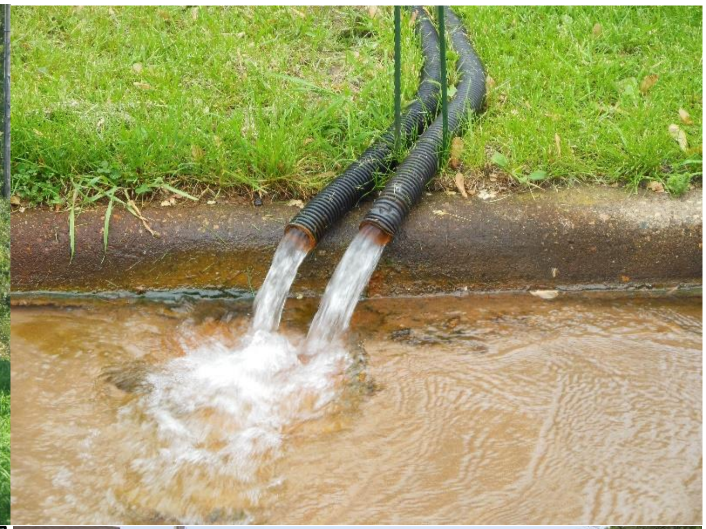
DRAFT - La Crosse, Wisconsin
Nonstructural Flood Mitigation Assessment

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United States Army Corps of Engineers-St. Paul District
Supported by the National Nonstructural Committee

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1.0 Introduction

This reconnaissance level nonstructural assessment has been conducted in support of the US Army Corps of Engineers (USACE) St. Paul District to assess the flood risk within La Crosse, Wisconsin. The 19 sample structures investigated as part of this assessment consist of residential, nonresidential commercial structures, and one public structure. The objective of this assessment is to identify potential opportunities for implementation of flood risk adaptive measures, generally referred to as nonstructural mitigation measures, to reduce flood damages from future flood events. A general location map for La Crosse, Wisconsin is presented in Figure 1.

The nonstructural assessment focused on structures at risk of flooding from the Mississippi River, Black River, La Crosse River, and internal storm water drainage. The Black and La Crosse Rivers are left-bank tributaries of the Mississippi River. La Crosse is on the left bank of the Mississippi River between approximately river miles 704 and 693. Flooding in La Crosse can occur from spring snowmelt events (riverine), summer rain events (interior drainage), and chronically elevated ground water tables.

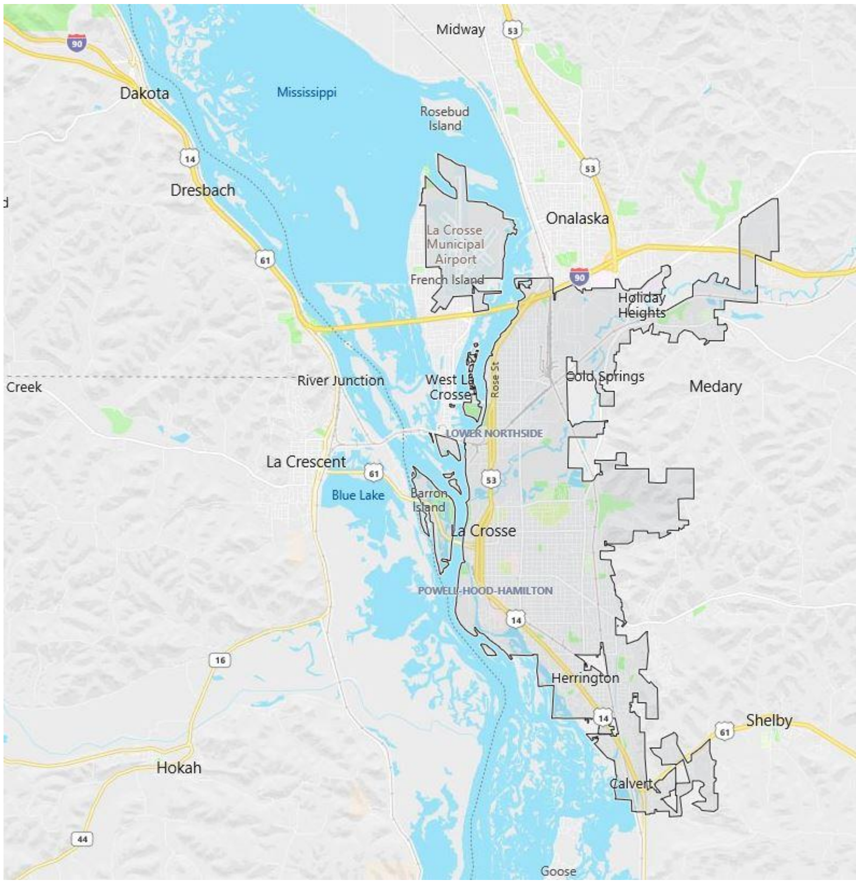


Figure 1
La Crosse, Wisconsin Assessment Area Map

1.1 Community Description.

This nonstructural assessment was conducted within the City of La Crosse, Wisconsin, on a sampling of residential, commercial and light industrial structures which were identified within the community. This area has been adversely impacted by flooding from various sources over the past several decades, most recently by elevated ground water caused by increased rainfall in the last three years. Flood impacts are not limited to one neighborhood. In addition to the existing ground water issues, there is the potential for flash flooding to occur from internal surface runoff from storm events and riverine flooding to occur from longer duration spring and summer floods.

The City of La Crosse has a population of approximately 51,227 from 2019 census estimate and is the county seat of La Crosse County. La Crosse is located on the western border of the midsection of Wisconsin, on a broad alluvial plain along the east side of the Mississippi River. The Black River empties into the Mississippi north of the city, and the La Crosse River flows into the Mississippi just north of the downtown area. Just upriver from its mouth, this river broadens into a marshland that splits the city into two distinct sections, north and south.

The city has a total area of 22.54 square miles (58.38 km^2), of which, 20.52 square miles (53.15 km^2) is land and 2.02 square miles (5.23 km^2) is water.

Surrounding the relatively flat prairie valley where La Crosse lies are 500-foot bluffs, one of the most prominent of which is Grandad Bluff, which has an overlook of the three states region. This feature typifies the topography of the glacial driftless area in which La Crosse sits. This region is composed of high ridges dissected by narrow valleys called coulees. As a result, the area around La Crosse is frequently referred to as the "Coulee Region".

1.2 Consequences of Flood Risks.

Flooding in La Crosse has the potential to impact residential, commercial, and public sector development and may require the response and recovery efforts of Federal, State, and County, as well as local and neighboring governments, residents and outside volunteers. When flooding occurs, the drain on human and financial resources is significant.

This reconnaissance level nonstructural assessment focuses on at-risk structures and contains the detailed technical assessment used for investigating the incorporation of nonstructural measures to reduce flood risk within the assessment area. Without the incorporation of nonstructural mitigation as discussed in this report or other structural measures, such as levees, floodwalls, or channel modifications, the existing structures are at risk of being damaged or destroyed during future flood events.

Depth of flooding relative to the first floor of a structure is one of the most practical indicators of flood risk for a structure and goes beyond the normal tendency to only indicate the 1% annual chance exceedance (ACE) or 0.2% ACE flood elevation at a structure. A 1% ACE depth of flooding measurement of two feet, when comparing to the first floor, would indicate that the 1% ACE flood event would be expected to flood the structure two feet above the first floor. A depth of flooding measurement of negative two feet would indicate that flooding may not reach the first floor, but instead could cause damage in a subfloor space such as a basement or crawlspace. Since the ground surface elevation changes spatially, the depth of flooding statistic provides the best overall characterization of flood risk to individual structures by being able to compare flood prone structures across an entire floodplain.

While nonstructural mitigation measures are specific to the individual structure being investigated, when considered for the mitigation of flood damages, the cumulative effect is to determine a strategy for incorporating a full range of nonstructural measures which are economically feasible, socially acceptable, environmentally adequate, and will reduce the cumulative risk of flooding. Each individual structure assessed may require a different nonstructural technique to be applied depending upon the type of construction. While this assessment relies on data collected in the field for implementation, the assessment is not conclusive as to the ultimate feasibility of the alternatives presented. Because of the limited scope of this investigation, this assessment was conducted as reconnaissance level detail and would require additional detailed analyses to determine economic feasibility for implementation.

Nonstructural flood risk adaptive measures require different implementation processes than structural measures. Since each structure is owned and typically occupied, nonstructural implementation agreements must be entered into with each individual owner. Nonstructural measures are proven methods and techniques specifically directed at reducing flood risk and flood damages in floodplains. Numerous structures across the nation are subject to reduced risk and damage or no risk and no damage due to implementation of nonstructural measures. Nonstructural measures are very effective for both short- and long-term flood risk and flood damage reduction and can be very cost effective when compared to other types of flood risk management (levee systems, detention, and channel modification) measures.

The ability of nonstructural measures to be implemented in very small increments, each increment producing flood risk reduction benefits is an important characteristic of this form of flood risk management. Also important is the ability to implement measures over intermediate and long periods such that layering of measures, each one providing a higher degree of risk reduction, is possible and given both Federal and non-Federal funding constraints, may be probable scenario for implementation.

2.0 Nonstructural Flood Risk Adaptive Measures

The overall purpose of a nonstructural flood risk adaptive measure is to reduce flood risk, decrease flood damages, and to potentially eliminate life-loss. Flood risk adaptive measures reduce risk by modifying the characteristics of vulnerable structures and structures that are subject to flooding or modifying the behavior of people living in or near floodplains. In general, nonstructural measures do not modify the characteristics of floods (stage, velocity, duration) nor do they induce development in a floodplain that is inconsistent with reducing flood risk. Some nonstructural measures that can be formulated for implementation include removing structures from the floodplain by relocation or acquisition; wet or dry flood proofing structures; implementing flood warning and emergency preparedness activities; and implementing floodplain regulation. The National Flood Insurance Program (NFIP) is also considered among nonstructural measures since it contains programs to provide minimum standards for floodplain regulation, to provide flood insurance, and to provide flood hazard mitigation. Some flood risk adaptive measures considered for flood damage reduction by USACE, such as dry flood proofing a residential structure, do not result in a flood insurance premium reduction for the owner as it would for a nonresidential structure. The intent of USACE is to recommend engineered applications of nonstructural flood risk adaptive measures which will reduce the risk and prevent future flood damages to a specific structure, even if an insurance premium reduction is not available for certain techniques.

In contrast, structural measures reduce flood risk by modifying the probability or frequency of flooding at a particular location. For instance, a levee will prevent flooding of the protected area, changing the natural probability of flooding for that location. Structural measures do not modify the characteristics of existing development in the floodplain. While structural measures may decrease the frequency of flooding at a specific location, they can actually increase flood risk if the consequences of flooding are allowed to increase through development.

Some of the basic considerations used to develop nonstructural measures are as follows:

- Relocate structures from the floodplain to a flood-free location.
- Acquire the floodplain land on which the relocated structures previously existed and enforce deed restrictions so the land will never be developed in the future for uses that are subject to flood risk.
- Acquire floodplain land that is in existing open space use to prevent future development that could be at flood risk.
- Acquire structures within the floodplain, demolish them, and enforce deed restrictions to prevent future development that could be at flood risk.
- Elevate structures to above a specified flood elevation.
- Dry flood proof structures (traditional structure waterproofing)
- Wet flood proof structures (retrofitting existing structures below a design flood elevation with water resistant materials and allowing flood water to flow through the structure).
- Develop evacuation procedures.
- Develop public alert flood warning systems.
- Develop and implement emergency flood preparedness plans.
- Employ educational outreach programs aimed at reducing flood risk.

Each of these general categories of nonstructural measures can be applied as a single measure or can be applied in combination with one another or with structural measures to reduce or eliminate flood risk. The range of benefits, costs, and residual damages associated with application of each measure is broad. The extent and severity of social and economic impacts associated with the various measures can be likewise broad and must be identified for any plan. Depending upon the nonstructural measures selected for application and the relative percentage of each applied, the future land use pattern of the area could look considerably different in specific areas.

The consequences associated with locating damageable property and people within floodplain areas can be extreme to property owners and floodplain occupants. Within the context of this assessment, an objective is to identify strategies and measures that can be used in tandem to reduce flood risk. Some strategies and measures may be more suited for Federal action while others will be more attuned to local regulatory action and administration. In either case, these measures must be effective, socially acceptable, environmentally suitable, and mindful of the existing neighborhood and community social and economic systems within which they would be implemented. It is the intent of this assessment to identify such nonstructural measures.

2.1 Floodplain and Flood Risk Characteristics

The major risks of flooding in La Crosse vary depending on the source of the flood event. Large spring floods usually caused by excessive snow melt have been observed on the Mississippi River. Other rivers that flood are the Black and La Crosse Rivers tributary to the Mississippi, and events on these can be exacerbated by backwater caused by high Mississippi River levels. Intense rain events are more likely to cause flash flooding along the streams that flow down from the ridge above the city, such as Pammel Creek, Ebner Coulee, State Road Coulee, and Mormon Coulee. Interior drainage issues in the bottoms of the flat low-lying river valleys can arise from these other flood events, and from high ground water levels due to soil saturation caused by years of excessive rainfall events.

The greatest known flood to have occurred on the Mississippi River at La Crosse was on April 20, 1965, with an estimated 170-year recurrence interval at a flow of 273,000 cubic feet per second and a stage of 17.90 feet. The largest recorded discharge for the La Crosse River occurred on August 8, 1935; however, the stage was lower than the 1965 flood due to backwater from the Mississippi River during the 1965 event. The drainage area at the confluence of the Mississippi and Lacrosse Rivers is 62,840 square miles.

2.2 Executive Order 11988; Floodplain Management (EO11988)

This Executive Order (EO11988) was issued by President Carter on 24 May 1977. In issuing EO11988, the President stated "…in order to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative, it is hereby ordered that each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities…". The nonstructural measures assessment contained herein was conducted in complete compliance with EO11988 meaning that any nonstructural measures that are incorporated into alternatives recommended for implementation support the vision of EO11988. A follow-on to this was Executive Order 13690 from January 2015 which places additional minimum elevation constraints on federal facilities and infrastructure projects that utilize federal funds for construction.

2.3 Local, State, and Federal Regulations

There are various local, state, and federal rules, statutes, ordinances, and regulations that need to be considered when planning an implementing flood risk mitigation measures. One rule that must be followed is the state dry land access rule, Section 115-281 (the full text can be found in Appendix B), which states that "Contiguous dry land access shall be provided from a structure to land outside of the floodplain, except as provided in subsection (3)a.4 of this section …" and continues "In developments where existing street or sewer line elevations make compliance with subsection (3)a.3 of this section impractical, the City may permit new development and substantial improvements where roads are below the regional flood elevation, if:

(i) The City has written assurance from police, fire and emergency services that rescue and relief will be provided to the structure(s) by wheeled vehicles during a regional flood event; or

(ii) The City has a DNR approved emergency evacuation plan.

The following documents can be used for reference purposes:

Floodplain Ordinance based on State 2012 model

https://library.municode.com/wi/la_crosse/codes/code_of_ordinances?nodeId=PTIILADEOR_CH115ZO_ARTVOVZODIRE_DIV2FLZO

State model floodplain ordinance

https://dnr.wi.gov/topic/floodplains/modelZoningOrdinances.html

2.4 Potential Mitigation Funding Sources

There are state and federal programs that might be able to provide funding assistance for the implementation of flood risk mitigation activities:

State funding programs

Wisconsin Department of Natural Resources Mitigation and Grants
https://dnr.wi.gov/topic/FloodPlains/mitigation.html

Wisconsin Department of Military Affairs Hazard Mitigation Assistance Programs
https://dma.wi.gov/DMA/wem/mitigation/hma

Flood Mitigation Assistance (FMA) Grant (Wisconsin)
https://www.firegrants.info/GrantDetails.aspx?gid=41143

Federal funding programs

FEMA Hazard Mitigation Assistance Grants
https://www.fema.gov/hazard-mitigation-grant-program

FEMA Building Resilient Infrastructure and Communities (BRIC)
https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

2.5 Critical Facilities

Facilities and structures which provide services for health, welfare, and public safety may become inoperable during a flood event and result in additional adverse impacts or hardship on the affected population are therefore considered to be critical facilities. They are essential during a flood to provide health, welfare, and human safety to the public. Critical facilities generally provide those services required during the flood such as police and fire protection, emergency operations, evacuation sites, and medical services. Facilities which house the elderly, disabled, or those requiring medical assistance, require extensive evacuation time and are considered significant. Facilities that could, if flooded, add to the severity of the disaster such as power stations, wastewater treatment plants, and toxic material storage sites are considered critical. Each significant and critical facility within the guidelines of EO11988 should be located at a flood free site. If this is not possible or practicable, the facility should be located external to the 0.2% annual chance exceedance flood event (500-year) floodplain. If this is not possible or practicable, the facility must be, at a minimum, protected to the extent that it can function as intended during all floods up to and equal to a 500-year event.

2.6 Common Nonstructural Flood Risk Adaptive Measures

The following flood risk adaptive measures are commonly utilized for reducing flood risk within urban and rural areas across the nation. Each measure must meet specific criteria that would make it acceptable to addressing the flood characteristics and site conditions. Some measures, due to the characteristics of the flood event, site location, and structure characteristics, are more implementable than others. This assessment strives to identify the most effective measure for implementation.

The measures described in report sections 2.6.1 - 2.6.8 are physical nonstructural measures, which means that these are measures which are applied to the physical structure in order to reduce flood damages. The measures do not affect the stage, velocity, or duration of the flood event as the measure is adapting the structure to the flood risk.

<u>2.6.1</u> <u>Acquisition with Demolition/Salvage of the Structure</u>. This measure consists of purchasing the structure and the associated land from the owner as part of the measure. The structure is either demolished or the structure is sold to others and relocated to a location external to the floodplain. In some instances, communities are finding a benefit in salvaging materials (wiring, plumbing, fixtures) from acquired structures rather than filling up landfills with the demolished structure. Development sites, if needed, can be a consideration as part of project development in order to have locations where displaced people can construct new homes or businesses.

<u>2.6.2 Relocation of Structure</u>. This measure requires physically moving the at-risk structure and purchasing the land upon which the structure is located. This measure achieves a high level of flood risk reduction when structures can be relocated from a high flood hazard area to an area that is located completely outside of the floodplain. Development of relocation sites where structures could be moved to achieve the planning objectives of reducing flood risk and retaining such aspects as community tax base, neighborhood cohesion, or cultural and historic significance can be part of any relocation project.

2.6.3 Basement Abandonment. This measure consists of relocation of the basement/crawlspace storage, utilities, mechanical equipment, electrical panels and circuits to above the base flood elevation (BFE) or design flood elevation (DFE). Filling in the existing basement/crawlspace without elevating the remainder of the structure if the structures' first floor is currently located above the BFE or DFE or whichever is higher. Placing an addition onto the structure as part of the measure to compensate for the loss of habitable basement space to the owner and to house the furnace, water heater, water softener and other utilities and appliances is a consideration. If the addition could not be developed because of limited space within the property parcel or because the owner did not want it, partial compensation for the lost basement/crawlspace area would be negotiable. Typically, basement/crawlspace areas are not of the same value as above ground finished living space.

2.6.4 Elevation of Structure. This measure requires lifting the entire structure or the habitable area to above a specified flood elevation, as shown in Figure 2. If a basement exists and had been fully developed prior to elevation and could not be developed post-elevation, compensation for removal of the basement space would be in order to the owner. Typically, basement space is not of the same value as above ground finished living space. This measure is applicable anywhere within the study area unless the required elevation is greater than a maximum of 12 feet above the adjacent grade, where the recommendation would be for acquisition or relocation. Velocity and hydrodynamic forces on the structure would also have to be considered to ensure stability of the elevated structure.

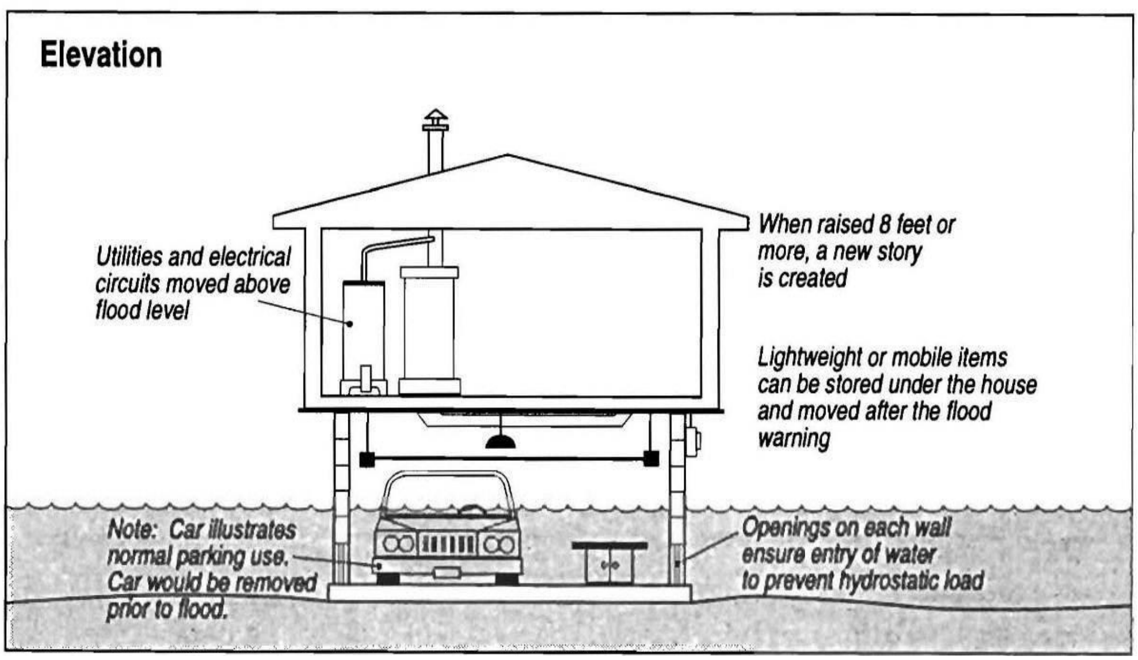


Figure 2
Elevation of Structure (Diagrammatic Section)

2.6.5 Dry Flood Proofing. This measure consists of waterproofing the structure. While this measure is generally acceptable with commercial structures, it can be conducted on residential homes as well as all other types of structures. An example is shown in Figure 3. This measure achieves flood risk reduction benefits for nonresidential structures but it is not recognized by the NFIP for any flood insurance premium rate reduction if applied to residential structures. Based upon testing, a "conventional" built structure can generally be dry flood proofed up to between 3 to 4 feet on the exterior walls. A structural analysis of the wall strength would be required if it was desired to achieve a higher level of protection. A sump pump and drain system may be required as part of the project to remove seepage or interior drainage. Closure panels are required for all openings. This concept does not work with basements or crawl spaces due to the possible infiltration of flood waters, unless complex and expensive cut-off walls are integrated into the design. These walls would resist failure of the basement/crawlspace walls and essentially failure of the entire structure envelope. For structures with basements and/or crawlspaces, the only way that dry flood proofing could be considered to work is for the first floor to be made impermeable to the passage of floodwater.

