



Peninsula Drainage District #2
Encroachment Evaluation
Summary Report



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Summary

Purpose of Report

If you own property or live in Peninsula Drainage District #2 (PEN 2), this guide is for you.

The purpose of this report is to give landowners, people living in PEN 2, and other interested parties more information about how structural encroachments affect the performance of the levee during high water events. This report provides:

- Flood safety information based on some of the risks identified at each levee section;
- Guidance for high water events based on the risk structures pose to the levee sections; and
- Reference information about the components of the levee, levee failure types, and risks associated with living on or near the levee.

Project Background

The Multnomah County Drainage District #1 (MCDD)—representing the four districts it manages: Peninsula Drainage District #1 (PEN 1), PEN 2, MCDD, and Sandy Drainage Improvement Company (SDIC) (the Districts)—reduces the risk of flooding to lives and property through proactive floodplain management.

The Districts are active partners in Levee Ready Columbia (LRC), a coalition that includes other drainage districts, public agencies, business groups, neighborhood associations, and nonprofit organizations. The LRC is working to make sure the levees meet federal standards in order to continue reducing flood risk and to have property owners aware of flood risk. One of the first steps in

this process is to evaluate the levee system and ensure that the levees retain certification and remain accredited by the Federal Emergency Management Agency (FEMA) and maintain good standing in the US Army Corps of Engineers' (USACE) Rehabilitation and Inspection Program (RIP).

The levees in PEN 2 are currently accredited by FEMA and in good standing in USACE's RIP. In re-applying for accreditation, FEMA has requested that the LRC evaluate the impact that existing structures have on the levee. Being accredited means that FEMA acknowledges that the levee system protects against a 1-percent-annual-chance flood event and ensure the Flood Insurance Rate Maps (FIRM) reflect this designation. Being in good standing in the RIP means that USACE will help us flood fight during high water events and will help pay for damages incurred to the flood management infrastructure after the event. **To obtain FEMA accreditation and maintain good standing in the RIP, LRC must perform a series of inspections and evaluations in PEN 2 to assess the condition of the system. One required evaluation is an assessment of the encroachments built into the levees.**

Encroachments are defined as elements built or growing in or on the levee (pipes, sign poles, trees, sheds, houses, roads, etc.). These are natural or man-made obstructions or physical intrusions into the levee. These obstructions or intrusions increase the risk of damage to the levee during high water events and intensify the risk to areas for which the levees were designed to reduce risk. This evaluation is focused on structural building encroachments and is not evaluating vegetation, fences, poles, or utilities at this time.

Figure 1 Example of PEN 2 survey work



Surveyors capturing ground elevations along Bridgeton Road levee

Project Overview

The LRC will need to conduct several studies to achieve its goals. The purpose of the encroachment study is to better understand how the encroachments effect the levees during high water events.

During the Summer and Fall of 2015, using existing information, design drawings, and field survey, LRC staff and surveyors documented all structures identified as structural encroachments (residential, commercial, and industrial) on or adjacent to the levee system in PEN 2. The project team identified 74 sections of levee with potential structural encroachments. All of this information, including the ground surface elevations of the structures, were identified and translated to computer aided design (CAD) drawings.

Using specialized computer software, an engineering consultant used the CAD drawings to create a model to show how the structures and levee would perform with water at different elevations. The highest elevation modeled was the design water surface elevation (the level of flood to which a system is designed) for the

