



**US Army Corps
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St. Paul District

FM Diversion Plan B River Stage 37' Impacts Appendix I

Fargo Moorhead Metropolitan Area
Flood Risk Management Project

Supplemental Environmental
Assessment Document

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FM Diversion Plan B- River Stage 37’ Impacts

To: FM Diversion Task Order 27
From: Houston-Moore Group
Subject: FM Diversion Plan B River Stage 37’ Impacts
Date: July 13, 2018
Project: 7438-0028

INTRODUCTION

One of the major changes for Plan B versus the Pre-Task Force alignment included passing a flow through the Fargo-Moorhead urban area (Flow Through Town) that results in a river stage (RS) 37’ at the USGS Fargo stream gage during the 1-percent annual chance (100-year) flood event. The Pre-Task Force project included passing a Flow Through Town that results in RS35’ during the 100-year flood event. It should also be noted that the Plan B changes also utilize the full period of Record Hydrology (100-year discharge = 33,000 cfs) vs. the wet (EOE) period of record hydrology (100-year discharge = 34,700 cfs), which was utilized for the Pre-Task Force project. Table 1 summarizes the resultant 100-year peak discharge and corresponding existing conditions frequency of this peak discharge for both the Pre-Task Force and Plan B Projects.

Table 1 – Residual Peak 100-year Flood Stage, Discharge, and Approximate Existing Frequency

Residual 100-year Flood Stage	Residual 100-year Peak Discharge	Approximate Existing Conditions Frequency (POR Hydrology)
RS35’ (Pre-Task Force)	17,000 cfs	10-year
RS37’ (Plan B)	21,000 cfs	20-year

This document summarizes the additional impacts and measures that will need to be implemented within the flood damage reduction area to accommodate a Flow Through Town that produces RS37’ during the 100-year flood event. The primary areas covered in the technical memorandum include:

- Changes to Residual Floodplain
- Impacts to Structures
- Required Flood Mitigation Measures
- Transportation Mitigation Measures

ANALYSIS

Changes to Residual Floodplain:

Increasing the Flow Through Town from RS35’ to RS37’ during the 100-year flood event increases the residual floodplain within the flood damage reduction area. Figures 1/1.1/1.2 show the residual floodplain for RS37’ with

the project in operation based on the Plan B alignment for the dam/southern embankment. The residual floodplain acreage for RS37' for the 100-year flood event is summarized in Table 2.

Table 2 – Residual Floodplain Acreage for RS37'

Residual 100-year Flood Stage	Residual 100-year Floodplain within the Flood Damage Reduction Area (Acres)
RS37' (Plan B)	24,173

Impacts to Structures:

Increasing the Flow Through Town from RS35' to RS37' during the 100-year flood event increases the impacts (through a reduction in benefits) to residential and non-residential structures within the flood damage reduction area. Figures 1/1.1/1.2 show the residual floodplain and impacted residential and non-residential structures for RS37' with the project in operation based on the Plan B alignment for the dam/southern embankment. These structures see a benefit over existing conditions with Plan B and mitigation for the impacted residential and non-residential structures for RS37' is not planned, unless the structures fall within the Flood Mitigation Measures discussed below. The residential and non-residential structure impacts for the 100-year flood event are summarized in Table 3.

Table 3 – Residential and Non-Residential Structure Impacts for RS37'

Residual 100-year Flood Stage	Residential Structures Impacted	Non-Residential Structures Impacted
RS37' (Plan B)	27	196

A number of property acquisitions are required to implement the Flood Mitigation Measures described below based on a Flow Through Town of RS37'. All property acquisitions will follow the federal and/or state acquisition process. Table 4 summarizes the estimated property acquisition costs for RS37' and Figures 3.1/3.2 highlight the property acquisitions.

Table 4 – Property Acquisition Costs for RS37'

City of Fargo Property Acquisitions	Number of Properties	Estimated Cost (Acquisition, plus Demo)
Total City of Fargo	42	\$ 26,900,000
City of Moorhead Property Acquisitions	Number of Properties	Estimated Cost (Acquisition, plus Demo)
Total City of Moorhead	69	\$ 25,800,000

Required Flood Mitigation Measures:

Several flood mitigation measures will be required to accommodate RS37'. These have been broken down into 2 categories as follows:

- Category 1 Measures – USACE Federal Project - These are flood protection measures that were required for RS35' and are part of the Federal Project for the FM Diversion. These measures have already been designed and constructed, with the exception of the 2nd Street South Closure and Pump Station being constructed under FM Diversion Authority Work Package 42E, and do not require modification to accommodate RS37' since they are designed to be certifiable to the current FEMA 100-year floodplain (RS39.3'). Funding for the design and construction of these measures has primarily been through state and local sources, with the exception of the Ridgewood/VA Levee and Floodwall and the 4th Street Levee, which also were constructed with federal funding.
- Category 2 Measures – Planned or Constructed Projects– These are flood protection measures that have been or are being designed and constructed by the Cities of Fargo and Moorhead using state and local funding. These flood protection measures address areas with ground elevations below the minimum freeboard height (RS37' plus 2.5 feet). The Category 2 measures have been divided into two subcategories. The Category 2a measures are those that have been completed. The Category 2a measures do not require modification to accommodate RS37' since they are designed to be certifiable to the current FEMA 100-year floodplain (RS39.3'). The Category 2b measures are measures that are planned or in progress. The schedule for completion of these measures is dependent on the availability of funding.

In addition to the flood mitigation projects consisting of levees and floodwalls, a number of stormwater lift stations in the cities of Fargo and Moorhead will require improvements to accommodate RS37'. Additional detail on the flood mitigation measures and the lift station improvements are discussed below.

Category 1 Measures – USACE Federal Project:

As noted above, these are flood protection measures that were required for RS35' and are part of the Federal Project for the FM Diversion. These measures have already been designed and constructed, with the exception of the 2nd Street South Closure and Pump Station being constructed under FM Diversion Authority Work Package 42E, which has not been constructed. The Category 1 measures do not require modification to accommodate RS37' since they are designed to be certifiable to the current FEMA 100-year floodplain (RS39.3'). The Category 1 measures include the following project areas that are highlighted in Figures 1/1.1/1.2.

- Ridgewood/VA Levee and Floodwall (City of Fargo)
- El Zagal Levee/Floodwall (City of Fargo)
- Mickelson Field Project (City of Fargo)
- 2nd Street/Downtown Levee/Floodwall Project (City of Fargo)
- 4th Street Levee and Floodwall (City of Fargo)
- Moorhead Country Club Project F1 Levee and Floodwall (City of Moorhead)
- Woodlawn Area Levee (City of Moorhead)

- Horn Park Area Levee and Floodwall (City of Moorhead)

Table 5 includes the remaining costs to implement the Category 1 Measures.

Table 5 – Category 1 Measures – USACE Federal Project

City of Fargo Category 1 Measures	Estimated Construction Costs
Work Package 42E – 2 nd Street South Closure and Pump Station	\$ 9,000,000

Category 2 Measures – Planned or Constructed:

As noted above, these are flood protection measures that have been or are being designed and constructed by the Cities of Fargo and Moorhead using state and local funding. These flood protection measures address areas with ground elevations below the minimum freeboard height (RS37' plus 2.5 feet). The Category 2 measures have been divided into 2 subcategories. The Category 2a measures are those that have been completed. The Category 2a measures do not require modification to accommodate RS37' since they are designed to be certifiable to the current FEMA 100-year floodplain (RS39.3'). The Category 2b measures are measures that are planned or in progress. The schedule for completion of these measures is dependent on the availability of funding.

The Category 2a Measures are highlighted in Figures 1/1.1/1.2 and are listed below. Since these measures are already complete, costs for them have not been included.