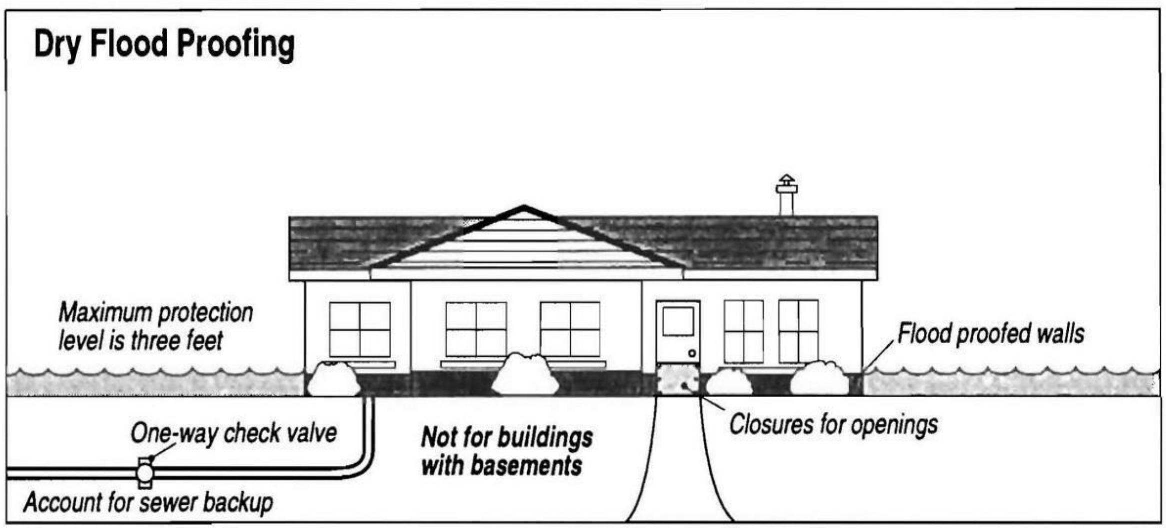


Figure 3
Dry Flood Proofing (Diagrammatic Detail)

2.6.6 Wet Flood Proofing. This measure is applicable as either a stand-alone measure or as a measure combined with other nonstructural measures such as elevation or dry flood proofing. As a stand-alone measure, all construction materials and finishing materials to a specified height are required to be water resistant. An example is shown in Figure 4. All utilities must be elevated above the design flood elevation. Because of these requirements, wet flood proofing of finished residential structures is generally not recommended. Wet flood proofing is applicable to commercial and industrial structures and should be considered for combining with a flood warning system, flood preparedness, and flood response plan. This measure is generally not applicable to large flood depths and high velocity flows due to possible failure of structure walls.

Figure 4
Wet Flood Proofing (Diagrammatic Detail/Section)

2.6.7 Berms, Levees, and Floodwalls. Although these items are structural in nature, and if considered for implementation by USACE, require USACE levee design criteria, they can sometimes be applied to individual structures without adversely impacting the floodplain by increasing stages, velocities, or durations. These measures are intended to reduce the frequency of flooding but not eliminate floodplain management and flood insurance requirements. An example is shown in Figure 5.

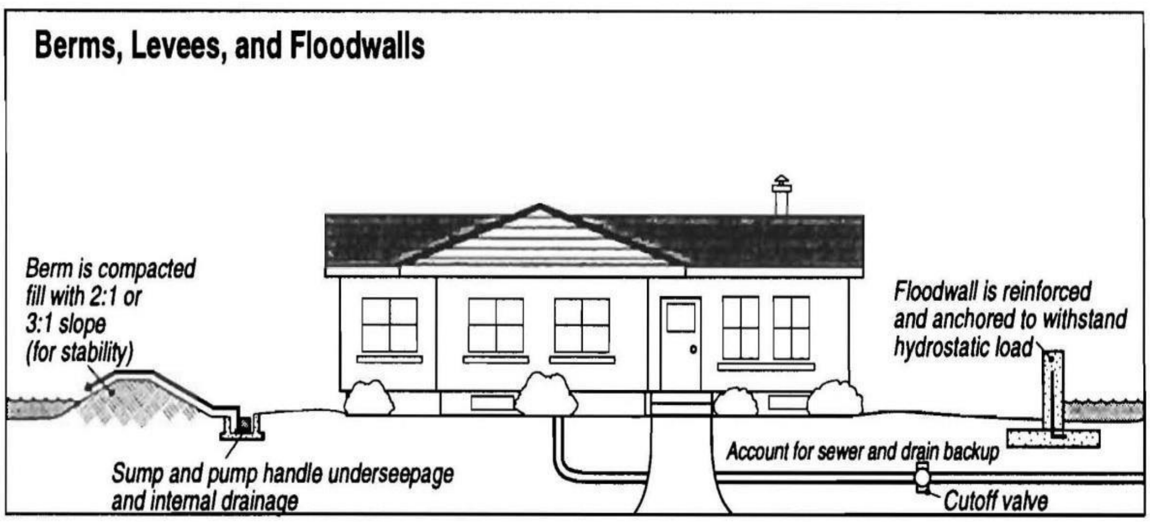


Figure 5
Berms, Levees, Floodwalls (Diagrammatic Detail)

The following report sections 2.6.8 – 2.6.11 refer to nonphysical nonstructural measures which are implemented as floodplain management programs as a comprehensive approach to address flood risk within a floodplain. These measures may be implemented individually or in combination with other measures in an attempt to eliminate all flood risk.

2.6.8 Public Alert Flood Warning, Flood Emergency Preparedness, Evacuation Plans and Pertinent Equipment Installation. Any flood risk management plan should consider the development and implementation of flood warning systems and emergency preparedness planning. The development of such plans and the installation of pertinent equipment such as data collection devices (rain gages, stream gages) and data processing equipment can become an integral feature of a project. Evacuation planning should consider vertical evacuation as well as lateral evacuation. Reunification sites should be a featured component of any evacuation plan.

2.6.9 Land Acquisition. Land acquisition can be in the form of fee title or permanent easement with fee title. Land use after acquisition is open space use via deed restriction that prohibits any type of development that can sustain flood damages or restrict flood flows. Land acquired as part of a nonstructural project can be converted to a new use such as ecosystem restoration and/or recreation that is open space based such as trails, shoreline access, and interpretive markers and possible recreation fields. Conversion of previously developed land to open space means that infrastructure no longer has need for utilities, streets, and sidewalks which can be removed as part of the project. By incorporating " new uses of the permanently evacuated floodplains" into the nonstructural flood risk reduction project, economic feasibility of the buyout or relocation projects is enhanced due to transfer of some flood risk management costs to ecosystem restoration and by adding the benefits and costs of recreation.

2.6.10 Floodplain Regulation and Floodplain Management. Floodplain regulation and floodplain management have proven to be very effective in reducing flood risk and flood damage. The basic principles of these tools are founded in the National Flood Insurance Program (NFIP) which requires minimum standards of floodplain management and floodplain regulation for those communities that participate in the NFIP. While the minimum standards have not resulted in substantial flood risk reduction, incorporation of more stringent building codes and zoning ordinances may meet community objectives of eliminating flood risk. Communities can establish more stringent ordinances.

2.6.11 National Flood Insurance Program. The NFIP was created as a result of the passage of the National Flood Insurance Act of 1968. Congress enacted the NFIP primarily in response to the lack of availability of private insurance and continued increases in federal disaster assistance due to floods. At the time, flood was viewed as an uninsurable risk and coverage was virtually unavailable from private insurance markets following frequent widespread flooding along the Mississippi River in the early 1960s. The NFIP is a Federal program, managed by the Federal Emergency Management Administration (FEMA), and has three components: to provide flood insurance, to improve floodplain management and to develop maps of flood hazard zones. The NFIP contains 3 basic components; Risk Management, Mitigation, and Federal Flood Insurance. Four mitigation programs exist within the NFIP. They are the Public Assistance Program, the Hazard Mitigation Grant Program, the Pre-Disaster Mitigation Program, and the Flood Mitigation Assistance Program. Within the floodplain regulation part of the NFIP, the program serves as a nonstructural measure indirectly through adoption of minimum floodplain management standards by communities participating in the NFIP.

2.7 Temporary Flood Risk Adaptive Measures

Reducing flood risk is an objective which should be conducted through permanent measures. Knowing the characteristics of flooding, such as the available warning time for making preparations, the projected depth of floodwaters, and the areal extent of flooding, along with the anticipated duration, are all factors which will allow community officials, business owners, and homeowners to make personal decisions regarding their ability to reduce property damages. Temporary flood proofing measures are those which, in order to protect a structure and its contents, must be implemented every time there is a risk of flooding. While the most effective and efficient process for reducing property damages is to implement permanent measures, where even features such as doorway and window barriers can be readily installed, there may be the need for interim temporary measures until permanent measures can be implemented. It is recommended that each owner transition to more permanent flood prevention measures as soon as reasonably possible.

This section of the report focuses on the use of temporary measures and the precautions which should be considered prior to implementation. The responsibility for flood proofing, including the detailed planning, purchase of flood proofing materials, and implementation, lies solely with the owner or tenant of each structure. Each building owner and the tenant, who occupies the building during the time of flooding, should weigh the time and costs associated with implementing temporary flood proofing measures numerous times as opposed to the long-term security and peace of mind that can come with implementing permanent measures.

2.7.1 Common Temporary Flood Risk Adaptive Measures. The most common temporary measures that are recommended for at-risk structures are: 1) polyethylene sheeting hung on the structure exterior (usually to a height of 3 feet above the first floor elevation and continued on the ground surface 4 feet out from the structure exterior), in combination with door and window closures, 2) clear liquid sealant applied to the structure exterior, in combination with caulking of large cracks in the exterior and placement of door and window closures, 3) sandbag berms located around all or a portion of the structure, and 4) any of the barriers certified through the National Flood Barrier Testing and Certification Program [see http://nationalfloodbarrier.org/].

A key difference between these temporary measures is that hydrostatic forces are applied to the structure walls when using the polyethylene sheeting and clear liquid sealant measures, but not with sandbag berms or the certified barriers.

2.7.2 Implementing Temporary Measures. Implementation of temporary measures can be successful in reducing or preventing flood damages when conducted correctly. The scope of this assessment does not allow for the Corps of Engineers to evaluate the individual structures and their sites in sufficient detail to guarantee the success of temporary flood proofing, as there are several factors that the owner or tenant must consider when implementing temporary measures:

2.7.2.1 Because of the serious nature of flooding and of the unknowns associated with the depth, velocity, and duration, as well as the condition of the structure, it is generally considered wise to not allow temporary flood proofing measures to be placed to a height of over 3 or 4 feet above the elevation of the first floor of the structure. The hydrostatic and hydrodynamic forces of floodwaters on the exterior walls can cause a catastrophic collapse due to the lack of lateral resistance from the structure as the floodwaters rise higher against the sides of the structure. And, since the characteristics of a flood (depth, velocity and duration) may change during a flood event, it must be noted that it is possible for failure of foundation systems, and closure panels to occur at a flood depth of less than 3 or 4 feet. If a basement or crawlspace exists, the effect of floodwaters on those foundation walls must also be taken into consideration. While a foundation wall may provide more resistance to flooding than a conventional wood wall, the depth of flooding and duration of flooding on the foundation wall needs to be assessed. Without a proper structural analysis of individual structures by a certified professional or contractor, failure of a structure can occur due to the hydrostatic and hydrodynamic pressures caused by water pooling up against or flowing directly into a structure. It is the highest recommendation of the team of engineers preparing this report that after the flood proofing measures have been implemented, all persons evacuate the structure to a predetermined location of safety.

2.7.2.2 Though obvious, it must be stated that a structure could be exposed to a flood event of a depth greater than for which temporary flood proofing measures have been erected.

2.7.2.3 Smaller, more frequent storm events that can cause localized flooding can occur in the City of De Soto. In these events, there may not be sufficient warning time for the owners or tenants to implement the temporary measures.

2.7.2.4 Preparing a structure for a flood requires significant effort, and it is impossible to accurately predict even one day in advance the depth to which flood waters from an approaching storm may rise. Therefore, the owner or tenant cannot be certain that the projected flood event will actually occur. The owner or tenant must find his own comfort level and balance the risk of not having the structure properly flood proofed, versus the risk that the effort to flood proof was not necessary.

2.7.2.5 In order to prevent unsanitary water from backing up into the structure, the owner should ensure that his sanitary drain line is fitted with a backflow preventer.

2.7.2.6 Downspouts and associated drainages must be considered. If a certified barrier or sandbag berm is erected, the downspouts need to be modified so they can be directed over the barrier; this would greatly reduce the amount of water to be pumped from within the protected area. Also, there may be drain lines that carry water from the downspout that pass under the certified barrier or sandbag berm, which must be plugged to prevent flood water from flowing through the line into the protected area.

2.7.2.7 If the exterior construction is not structurally sufficient to withstand a significant water load the force of water at a depth of three feet (or perhaps less) could collapse walls. Therefore, it is recommended that when the temporary measures include placement of polyethylene sheeting on the exterior of a structure, a thick layer of plywood (up to 1 inch) be attached to the exterior surface of the structure up to the level of protection. The plywood could be attached to wall studs using countersunk threaded anchors with bolts, and sheeting would be placed over the plywood. Again, structural evaluation by a certified professional or contractor is recommended.

2.7.3 Flood Characteristics Dictating Temporary Measures. There are numerous characteristics associated with temporary flood proofing, many of which may be unknown to the owner or tenant. Some of these include: 1) characteristics of the flood itself (depth, duration, and velocity. Note that velocities will generally be greater near the channel), 2) the precise condition of the structure being protected (condition of the foundation, crawlspace, basement, and type of construction of the first floor and side walls), and 3) the surrounding site conditions (soil permeability, the density of landscaping, and the location of utilities as well as other external features).

2.7.4 Planning and Preparation of Temporary Measures. The information provided in this report section is the basis for developing temporary mitigation measures to reduce the possibility of extensive flood damages. In order for flood proofing to be successful, a thorough plan for each individual structure needs to be developed and implemented. The plans will vary from structure to structure, depending upon structure type, projected depth of flooding, the velocity of floodwaters, the time available to implement the measures, and the availability of flood proofing materials. In some instances, due to the depth of flooding or the projected velocity of the floodwaters, rather than attempt to keep floodwater out of the structure, it may be more cost effective to remove or elevate to a higher interior location, those items (business records, electronics, computers, heirlooms, artwork, etc.) which contain a high value, intrinsic or monetary, so as to avoid exceptional loss.

For individuals wishing to implement temporary flood proofing measures, a plan should be developed to ensure that the measures can be employed as quickly as possible when the threat of flooding is imminent. Locations for storage of the materials and equipment should be designated far in advance of an event. Storage can occur on or off-site; however, if materials and equipment are maintained off-site, arrangements should be made to transport these materials and equipment to the site for implementation. Because the limited time available to install temporary measures is a critical factor in the prevention of flood damages, site preparation, maintaining the proper inventory of flood proofing materials, and having a well-prepared emergency response plan are crucial to a successful outcome. Early preparation can make the difference between minimal dollar damages and a catastrophic loss. While even the best laid plans may go awry, nationwide data indicate that the owners who pay attention to the details, establish a thorough step-by-step process for implementing their temporary flood proof measures, and prepare themselves and their structures prior to the start of the flood season, fare far better than those individuals who rush against time to install temporary measures which have not been thoroughly planned out.

It is imperative that the structure owner or tenant determine the type and amount of materials required to be on hand each year through the forecasted flood season. A checklist of these items or material requirements should be prepared, including the sequence of placement of materials in order to establish the most time-effective process for implementing the temporary measures. Each year prior to the start of the flood season, the owner or tenant should review the checklist, replace missing or damaged items, and prepare to implement the entire flood proofing measure during the first signs or indication of imminent flooding. In addition, the owner and/or tenant should develop a procedure for ensuring that all employees, residents and others who may have been in the structure prior to the flood event are accounted for after evacuation. This may be accomplished by planning to contact all personnel via cell phone and/or by arranging to meet at a designated location.

Once the owner or tenant has established a temporary protection plan for the structure, it may be beneficial to test the plan for efficiency and effectiveness in order to optimize the plan. The flood fight materials and equipment should be stored in such a manner that they will not be damaged and should be monitored on a regular basis to ensure that these materials will be effective when and if needed. For instance, blue plastic tarps can become damaged with holes from animals or normal weathering and should be replaced if any damage occurs, and plywood should be stored such that it will not rot or be damaged by termites or storage in a wet or damp environment.

While protection of the structure and of the structure contents are of high importance, during any flood event there is a possibility of extensive damage to the structure. It is worth repeating that, in order to prevent extensive loss or damage to high value items, it is recommended that the emergency response plan also consider relocating away from the structure or to a higher elevation, those items which would be difficult or impossible to replace.

Again, it is imperative that each structure owner understand that the intent of these proposed measures is to provide only temporary protection from flooding. After the temporary measures have been implemented, after the sump pump(s) has been positioned and flooding appears to be imminent, the owner and all associated persons should evacuate the premises during the flood event. There is always a possibility that catastrophic failure of a structure or loss of life could occur during a flood event.

<u>2.7.5</u> <u>Site Preparation.</u> The type and amount of site preparation will vary with each structure. For many structures, one of the recommendations is that, in order to prevent floodwaters from entering a structure and causing damage, the site surrounding the structure be prepped to a condition which allows relatively easy and quick installation of temporary flood proofing measures. For each structure, the owner or tenant should try to achieve at least 4 feet of leveled access area around all exposed sides of the structure. The placement of polyethylene (also known as polyurethane or plastic) sheeting and/or sandbags as a preventive barrier to flooding requires a leveled surface in order to resist seepage into the protected area.

While shrubs, flowers and trees provide character and add value to a property, it is important that they be removed from within the “leveled access area” in order to establish a preventive barrier to flooding. If the owner is unable to remove landscape items, it is important that a uniform barrier of protection be established by placing polyethylene sheeting or sandbags as close to the protruding plant as possible to develop a cohesive barrier between the ground and the employed flood proofing measures. Even a small weakness in the flood proofing measure could result in catastrophic failure and damage.

In certain circumstances, it will benefit the owner to identify appurtenances such as fence posts, gates, storage sheds and utility boxes which may prevent the establishment of a waterproof barrier. These items should be removed as much as possible from the “leveled access area.” Utilities and HVAC units must be considered. Where possible, vital utilities and HVAC units should be raised in height to a reasonable level. Otherwise, provisions in the flood proofing plan need to include the protection of these utilities and units. Also, these items are usually associated with wall openings through which flood waters may enter a structure. These openings must be sealed, along with any other holes or cracks in the exterior walls and foundation.

2.7.5.1 Removal of Interior Flood Water. The removal of flood waters from a structure to prevent inundation of the first floor can be one of the most important and critical ways to protect a structure from flooding. The use of sump pumps is one of the best and easiest methods to accomplish this. For most of the assessed structures, the Corps' recommendation is to install one or more sump pumps. Loss of electricity during a flood event must also be considered; therefore, it is recommended that the owner utilize pumps that can be powered with a battery power supply. In most cases, the installation of these pumps is relatively simple, and in some cases, the use of multiple pumps may be necessary.

2.7.5.2 Materials and Equipment Required for Temporary Measures. The owner should ensure that the materials recommended for protecting the structure have been obtained prior to the start of the flood season. Materials required for implementing a preventive barrier to flooding should be stockpiled in an accessible location. Materials remaining from the previous flood season should be inspected to determine condition for reuse. Some of the more frequent materials required for implementing successful temporary flood proofing measures includes:

2.7.5.2.1 Polyethylene Sheeting. This sheeting material (also known as visqueen, polyurethane or plastic sheeting) is often recommended for use when employing a temporary waterproof barrier around a structure. The sheeting should be purchased in rolls, typically 5-6 mils thick, and will be cut long enough to extend from no more than 3 feet above the first floor of the structure to, at a minimum, 4 feet out from the structure. The further the “leveled access area” and polyethylene material extend beyond the exterior wall of the structure, the longer the flow path for floodwaters to enter a structure, including the crawlspace or basement, is extended, increasing the resistance to flooding. The shorter the flow path is to a foundation, the higher the risks of complete soil saturation around a foundation, resulting in complete inundation of the crawlspace or basement. Once the floodwaters have access to the crawlspace or basement, it becomes more difficult to remove the floodwaters and to prevent or limit damages.