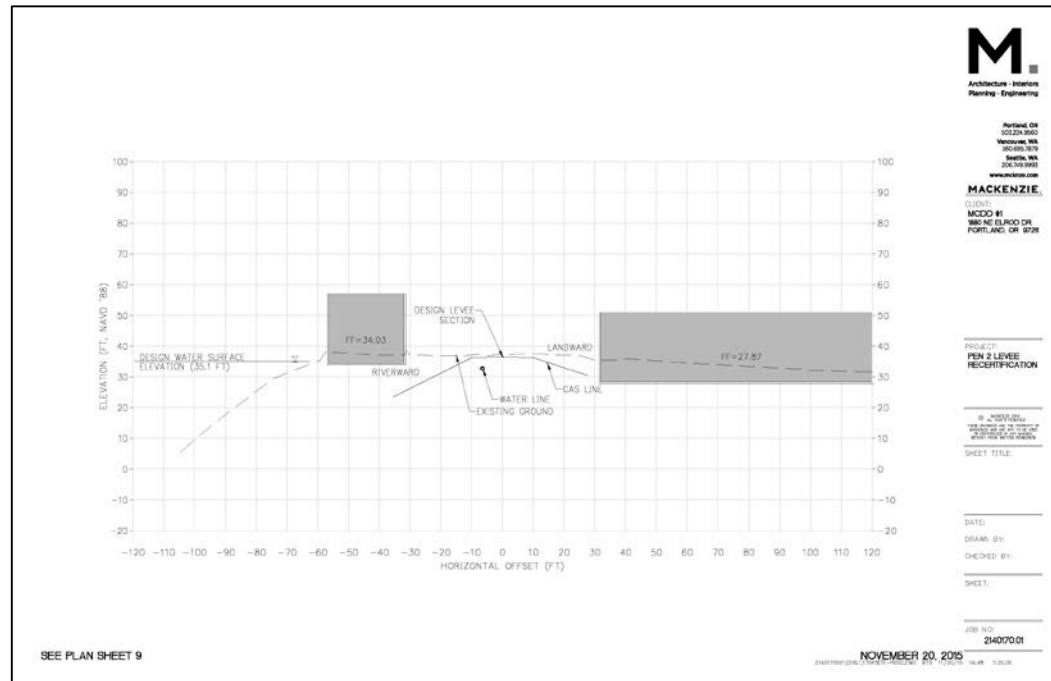
levee. The design water surface elevations are higher than the 1-percent-annual-chance flood—or 100-year flood—elevations used for other analyses, such as FEMA FIRM mapping. **More information on the design water surface elevation is available in the section titled Flood Damage .**

The study sought to identify conditions that might present a potential failure of the levee. Additionally, the consultant reviewed encroachments for key factors that might affect PEN 2’s ability to perform levee inspections, monitoring, and flood fighting.

Many structural encroachments in PEN 2 are built on overbuild sections of the levee. Overbuild is defined as those sections with excess soil or other material that has been placed on top of the original levee design sections. Encroachments built on this overbuild generally do not affect the original design function of the levee with regard to seepage and stability.

The analysis does not include an assessment of what will happen to the structures during a high water event. Flooding, damage, and destruction of structures are all possible in a high water event. Levees reduce the risk of flooding, but no levee system can eliminate all flood risk. A levee is generally designed to control a certain amount of floodwater. Although levees may be designed to the highest engineering standards, levees can and do fail.

Figure 2 Example cross-section used for modeling analysis



This image is an example of the drawings used for the modeling analysis. It features the structures (grey boxes), the existing ground (dotted line), the design levee section (solid line in center of image), and the design water surface elevation (solid line at left side of drawing).



Figure 3 Section 408 Introduction

Section 408 Permitting and Your Property

The Districts' levees were first constructed by local interests, primarily for agricultural reasons, but over time the majority of the system was converted to federally engineered levees by USACE.

Because USACE, as the federal government, made an investment in our local levee system, it also retains an interest in the levee and requires PEN 2 to operate and maintain the levee to strict federal standards. Levee systems support life safety by reducing flood risk for people and property. The levee is therefore subject to a long standing federal statute, 33 U.S.C. § 408 (Section 408), that aims to protect these federal investments.

It is important that the intended function of the levee is not compromised. Section 408 means that proposed alternations to the levee must undergo a thorough review of the alteration's potential impacts to ensure the levees continue to function as intended. Alterations include structural encroachments such as pipes, buildings, fences, and other objects placed in, on, or adjacent to the levee that may affect the levee's performance in a high water event. To make any alteration, a non-federal interest (such as a property owner, a utility company, the Districts, etc.) must apply for a Section 408 Permit. Ultimately, the purpose of 408 permits is to keep you and the community safe by ensuring the integrity of the levee system.

Any alteration to property on the levee that may affect the integrity or performance of the levee **must** pass through a Section 408 permitting process. Property owners must submit a permit application to MCDD to initiate the process. As the local levee sponsor, MCDD must endorse a Section 408 permit application before USACE can review and approve it.