North Dakota/City of Fargo:

- North Oaks
- Fargo Country Club/Southwood
- Lemke Park
- Harwood, Hackberry, and River Drive
- University Drive South
- South Acres Addition
- River Vili
- Rose Creek
- Oakcreek
- Coulees Crossing
- Timberline
- Meadow Creek
- Drain 27 (40th Ave to I-29 areas)
- Drain 27 (I-29 to 42nd St. areas)
- Drain 27 (South of 52nd Ave. S.)
- Drain 53 (South of 52nd Ave. S.)
- Drain 53 (South of 64th Ave)

Minnesota/City of Moorhead:

- 27th Ave. N. Levee Phase 1 and 2
- River Haven Road
- Caddy/18th Ave N Area Levee
- Hjemkomst Area Levee
- Brookdale Levee
- I-94 Right-of-Way Floodwall and Levee
- Public Works Yard Levee
- The Saddle – Phase 1 and 2
- 2900 Block of Rivershore Drive Levee
- Davy Park Levee
- Public Housing High Rise – North, South, and Middle Levees
- 7th Street South Levee
- Bridgeview Levee – Phase 1
- 15th Ave North/St. Francis De Sales Levee and Road Raise
- Bluestem Levee
- Rivers Edge Levee
- Rivershore Drive Floodwall and Road Closure Structure
- River Oak Circle
- 43rd Ave N Road Raise
- Project A Levee
- Project B
- Project C
- 50th Ave S. Levee – South, NW, and NE Levees
- Tessa Terrace
- Project D and E
- Elm Street: 600 Block
- 2nd Ave S Flood Mitigation
- 7th St N Cul-De-Sac Road Raise
- Oakport Protection

The Category 2b Measures, which are those that are planned or in progress, are highlighted in Figures 4.1/4.2 and 5. Opinions of probable cost were prepared for the Category 2b Measures and are summarized in Table 6.

Table 6 – Category 2b Measures – Planned Non-USACE Costs

City of Fargo Category 2 Measures	Estimated Construction Cost
Drain 27 inlet culvert replacement	\$ 150,000
North Side Protection – Drain 10	\$ 9,830,000
Royal Oaks Levee	\$ 630,000
Elm Circle	\$ 160,000
Riverwood	\$ 90,000

Woodcrest	\$ 3,000,000
Oak Grove	\$ 440,000
I-29 Ditch	\$ 390,000
Oakcreek, Copperfield Court	\$ 1,820,000
Belmont	\$ 10,390,000
Harwood, Hackberry, River Drive gaps	\$ 500,000
64 th Ave Borrow Pit/Bison Meadows	\$ 1,200,000
Rosewood	\$ 4,000,000
Total City of Fargo	\$ 32,600,000
City of Moorhead Category 2b Measures	
Estimated Construction Cost	
North Moorhead	\$ 6,000,000
Moorhead Center Mall Sanitary Lift Station #2	\$ 1,000,000
1 st Avenue North Levee	\$ 1,020,000
Riverview Circle	\$ 650,000
Total City of Moorhead	\$ 8,670,000
Total Category 2b Measures	\$ 41,270,000

Stormwater Lift Station Improvements:

As noted above, a number of stormwater lift stations in the cities of Fargo and Moorhead will require improvements or replacement to accommodate RS37'. These stormwater lift stations are highlighted in Figures 6 and 7. Opinions of probable cost were prepared for the Stormwater Lift Station Improvements and are summarized in Table 7.

Table 7 – Stormwater Lift Station Improvements

City of Fargo Structure Replacement	Estimated Construction Cost
COF Lift Station 11	\$ 1,100,000
COF Lift Station 15	\$ 2,860,000
COF Lift Station 24	\$ 3,600,000
COF Lift Station 27	\$ 3,550,000
COF Lift Station 39	\$ 6,550,000
COF Lift Station 40	\$ 1,200,000
COF Lift Station 41	\$ 2,500,000
COF Lift Station 42	\$ 2,450,000
COF Lift Station 47	\$ 2,550,000
COF Lift Station 48	\$ 2,550,000
COF Lift Station 53	\$ 4,910,000
COF Lift Station 55	\$ 2,720,000
COF Lift Station 56	\$ 2,500,000

COF Lift Station 57	\$ 1,300,000
COF Lift Station 58	\$ 1,500,000
COF Lift Station 66	\$ 1,300,000
COF Lift Station 67	\$ 1,600,000
COF Lift Station 68	\$ 1,600,000
Total City of Fargo	\$ 46,340,000
City of Moorhead Structure Modification	Estimated Construction Cost
Moorhead Storm Structure FC 7	\$ 150,000
Moorhead Storm Structure FC 8	\$ 150,000
Moorhead Storm Structure FC 9	\$ 150,000
Moorhead Storm Structure FC 10	\$ 150,000
Moorhead Storm Structure FC 11	\$ 150,000
Moorhead Storm Structure FC 13	\$ 150,000
Moorhead Storm Structure FC 14	\$ 150,000
Moorhead Storm Structure FC 15	\$ 150,000
Moorhead Storm Structure FC 16	\$ 150,000
Moorhead Storm Structure GS24	\$ 200,000
Moorhead Storm Structure GS 47	\$ 150,000
Total City of Moorhead	\$ 1,700,000
Total Stormwater Lift Station Improvements	\$ 48,040,000

Transportation Mitigation Measures:

Increasing the Flow Through Town from RS35' to RS37' during the 100-year flood event increases the impacts to the transportation system within the flood damage reduction area. To quantify the impacts and required mitigation, the transportation impacts were reviewed for RS37' and areas for potential grade raises were identified to maintain access in key areas. Figure 2 shows required road raises for RS37' with the project in operation based on the Plan B alignment for the dam/southern embankment. The length of roadway that will require grade raises is summarized in Table 8.

Table 8 – Required Transportation Improvements for RS37'

Residual 100-year Flood Stage	Road Raises within the Flood Damage Reduction Area
RS37' (Plan B)	8.4 miles

When evaluating the road raises, areas where water inundated the driving lane (12' from centerline of roadway) were considered impacted and were raised to prevent future inundation when river levels through the FM area are at RS37'. The horizontal and vertical geometrics were designed to meet 55 mph unless existing site conditions dictated a lesser design speed. In North Dakota, sag vertical curves were evaluated based on

comfort criteria and crest vertical curves were designed to satisfy stopping sight distance. Minnesota vertical curvature meets requirements published by MnDOT for County State Aid Highways.

Approximately 4.4 miles of roadway were identified for improvement in North Dakota at RS37', with a maximum grade raise height of 1.5'. While in Minnesota, approximately 4.0 miles of roadway were identified to be impacted at RS37' with a maximum grade raise height of approximately 4'. For estimating purposes, a 6" hot mix asphalt pavement on 12" aggregate base was utilized on all existing paved sections. For the existing gravel roadways, a 6" aggregate section was utilized for estimating purposes. Table 9 includes a summary of costs for transportation improvements associated with RS37'.

Table 9 – Transportation Improvement Costs for RS37'