2.7.5.2.2 Connectors for Attaching Polyethylene Sheeting to Structure Exterior. The type of connector needed depends upon the type of exterior surface of the structure to which the sheeting is being fastened. Hooks, whether self-tapping or through drilled anchor connection, are normally recommended for use in fastening the polyethylene sheeting to the structure. Spacing of the hooks should be such that no spanis greater than 2 feet. Hooks should be placed permanently for continuous use from one flood season to the next.

2.7.5.2.3 Water Resistant Tape for Polyethylene Sheeting. For firm cohesiveness between the polyethylene sheeting and the exterior structure surface or between adjacent polyethylene sheets, this type tape is recommended for use. These tapes incorporate PVC adhesives and are ideal for use in outdoor situations. Consideration should be made for vinyl coated cloth tapes for effectiveness where product performance is critical; these tapes can sustain harsh weather conditions and can be used for repairs to many surface types. It is further recommended that tapes containing water resistant properties, all-weather properties, brittle resistance, and anti-aging properties be obtained.

2.7.5.2.4 Closures panels (plywood and other material). A temporary closure system consisting of 1-inch thick plywood or Oriented Strand Board (OSB) is often recommended for flood barrier construction at doorways and windows; no closure should have a horizontal or vertical span in excess of 3 feet without incorporating additional supports. Because 1-inch paneling may be expensive, a 1-inch closure can be pre-made by using a grid of screws to connect two boards of lesser thickness. Vent openings can usually be protected with a lesser thickness. Do not use materials that are not water resistant. The closure panel should be measured, cut, and identified for the specific location in the temporary flood barrier and should be available for use from one flood season to the next. The panels should be held in place with water resistant caulking, nails, screws and/or liquid nail. For doorways which open inwards, or for over the top of window glass, the closure panel should extend onto the exterior wall.

2.7.5.2.5 Sand and Sandbags. Considered to be one of the most durable and easily employed flood-fight products on the market, sandbags are an integral component of many temporary barriers to flooding. Sandbags should be made of nylon or polyethylene. Generally, bags can be placed in a single row up to 3 bags high. Berms more than 3 bags high should be built in pyramid fashion; these berms should be as many bags- wide at the base as they are bags-high. Bags should be filled between half-way and two-thirds full, should not be tied and should be placed with the top of the bag tucked under the bag. After placement of each layer, the bags should be walked on to provide a better seal with adjacent bags. The bags in each course should be placed so that they cover to the maximum possible extent the joints in between the bags in the same course and also between the bags in the course below. Additional guidance on sandbagging is available from the Corps of Engineers.

Sandbag closures at doorways and similar openings can work well but must be carefully sealed at the ends. The owner may prefer to use a plywood or other type closure panel.

2.7.5.2.6 Caulk and Clear Sealant for Structure Exterior. If any portion of the structure to be protected consists of brick, stone, stucco, concrete, cinder block, or tile, a water resistant sealant may be recommended for use. It is best to use a clear liquid sealant which may be applied by brush, roller, or sprayer. The sealant should be applied to all porous surfaces, which have been thoroughly cleaned and dried to allow deep penetration and maximum resistance to the effects of water. The sealant should be extended above the area of proposed protection for best coverage. While at this time, no government testing programs have rated these commercial sealants, manufacturer's information indicate that commercial sealants may last up to 20 years without discoloration.

In addition, if large cracks and voids in the structure exterior need to be filled; many products carried by local hardware companies are compatible with the materials on the exterior of the structures.

2.7.5.2.7 Certified Temporary Flood Barriers. Preventing flood waters from entering a structure requires the use of temporary flood barriers. While there are many products marketed as flood barriers, very few have tested and achieved certification for preventing damages. The Association of State Flood Plain Managers (ASFPM) in collaboration with FM Approvals, the independent testing arm of international insurance carrier, FM Global, and the USACE National Nonstructural Committee (NNC) have implemented a national program of testing and certifying flood barrier products used for flood proofing and flood fighting. The purpose of this program is to provide an unbiased process of evaluating products in terms of resistance to water forces, material properties, and consistency of product manufacturing. This is accomplished by testing the product against water related forces in a laboratory setting, testing the product against material forces in a laboratory setting, and periodic inspection of the product manufacturing process for consistency of product relative to the particular product that received the original water and material testing. Upon products meeting the consistency of manufacturing criteria and meeting the established standards for the material and water testing, the certification part of the program becomes available to the product. Since the testing part of the program is conducted in a laboratory setting, not all forces and impacts to which the product could be subjected to during an actual flood event will be tested.

Certification will also reflect, in terms of flood proofing, the suitability of the product, the performance of the product based on the product deployment literature, the durability and reliability of the product, and the consistency of the product. All products will be examined and evaluated on a model by model, type by type, plant by plant, and manufacturer by manufacturer basis. For additional information on this program and a list of certified products, visit http://nationalfloodbarrier.org/.

2.7.5.2.8 Interior Drainage Pump and Power Supply. In order to prevent flood damages due to seepage of floodwaters through the temporary flood barrier or resulting from a rising water table, it may be recommended that pumps be incorporated into the protection measures. Pumps will be needed inside the structure to collect seepage. At a minimum, one pump with a capacity of at least 20 gallons per minute should be considered for installation in the structure for every 2,000 square feet of floor space. 115-volt AC powered pumps can be used provided electricity is available throughout the flood event. The owner may consider installing a permanent sump pump with sump pit or can bring in one or more pumps for temporary use. If loss of electrical power during a flood is a concern, the owner could employ a gasoline-powered electric generator to power the AC pump or could use one or more battery-powered sump pumps. The user will have to be aware that the battery life is limited; therefore, a spare battery should be kept on-hand. The life of the battery recommended in the battery powered back-up sump pump 10 to 14.5 hours of pump use. Because it is impossible to know how much the pump will be operating, the user will need to monitor it often and be prepared to replace the battery. If there is no basement or crawl space, the owner may elect to use a floor-type pump that can maintain the depth of water on the floor to 1/8 inch. If the structure being protected does have a basement or crawlspace, the pump needs to be placed at the lowest elevation in order to work most efficiently. In some instances, the owner may consider cutting a small hole through the floor of a closet space, for concealment purposes, and lowering the pump to the lower level. For a slab on grade structure, the pump should be placed in a location upon the floor where floodwaters may begin to collect. In all cases, the owner should consider placing the pump at a location where the discharge hose is easily positioned to extend beyond the limits of the protection measures.

The discharge side of the pump should be sized to match a common 1-inch diameter garden hose or should be equipped with an adaptor to 1 inch. If there is a sandbag berm, a pump with significant capacity will be needed to collect rainfall, seepage and rising groundwater within the area of the berm.

3.0 Nonstructural Assessment Objectives

This nonstructural assessment consists of a sampling of at-risk residential and commercial structures, and one public building located in Eureka. For a nonstructural assessment, each structure must be individually investigated for purposes of determining what type of flood risk adaptive measure is most appropriate for that particular structure, given structure construction, where the structure is located within the floodplain, structure condition, what the local flood characteristics are (depth, velocities, and duration), and other site conditions (soil, permeability, vegetation). A 1% annual chance exceedance flood was considered as the benchmark for implementation of nonstructural measures to mitigate the flood risk. Detailed structure information was collected in the field, and combined with information obtained by USACE-St. Paul District with additional assistance from La Crosse.

Assessment objectives included a review and confirmation of the flood problem and determination of the appropriate nonstructural technique for each sample structure. There were several influences on each structure which were required to be evaluated to determine if the nonstructural measures considered would be appropriate for a given structure. In particular, each structure has to be in relatively good condition, i.e., has to be structurally sound, in order to withstand elevation, relocation, or flood proofing. If the structure is in poor condition, then only filling in the basement/crawlspace, if one exists, would be considered, without investigating elevation, relocation, or flood proofing, for partially reducing the flood risk. Also, there needs to be adequate space located around the structure to maneuver the necessary equipment if elevation is determined to be the designated nonstructural technique.

Abandoning the basement/crawlspace by filling with clean sand or pea gravel also includes relocating utilities, mechanical equipment (furnace, water heater, water softener, and appliances), possibly ductwork and plumbing, electrical panels and circuits, as well as some storage to a new location above the BFE. These measures were considered because they would both reduce future flood damages to the structure and reduce flood insurance premiums for the owner, which start at the lowest habitable floor elevation.

For dry flood proofing, the depth of flooding has to be limited to between three to four feet above ground elevation and the exterior walls of the structure have to be of such structural integrity as to being able to withstand the lateral forces applied by floodwaters.

Relocation of a structure is also considered if the depth of flooding is determined to be greater than 12-feet, where, if the depth at the structure is greater than 12-feet it would require the structure to be elevated to such a height that it would be unreasonable to inhabit the structure would place first responders at risk, or the costs to elevate may significantly increase due to the need for structural stability to resist wind forces on the elevated structure.

The assessment indicated that there are a significant number of at-risk structures located throughout the study area. While most of the commercial structures appear to have been constructed at ground or street level elevation, the residential structures vary in the first floor height off of the ground depending upon the style of the structure and whether a crawlspace or basement were contained within the structure. The size of structures also varied from single story to multi-story for residential structures and from individual stand-alone to multi-bay commercial structures. Many of the commercial structures were constructed as slab-on-grade, with walls being constructed of masonry, metal, or wood.

3.1 Description of Structure Dataset

For this nonstructural assessment, information was collected for a sampling of 19 structures located throughout the study area. The structures assessed are summarized in Table 1.

Table 1
La Crosse Structure Inventory Data

Structure ID#	Address	Occupancy	First Floor Elevation	Ground Elevation	1% Elevation
1	1220 St. Andrews Street	Com	643.8	642.7	645.0
2	162 Caledonia Street	Res	643.4	641.1	646.0
3	332 Caledonia Street	Res	645.2	643.0	645.4
4	307 Liberty Street	Res	643.4	640.8	646.0
5	312 Liberty Street	Res	643.0	640.2	646.0
6	1626 Onalaska Avenue	Res	643.7	641.2	645.0
7	1700 Onalaska Avenue	Res	646.0	644.0	644.0
8	1704 Onalaska Avenue	Res	644.9	642.5	645.0
9	1716 Onalaska Avenue	Res	644.0	643.7	645.0
10	2135 Kane Street	Res	644.4	641.6	643.8
11	2123 Kane Street	Res	645.4	642.9	643.8
12	2218 Charles Street	Res	642.1	641.6	643.8
13	2114 Charles Street	Res	644.1	641.2	643.8
14	1010 28th Street South	Res	658.1	656.5	658.4
15	1029 28th Street South	Res	658.1	656.0	658.4
16	1037 28th Street South	Res	658.2	656.4	658.4
17	1034 28th Street South	Res	658.3	656.8	658.0
18	223 Lang Drive	Com	649.1	644.9	646.0
19	30 Copeland Avenue	Com	647.0	642.5	644.9

Most of the inventory structure data was obtained through research conducted by the USACE-St. Paul District and additional information and photographs were collected during the field investigation with staff members from the National Nonstructural Committee and the City of La Crosse. The depths of flooding were obtained from data developed by USACE for Mississippi River Hydraulic models. Ground elevations adjacent to structures

were obtained from City of La Crosse property records. The assessment conducted was reconnaissance level in detail. Prior to mitigation being implemented on an individual structure additional detailed data would be required. For this assessment, the level of detail from the data collected is sufficient to identify potential nonstructural measures which could be effective in reducing future flood risk, life loss and property damage.

4.0 Description of Nonstructural Assessment

A site visit followed by an office assessment was conducted by members of the USACE National Nonstructural Committee (NNC) and personnel from USACE-St. Paul District for each of the 19 sample structures. The field visit allowed the USACE team to observe each structure from the exterior and interior and to reaffirm the previous data collected for each individual structure. Structure and site conditions, as well as flood elevations were compiled with field observations onto structure data/assessment sheets. The compiled information on the structure data/assessment sheets helped to demonstrate the potential flood risk and were used to identify potential nonstructural measures for implementation.

The Base Flood Elevation (1% annual chance exceedance flood elevation) was targeted for mitigation recommendations. Each structure was assessed using a similar format. The assessments and recommendations focused on mitigating structures by utilizing elevation, dry flood proofing, wet flood proofing, basement/crawlspace abandonment, or relocation/acquisition. Nonstructural flood risk adaptive measures which would be compliant with the NFIP and would reduce flood insurance premiums for the structure owner were primarily considered for potential implementation.

The nonstructural measures presented in this report are stand-alone mitigation techniques for individual structures or combination techniques to provide the most effective level of flood risk management through property damage reduction.

The following assumptions were incorporated into the assessment because of the reconnaissance level of detail:

1. Basement utilities, equipment and storage are proposed to be relocated to existing space or to a new utility addition onto the existing structure and above the mitigation flood elevation. A more detailed investigation would be required to determine the specific area to accommodate these items.
2. Inventory data adjusted based on field observations.
3. Dry flood proofing was limited to four feet in height unless the structure appeared to have the structural integrity to be capable of withstanding greater forces.
4. If the flood elevation is greater than the first-floor elevation and a basement/crawlspace exists, the first floor cannot be dry flood proofed without eliminating the basement/crawlspace by the placement of fill material.

5.0 Recommendation of Nonstructural Flood Risk Adaptive Measures

Based upon the data collected for the 19 sample structures and the potential depth of flooding for the 1% annual chance exceedance flood event, the recommended mitigation measures are identified in Table 2. The heart of the nonstructural assessment regarding the recommended nonstructural technique for each of the sample structures is provided in Appendix A which contains the individual assessment sheets for each structure. The structure assessments in Appendix A contain more detail than Table 2.

Table 2
Recommended Nonstructural Mitigation Measures

Structure ID#	Address	Occupancy	Nonstructural Technique Proposed
1	1220 St. Andrews Street	Com	Dry and wet flood proof, install flood resistant doors
2	162 Caledonia Street	Res	Elevate structure, wet flood proof crawl space
3	332 Caledonia Street	Res	Fill and wet flood proof crawl space, elevate structure
4	307 Liberty Street	Res	Fill basement, elevate structure, wet flood proof
5	312 Liberty Street	Res	Fill basement, elevate structure, wet flood proof
6	1626 Onalaska Avenue	Res	Fill basement, elevate structure, wet flood proof
7	1700 Onalaska Avenue	Res	Fill basement, relocate utilities, wet flood proof
8	1704 Onalaska Avenue	Res	Elevate structure, wet flood proof crawl space
9	1716 Onalaska Avenue	Res	Elevate structure, wet flood proof crawl space
10	2135 Kane Street	Res	Fill and wet flood proof crawl space, relocate utilities
11	2123 Kane Street	Res	Fill basement, relocate utilities, wet flood proof
12	2218 Charles Street	Res	Elevate structure, wet flood proof crawl space
13	2114 Charles Street	Res	Fill and wet flood proof crawl space, relocate utilities
14	1010 28th Street South	Res	Fill basement, elevate structure, wet flood proof
15	1029 28th Street South	Res	Fill basement, elevate structure, wet flood proof
16	1037 28th Street South	Res	Fill basement, elevate structure, wet flood proof
17	1034 28th Street South	Res	Fill basement, relocate utilities, wet flood proof
18	223 Lang Drive	Com	Dry flood proof, construct floodwall
19	30 Copeland Avenue	Com	Elevate electrical, construct optional floodwall

It was beyond the scope of this assessment to determine the economic feasibility of implementing any of the recommended nonstructural mitigation techniques. To do so would require a detailed feasibility level cost estimate for each of the mitigation measures, then annualize the cost over a 50-year project life to determine the annual cost per individual structure. Similarly, the annual benefits derived from each individual mitigation measure would be required. By estimating the reduction in future flood damages, where those prevented damages are the benefits of implementing a nonstructural technique, then annualized, a comparison of annual benefits and costs could be conducted. If the annualized benefits for a structure are divided by the annualized costs for that structure, a benefit to cost ratio (BCR) can be determined. A BCR greater than 1.0 indicates that the nonstructural mitigation measure has more benefits than costs and is worth further consideration for implementation.

6.0 Floodplain Management Recommendations for Minimizing Damages

In addition to the nonstructural measures recommended in the previous sections, there are additional low impact measures/actions which should be considered for minimizing future flood damages in the vicinity of existing properties. Simple precautionary actions can be the difference between a minor clean-up and a major replacement after a flood event.

6.1 Local Drainage and Utility Protection

During the field assessment, it became apparent from viewing some of the sample structures that local drainage problems and utility damages were prevalent within the study area and that owners could take actions to minimize future damages. As shown in Figure 6, these are two examples of actions being taken to reduce future flood damages. Many of the downspouts discharging rooftop runoff (photograph on left) were not properly directing water away from the foundation, causing erosion, and thereby exposing and weakening the foundation and providing potential pathways for floodwaters to enter or further damage some structures. The owner in this instance connected corrugated plastic drains to the downspouts and routed the runoff away from the structure.

Figure 6
Localized Interior Drainage and Utilities

After having had floodwaters damage an external HVAC system, the owner elevated the replacement system (photograph on right) onto a couple of layers of concrete modular units. It is also recommended that the owner secure and stabilize the platform to ensure that in the future, moving floodwaters do not cause the platform to fail.

7.0 Flood Insurance Premium Reduction from Nonstructural Measures

Implementation of nonstructural measures may result in reduced flood insurance premiums under the NFIP for certain structure types. Insurance premiums for structures located within the Special Flood Hazard Area are functions of the elevation of the first floor of the structure (which may be a basement or crawlspace floor, if either exists) with respect to the BFE. The lowest habitable floor elevation will dictate the premium rate for flood insurance.

For residential structures, elevation has the effect of reducing the flood insurance premium because the structure is being moved away from the flood risk. It is important to note that the insurance is based upon a single flood event, the 1% ACE flood event and not a range of flood events. If the residential structure is elevated to be above the 1% flood, there is still a possibility that a larger flood event could occur. Figure 15 illustrates the potential reduction in insurance premium for a sample structure elevated on extended foundation walls.

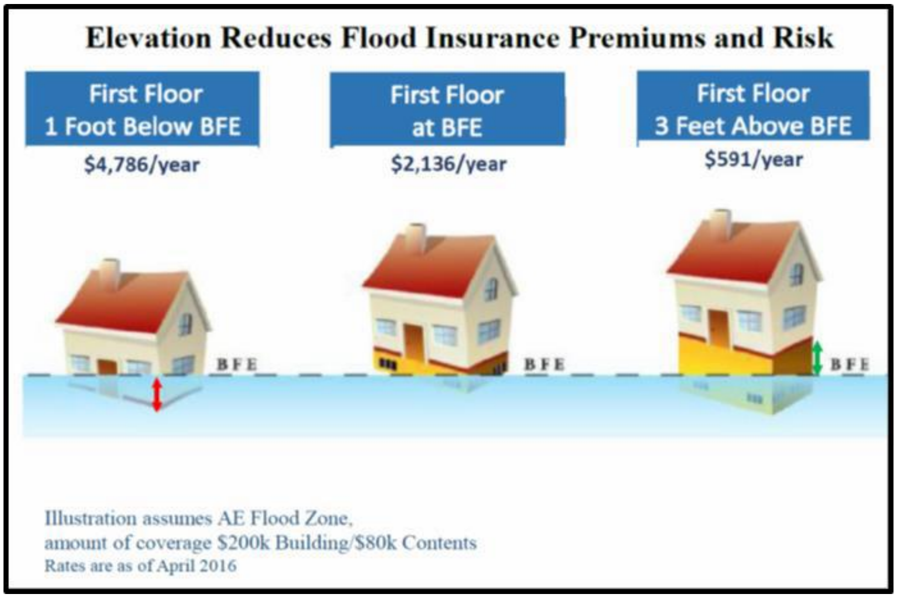


Figure 7
Flood Insurance Premium Reduction through Elevation

Currently, with regards to residential structures, no other physical nonstructural measure, other than elevation, acquisition or relocation of the structure provides a benefit by reducing the flood insurance premium. While wet flood proofing and dry flood proofing a residential structure have the potential to reduce property damages associated with flooding, neither technique results in a reduction in insurance premiums. FEMA was directed by Congress under the Homeowner Flood Insurance Affordability Act of 2014 (HIFAA) to produce guidelines for structure owners regarding alternative mitigation efforts, other than structure elevation, acquisition, or relocation, to reduce flood risk to residential structures that cannot be elevated due to structural characteristics. This request by Congress requires alternative forms of mitigation measures to be considered in the calculation of flood insurance premium rates. At the time of the publication of this report, the guidelines had not been finalized.

However, for nonstructural mitigation of commercial structures, a reduction in flood insurance premium may be obtainable if the flood risk for an individual structure can be reduced through mitigation such as elevation or dry flood proofing. As discussed in section 2.4.5, dry flood proofing is the prevention of flood waters from entering a commercial structure through implementation of engineered systems.

If dry flood proofing is a consideration for reducing flood risk, it is recommended that the structure owner employ closure barriers which have been certified through the National Flood Barrier Testing and Certification program. The purpose of the testing program is to provide a process for evaluating flood fight products in terms of their resistance to floodwaters, their material properties, and consistency of product manufacturing. Products are tested against water forces in the USACE Engineer Research and Development Center laboratory, tested against material forces in an FM Approval laboratory setting, and undergo periodic inspection of the manufacturing process for consistency of product.