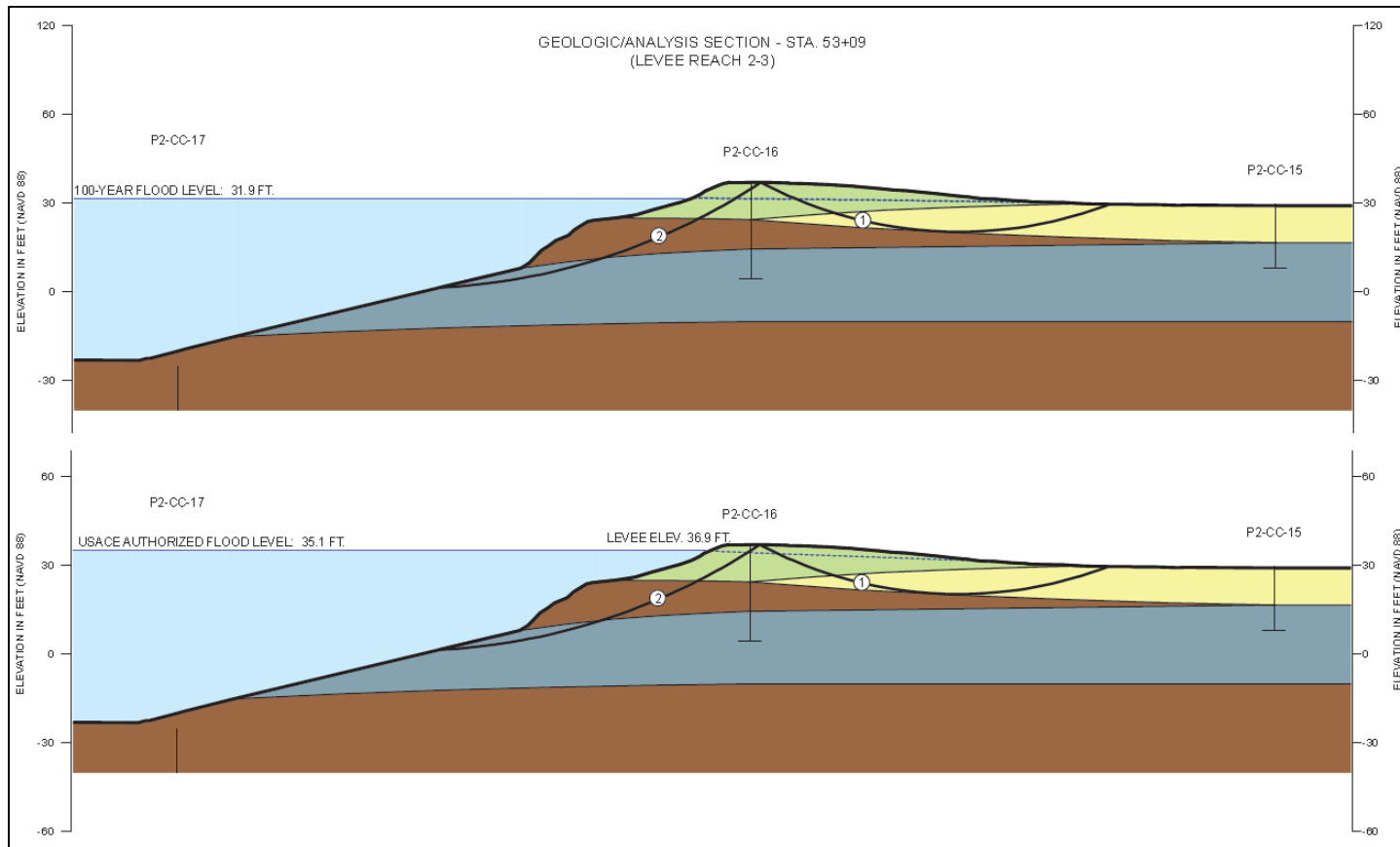
Any proposed alteration pursuant to Section 408 must meet USACE design and construction standards. As a general rule, alterations that would or could adversely affect or impair levees will not be approved.

Please contact MCDD staff for more information: 503-281-5675

Get to know your levee system

Levees are earthen embankments designed to direct the flow of water and reduce the risk of flooding. These large structures are composed of various types of material including silt, sand, and gravel. Our levees were designed by engineers to be semi-permeable, allowing a manageable amount of water to seep through the levee (seepage). The levees are one element in our flood management system. The system also includes concrete floodwalls, as well as the sloughs, various ditches, other conveyance channels, a series of pump stations, culverts, and floodgates that allow the Districts to flush seepage and other stormwater out of the Districts.