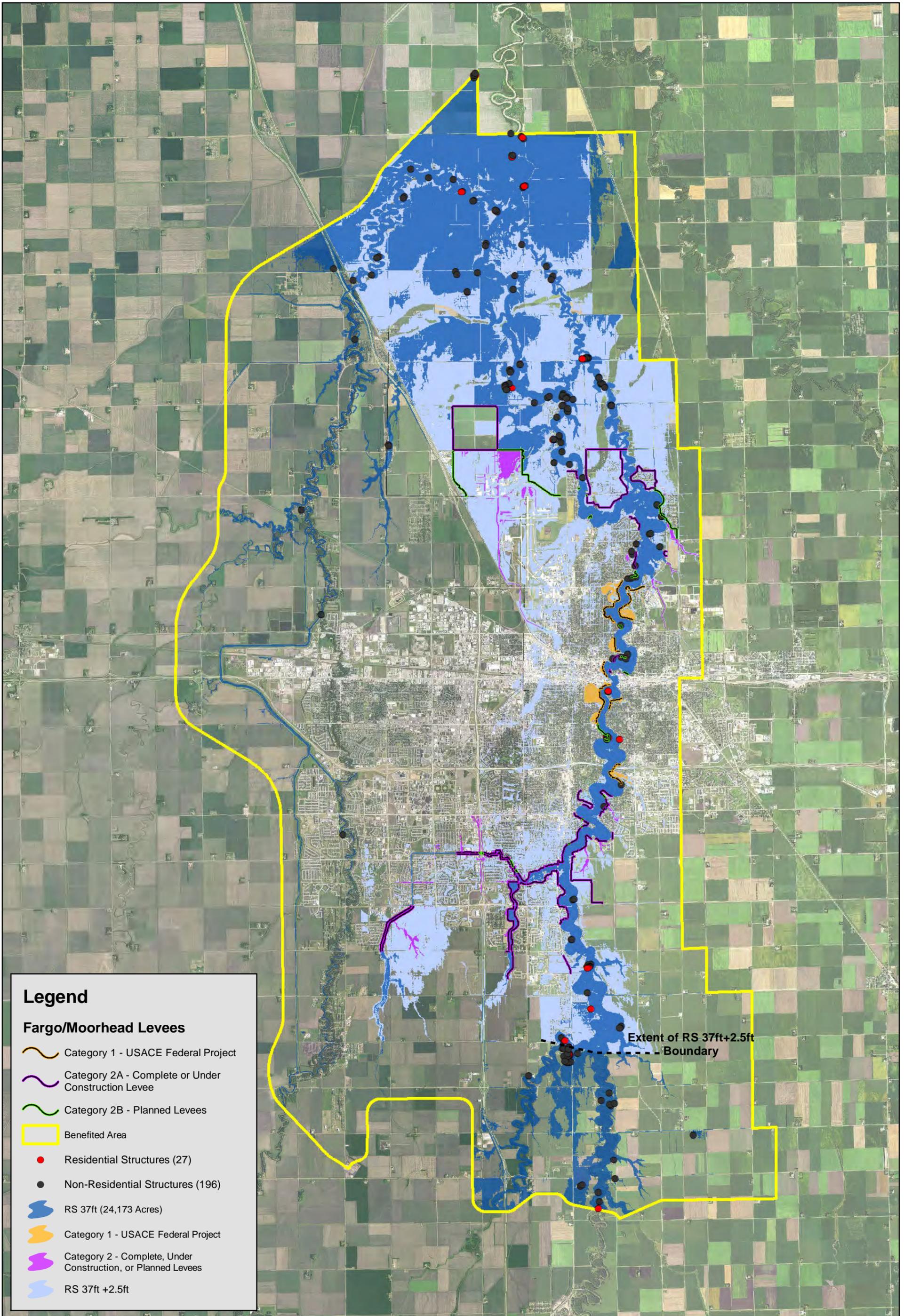
ND Roadway/Segment	RS37' Estimated Construction Cost
ND I-29 SB Exit Ramp (CR 16)	\$128,000
ND County Road 22	\$936,000
ND County Road 31, South Segment	\$258,000
ND County Road 31, South Center Segment	\$84,000
ND County Road 31, North Center Segment	\$363,000
ND County Road 31, North Segment	\$1,904,000
Total ND Transportation Improvement Cost	\$3,673,000
MN Roadway/Segment	
	RS 37' Estimated Construction Cost
MN Broadway	\$201,000
MN 10th St N	\$299,000
MN 100th Ave N	\$159,000
MN 110th Ave N	\$274,000
MN 120th Ave N	\$121,000
MN 130th Ave N	\$392,000
MN 140th Ave N	\$238,000
MN 15th St N, South Segment	\$344,000
MN 15th St N, Middle Segment	\$559,000
MN 15th St N, North Segment	\$512,000
Total MN Transportation Improvement Cost	\$3,099,000
Total Transportation Improvement Cost	\$6,772,000

Summary:

This Technical Memorandum summarizes the additional impacts and measures that will need to be implemented within the flood damage reduction area to accommodate a Flow Through Town that produces RS37' during the 100-year flood event. This includes costs for property acquisitions, flood mitigation measures and transportation improvements. The total costs broken down by State are summarized in Table 10.

Table 10 – RS37' Cost Summary

North Dakota Mitigation Features	Estimated Construction Cost
Property Acquisitions	\$ 26,900,000
Category 1 Flood Mitigation Measures	\$ 9,000,000
Category 2b Flood Mitigation Measures	\$ 32,600,000
Stormwater Lift Station Improvements	\$ 46,340,000
Transportation Improvements	\$ 3,673,000
Engineering and Administration (10%)	\$ 11,850,000
Total North Dakota	\$ 130,363,000
Minnesota Mitigation Features	
Estimated Construction Cost	
Property Acquisitions	\$ 25,800,000
Category 2b Flood Mitigation Measures	\$ 8,670,000
Stormwater Lift Station Improvements	\$ 1,700,000
Transportation Improvements	\$ 3,099,000
Engineering and Administration (10%)	\$ 3,970,000
Total Minnesota	\$ 43,239,000



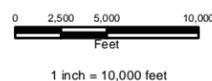
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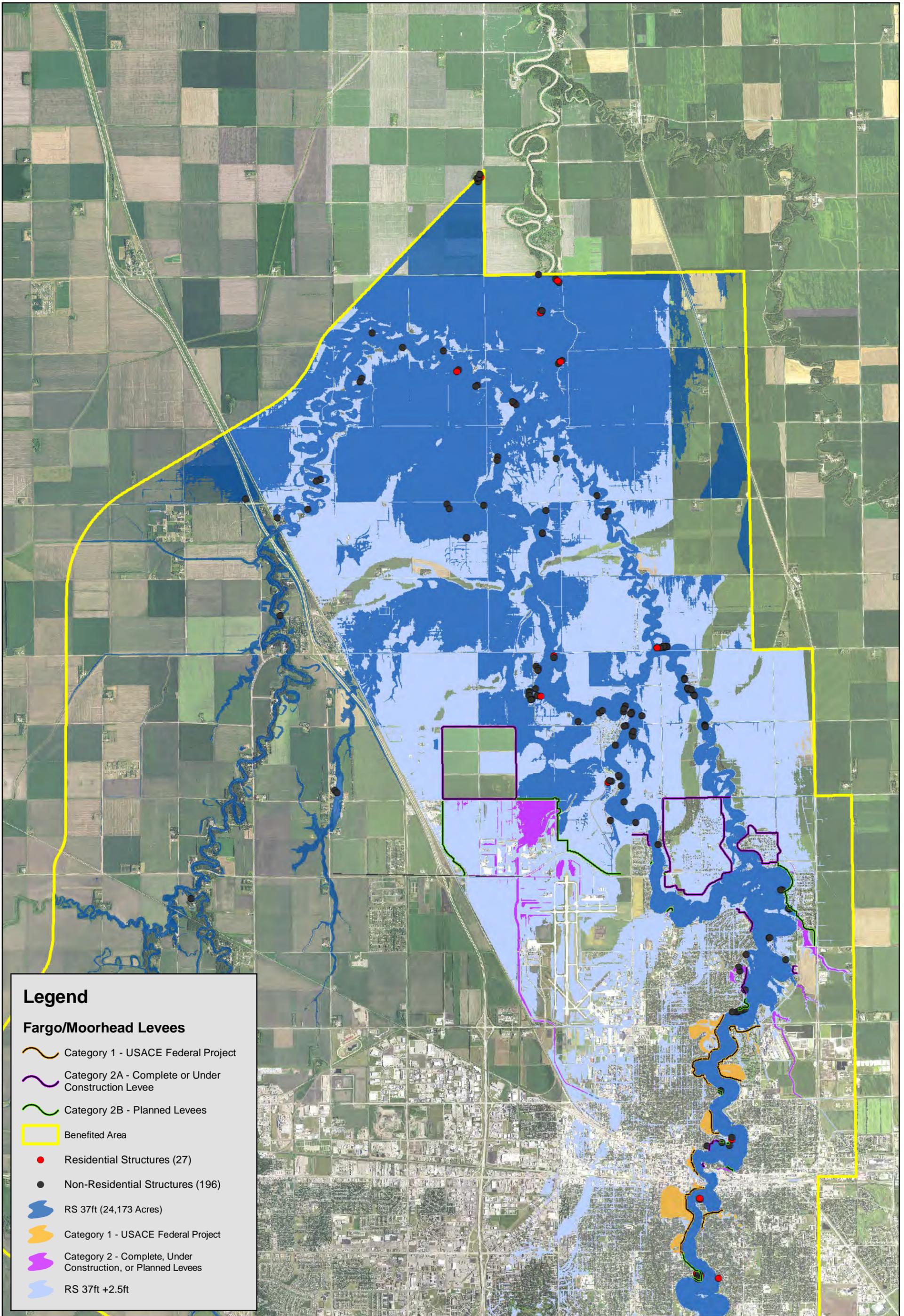
Fargo/Moorhead Levels