Additional information regarding the certification program can be found at the following Association of State Floodplain Managers web site: http://nationalfloodbarrier.org/

8.0 Managing Flood Risk

Existing hydrologic and hydraulic analyses indicates that the flood hazard along the Lower Meramec River has the potential to be very severe.

Based upon the nonstructural assessment of 19 sample structures to determine an estimation of their exposure to flooding, there are several potential opportunities for managing the flood risk. From this assessment it appears that flood risk can be managed through implementation of nonstructural measures, by increasing overall risk preparedness, managing development through local zoning and building codes, or a combination of all. These measures are discussed in greater detail below.

8.1 Flood Preparedness Planning

Community outreach initiatives such as providing flood information pamphlets and flood maps, conducting workshops, erecting high water mark and flood history signs, can increase the awareness of flood risk among residents and draw interest toward incorporation of long-term flood risk activities. Results from this assessment may be used by local and county officials to conduct emergency preparedness activities such as evaluating roles and responsibilities, flood fight plans, and response capabilities in the event of a flood.

8.2 Future Development

Local zoning and/or building codes may be used to reduce flood risk for new construction and for community efforts in managing flood risk required by the NFIP. Given the flood risk identified along the Lower Meramec River, it is highly recommended that the communities coordinate with the State Emergency Management Agency (SEMA) regarding potential ordinances that could be adopted by a community for increasing their long-term flood resiliency.

8.3 Risk Management through Flood Insurance

The communities featured in this assessment currently participate in the NFIP, so flood insurance is available for all structures in each community regardless of their flood zone designation. Whether or not a structure is modified by implementing a nonstructural technique, flood insurance is advocated because future flooding could be greater than what has been experienced in the past or may be more severe than what a structure has been mitigated to withstand.

9.0 Assessment Conclusions

The community of La Crosse is located along the east bank of the Mississippi River and includes tributaries such as the Black and La Crosse River, Pammel Creek, State Road Coulee, Ebner Coulee, and Mormon Coulee. Numerous structures reside in the vicinity of the 1% annual exceedance floodplain and other flood-prone are and are at risk of flooding. The USACE St. Paul District collaborated with LA Crosse on a nonstructural assessment to identify potential nonstructural measures on a sampling of 19 structures in flood prone areas. The proposed solutions can be applied to other structures in La Crosse.

As a function of this assessment, the primary characteristics of flooding, such as depth, velocity, duration, and areal extent were combined with structure attributes for each of the 19 sample structures to determine the flood risk for the target 1% annual chance exceedance flood event. From this information, potential nonstructural measures for each structure could be determined. The measures proposed were scaled to the flood risk for the individual structure. As an example, if the 1% annual chance exceedance flood depth were no greater than a foot or two above the first floor elevation of a structure, there would be no need to consider acquisition or relocation of the structure, when elevating or dry flood proofing the structure may significantly decrease the flood risk and ensure that the structure remains active on the property tax rolls.

Since flooding within the assessment area could occur after a significant rainfall event, this assessment also provides practical information for the implementation of temporary measures as a stop-gap consideration prior to implementing permanent measures. Materials and equipment needs are described in section 2.7 in an effort to provide the owner/tenant with enough background information to develop a successful temporary measures flood response plan.

With regards to the implementation of permanent nonstructural measures, the assessment identified one practical technique for each of the sample structures, which could be implemented to reduce flood risk. Appendix A contains copies of the individual assessment sheet for each of the 19 sample structures which identify the proposed nonstructural measure for consideration.

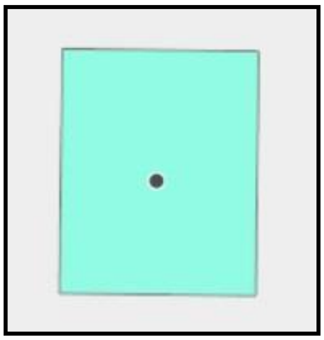
As stated earlier in this report, for structures located within the regulatory floodway, it is USACE policy to only recommend acquisition or relocation of such structures in order to prevent occupation of an area of flood risk established for conveyance of the 1% annual chance exceedance flood.

This assessment should be used as a tool to educate community officials, residents, and business owners about the risk of flooding as well as the potential opportunities for reducing the flood risk through the nonstructural techniques presented.

APPENDIX A:
Structure Assessment Sheets

1220 St. Andrews Street

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	1	First Floor Area (ft^2)	12650
Year Constructed	2002	First Floor Elevation (FF)	643.8
Occupancy type	Commercial	Basement/Crawlspace Elevation (B)	NA
Number of Stories	1	Lowest Adjacent Grade (LAG)	642.7
Wall Construction	Masonry	Base Flood Elevation (BFE)	645
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Slab	FF minus BFE	-1.2
Condition (Good/Fair/Poor)	Good	FF minus LAG	1.1
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	2.3



Structure Footprint

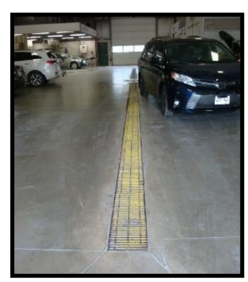
Left Side and Front

Front and Right Side

Rear

Guides for Stop Logs

Exterior Crawlspace Access

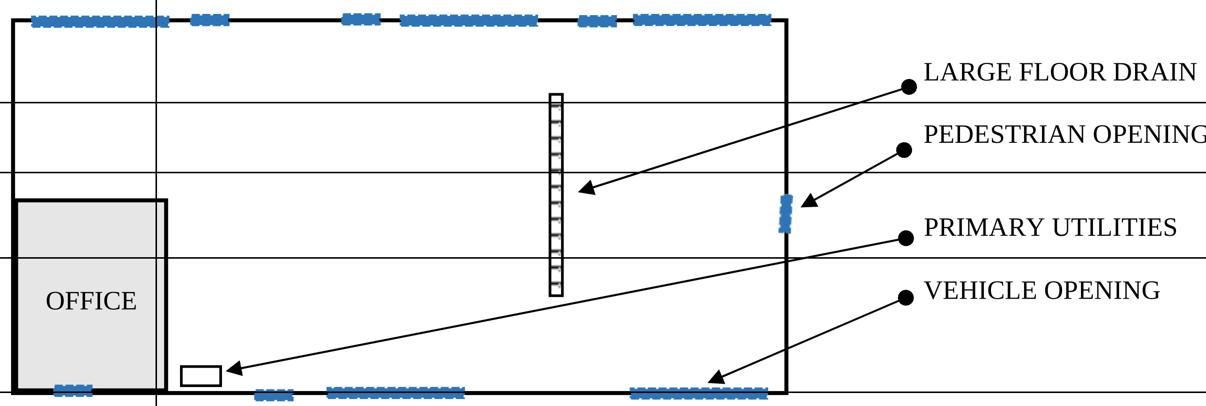


Interior Flood Drain

Site Visit Observations
1. Met owner and was approved to view interior and exterior of structure.
2. Pedestrian doorways have stop log guides. Vehicle entrances with bollards for structure protection.
3. Mechanical and electrical components elevated with exception to interior electrical panel.

Structure ID	Structure Address
#1	1220 St Andrews Street

Existing Structure (Plan View)

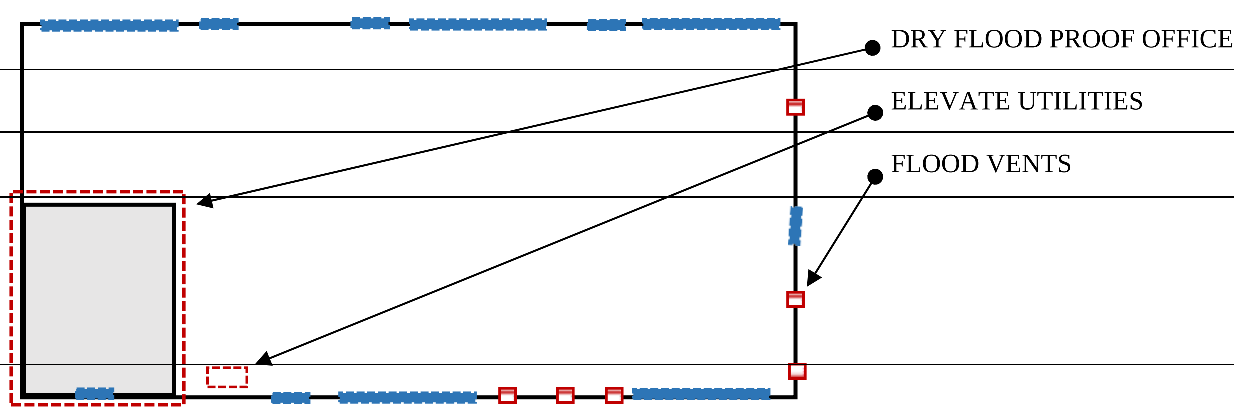


<u>DIAGRAMATIC BUILDING SECTION (EXISTING)</u>

NOT TO SCALE

Nonstructural Recommendation
1. Existing first floor of structure is currently 1.2 feet below the BFE of 645.
2. Dry flood proof entire office area and wet flood proof remaining area due to large number of openings.
4. Elevate all electrical to 2-feet above the BFE, with focus on primary electrical utilities.
5. Install flood resistant doors/frames for office entrances, flood vents for structure (walls/vehicle entrance doors).

Diagrammatic Structure Section (Recommendation)



<u>DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)</u>

NOT TO SCALE

<u>162 Caledonia Street</u>

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	2	First Floor Area (ft^2)	908
Year Constructed	1920	First Floor Elevation (FF)	643.4
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	641.8 est
Number of Stories	1	Lowest Adjacent Grade (LAG)	641.1
Wall Construction	Stucco	Base Flood Elevation (BFE)	646.0
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Crawlspace	FF minus BFE	-2.6
Condition (Good/Fair/Poor)	Fair	FF minus LAG	2.3
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	4.9

Building Footprint

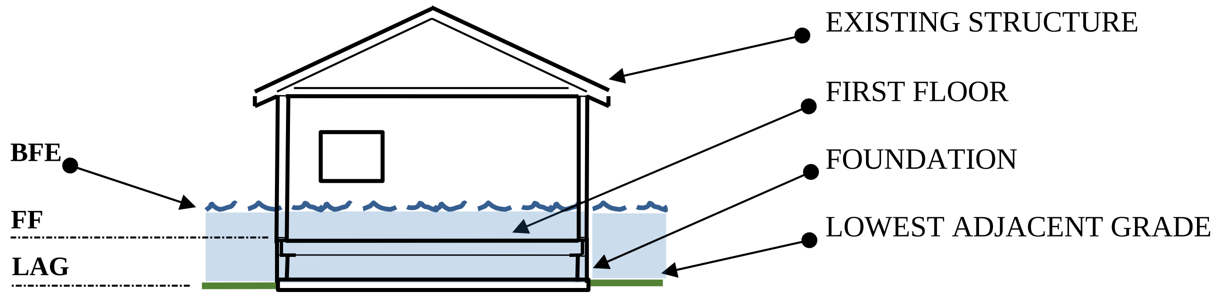
Front View

Side View

Site Visit Observations
1. No right of entry. 2. No internal view. 3. Detached garage. 4. The first floor is approximately 2.6 feet below the Base Flood Elevation of 646. 5. Elevation Certificate indicates structure is slab on grade, but site visit indicates extended foundation. 6. From street view, no windows or vents identified in foundation walls.

Structure ID	Structure Address
#2	162 Caledonia Street

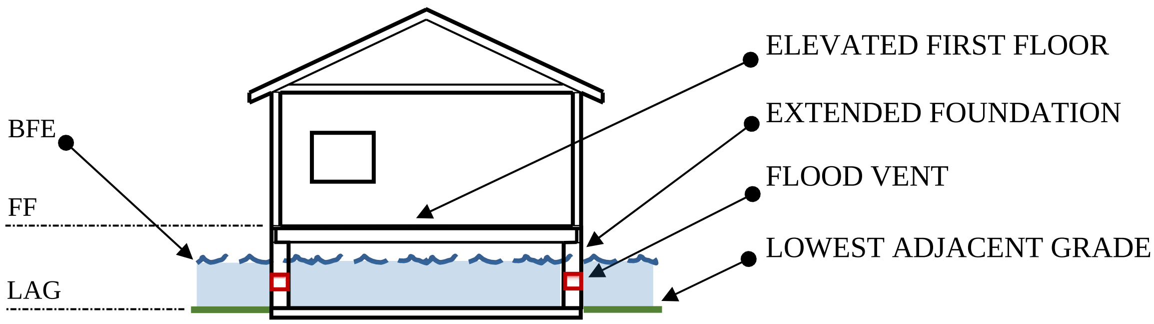
Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)

NOT TO SCALE

Nonstructural Recommendation
1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE. 2. Wet flood proof crawl space and incorporate flood vents
Diagrammatic Structure Section (Recommendation)

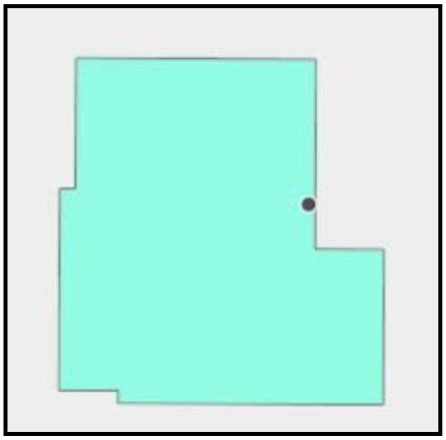


DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)

NOT TO SCALE

332 Caledonia Street

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	3	First Floor Area (ft^2)	2218
Year Constructed	1914	First Floor Elevation (FF)	645.2
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	638.2
Number of Stories	2	Lowest Adjacent Grade (LAG)	643.0
Wall Construction	Stucco	Base Flood Elevation (BFE)	645.4
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Crawlspace	FF minus BFE	-0.2
Condition (Good/Fair/Poor)	Fair	FF minus LAG	2.2
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	2.2


Structure Footprint


Front

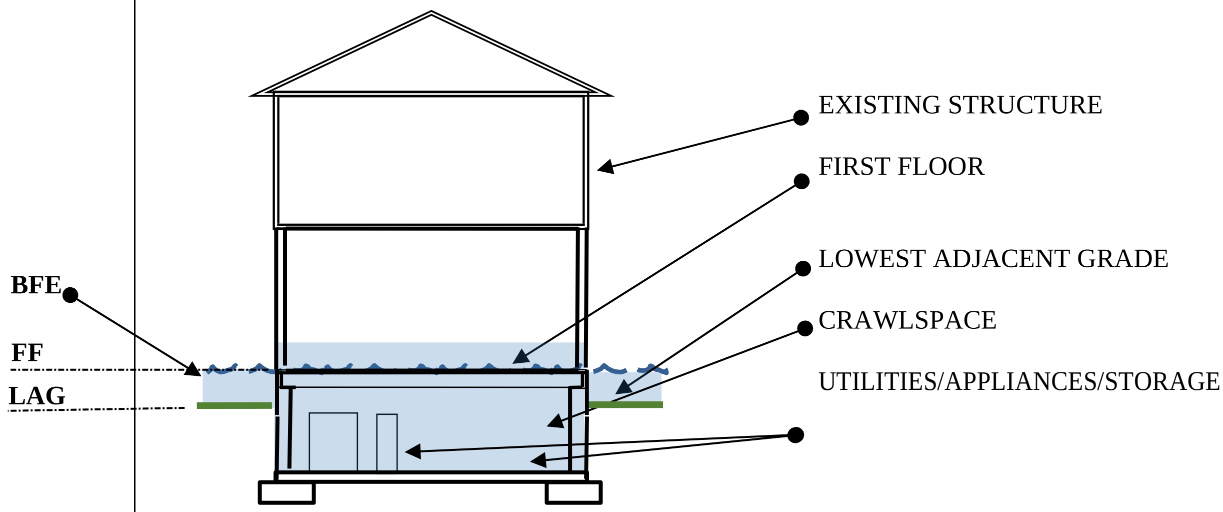

Left Side and Front


Rear

Site Visit Observations
1. No right of entry and no internal view of structure. 2. Exterior walls are stucco and foundation appears to be concrete. 3. A vent, possibly for clothes dryer, was visible is foundation left side view. 4. Window identified in right side view. 5. Detached garage. 6. First floor is 0.2 feet below Base flood elevation of 645.4

Structure ID	Structure Address
#3	332 Caledonia Street

Existing Structure

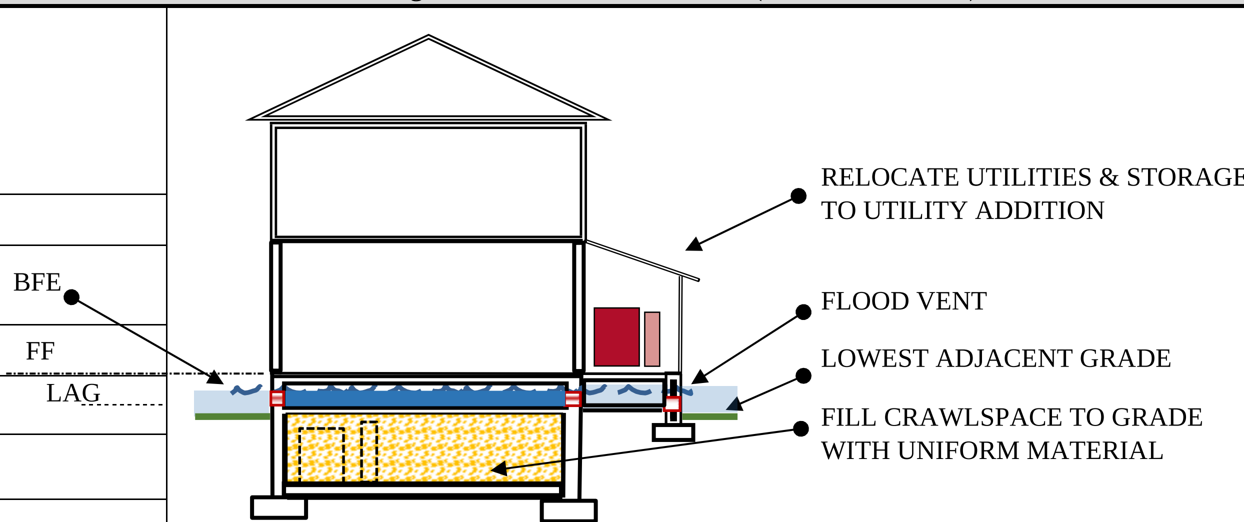


DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

Nonstructural Recommendation

1. Relocate crawlspace utilities/appliances/partial storage to utility addition above BFE.
2. Fill crawlspace to grade level. Consider maintaining 5-foot by 8-foot shaft as storm shelter in crawlspace.
3. Elevate structure on extended foundation walls with 2-foot of freeboard.
4. Wet flood proof above grade crawl space and incorporate flood vents

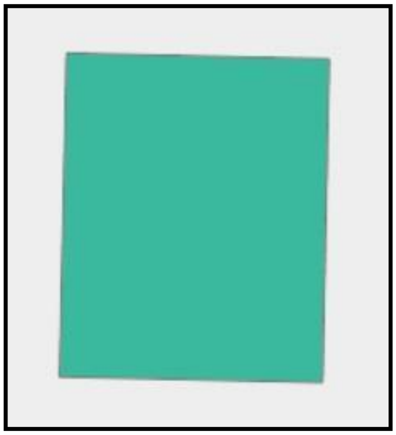
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

307 Liberty Street

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	4	First Floor Area (ft^2)	780
Year Constructed	1958	First Floor Elevation (FF)	643.4
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	635.8
Number of Stories	1	Lowest Adjacent Grade (LAG)	640.8
Wall Construction	Wood	Base Flood Elevation (BFE)	646
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Basement	FF minus BFE	-2.6
Condition (Good/Fair/Poor)	Fair	FF minus LAG	2.6
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	5.2


Structure Footprint


Front


Left Side and Front

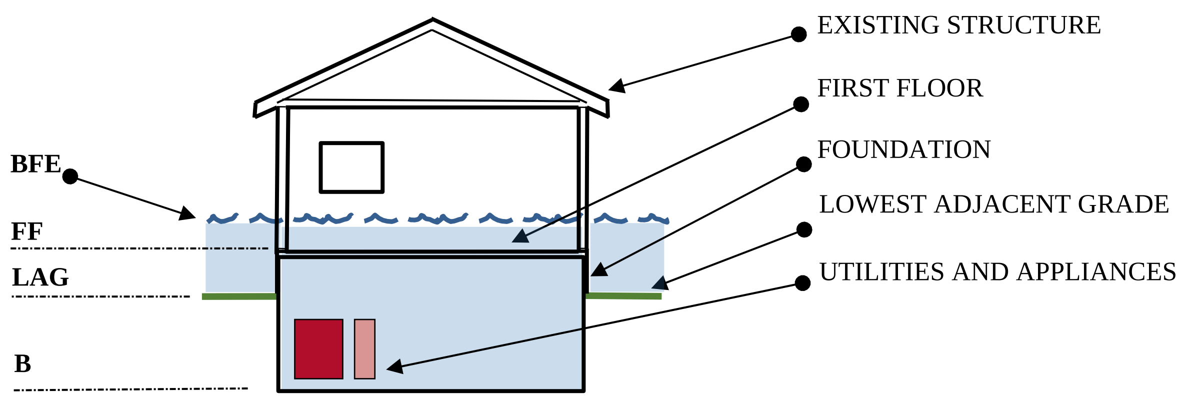

Right Side


Sump Pump Discharge

Site Visit Observations
1. No right of entry or internal view of structure. 2. Structure has attached garage. 3. First floor is 2.6 feet below Base Flood Elevation of 646. 4. Excessive sump pump discharge occurring from basement with fine material being removed.