Figure 4 1-Percent-Annual-Chance Elevation and Design Surface Elevation against the PEN 2 levee system

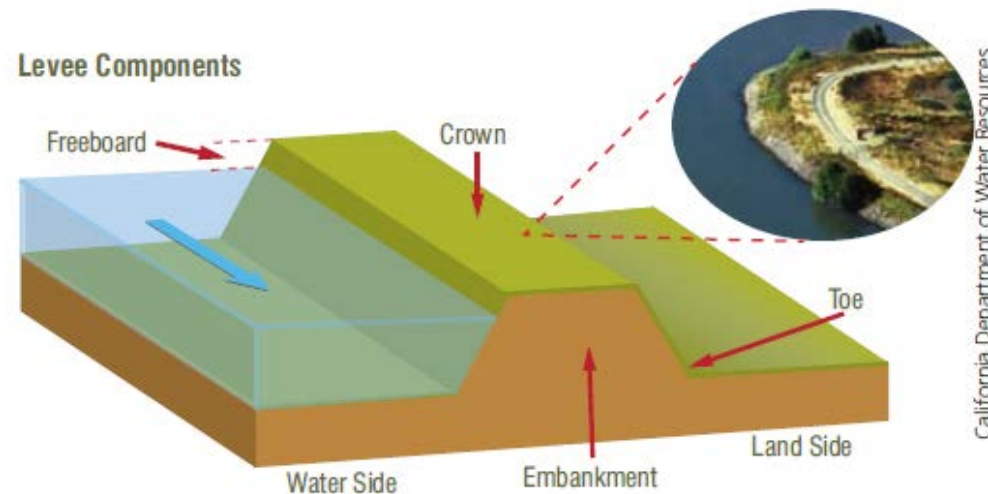


As operators of a near-century-old levee system, the Districts have worked to operate and maintain the original function of the levees as land uses rapidly changed behind—and on—the levees. Over time, these structures have been reinforced and rebuilt, and some encroachments have been constructed. These encroachments include roads, structures, utility lines, pipes, and sign posts.

When the PEN 2 signed on as non-federal sponsor of the system in 1940, the District signed operation and management agreements with USACE for a system that primarily protected agricultural and open space uses. Since that time, PEN 2 has experienced substantial residential, commercial, and industrial development with many private residences built along or on the levee itself. The changes this area has experienced, coupled with evolving knowledge about levee performance, have caused a substantial increase in the system’s risk profile.

The levee system in PEN 2 is designed to manage a certain amount of flood water, often called the design flood at the design water surface elevation. The design water surface elevation of the PEN 2 levee is built for an approximate 470-year event, or a little under a 0.2-percent-annual-chance event. Figure 5 illustrates the components of a levee. In sum, the PEN 2 levee is built for high water and infrequent flood stages, but risk continues to exist. Figure 4 depicts the water surface elevation the PEN 2 levee is designed to accommodate, with a comparison of the 1-percent-annual-chance flood elevation.

Figure 5 Levee Components Diagram



A levee system is a flood risk management tool; it does not entirely eliminate flood risks.



Encroachment Evaluation

Potential Failure Modes Assessment

Why this was performed

To identify and list the potential threats to the integrity and stability of the levee. See Figure 6 for examples of failure modes.

How this was performed

Modeling is a way to simulate anticipated conditions using software programmed to replicate flood conditions. The project team and USACE Portland District staff developed an appropriate model to address encroachment concerns. This analysis modeled the amount of seepage through the levee as it passes encroachments.

Another model tested the stability of the slopes where the encroachments are

located, based on rising river elevations or flood stages.

To get structure-specific results, assessments of the encroachments were modeled to simulate potential failures and negative impacts on the integrity and stability of the levee.