-  Category 1 - USACE Federal Project
-  Category 2A - Complete or Under Construction Levee
-  Category 2B - Planned Levees
-  Benefited Area
-  Residential Structures (27)
-  Non-Residential Structures (196)
-  RS 37ft (24,173 Acres)
-  Category 1 - USACE Federal Project
-  Category 2 - Complete, Under Construction, or Planned Levees
-  RS 37ft +2.5ft

Extent of RS 37ft+2.5ft Boundary

Figure 1 - RS37ft Floodplain & Structure Impacts Plan B
1 - Percent Chance Flood Event



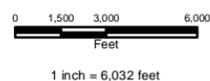


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Fargo/Moorhead Levels

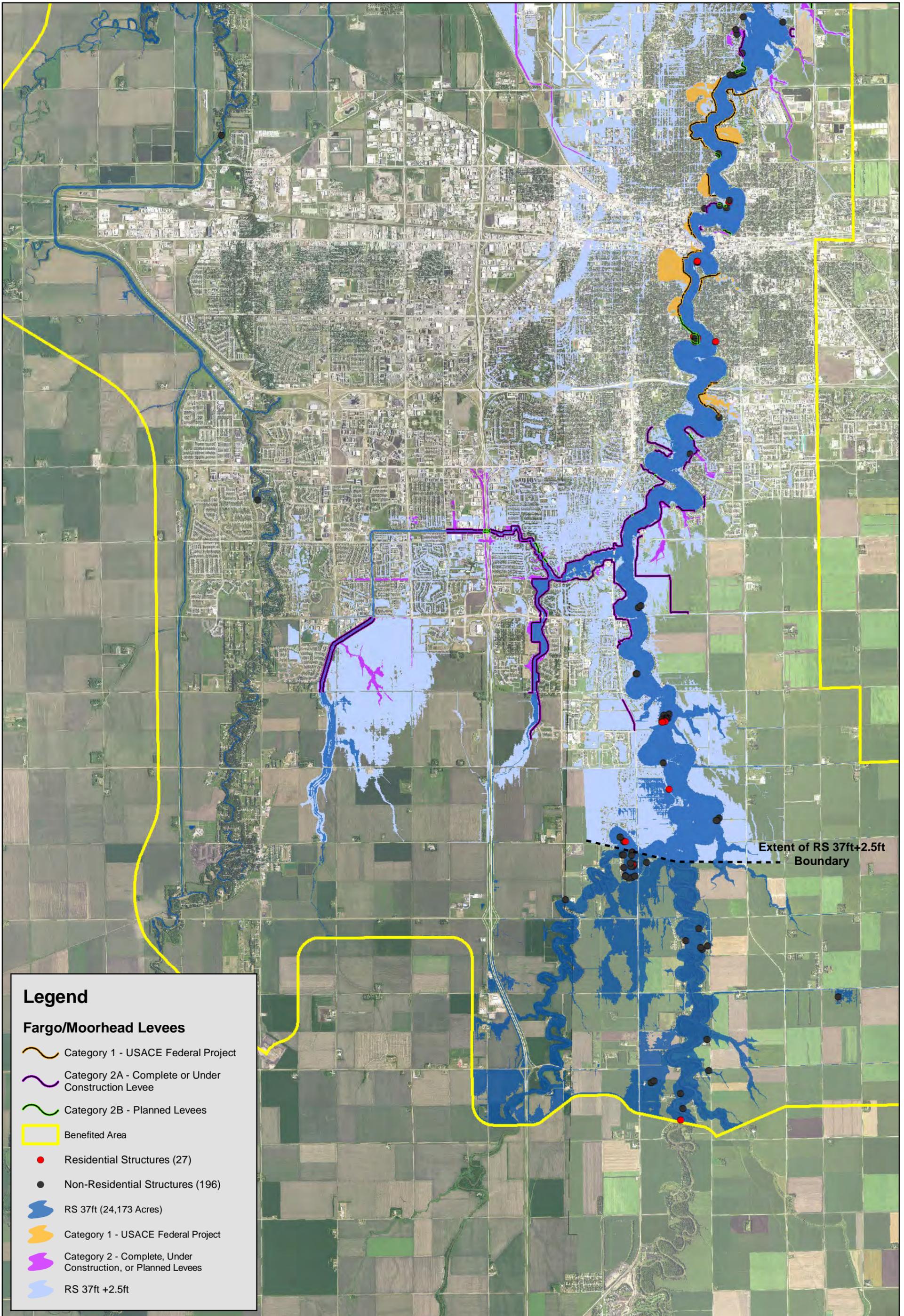
-  Category 1 - USACE Federal Project
-  Category 2A - Complete or Under Construction Levee
-  Category 2B - Planned Levees
-  Benefited Area
-  Residential Structures (27)
-  Non-Residential Structures (196)
-  RS 37ft (24,173 Acres)
-  Category 1 - USACE Federal Project
-  Category 2 - Complete, Under Construction, or Planned Levees
-  RS 37ft +2.5ft

**Figure 1.1 - RS37ft Floodplain & Structure Impacts
Plan B
1 - Percent Chance Flood Event**



1 inch = 6,032 feet





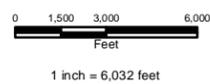
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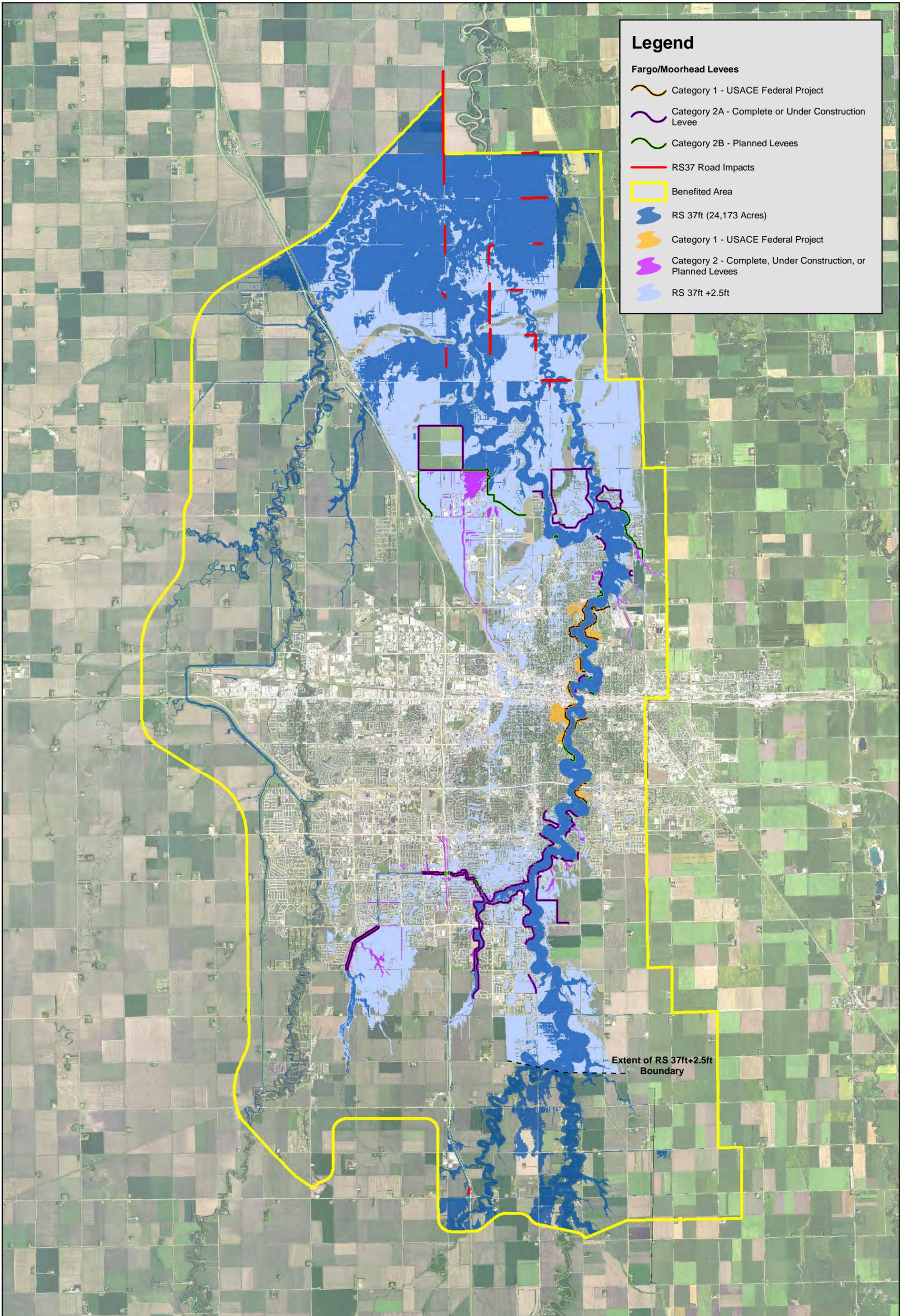
Fargo/Moorhead Levels