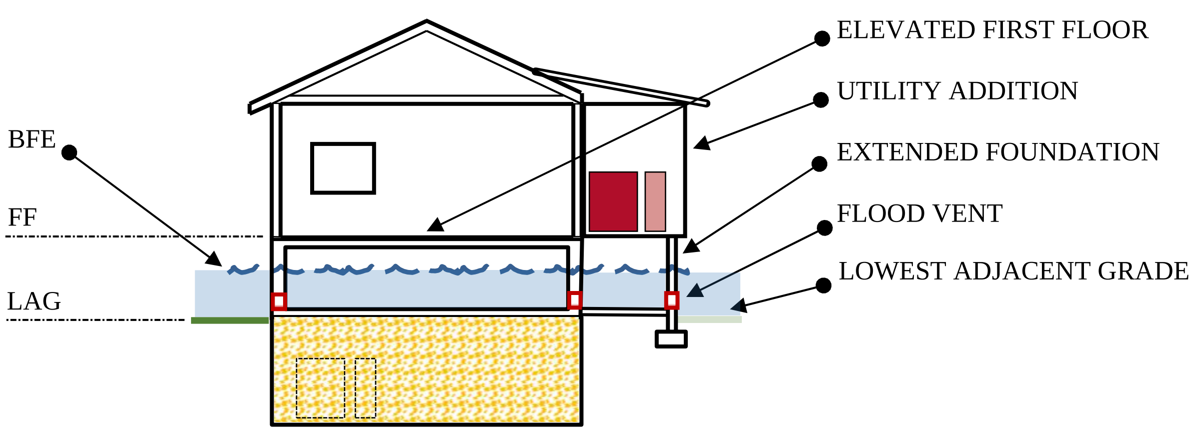
Structure ID	Structure Address
#4	307 Liberty Street

Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

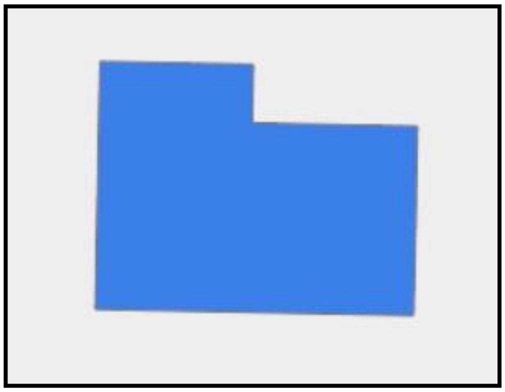
Nonstructural Recommendation
1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE. 2. Abandon basement and fill with uniform material. Consider incorporating 5-foot x 8-foot storm shelter. 3. Relocate utilities and appliances to utility addition. 4. Wet flood proof crawl space and incorporate flood vents.
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

<u>312 Liberty Street</u>

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	5	First Floor Area (ft^2)	1358
Year Constructed	1885	First Floor Elevation (FF)	643.0
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	634.8
Number of Stories	2	Lowest Adjacent Grade (LAG)	640.2
Wall Construction	Wood	Base Flood Elevation (BFE)	646
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Basement	FF minus BFE	-3.0
Condition (Good/Fair/Poor)	Good	FF minus LAG	2.8
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	5.8



Structure Footprint

Front

Left Side and Front

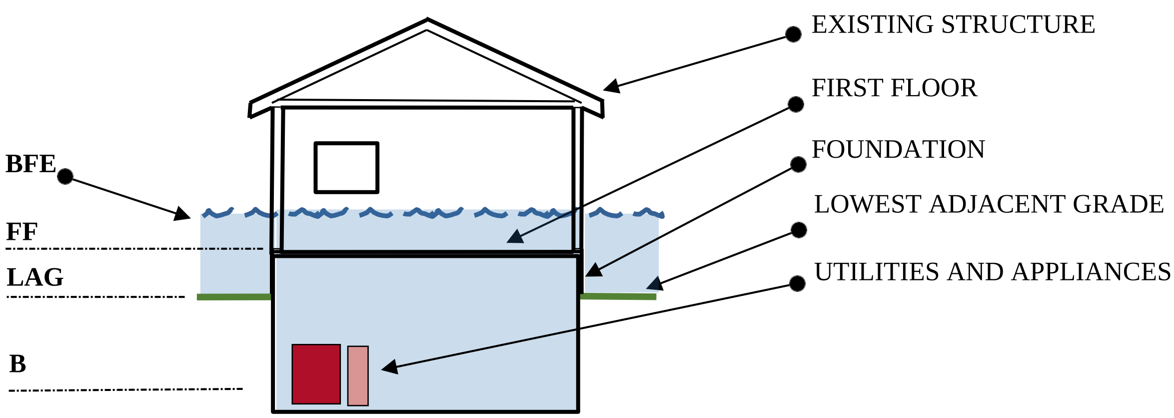
Front and Right Side

Sump Pump Discharge

Site Visit Observations
1. No right of entry or internal view of structure.
2. Structure has detached garage.
3. First floor is 3.0 feet below Base Flood Elevation of 646.
4. Excessive sump pump discharge occurring from basement with fine material being removed.

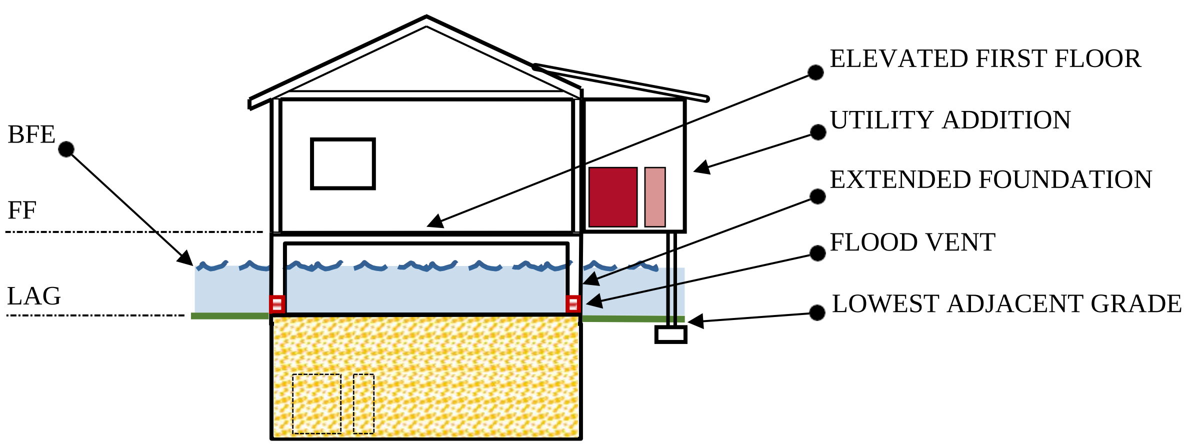
Structure ID	Structure Address
#5	312 Liberty Street

Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

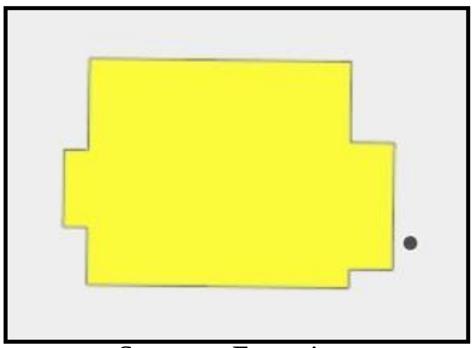
Nonstructural Recommendation
1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE. 2. Abandon basement and fill with uniform material. Consider incorporating 5-foot x 8-foot storm shelter. 3. Relocate utilities and appliances to utility addition. 4. Wet flood proof crawl space and incorporate flood vents.
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

1626 Onalaska Avenue

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	6	First Floor Area (ft^2)	1276
Year Constructed	1948	First Floor Elevation (FF)	643.7
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	634.7 est
Number of Stories	1.5	Lowest Adjacent Grade (LAG)	641.2 est
Wall Construction	Wood	Base Flood Elevation (BFE)	645
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Basement	FF minus BFE	-1.3
Condition (Good/Fair/Poor)	Good	FF minus LAG	2.5
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	3.8


Structure Footprint


Front

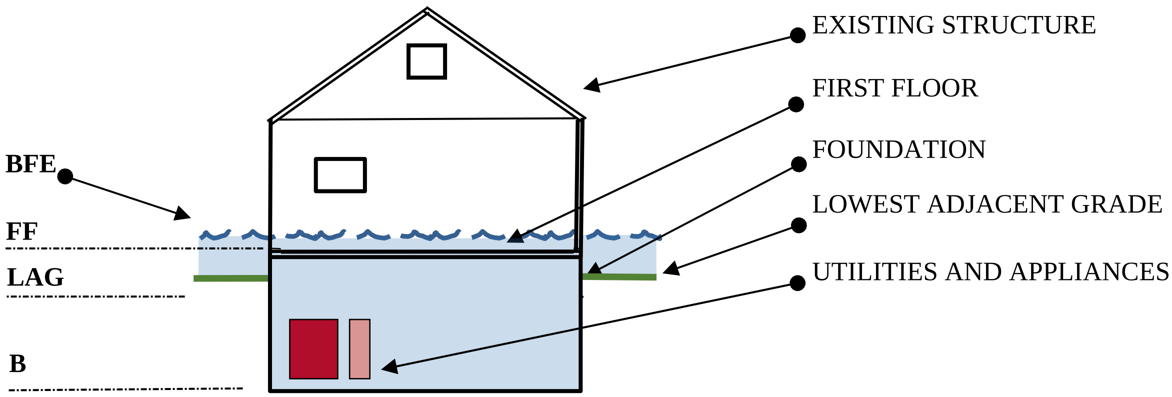

Left Side and Front


Front and Right Side

Site Visit Observations
1. No right of entry or internal view of structure. 2. Property is elevated approximately one foot above curb elevation. 3. First floor is 1.3 feet below the Base flood Elevation of 645. 4. Detached garage.

Structure ID	Structure Address
#6	1626 Onalaska Avenue

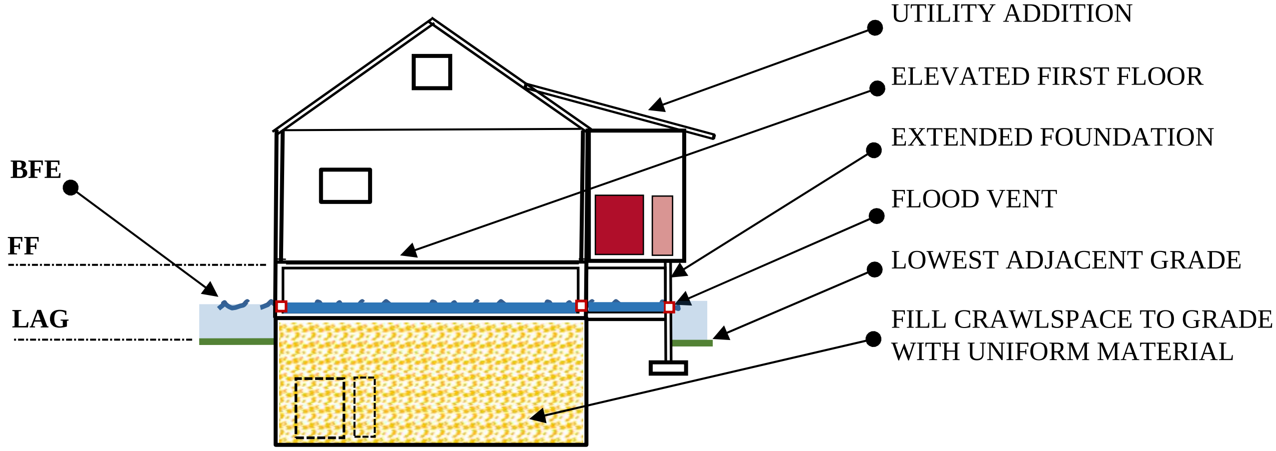
Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)

NOT TO SCALE

Nonstructural Recommendation
1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE. 2. Abandon basement and fill with uniform material. Consider incorporating 5-foot x 8-foot storm shelter. 3. Relocate utilities and appliances to utility addition. 4. Wet flood proof crawl space and incorporate flood vents.
Diagrammatic Structure Section (Recommendation)

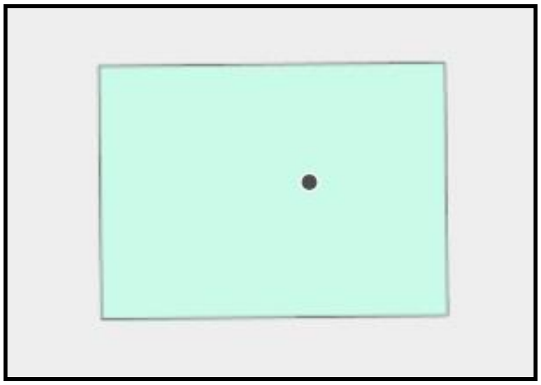


DIAGRAMATIC BUILDING SECTION (EXISTING)

NOT TO SCALE

1700 Onalaska Avenue

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	7	First Floor Area (ft^2)	1872
Year Constructed	1986	First Floor Elevation (FF)	646.0
Occupancy type	Residential (duplex)	Basement/Crawlspace Elevation (B)	637.9
Number of Stories	2	Lowest Adjacent Grade (LAG)	644.0
Wall Construction	Wood	Base Flood Elevation (BFE)	644
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Basement	FF minus BFE	2.0
Condition (Good/Fair/Poor)	Fair	FF minus LAG	2.0
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	0


Structure Footprint


Front

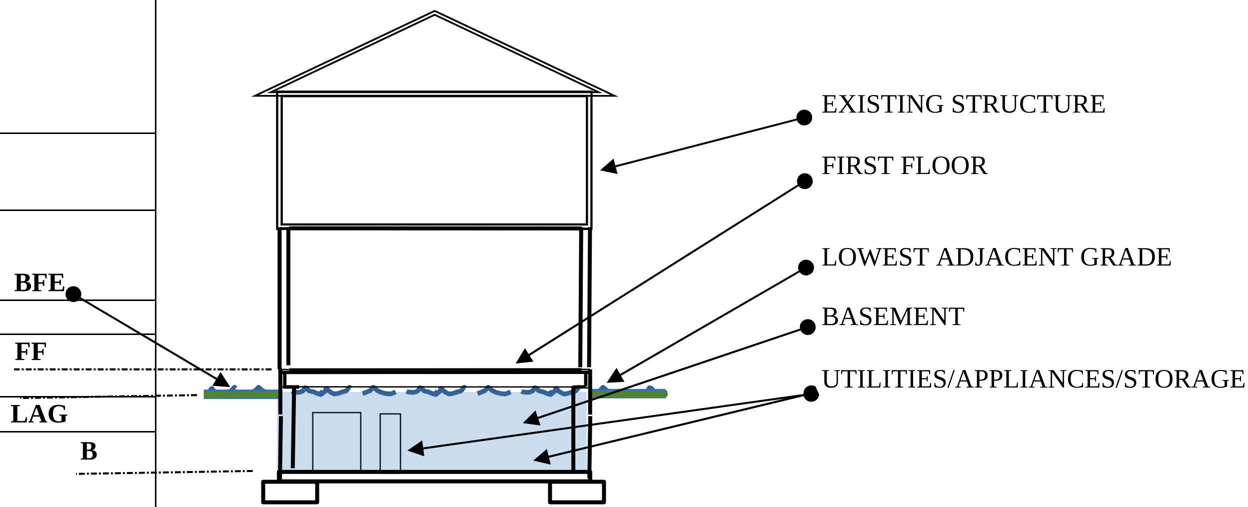
Left Side

Rear

Site Visit Observations
1. No right of entry but tenant gave permission to view exterior.
2. Structure is a duplex with basement.
3. First floor is 2.0 feet above the Base Flood Elevation of 644.
4. Tenant indicated that interior drain system was being incorporated into basement (see Left Side photo)

Structure ID	Structure Address
#7	1700 Onalaska Avenue

Existing Structure



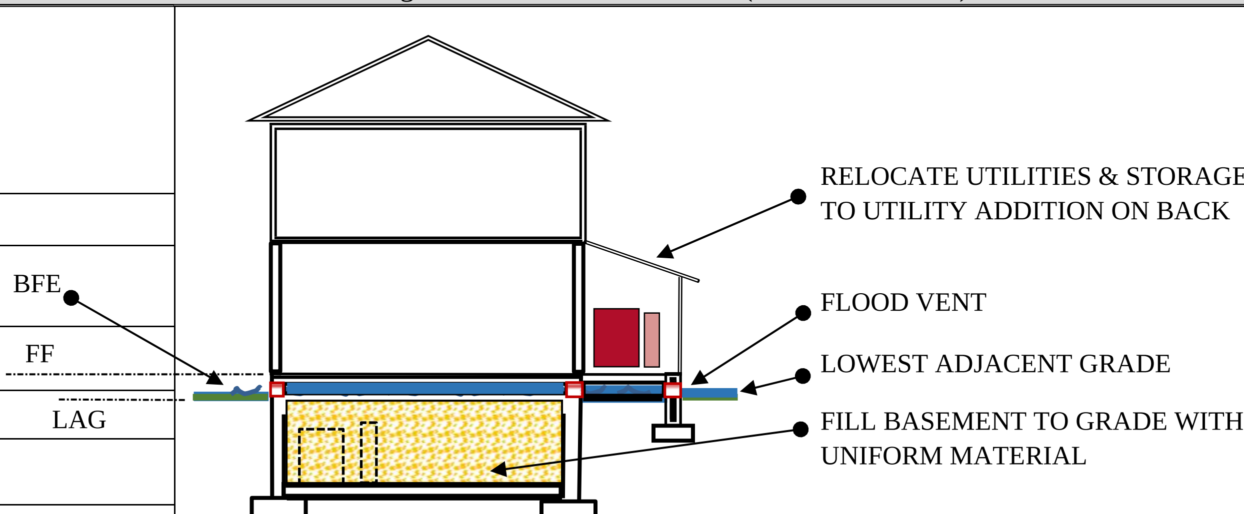
DIAGRAMATIC BUILDING SECTION (EXISTING)

NOT TO SCALE

Nonstructural Recommendation

1. If the proposed interior drainage system does not function appropriately, the following items are recommended.
2. Relocate basement utilities/appliances/partial storage to utility addition at FF elevation which is above the BFE.
3. Fill basement to grade level. Consider maintaining 5-foot by 8-foot shaft as storm shelter in basement.
4. Add flood vents to crawlspace (area between basement cap and first floor).

Diagrammatic Structure Section (Recommendation)

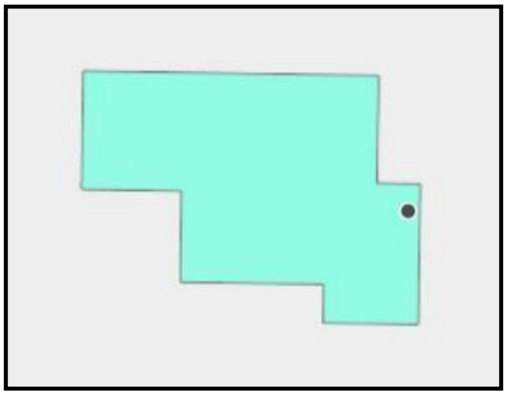


DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)

NOT TO SCALE

1704 Onalaska Avenue

Structure Information/Data:		Structure/Flood Elevations:	
Structure Number	8	First Floor Area (ft^2)	709
Year Constructed	1952	First Floor Elevation (FF)	644.9
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	636.9
Number of Stories	1	Lowest Adjacent Grade (LAG)	642.5
Wall Construction	Wood	Base Flood Elevation (BFE)	645
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Crawl and Basement	FF minus BFE	-0.1
Condition (Good/Fair/Poor)	Fair	FF minus LAG	2.4
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	2.5



Structure Footprint

Front

Left Side

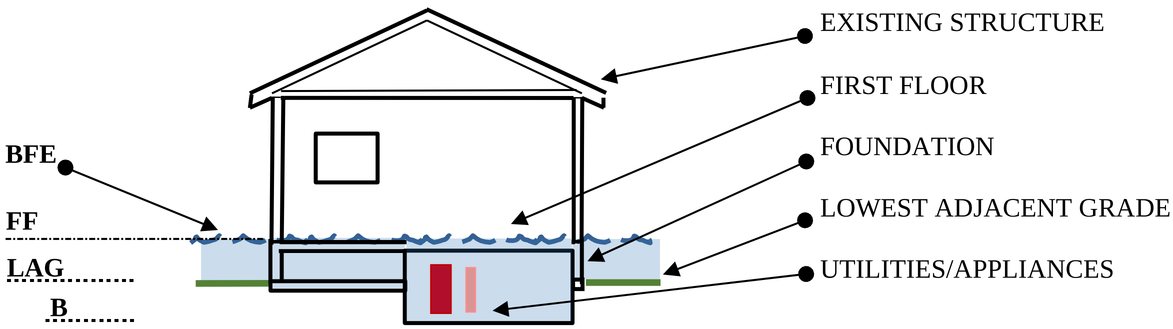
Right Side

Rear

Site Visit Observations
1. No right of entry but owner granted permission to view exterior. 2. Structure has exterior access to crawlspace and basement. 3. First floor is 0.1 feet above the Base Flood Elevation of 645. 4. Sump pump was discharging significant amount of water from basement. 5. Structure has detached garage.