What we found

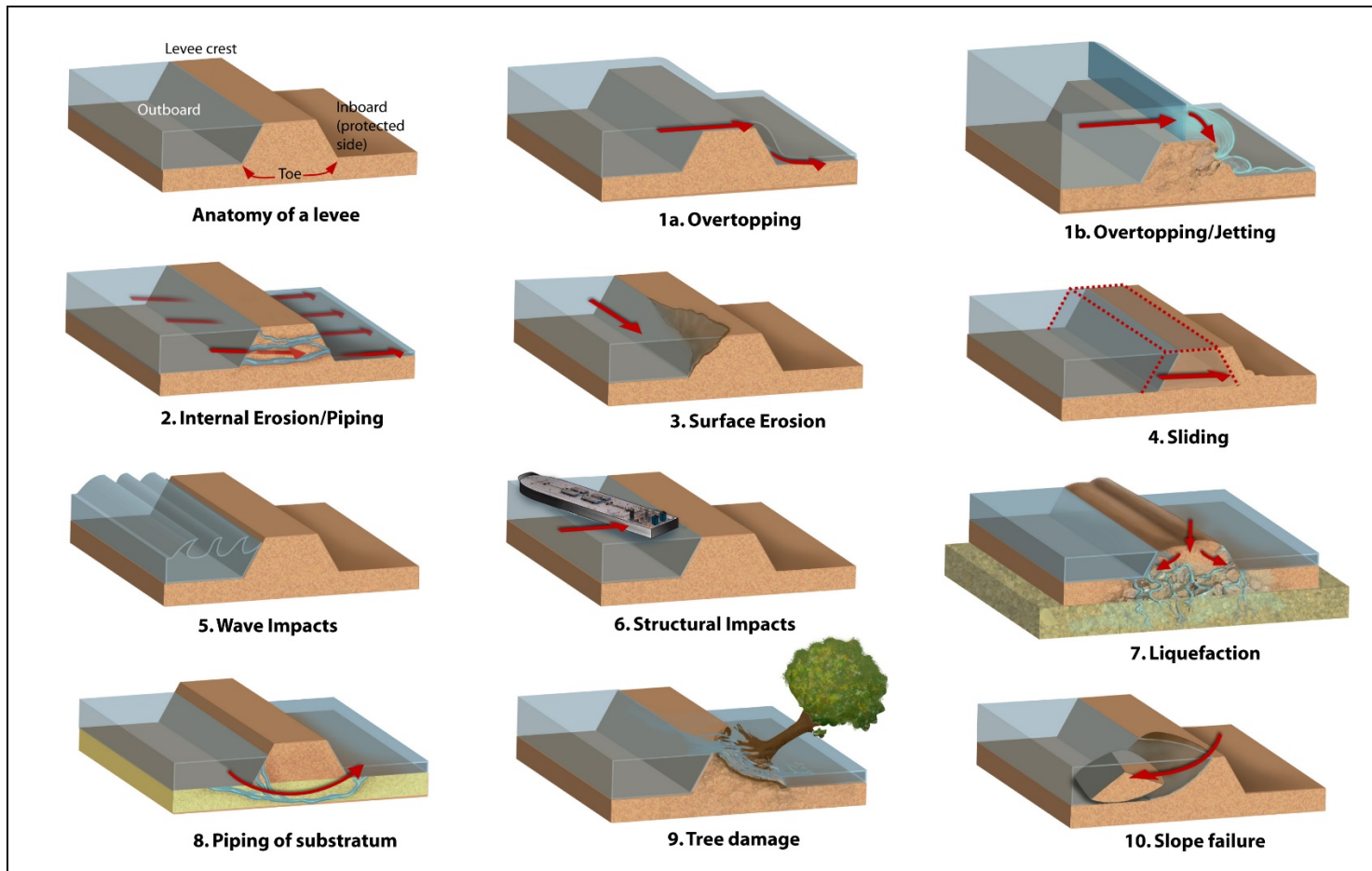
None of the 74 levee sections studied were found to have a high risk of levee failure. More specifically, the levee sections with potential encroachments do not present conditions that raise immediate concerns with regards to seepage and stability or factors that might affect the District's ability to perform levee inspections, monitoring, and flood fighting. These are positive findings!

In PEN 2, the levee sections are typically quite wide, and the ground surface elevation on the landward side of the

levee is high relative to the crest (the mid-section of the levee), which results in a very long seepage path and very flat slopes. Both the long seepage paths and flat slopes are considered beneficial for the integrity of the PEN 2 levee.

Areas of concern include structures that have been embedded relatively deeply into the levee. This type of occurrence can negatively impact the structural integrity of the levee by: 1) shortening the seepage path across the embankment, and thereby raising the risk of internal erosion (or, "piping"); and 2) causing slope stability problems by either increasing or decreasing pressure on the levee at the top or bottom of the levee embankment. Figure 6 illustrates some of the most common levee failure modes.

Figure 6 Levee Failure Mode Illustration¹



¹ Zina Deretsky, National Science Foundation. Accessed online March 9, 2016: http://www.nsf.gov/news/mmg/media/images/levee2_h1.jpg

Levee Inspection, Monitoring, and Flood Fighting Assessment

Why this was performed

Flood fighting is a key component to MCDD's work. While we work diligently to maintain and operate the levee and flood management system to the highest level, flood fighting is a necessary part of our work. Flood fighting actions are actions taken to reduce the impact of an ongoing flood. This includes actions such as inspecting the levee for erosion, cracking and seepage, adding additional materials to the levees like sandbags or plastic sheeting to improve levee performance, making emergency repairs to the levees, and controlling seepage paths. The levee inspection, monitoring, and flood fighting assessment was performed to help identify issues we might encounter during high water events.

How this was performed

Inspections looked for structures that could impede flood fighting equipment or obscure the ground surface, thereby preventing early seepage and scour detection.