-  Category 1 - USACE Federal Project
-  Category 2A - Complete or Under Construction Levee
-  Category 2B - Planned Levees
-  Benefited Area
-  Residential Structures (27)
-  Non-Residential Structures (196)
-  RS 37ft (24,173 Acres)
-  Category 1 - USACE Federal Project
-  Category 2 - Complete, Under Construction, or Planned Levees
-  RS 37ft +2.5ft

Extent of RS 37ft+2.5ft Boundary

**Figure 1.2 - RS37ft Floodplain & Structure Impacts
Plan B
1 - Percent Chance Flood Event**



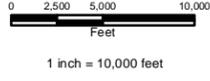


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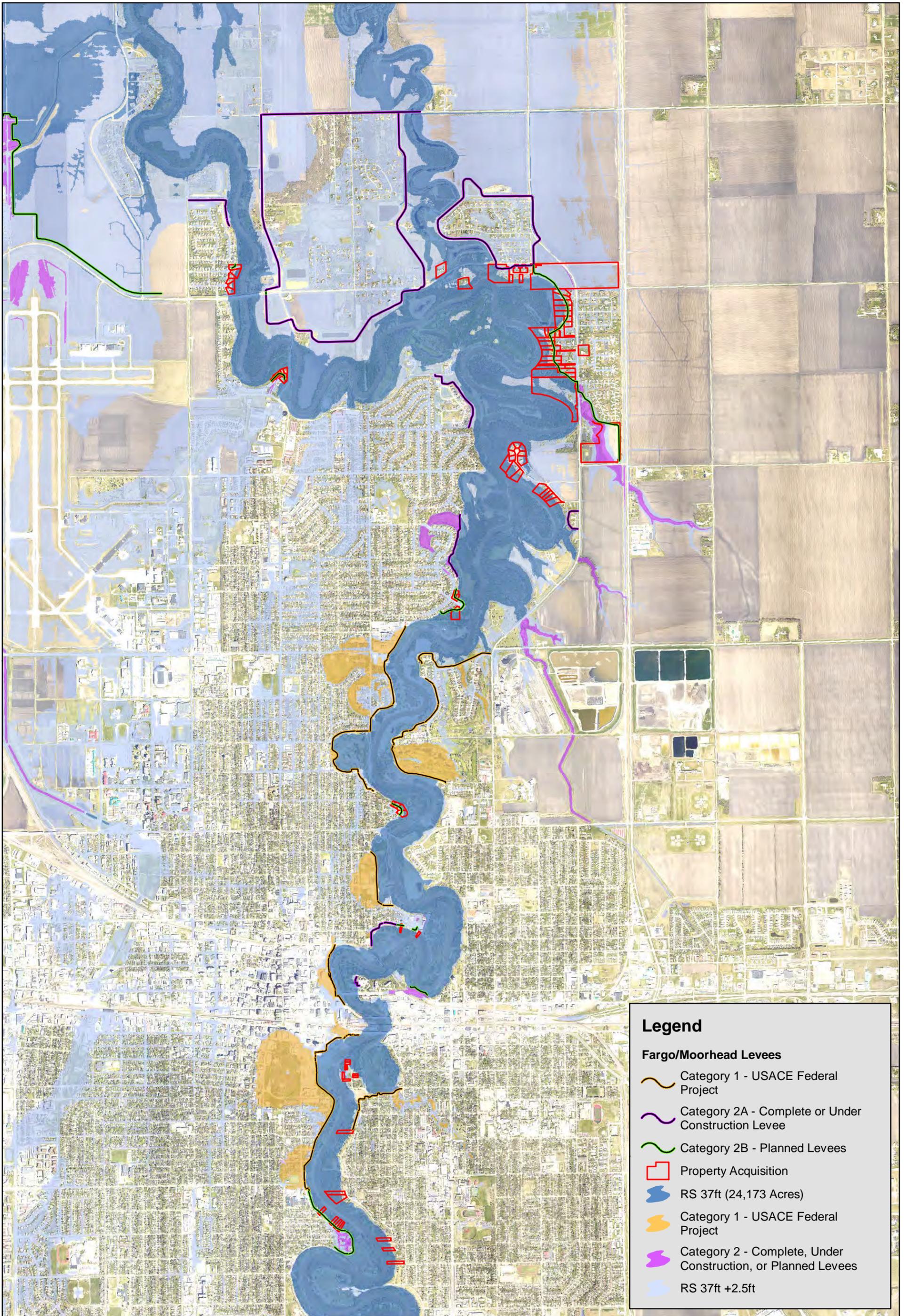
- Fargo/Moorhead Levees**
-  Category 1 - USACE Federal Project
 -  Category 2A - Complete or Under Construction Levee
 -  Category 2B - Planned Levees
 -  RS37 Road Impacts
 -  Benefited Area
 -  RS 37ft (24,173 Acres)
 -  Category 1 - USACE Federal Project
 -  Category 2 - Complete, Under Construction, or Planned Levees
 -  RS 37ft +2.5ft

Extent of RS 37ft+2.5ft Boundary

**Figure 2 - RS37ft Roadway Impacts
Plan B
1 - Percent Chance Flood Event**



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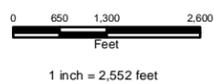