Structure ID	Structure Address
#8	1704 Onalaska Avenue

Existing Structure



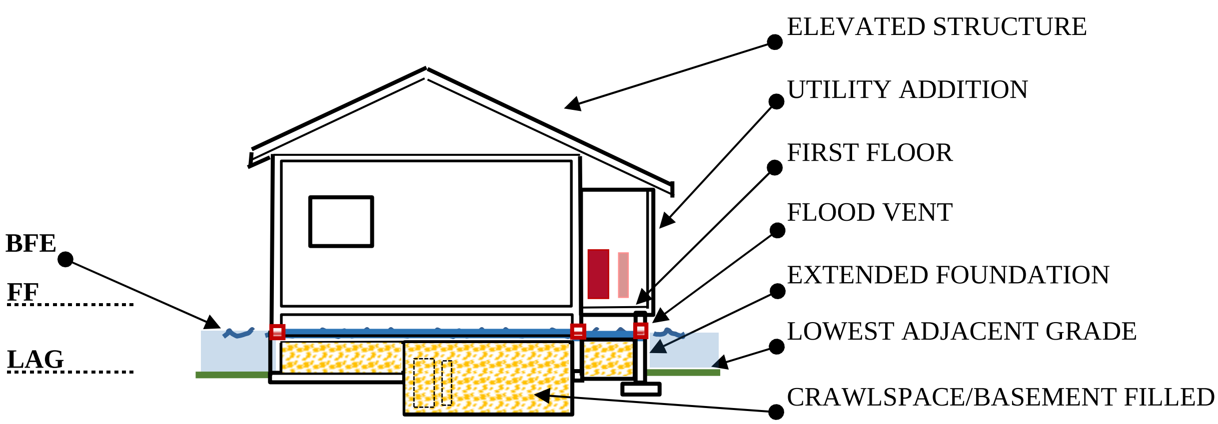
DIAGRAMATIC BUILDING SECTION (EXISTING)

NOT TO SCALE

Nonstructural Recommendation

1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE.
2. Wet flood proof crawl space and incorporate flood vents

Diagrammatic Structure Section (Recommendation)

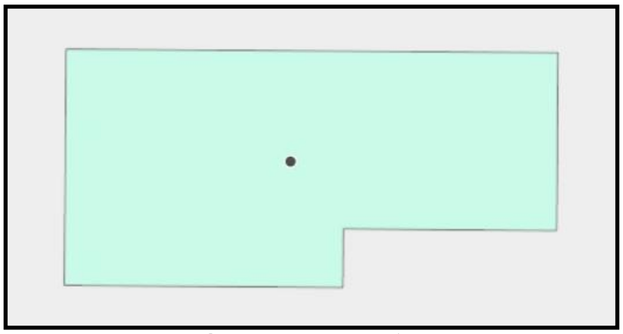


DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)

NOT TO SCALE

1716 Onalaska Avenue

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	9	First Floor Area (ft^2)	1533
Year Constructed	1968	First Floor Elevation (FF)	644.0
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	NA
Number of Stories	1	Lowest Adjacent Grade (LAG)	643.7
Wall Construction	Brick	Base Flood Elevation (BFE)	645
Foundation Construction	Slab	1% ACE Velocity	
Slab/Crawlspace/Basement	Slab	FF minus BFE	-1.0
Condition (Good/Fair/Poor)	Good	FF minus LAG	0.3
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	1.3



Structure Footprint

Front

Left side (from rear)

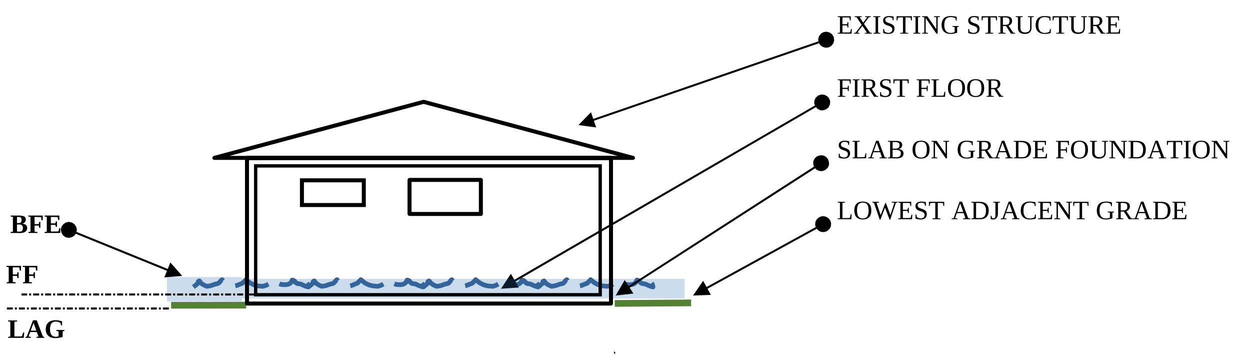
Right Side

Rear (breezeway connecting garage)

Site Visit Observations
1. No right of entry but owner granted permission to view exterior.
2. First floor is 1.0 feet below the Base Flood Elevation of 645.
3. Structure originally had detached garage which now has been connected to house by breezeway.

Structure ID	Structure Address
#9	1716 Onalaska Avenue

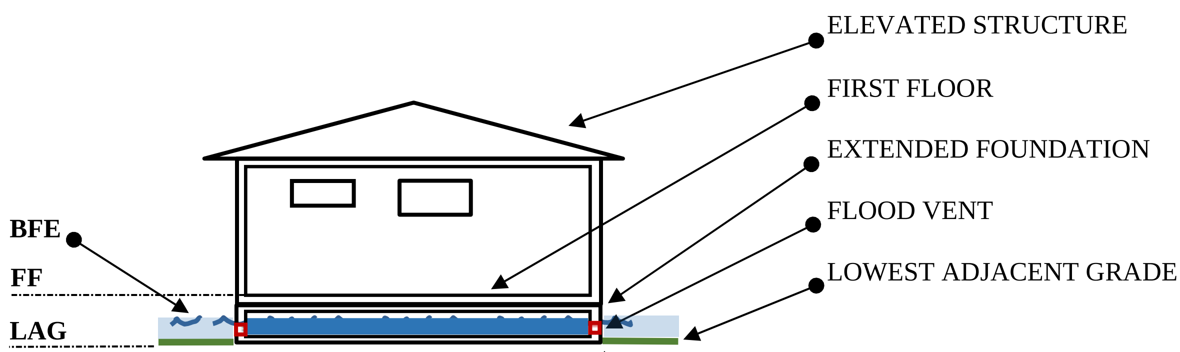
Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)

NOT TO SCALE

Nonstructural Recommendation
1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE. 2. Wet flood proof crawl space and incorporate flood vents. 3. If garage is for vehicles, rather than elevating garage floor, recommend wet flood proofing to 3-foot height. 4. If garage has previously been converted to living space, elevate with primary structure.
Diagrammatic Structure Section (Recommendation)

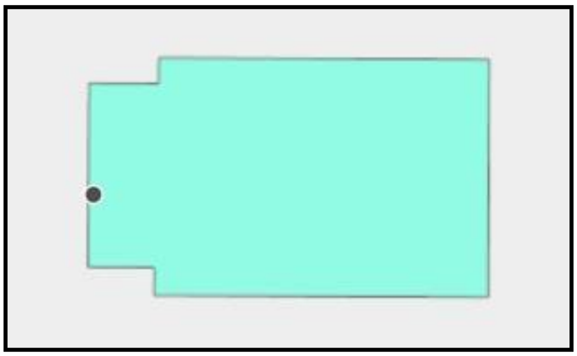


DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)

NOT TO SCALE

2135 Kane Street

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	10	First Floor Area (ft^2)	1008
Year Constructed	1925	First Floor Elevation (FF)	644.4
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	637.2
Number of Stories	1	Lowest Adjacent Grade (LAG)	641.6
Wall Construction	Wood	Base Flood Elevation (BFE)	643.8
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Crawl and Basement	FF minus BFE	0.6
Condition (Good/Fair/Poor)	Fair	FF minus LAG	2.8
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	2.2


Structure Footprint


Front


Left Side and Front

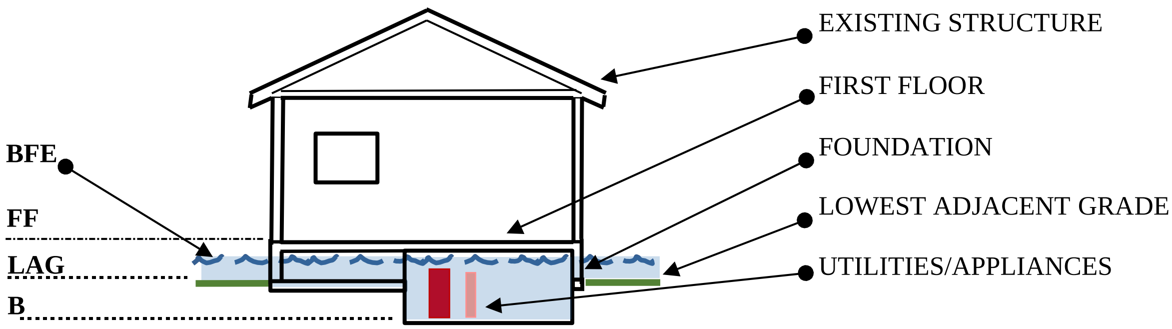

Right Side


Rear

Site Visit Observations
1. No right of entry or interior view of structure. 2. First floor is 0.6 feet above the Base Flood Elevation of 643.8 3. Structure has detached garage

Structure ID	Structure Address
#10	2135 Kane Street

Existing Structure

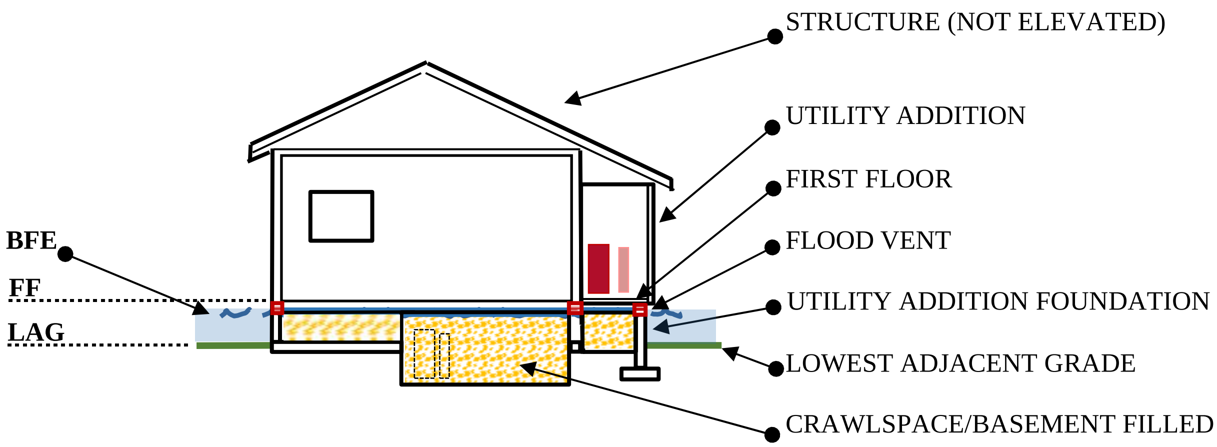


DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

Nonstructural Recommendation

1. First floor elevation is above the BFE.
2. Abandon crawlspace/basement, fill with uniform material, and relocate utilities/appliances to utility addition.
3. Wet flood proof new crawlspace and incorporate flood vents.

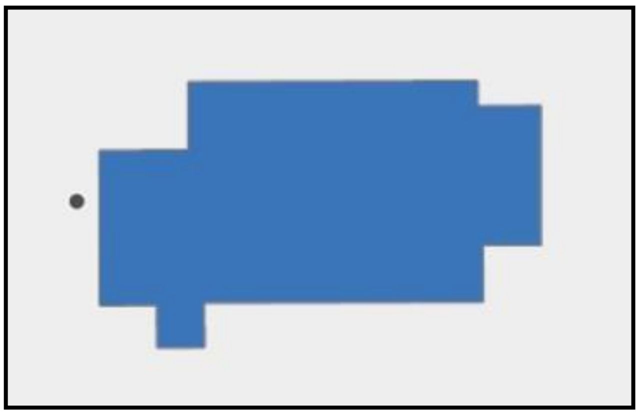
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

2123 Kane Street

Structure Information/Data:		Structure/Flood Elevations:	
Structure Number	11	First Floor Area (ft^2)	1344
Year Constructed	1924	First Floor Elevation (FF)	645.4
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	638.1
Number of Stories	1.5	Lowest Adjacent Grade (LAG)	642.9 est
Wall Construction	Wood	Base Flood Elevation (BFE)	643.8
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Basement	FF minus BFE	1.6
Condition (Good/Fair/Poor)	Fair	FF minus LAG	2.5
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	0.9


Structure Footprint


Front


Left Side

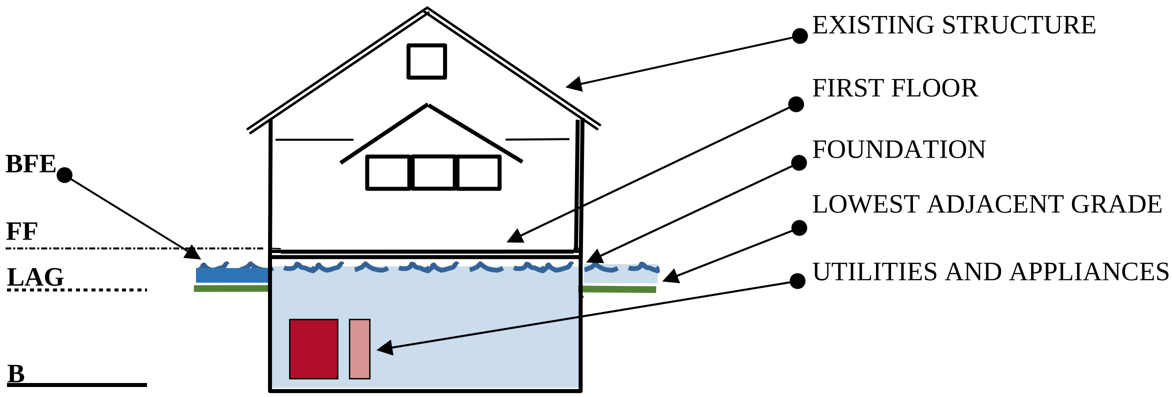

Right Side


Rear

Site Visit Observations
1. No right of entry or interior view of structure. 2. First floor is 1.6 feet above the Base Flood Elevation of 643.8 3. Structure has an attached garage located at rear of structure at basement level.

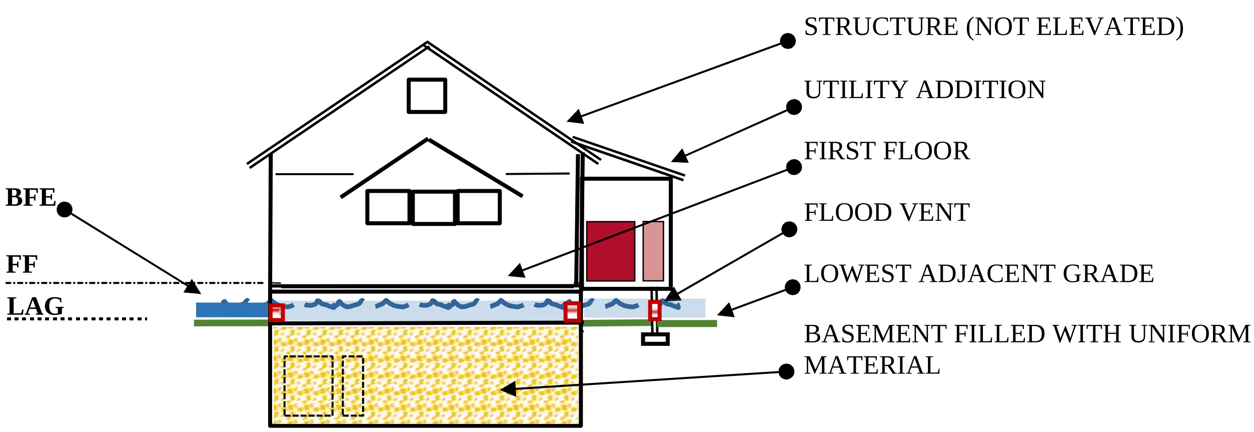
Structure ID	Structure Address
#11	2123 Kane Street

Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

Nonstructural Recommendation
1. First floor elevation is already above the BFE. 2. Abandon basement and fill with uniform material. Consider incorporating 5-foot x 8-foot storm shelter. 3. Relocate utilities and appliances to utility addition. 4. Wet flood proof crawl space and incorporate flood vents.
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

2218 Charles Street

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	12	First Floor Area (ft^2)	935
Year Constructed	1948	First Floor Elevation (FF)	642.1
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	638.1 est
Number of Stories	1	Lowest Adjacent Grade (LAG)	641.6
Wall Construction	Wood	Base Flood Elevation (BFE)	643.8
Foundation Construction	Slab	1% ACE Velocity	
Slab/Crawlspace/Basement	Crawlspace	FF minus BFE	-1.7
Condition (Good/Fair/Poor)	Fair	FF minus LAG	0.5
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	2.2

Structure Footprint

Front

Front and Right Side

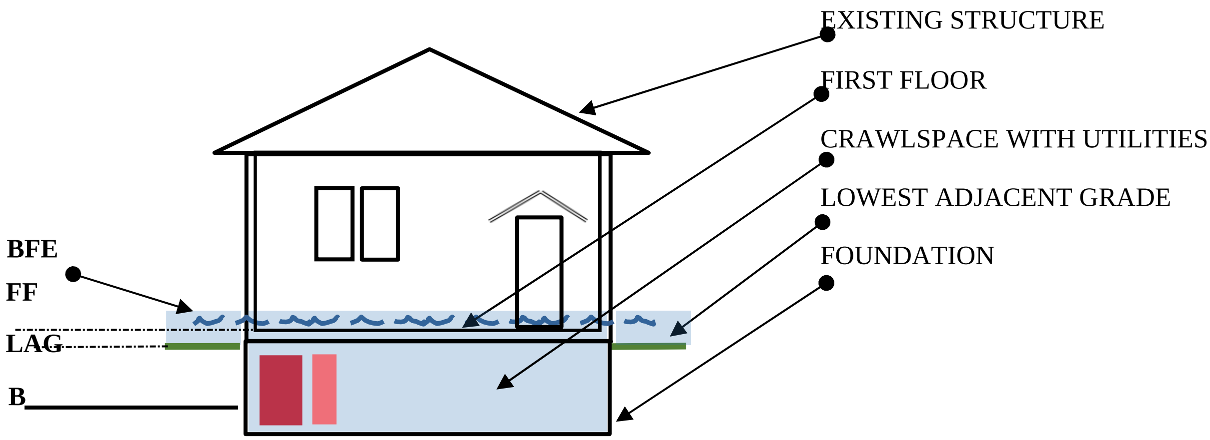
Right Side and Rear (from rear)

Rear and Left Side (from rear)

Site Visit Observations
1. No right of entry or interior view of structure. 2. First floor is 1.7 feet below the Base Flood Elevation of 643.8 3. No garage. 4. Unable to determine if utilities exist within the crawlspace.

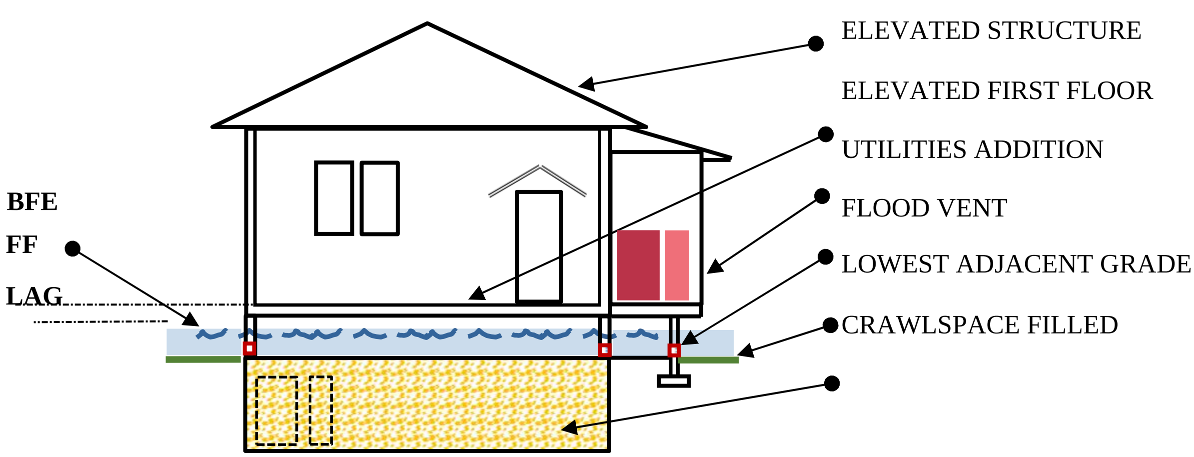
Structure ID	Structure Address
#12	2218 Charles Street

Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

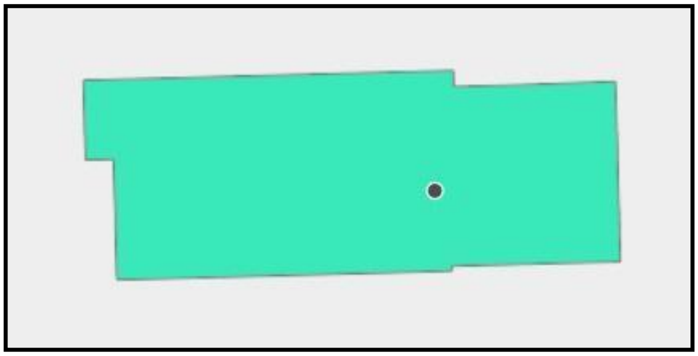
Nonstructural Recommendation
1. Determine if slab is reinforced or poured for elevation considerations. 2. Elevate slab and structure on extended foundation walls with 2-foot of freeboard above BFE. 3. Wet flood proof remaining crawlspace and incorporate flood vents.
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

2114 Charles Street

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	13	First Floor Area (ft^2)	1538
Year Constructed	1925	First Floor Elevation (FF)	644.1
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	636.9
Number of Stories	1	Lowest Adjacent Grade (LAG)	641.2
Wall Construction	Wood	Base Flood Elevation (BFE)	643.8
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Crawlspace	FF minus BFE	0.3
Condition (Good/Fair/Poor)	Fair	FF minus LAG	2.9
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	2.6



Structure Footprint

Left Side and Front

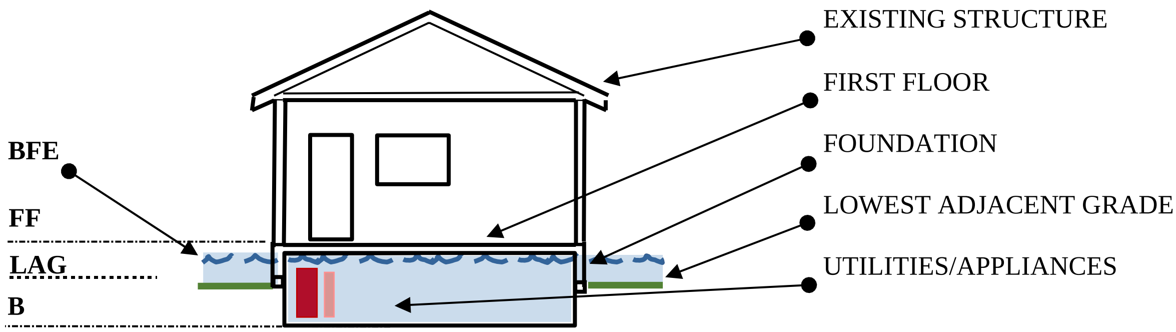
Rear and Left Side (from rear)

Right Side and Rear (from rear)

Site Visit Observations
1. No right of entry or interior view of structure. 2. First floor is 0.3 feet above the Base Flood Elevation of 643.8 3. Owner stated that the house had been elevated approximately 2-feet in the 1940's. 4. Structure has detached garage. 5. Could not determine if utilities were located in the crawlspace.