What we found

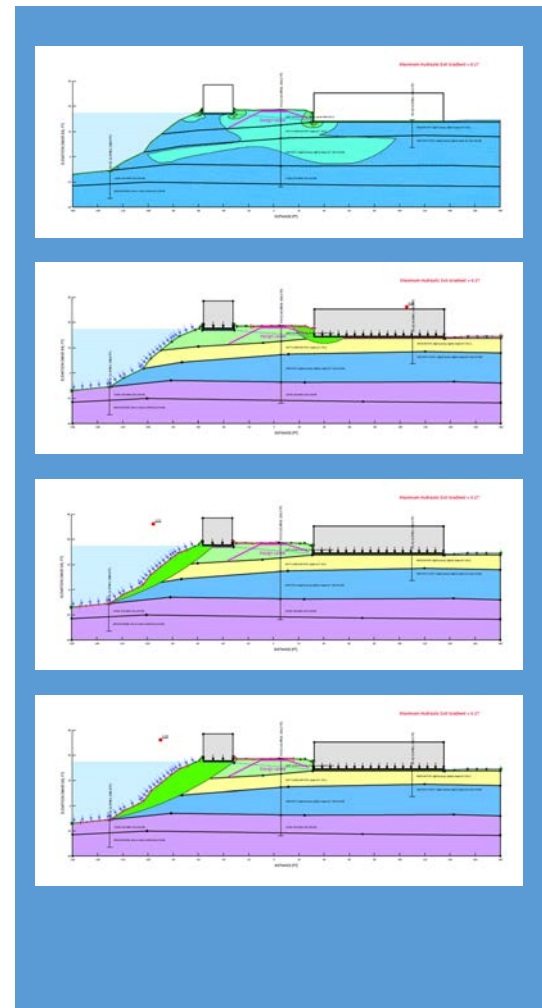
Many of the encroachments analyzed raised concerns for seepage detection, including:

- Areas where long stretches of buildings and pavement affect detection efforts,
- Areas where pilings and other obstructions make it difficult to access riverward levee sections, and
- Locations where structure size limits access and detection.

Property reports provides information about levee inspection, monitoring, and flood fighting. The reports will help you understand the actions you can take in assisting MCDD to inspect and monitor before, during, and after high water events.

There are several areas around PEN 2 that exhibit good access to the levee crest and landward side, which could be very useful for temporary stockpiling and staging areas during flood fighting activities. These potential staging areas are identified in the property reports and are highlighted on the summary map.

Figure 7 Examples of Modeling Analysis





Qualitative Risk Analysis

Why this was performed

Assigning a qualitative level of risk allows us to quickly categorize the findings from the seepage and stability reports and the inspection, monitoring, and flood fighting reports. These categories provide general information about risks properties face and steps to take before, during, and after a high water event. In MCDD's capacity as flood fighters, assigning categories of risk helps MCDD focus inspection and monitoring efforts in certain locations and assists how we organize our flood fighting response.

How this was performed

Based on USACE's standards, risk categories of low, medium, and high are generally defined as follows.

Low – The seepage and stability analyses meet USACE standards, and/or encroachment does not appear to

significantly impact levee performance, inspection, or flood fighting capabilities.

Medium – The seepage and stability analyses generally meet USACE standards, with minor possible exceptions. Structural encroachment could potentially hinder riverward or landward inspection and flood fighting efforts.

High – The levee section does not meet USACE seepage and stability standards, and/or the encroachment presents a clear concern for seepage or stability issues during flooding. The encroachment may also severely hinder or prevent levee inspection and access during flood fighting efforts.

Risk categories will be further evaluated and discussed through the LRC process to determine whether or not mitigation is needed, the type needed, and what steps should be taken.

What we found

The great majority of the PEN 2 levee structural encroachments were found to be in the Low risk category. These are great findings, but **it is important to remember that living in a managed floodplain is never without flood risk.**

The positive findings are due primarily to the results of seepage and stability analyses, where we found results met or exceeded USACE standards, combined with the minor concerns regarding inspection and flood fighting.

Only eight of the levee sections with structural encroachments were rated Medium risk. **A total of 25 individual addresses in 11 structures are located on the eight Medium risk levee sections.** No structural encroachment sections were categorized in the High risk category.



Flood Damage to the PEN 2 Levee

Overview

Purpose of the Property Reports

It will never be possible to prevent flooding entirely, but we can manage flood risk and reduce the impact of flooding to the entire District by maintaining the structural integrity of the levee. One of the purposes of this report is to provide landowners and residents of PEN 2 information about what to look for during high water events and other emergency situations. This section of the report provides actions for landowners and residents.