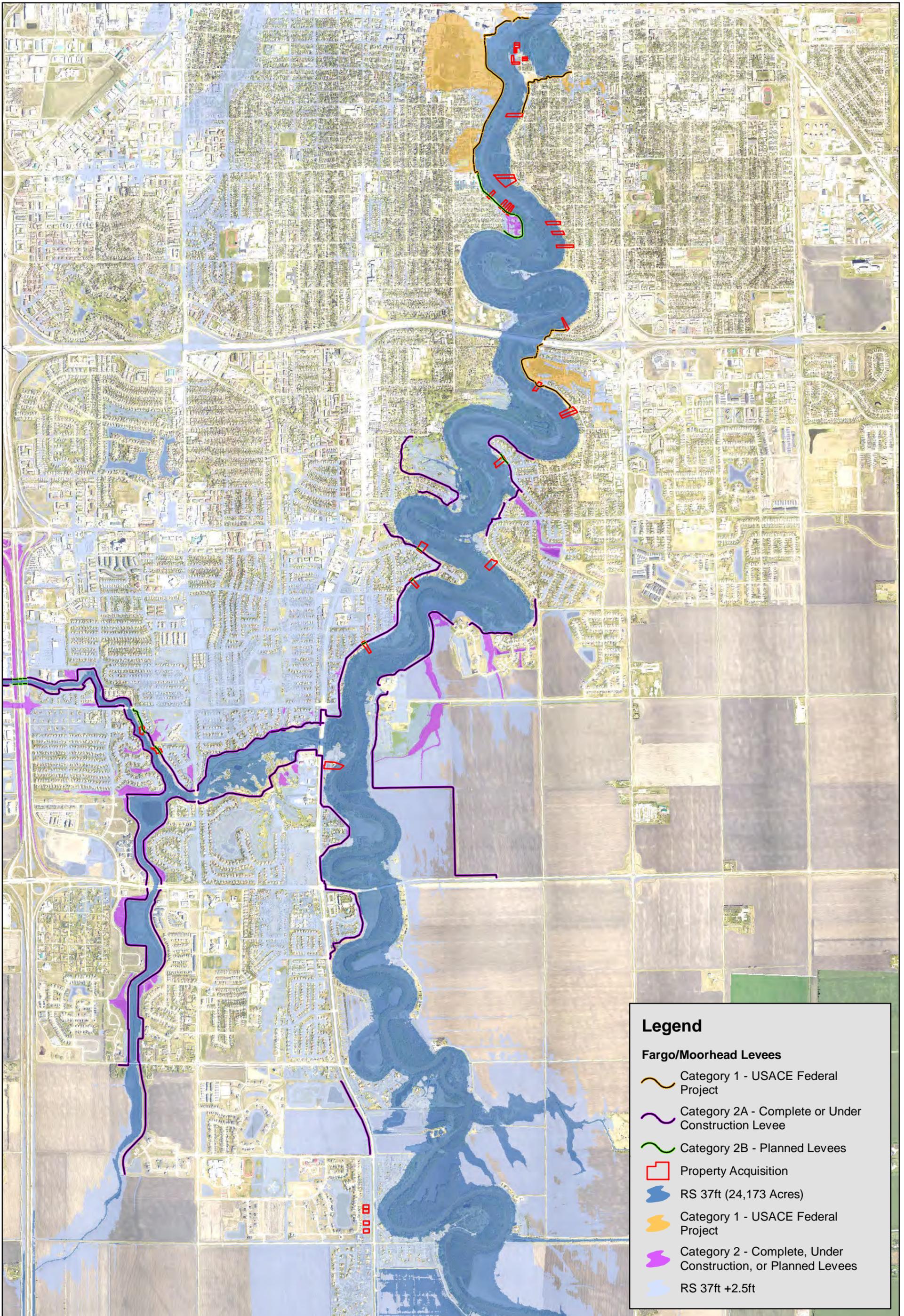
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Fargo/Moorhead Levees

-  Category 1 - USACE Federal Project
-  Category 2A - Complete or Under Construction Levee
-  Category 2B - Planned Levees
-  Property Acquisition
-  RS 37ft (24,173 Acres)
-  Category 1 - USACE Federal Project
-  Category 2 - Complete, Under Construction, or Planned Levees
-  RS 37ft +2.5ft

**Figure 3.1 - RS37ft Property Acquisition
Parcels - Plan B
City of Fargo & Moorhead**



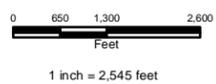


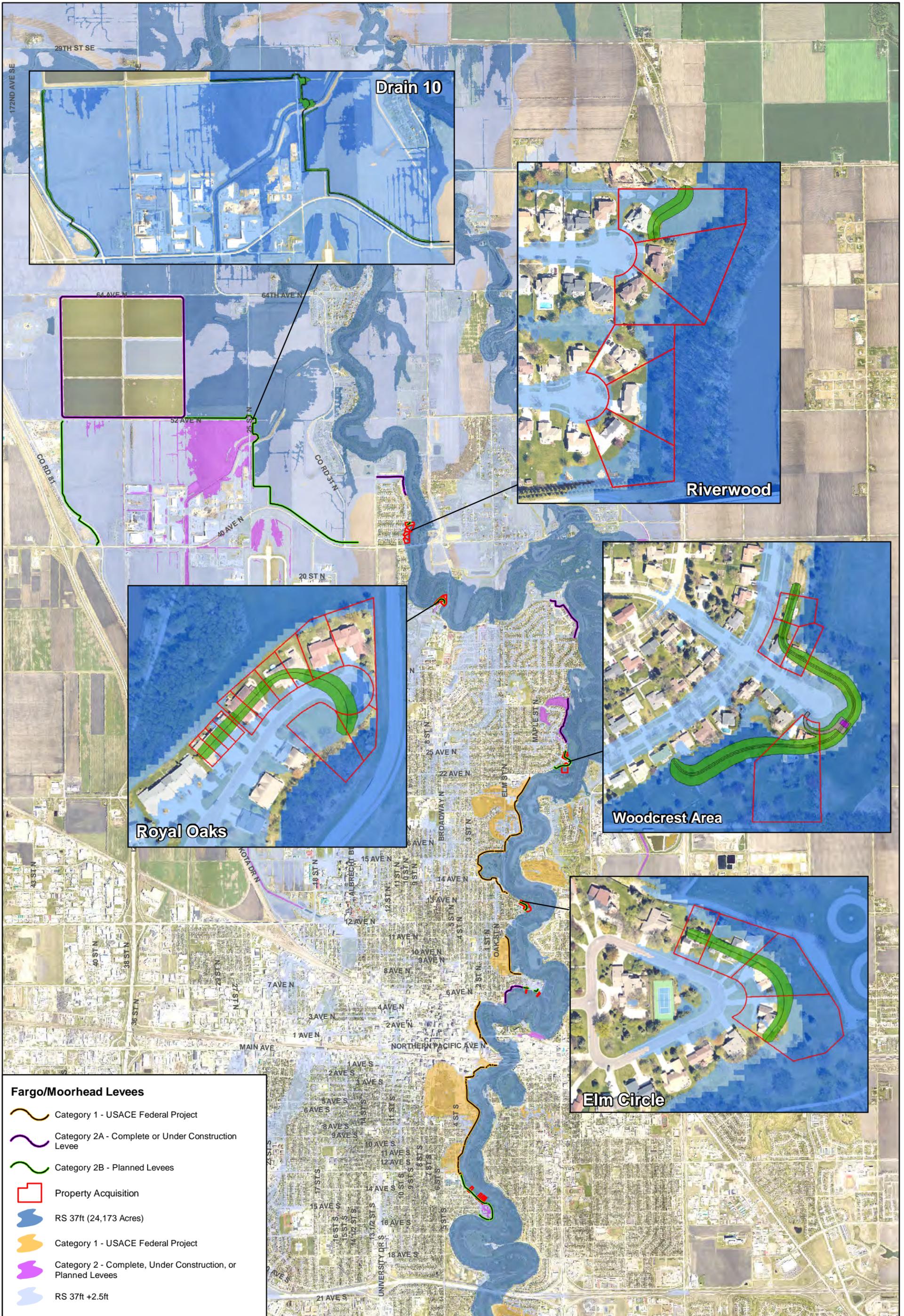
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Fargo/Moorhead Levees

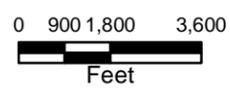
-  Category 1 - USACE Federal Project
-  Category 2A - Complete or Under Construction Levee
-  Category 2B - Planned Levees
-  Property Acquisition
-  RS 37ft (24,173 Acres)
-  Category 1 - USACE Federal Project
-  Category 2 - Complete, Under Construction, or Planned Levees
-  RS 37ft +2.5ft