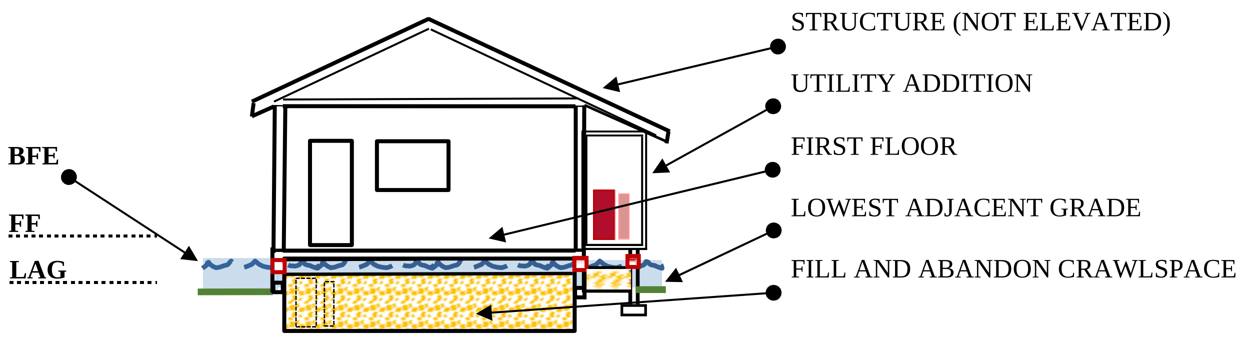
Structure ID	Structure Address
#13	2114 Charles Street

Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

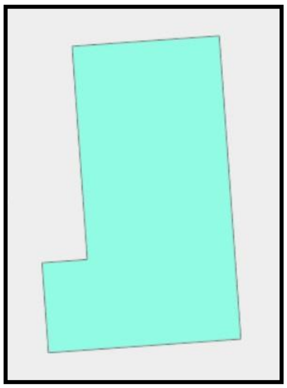
Nonstructural Recommendation
1. First floor is located above the BFE and does not require elevation. 2. Abandon and fill existing crawlspace with uniform material and relocate utilities to a utility addition. 3. Wet flood remaining proof crawl space and incorporate flood vents.
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

1010 28th Street South

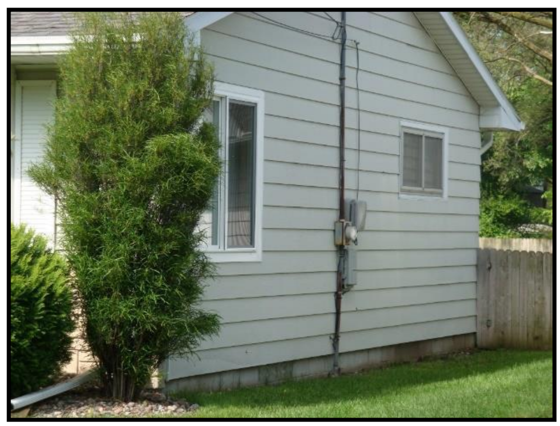
Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	14	First Floor Area (ft^2)	1276
Year Constructed	1963	First Floor Elevation (FF)	658.1
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	650.1
Number of Stories	1	Lowest Adjacent Grade (LAG)	656.5
Wall Construction	Wood	Base Flood Elevation (BFE)	658.4
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Basement	FF minus BFE	-0.3
Condition (Good/Fair/Poor)	Fair	FF minus LAG	1.6
Existing Fireplace (Y/N)	1	Flood Depth (BFE-LAG)	1.9



Structure Footprint

Front

Left Side and Front

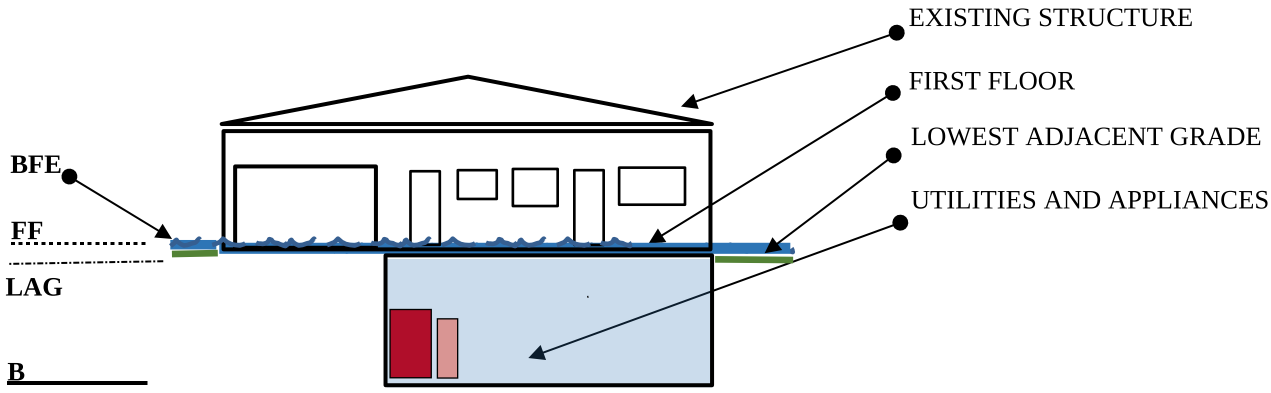


Right Side

Site Visit Observations
1. No right of entry or interior view of structure. 2. First floor is 0.3 feet below the Base Flood Elevation of 658.4 3. Structure backs up to Coulee 4. Structure has attached garage.

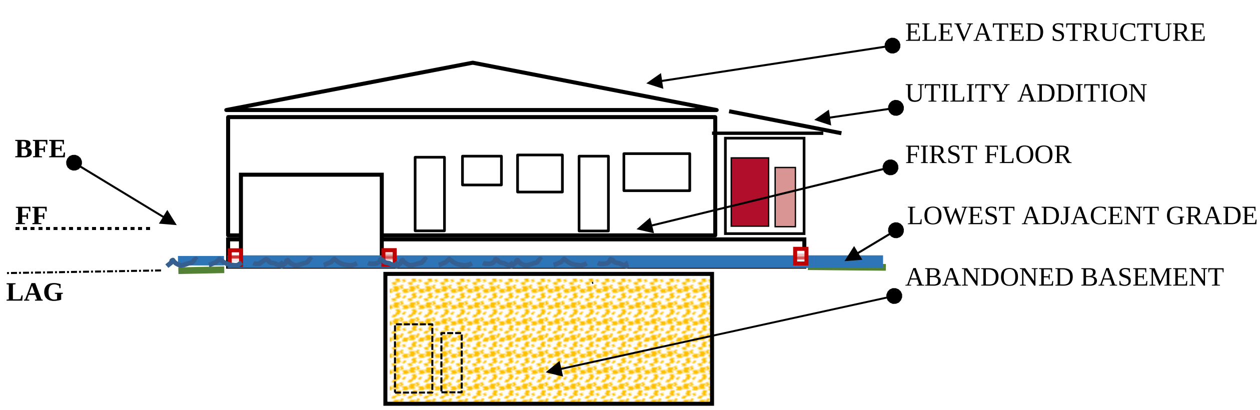
Structure ID	Structure Address
#14	1010 28th Street S

Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

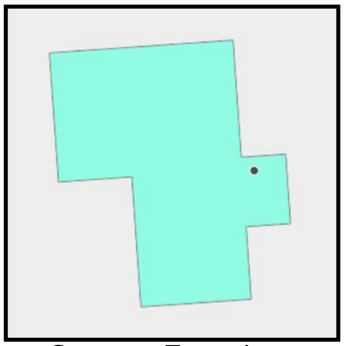
Nonstructural Recommendation
1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE.
2. Abandon basement and fill with uniform material. Consider incorporating 5-foot x 8-foot storm shelter.
3. Relocate utilities and appliances to utility addition.
4. Wet flood proof crawlspace, the garage, and incorporate flood vents.
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

1029 28th Street South

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	15	First Floor Area (ft^2)	1588
Year Constructed	1962	First Floor Elevation (FF)	658.1
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	650.3
Number of Stories	1	Lowest Adjacent Grade (LAG)	656.0
Wall Construction	Wood	Base Flood Elevation (BFE)	658.4
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Crawl and Basement	FF minus BFE	-0.3
Condition (Good/Fair/Poor)	Good	FF minus LAG	2.1
Existing Fireplace (Y/N)	1	Flood Depth (BFE-LAG)	2.4



Structure Footprint

Front

Left Side

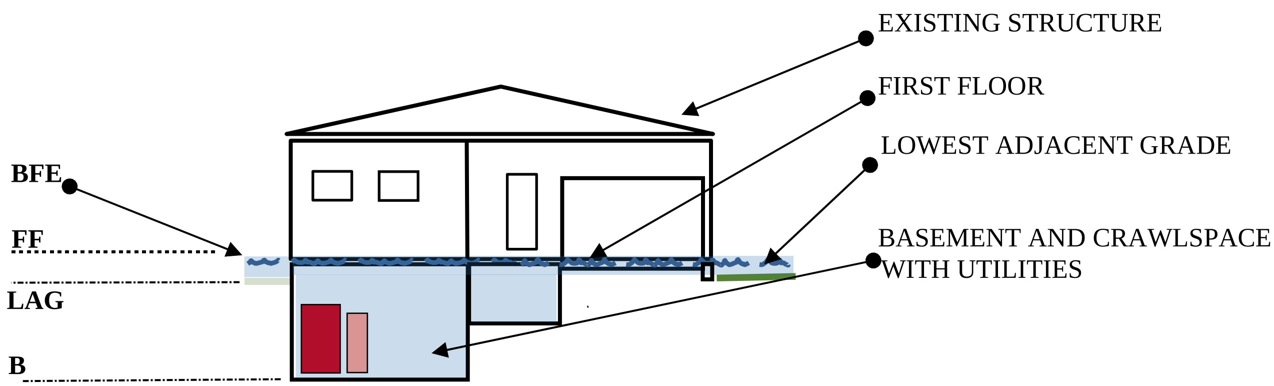
Right Side

Rear

Site Visit Observations
1. No right of entry or interior view of structure, but owner granted permission to view exterior. 2. First floor is 0.3 feet below the Base Flood Elevation of 658.4 3. Structure has a crawlspace and a basement. Exact location not determined. 4. Structure has attached garage.

Structure ID	Structure Address
#15	1029 28th Street S

Existing Structure

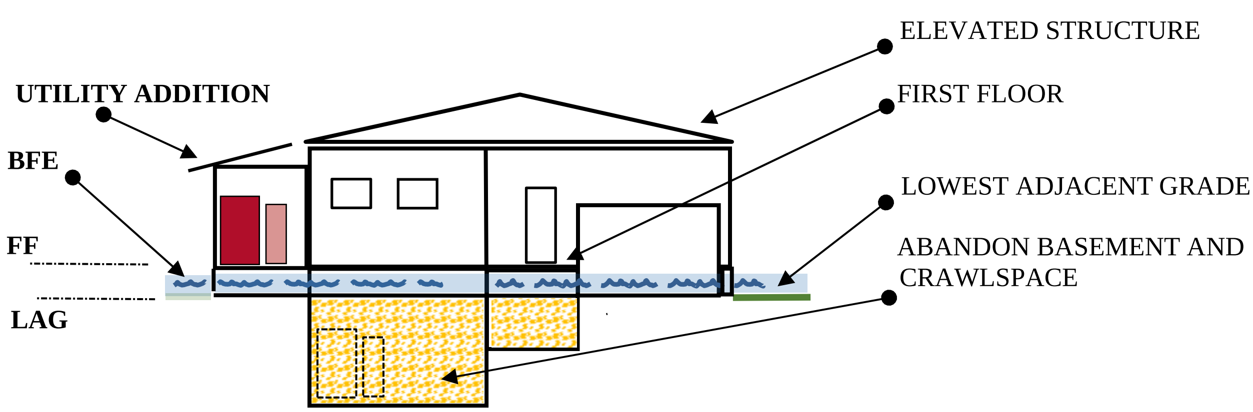


DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

Nonstructural Recommendation

1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE.
2. Abandon basement and fill with uniform material. Consider incorporating 5-foot x 8-foot storm shelter.
3. Relocate utilities and appliances to utility addition.
4. Wet flood proof crawlspace, the garage, and incorporate flood vents.

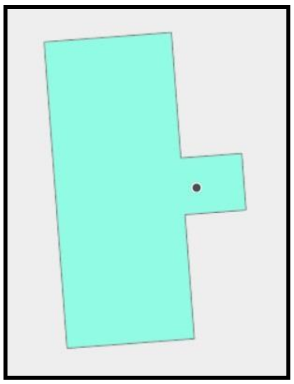
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

1037 28th Street South

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	16	First Floor Area (ft^2)	1056
Year Constructed	1959	First Floor Elevation (FF)	658.2
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	649.2 est
Number of Stories	1	Lowest Adjacent Grade (LAG)	656.4
Wall Construction	Wood	Base Flood Elevation (BFE)	658.4
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Basement	FF minus BFE	-0.2
Condition (Good/Fair/Poor)	Good	FF minus LAG	1.8
Existing Fireplace (Y/N)	1	Flood Depth (BFE-LAG)	2.0



Structure Footprint

Front

Right Side and Rear

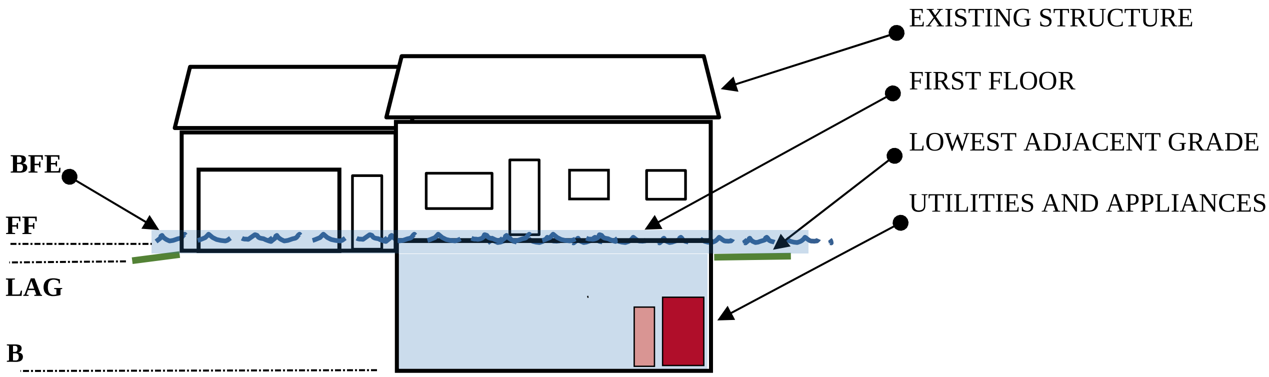
(Rear (left)

Rear (right)

Site Visit Observations
1. No right of entry or interior view of structure, but owner granted permission to view exterior.
2. First floor is 0.2 feet below the Base Flood Elevation of 658.4
3. Structure has attached garage which is as slightly lower elevation than the first floor.
4. Assumed that utilities (furnace, water heater) / appliances (washer and dryer) located in the basement

Structure ID	Structure Address
#16	1037 28th Street S

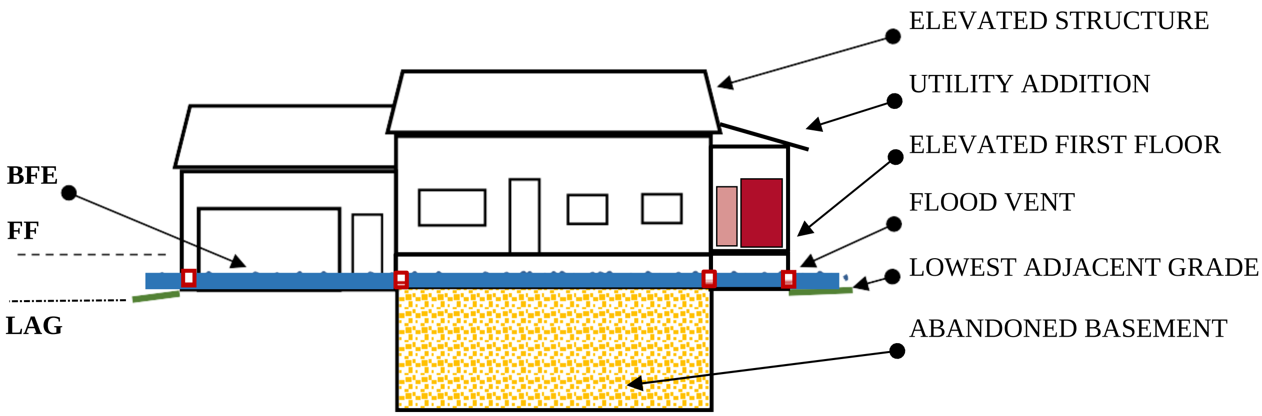
Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

Nonstructural Recommendation
1. Elevate structure on extended foundation walls with 2-foot of freeboard above BFE.
2. Abandon basement and fill with uniform material. Consider incorporating 5-foot x 8-foot storm shelter.
3. Relocate utilities and appliances to utility addition to back side of structure.
4. Wet flood proof crawlspace, the garage, and incorporate flood vents.

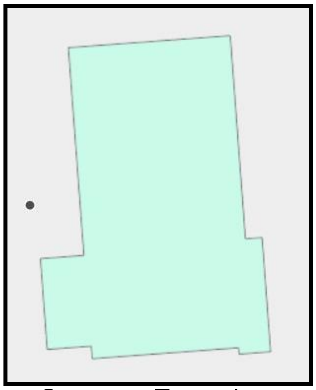
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

1034 28th Street South

Structure Information/Data:		Structure/Flood Elevations:	
Structure Number	17	First Floor Area (ft^2)	1466
Year Constructed	1962	First Floor Elevation (FF)	658.3
Occupancy type	Residential	Basement/Crawlspace Elevation (B)	650.1
Number of Stories	1	Lowest Adjacent Grade (LAG)	656.8
Wall Construction	Wood	Base Flood Elevation (BFE)	658
Foundation Construction	CMU	1% ACE Velocity	
Slab/Crawlspace/Basement	Basement	FF minus BFE	0.3
Condition (Good/Fair/Poor)	Good	FF minus LAG	1.5
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	1.2


Structure Footprint


Front

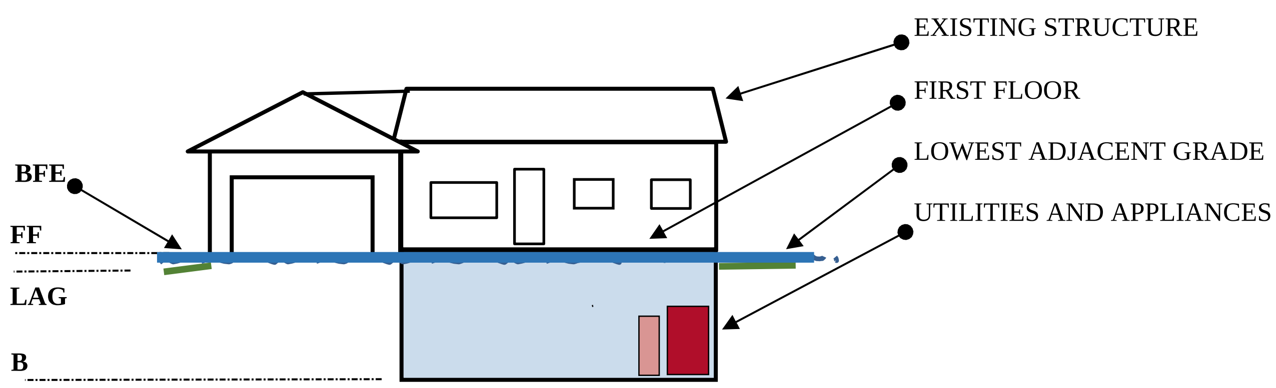

Left Side


Rear

Site Visit Observations
1. No right of entry or interior view of structure, but owner granted permission to view exterior.
2. First floor is 0.3 feet above the Base Flood Elevation of 658
3. Structure has an attached garage which has floor elevation at lowest adjacent ground elevation.
4. Property backs up to Coulee.

