**Purpose**

During the week of November 12th, 2018, staff from DOWL and Northern Engineering and Consulting, Inc. (NECI) completed a site investigation for the Willow Creek Watershed Project located on the Blackfeet Indian Reservation near Browning, MT. The site investigation was performed under Task 1A – Preliminary Investigations. The purpose of the site investigation was to acquire survey data necessary to complete the hydraulic modeling of Willow Creek, as well as gather information regarding historic flooding. The primary goals of the site investigation were identified as follows:

**Purpose of the Site Investigation:**

1. Acquire survey and photographs of hydraulic structures along Willow Creek for use in creating a hydraulic model of Willow Creek through Browning.
2. Interview community members:
   a. Historic and/or natural drainage patterns
   b. Observed flood hazards and areas at risk
   c. Existing drainage patterns and impacts of development on the natural drainage patterns
3. Identify any additional flood risks and concerns

This memorandum documents the information obtained during the site investigation and identifies relevant items that will be considered when performing the hydraulic analysis and evaluating viable alternatives to reduce flood hazards.

**Investigation Results**

As previously stated, the purpose of the site investigation was to 1) acquire data for the hydraulic structures, 2) interview community members to gather information relevant to flood risks, and 3) identify additional flood risks and concerns.

**Survey Data**

Survey data was collected for the hydraulic structures identified in the Willow Creek Survey Request, as well as an additional pedestrian bridge that was identified in the field. Survey was collected for a total of 18 crossings, including 7 culvert crossings and 11 bridge crossings. A total of 48 bathymetric cross sections were also surveyed. Photographs were taken of each structure and the stream adjacent to each structure. Photographs were also collected for additional structures identified during the interviews with the community and the storm drain system in the city blocks adjacent to Willow Creek.
Interview Community Members

DOWL interviewed community members on November 14, 2018. The details of the interview are as follows:

<table>
<thead>
<tr>
<th>Host</th>
<th>Josh Robbins, Water Resources Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time/Date</td>
<td>2:30 pm / November 14, 2018</td>
</tr>
<tr>
<td>Community Members</td>
<td>Don White, Blackfeet Tribal Transportation Program Joe Birdrattler, Blackfeet Tribal Security</td>
</tr>
<tr>
<td>Topics of Discussion</td>
<td>Historic drainage patterns and flooding, man-made changes to infrastructure and natural drainages, potential causes of flooding, and areas at risk of flooding</td>
</tr>
</tbody>
</table>

Information gathered during the interviews and site investigation revealed factors within the Willow Creek Watershed and the City of Browning that are likely contributing to the observed flood hazards.

Flood Hazards Identified during Interviews

Flooding in the Willow Creek Watershed is reported to occur most frequently during winter and spring. The region is susceptible to heavy rain and snow storms, with fast warming cycles driven by chinook winds. Willow Creek is a highly sinuous stream and the characteristics vary from reaches of riffles/pools to sluggish reaches with intermittent beaver ponds. The sluggish reaches provide optimal conditions for ice formation, and flooding caused by ice jams is a concern.

The flood events of 1964 and 1972 were noted to cause the most severe flooding in the City of Browning. These flood events overwhelmed the channel capacity of Willow Creek and flood flows crossed over the wide, broad overbanks as the stream passed through the city – causing widespread flooding. The approximate flood extents of the 1964 flood event are shown on Exhibit 1.

In addition to the significant past flood events, a portion of the city that experiences flooding nearly every year was also identified. The primary area of flooding begins north of HWY 2 and extends from NW Boundary St to N Pegan St. As shown on Exhibit 1, an open ditch once conveyed flow through this area. The old ditch began near the intersection of HWY 2 and HWY 89 and continued along NW Boundary St and N Boundary St before reaching Willow Creek near the intersection of 1st St NE and 5th Ave NW. Over the years, the ditch alignment was relocated to discharge into Willow Creek northeast of 2nd St NW. The length of the ditch alignment was reduced and the confluence with Willow Creek was moved further upstream (upstream of three roadway crossings). Further, two segments of the open ditch were replaced with an underground pipe. Flood flows frequently overtop the ditch at the intersection of NW Boundary St and 2nd Ave NW and continue through the city streets.

Exhibit 2 identifies another area of flooding in the City of Browning. As shown, there was once an open ditch that provided an outlet from the lake east of West Boundary St. When the roadway for West Boundary St. was constructed, an outlet from the lake was not included. The lake was reviewed during the field investigation and the lake does not have an outlet to convey excess
runoff. As shown in Exhibit 2, the lake has overtopped in the past and has flooded the basements of homes in the adjacent neighborhood.

**Additional Flood Risks and Concerns**

During the field investigation, several additional concerns were identified that may be amplifying flood hazards along Willow Creek and within the City of Browning. These concerns include the condition of the existing infrastructure, maintenance of infrastructure, and wildlife impacts that limit the conveyance capacity of Willow Creek.

A brief review of the urban storm drain system in the city blocks adjacent to Willow Creek revealed curb inlets that were not functioning properly. Some inlets held standing water and did not drain, while others were covered with ice and snow. The condition and maintenance of the storm drain system in town is a concern, especially in areas that have experienced frequent flooding.

Maintenance of the ditch at the intersection of NW Boundary St and 2nd Ave NW and the crossing structures along Willow Creek is also a concern. Debris and trash is common in the ditch and may be hindering the hydraulic performance of the ditch and, potentially, obstructing flow through the closed conduit. Several of the bridge and culvert crossings along Willow Creek also had a significant amount of debris limiting the conveyance capacity at the entrance to the crossing. Maintenance of the crossings along Willow Creek is a concern.

While performing the hydraulic survey, numerous locations were reviewed along Willow Creek. At each location, it was clear that beavers are prevalent throughout the study area and have impacted the conveyance capacity of the stream. Beavers have developed numerous dams along the study reach and have downed trees within the stream channel. Some of the beaver dams are as high as 4-5 feet and dramatically change the stream characteristics and conveyance capacity.
Site Investigation Report - Exhibit 1
Willow Creek Watershed Drainage Patterns
Site Investigation Report - Exhibit 2
Additional Past Flooding

Legend
- Historic Open Ditch
- Basement Flooding