emmons County, North Dakota.

North Dakota State Water Commission, 2016. Beaver Creek Hydrology Report, Emmons, Logan, and McIntosh Counties, North Dakota.