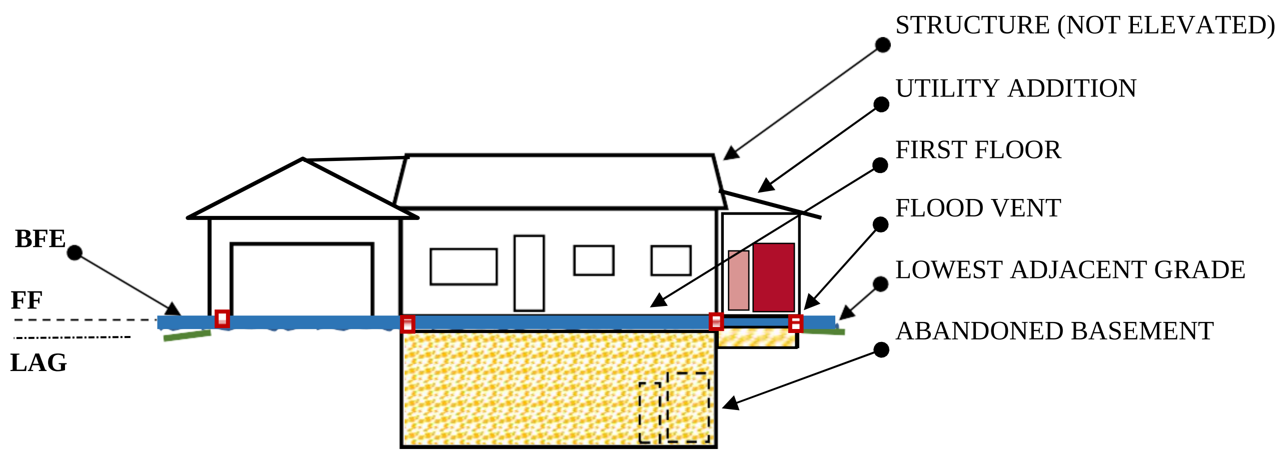
Structure ID	Structure Address
#17	1034 28th Street S

Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

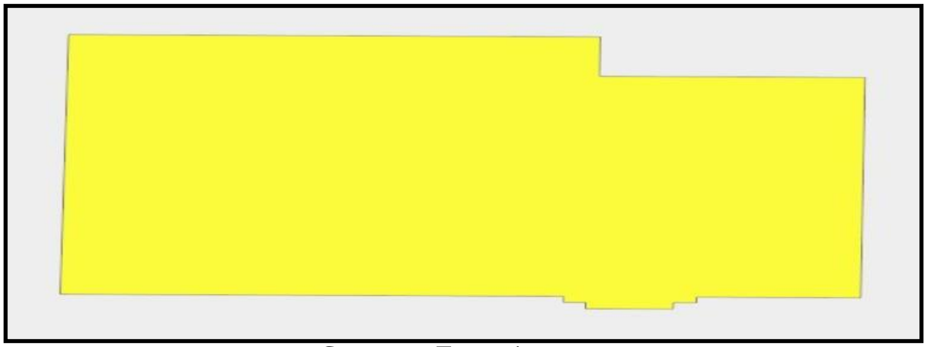
Nonstructural Recommendation
1. Existing first floor of structure is currently located above the BFE. 2. Abandon basement and fill with uniform material. Consider incorporating 5-foot x 8-foot storm shelter. 3. Relocate utilities and appliances to utility addition to back side of structure. 4. Wet flood proof crawlspace, the garage, and incorporate flood vents.
Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

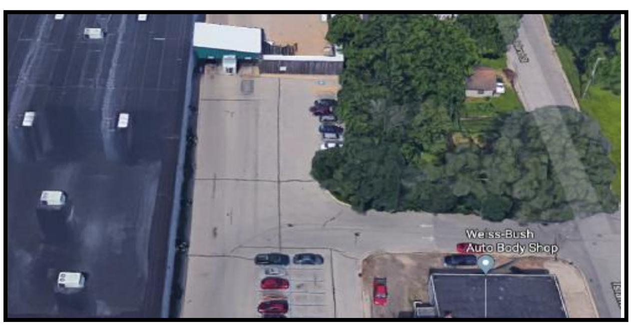
223 Lang Drive

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	18	First Floor Area (ft^2)	192211
Year Constructed	2005	First Floor Elevation (FF)	649.1
Occupancy type	Commercial	Basement/Crawlspace Elevation (B)	
Number of Stories	1	Lowest Adjacent Grade (LAG)	644.9
Wall Construction	Concrete	Base Flood Elevation (BFE)	646
Foundation Construction	Slab	1% ACE Velocity	
Slab/Crawlspace/Basement	Slab	FF minus BFE	3.1
Condition (Good/Fair/Poor)	Good	FF minus LAG	4.2
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	1.1



Structure Footprint

Front



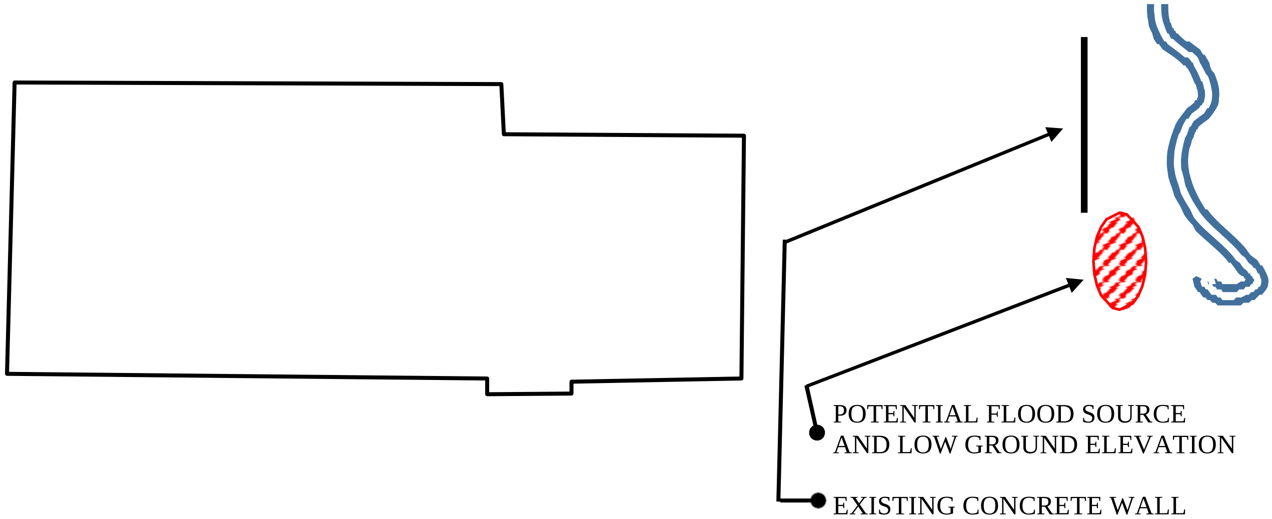
Aerial of Potential Problem Area

View of low elevation from Island Street

Site Visit Observations
1. No right of entry or interior view of structure. Limited view of potential flood source. 2. First floor is 3.1 feet above the Base Flood Elevation of 646 3. Flood source originates along drainage channel, just off of property.

Structure ID	Structure Address
#18	223 Lang Drive

Existing Structure (Plan View)

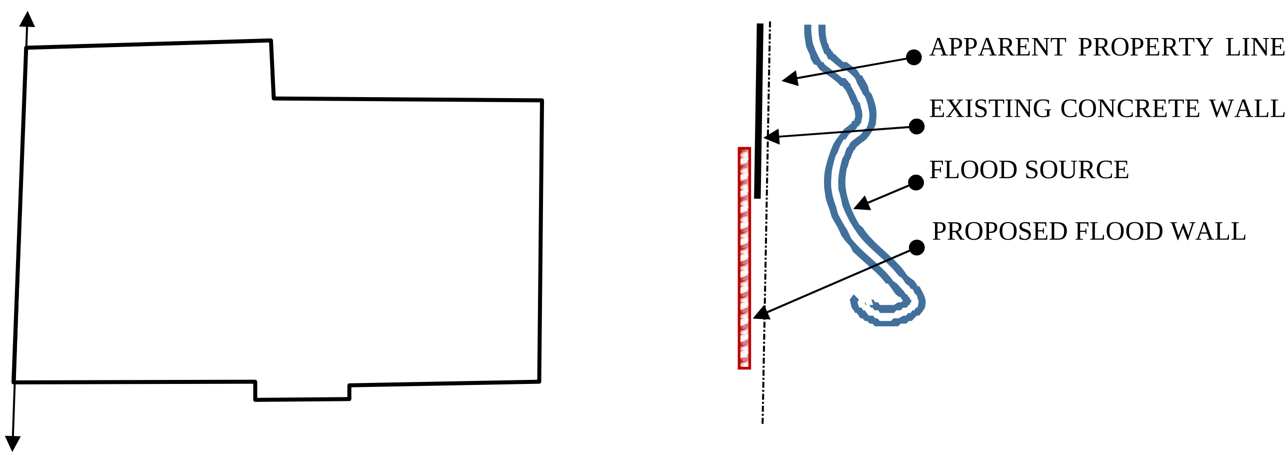


DIAGRAMATIC BUILDING SECTION (EXISTING)
NOT TO SCALE

Structural Recommendation

1. The proposed flood risk reduction measure is structural rather than nonstructural.
2. Construct concrete flood wall to run parallel to existing retaining wall beyond low elevation area.
3. Flood wall could prevent access to structure from Island Street.
4. Flood wall would extend from high ground to high ground.

Diagrammatic Structure Section (Recommendation)

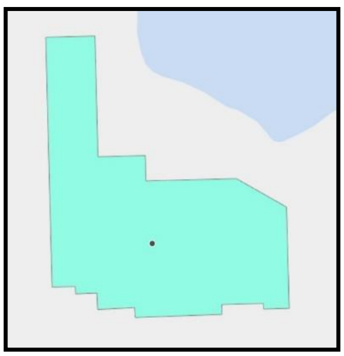


DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)
NOT TO SCALE

30 Copeland Avenue

Structure Information/Data:		**Structure/Flood Elevations:**	
Structure Number	19	First Floor Area (ft^2)	67319
Year Constructed	2005	First Floor Elevation (FF)	647.0
Occupancy type	Commercial	Basement/Crawlspace Elevation (B)	
Number of Stories	1	Lowest Adjacent Grade (LAG)	642.5 load dock
Wall Construction	Masonry	Base Flood Elevation (BFE)	644.9
Foundation Construction	Slab	1% ACE Velocity	
Slab/Crawlspace/Basement	Slab	FF minus BFE	2.1
Condition (Good/Fair/Poor)	Good	FF minus LAG	4.5
Existing Fireplace (Y/N)	N	Flood Depth (BFE-LAG)	2.4

Front



Structure Footprint

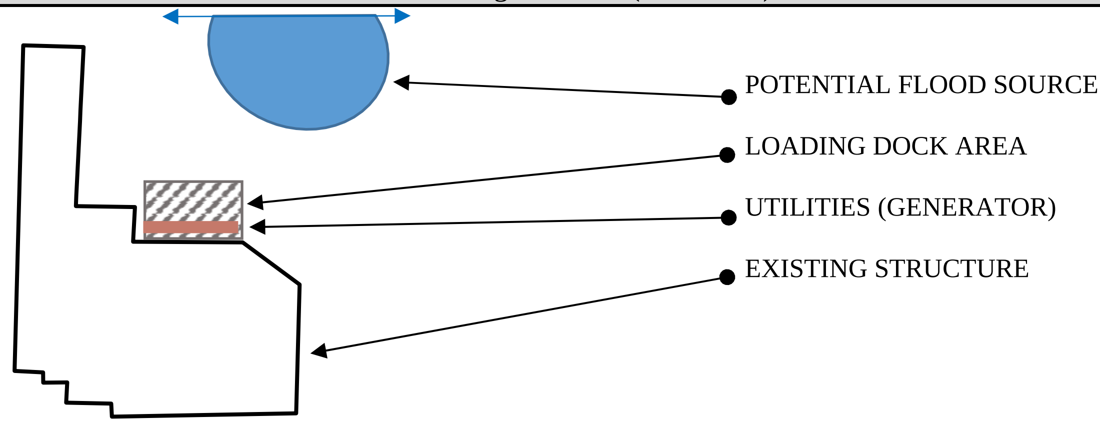
Potential Problem area (Loading Dock)

Aerial View (Potential Problem Area)

Site Visit Observations
1. No right of entry or interior view of structure. 2. First floor is 2.1 feet above the Base Flood Elevation of 644.9 3. Structure is very large commercial business. 4. Lowest adjacent grade of 642.5 occurs at ground level at loading dock.

Structure ID	Structure Address
#19	30 Copeland Avenue

Existing Structure (Plan View)



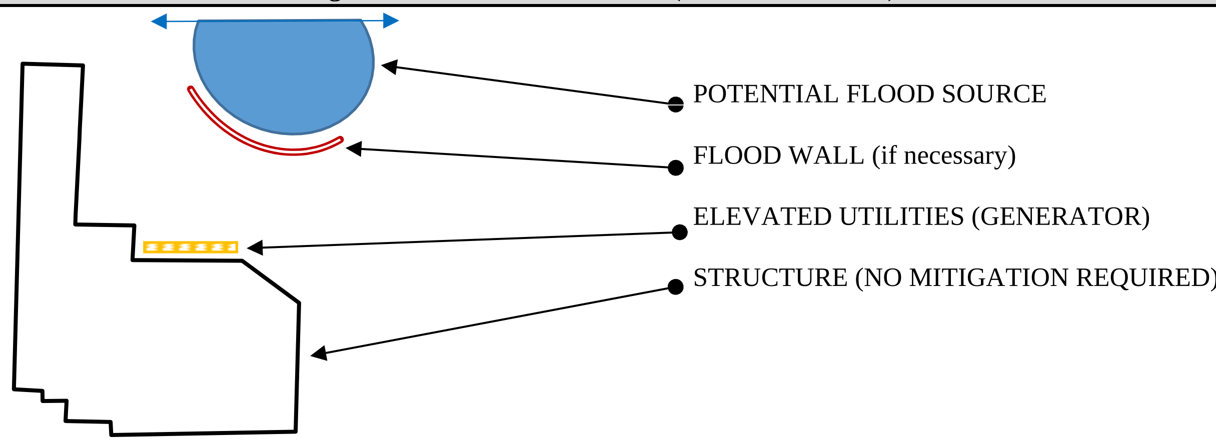
DIAGRAMATIC BUILDING SECTION (EXISTING)

NOT TO SCALE

Structural Recommendation

1. While the ground level of the loading dock area is below the BFE, the dock is 2.1 feet above BFE.
2. Elevate all electrical (generator) to 2-feet above the BFE.
3. If seeking additional risk reduction, consider constructing small flood wall near source of flooding so that it runs from high ground to high ground and prevents flood flows at the adjacent low elevation.

Diagrammatic Structure Section (Recommendation)



DIAGRAMATIC BUILDING SECTION (WITH MITIGATION)

NOT TO SCALE

APPENDIX B:
Dry Land Access Rules of Ordinance Section 115-281

The following is the dry land access rules of ordinance Sec 115-281

Since it is part of the state ordinance, a proposal to allow elevation in La Crosse would require a change or amendment to the ordinance.

Sec. 115-281. - Floodfringe district (FF).
Zone AE on the FIRM Map; outside the floodway which is covered by floodwaters during the regional flood and is associated with standing water rather than flowing water.

(1) Applicability. This section applies to all floodfringe areas shown on the floodplain zoning maps and those identified pursuant to section 115-282(1)(d). (2) Permitted uses . Any structure, land use, or development is allowed in the Floodfringe District if the standards in section 115-281(3) are met, the use is not prohibited by this or any other ordinance or regulation and all permits or certificates have been issued. (3) Standards for development in the Floodfringe . Section 115-276 shall apply in addition to the following requirements according to the use requested. Any existing structure in the floodfringe must meet the requirements of section 115-222 Nonconforming Uses; a. Residential uses . Any structure, including a manufactured home, which is to be newly constructed, or moved into the floodfringe shall meet or exceed the following standards: Any existing structure in the floodfringe must meet the requirements of section 115-222 Nonconforming Uses; 1. The elevation of the lowest floor shall be at or above the flood protection elevation on fill unless the requirements of section 115-281(3)(a)(2) can be met. The fill shall be one foot or more above the regional flood elevation extending at least 15 feet beyond the limits of the structure. 2. The basement or crawlway floor may be placed at the regional flood elevation if it is floodproofed to the flood protection elevation. No basement or crawlway floor is allowed below the regional flood elevation; 3. Contiguous dry land access shall be provided from a structure to land outside of the floodplain, except as provided in subsection (3)a.4 of this section. 4. In developments where existing street or sewer line elevations make compliance with subsection (3)a.3 of this section impractical, the City may permit new development and substantial improvements where roads are below the regional flood elevation, if: (i) The City has written assurance from police, fire and emergency services that rescue and relief will be provided to the structure(s) by wheeled vehicles during a regional flood event; or (ii) The City has a DNR approved emergency evacuation plan. b. Accessory structures or uses . 1. Accessory structures shall be constructed on fill with the lowest floor at or above the regional flood elevation. c. Commercial uses . Any commercial structure which is erected, altered or moved into the floodfringe area shall meet the requirements of subsection (3)a of this section. Subject to the requirements of subsection (3)f of this section, storage yards, surface parking lots and other such uses may be placed at lower elevations if an adequate warning system exists to protect life and property. d. Manufacturing and industrial uses . Any manufacturing or industrial structure which is erected, altered or moved into the floodfringe shall have the lowest floor elevated to or above the flood protection elevation or be in compliance with the other floodproofing measures in section 115-223(e). Subject to the requirements of subsection (3)e of this section, storage yards, surface parking lots and other such uses may be placed at lower elevations if an adequate warning system exists to protect life and property. e. Storage of materials . Materials that are buoyant, flammable, explosive, or injurious to property, water quality or human, animal, plant, fish or aquatic life shall be stored at or above the flood protection elevation in compliance with the other floodproofing measures in section 115-223(e). Adequate measures shall be taken to ensure that such materials will not enter the water body during flooding. f. Public utilities, streets

and bridges . All utilities, streets and bridges shall be designed to be compatible with comprehensive floodplain development plans and: 1. When failure of public utilities, streets and bridges would endanger public health or safety, or where such facilities are deemed essential, construction or repair of such facilities shall only be permitted if they are designed to comply with section 115-223; 2. Minor roads or nonessential utilities may be constructed at lower elevations if they are designed to withstand flood forces to the regional flood elevation. g. Sewage systems . All sewage disposal systems shall be designed to minimize or eliminate infiltration of flood water into the system pursuant to section 115-223, to the flood protection elevation and meet the provisions of all local ordinances and Wis. Admin. Code ch. SPS 383. h. Wells . All wells shall be designed to minimize or eliminate infiltration of flood water into the system pursuant to section 115-223, to the flood protection elevation and shall meet the provisions of Wis. Admin. Code NR chs. 811 and 812. i. Solid waste disposal sites . Disposal of solid or hazardous waste is prohibited in floodfringe areas. j. Deposition of materials . Any deposited material must meet all the provisions of this division. k. Manufactured homes . 1. Owners or operators of all manufactured home parks and subdivisions shall provide adequate surface drainage to minimize flood damage, and prepare, secure approval, and file an evacuation plan, indicating vehicular access and escape routes, with local emergency management authorities. 2. In existing manufactured home parks, all new homes, replacement homes on existing pads, and substantially improved homes shall: (i) Have the lowest floor elevated to the flood protection elevation; and (ii) Be anchored so they do not float, collapse or move laterally during a flood; (iii) Outside of existing manufactured home parks, including new manufactured home parks and all single units outside of existing parks, all new, replacement and substantially improved manufactured homes shall meet the residential development standards for the floodfringe in subsection (3)a of this section. 3. All mobile homes to be placed on a site located in any floodplain zoning district shall be placed to prevent the flotation, collapse or lateral movement of the structure due to flooding. Such mobile homes shall be anchored according to the following specifications: (i) Over-the-top ties shall be provided at each of the four corners of the mobile home, with two additional ties per side at intermediate locations and mobile homes less than 50 feet long shall require one additional tie per side; (ii) Frame ties shall be provided at each corner of the mobile home with five additional ties per side at intermediate points and mobile homes less than 50 feet long shall require four additional ties per side; (iii) All components of the anchoring system shall be capable of carrying 4,800 pounds; and (iv) Any additions to the mobile home shall be similarly anchored. l. Mobile recreational vehicles . All mobile recreational vehicles that are on site for 180 consecutive days or more or are not fully licensed and ready for highway use shall meet the elevation and anchoring requirements in subsection (3)k.2(ii) and (iii) of this section. A mobile recreational vehicle is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick-disconnect utilities and security devices and has no permanently attached additions.