**Figure 3.2 - RS37ft Property Acquisition
Parcels - Plan B
City of Fargo & Moorhead**



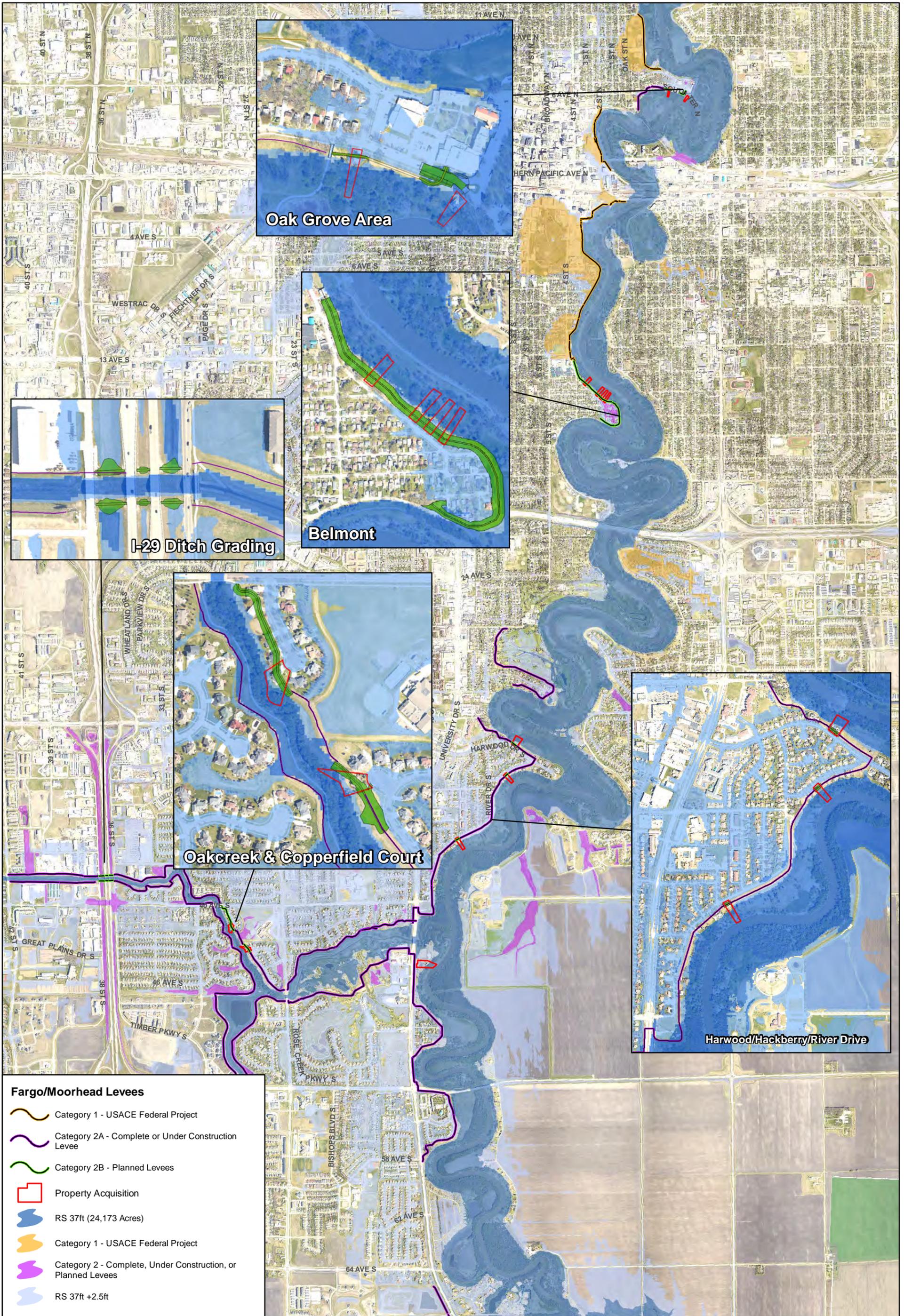


**Figure 4.1 - RS37ft Planned Flood Mitigation Projects
City of Fargo**

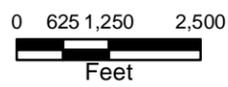


1 inch = 3,621 feet



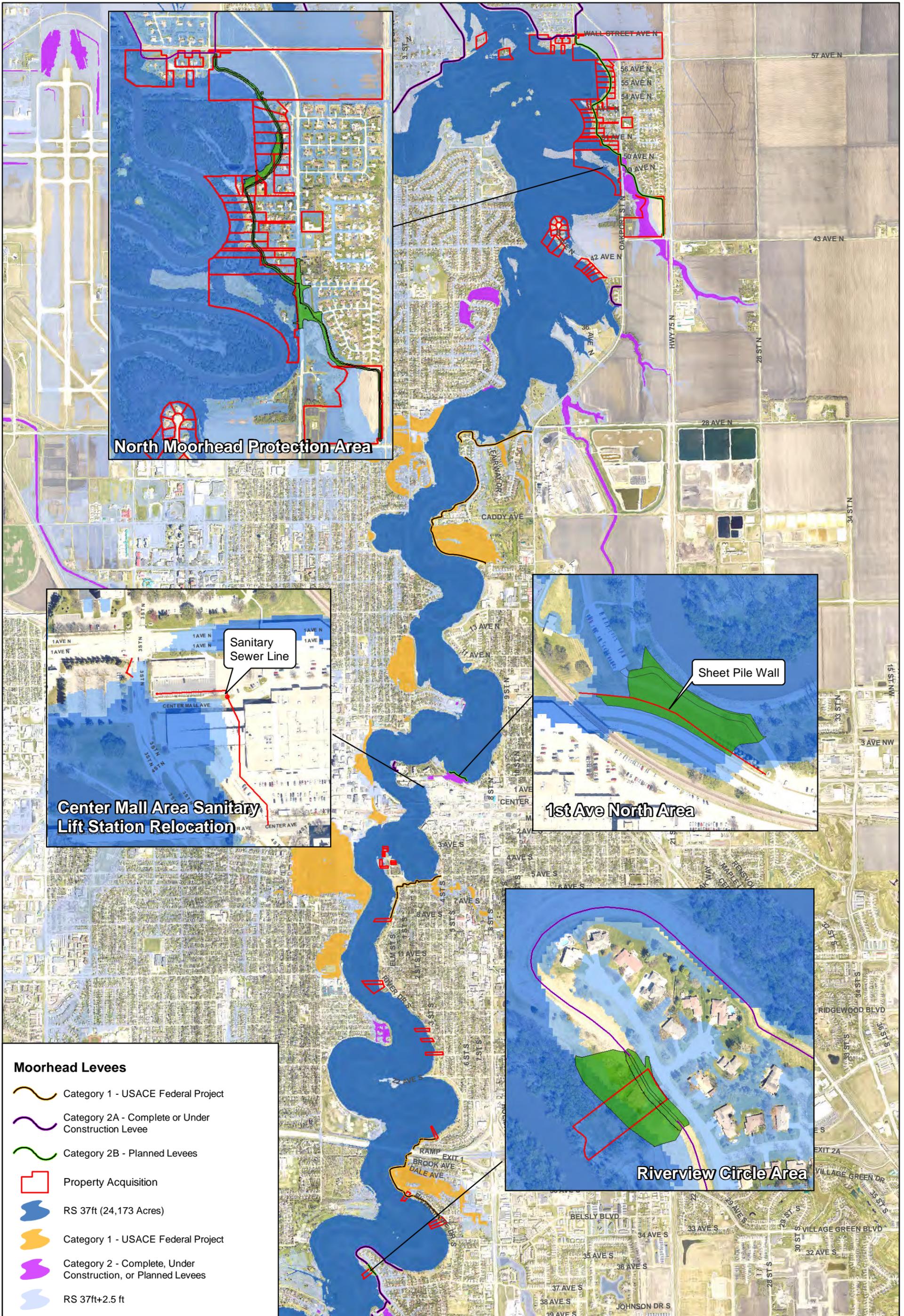


**Figure 4.2 - RS37ft Planned Flood Mitigation Projects
City of Fargo**



1 inch = 2,494 feet





North Moorhead Protection Area

Sanitary Sewer Line

Center Mall Area Sanitary Lift Station Relocation

Sheet Pile Wall

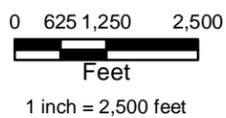
1st Ave North Area

Riverview Circle Area

Moorhead Levees

-  Category 1 - USACE Federal Project
-  Category 2A - Complete or Under Construction Levee
-  Category 2B - Planned Levees
-  Property Acquisition
-  RS 37ft (24,173 Acres)
-  Category 1 - USACE Federal Project
-  Category 2 - Complete, Under Construction, or Planned Levees
-  RS 37ft+2.5 ft