The property report provides three pieces of specific information:

1. The results of the seepage and stability analysis and how it compares to USACE standards;
2. An assessment of levee inspection, monitoring, and flood fighting at that levee section; and
3. The qualitative risk category assigned to the levee section that includes specific flood fighting measures based on the findings of the seepage and stability analysis and the results of the levee inspection, monitoring, and flood fighting assessment.

Figure 8 provides a list of safety concerns and actions for property owners or residents to take. Please familiarize yourself with some of these concerns.

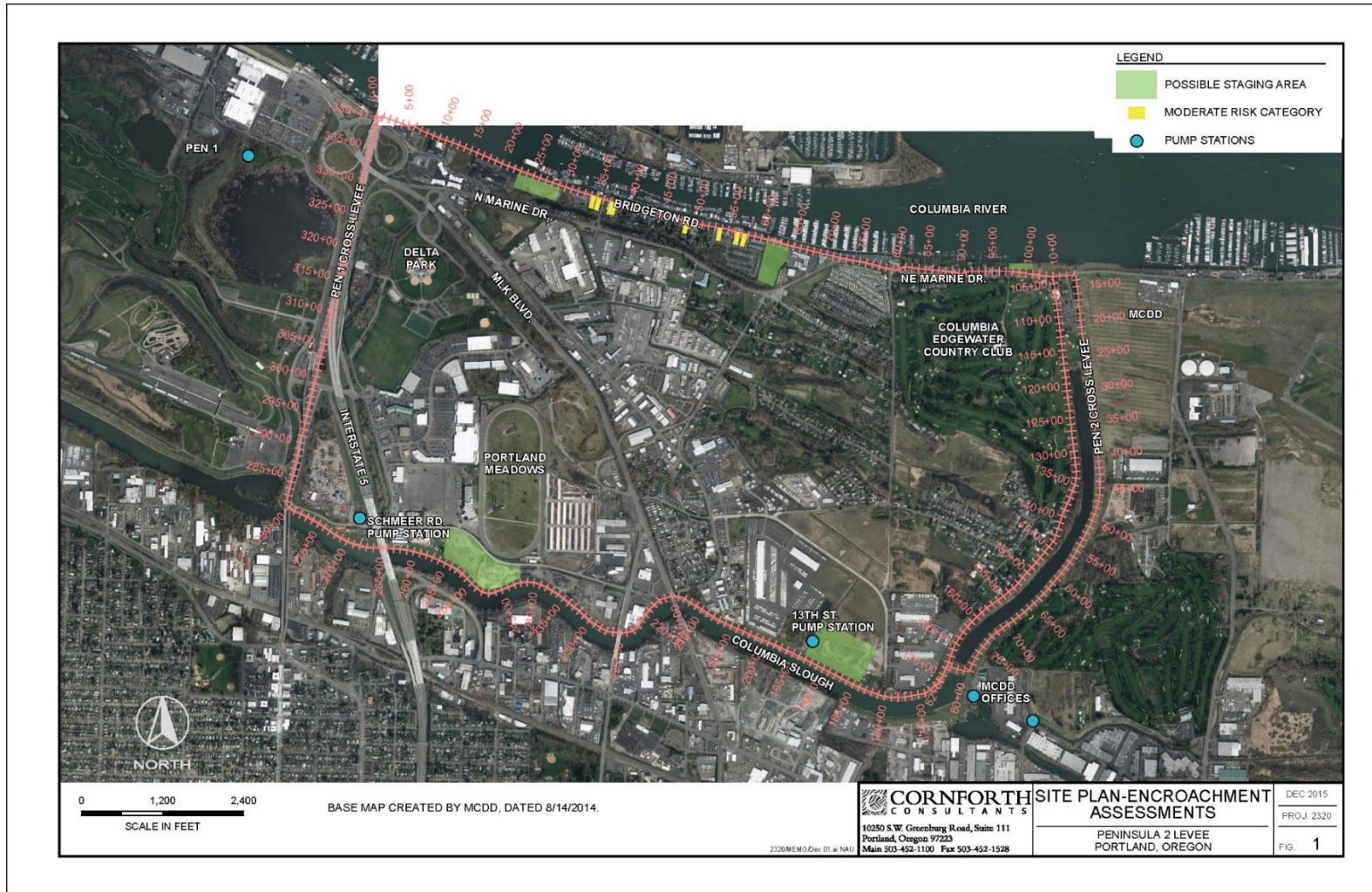


Figure 8 Levee Safety Concerns and Property Owner/ Resident Actions

SAFETY CONCERN	PROPERTY OWNER / RESIDENT ACTIONS
<p>Levee Seepage and Stability Concerns: Could result in sloughing or levee failure if not addressed properly.</p>	<p>Report any of the following observations to MCDD:</p> <ul style="list-style-type: none"> • Wide deep cracks in the riverbank or levee crest; In the case of levees, these cracks may also extend down the slope of the levee. • Vertical movement of the material along the crack. Remember that this movement may be very obvious or very subtle, if the stability problem is just starting to develop. • If the slope has slumped or is starting to slump, please contact MCDD for inspection. In many cases there will be a noticeable bulge in the slope or riverbank. • Report anything else unusual, like ponding, unusual wetness, ground settlement, or levee sloughing.
<p>Seepage Monitoring and Inspections Issues: Seepage can potentially pull out levee material and put the levee at risk of failing if not addressed properly.</p>	<p>Report any of the following observations to MCDD:</p> <ul style="list-style-type: none"> • Watch your property for ponding, unusual wetness, and sand boils. Because there may be something blocking seepage pathways, the sand boils or ponding may seem unusually far away from the levee. • Any basement or similar depression near the levee should be closely watched for heaving of floors, caving of walls, and boil activity. • When seepage exits landward of the levee toe at a pressure that creates a sensation like the soil is fluid, the levee and foundation become susceptible to sliding and/or sloughing which can lead to an embankment failure. Report landward levee bank sloughing.
<p>Access Issues: Possibly Impeding Monitoring or Flood Fighting</p>	<p>See Seepage and Monitoring Inspections in the Property Report section.</p> <p>Common impediments:</p> <ul style="list-style-type: none"> • Unauthorized vegetation blocking inspection/observations, including vegetable boxes built into the levee. • Stockpiling materials, such as soil, sand, or debris, along or on the levee. • Locked fences preventing access across the levee, as during flooding patrollers must walk the levee length. • Objects in yard block inspection/observations (lawn furniture, trailers, yard equipment, kid pools, etc.). • Objects blocking visibility of exterior walls where it meets the levee, preventing seepage and cracking observations. <p>If an issue arises on your property, flood fighting actions may need to happen very close to your structure.</p>