**Figure 5 - RS37ft Planned Flood Mitigation Projects
City of Moorhead**



1 inch = 2,500 feet



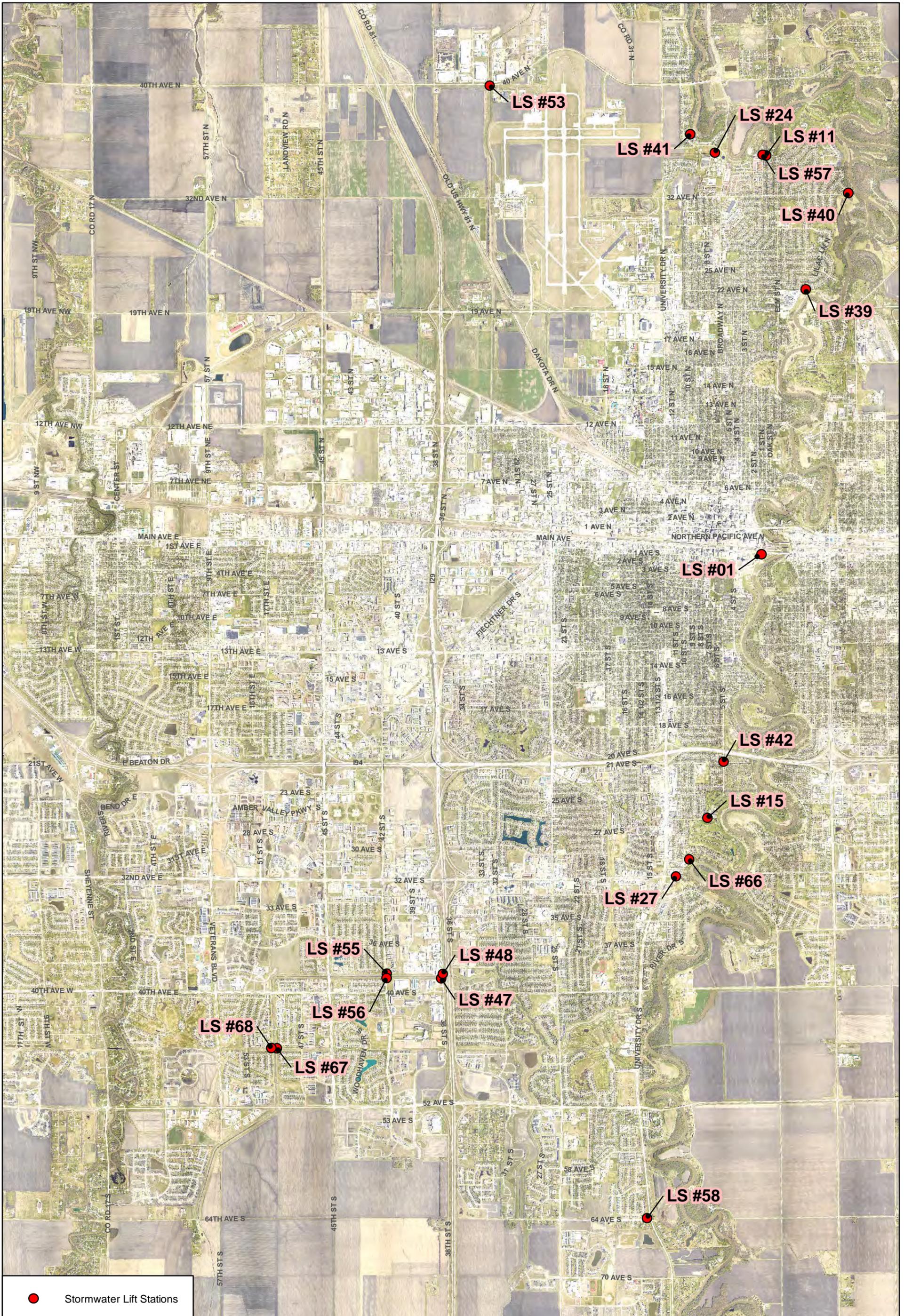
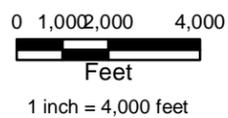
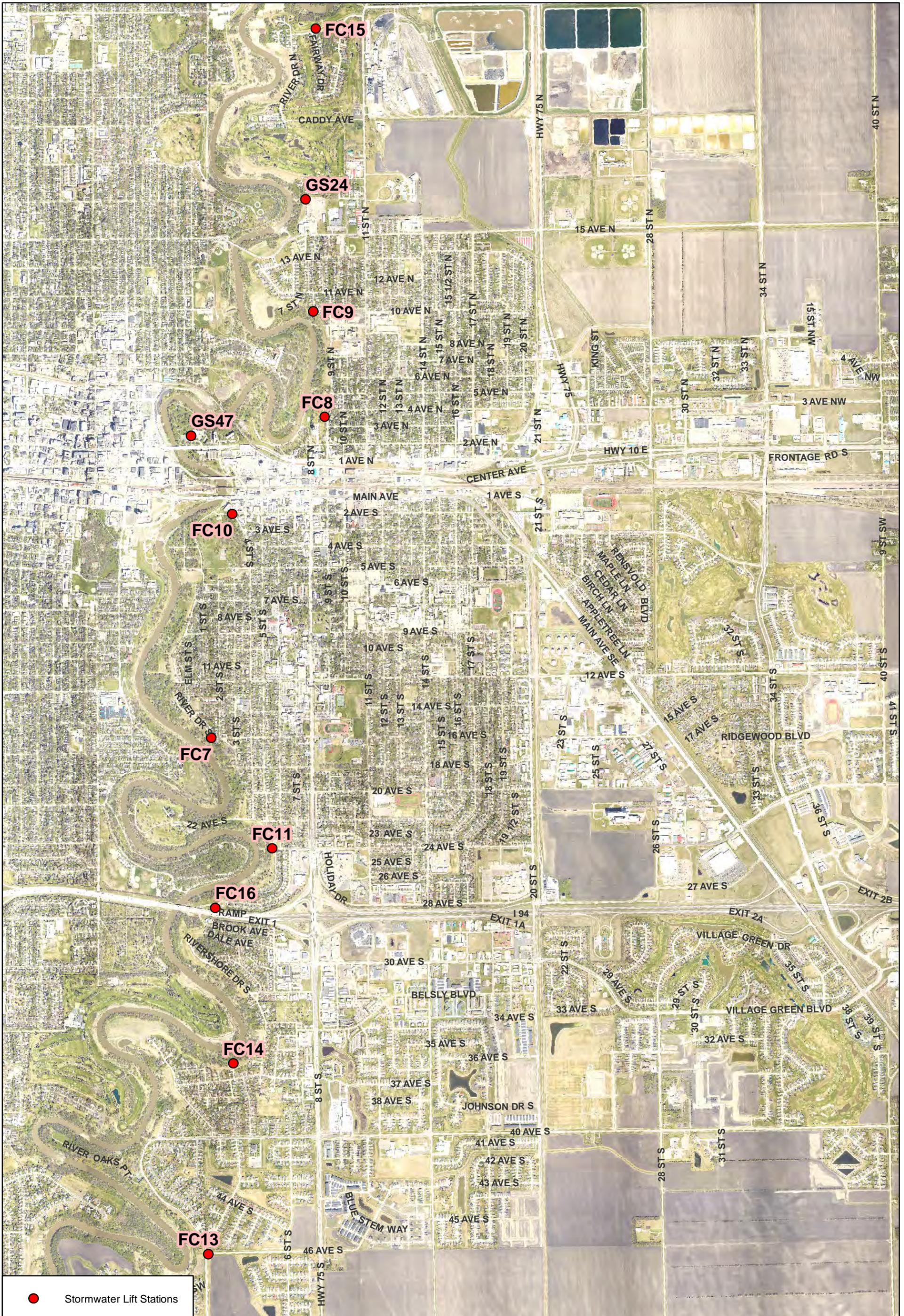


Figure 6 - RS37ft Stormwater Lift Station Improvements
City of Fargo





**Figure 7 - RS37ft Stormwater Lift Station Improvements
City of Moorhead**