Property Reports

Figure 9 Peninsula Drainage District #2 Map





Riverward and Landward Encroachments

This section summarizes the types of encroachments found on or near the address that are located near the riverward and landward side of the levee at this section. The categories of encroachments included were trees of significant vegetation, homes or condos, commercial buildings, paved lots, watercraft (boats, docks, houseboats), and access limitations.

Levee Inspection, Monitoring, and Flood Fighting Notes

A key part of performing the seepage and stability reports for the levee sections with encroachments is to identify issues for levee inspection, monitoring, and flood fighting. The 2015 International Levee Handbook provides guidance for levee flood risk management and lists levee inspection frequency and hazard communication as potential methods to reduce levee failure risks. During a flood incident, the area that needs to be inspected is not just the levee structure, but also up to 300 feet from the landward toe of the levee. This is to check for signs of levee damage, such as sand boils, seepage, and piping. Encroachments, as well as structures or items further from the levee, may impact ease of inspection.

Your Qualitative Risk Category

The qualitative level of risk each encroachment poses to the levee features ratings of Low, Medium, and High. These ratings are based on the seepage and stability analysis in combination with the assessment of levee inspection, monitoring, and flood fighting characteristics. These risk categories represent the level of risk properties pose to the levee, to the levee system, and/or to MCDD’s ability to flood fight.

Risk categories of Low, Medium, and High are generally defined as follows:

RISK CATEGORY	DEFINITION
LOW	Seepage and stability analyses meet USACE standards, and/or encroachment does not appear to significantly impact levee performance, inspection, or flood fighting capabilities.
MEDIUM	Seepage and stability analyses generally meet USACE standards, with minor possible exceptions. Structural encroachment could potentially hinder riverward or landward inspection and flood fighting efforts.
HIGH	Levee section does not meet USACE seepage and stability standards, and/or the encroachment presents a clear concern for seepage or stability issues during flooding. The encroachment may also severely hinder or prevent levee inspection and access during flood fighting efforts.



Risk Reduction Measures for Medium Risk Encroachment Areas

The project team developed a set of site-specific risk reduction measures for levee encroachment structures assigned Medium or High risk levels. While no structures were assigned a High risk designation, eight levee sections were assigned a Medium risk designation. All Medium risk designated addresses are located on Bridgeton Road.

Risk reduction measures for your medium properties generally state

Seven of eight medium risk levee sections of the PEN 2 levee contains private structures located both on the riverward levee section and along the landward levee section, varying by levee section. In these section the crest and landward sections of the levee are paved or covered by structures. Generally, access to the riverward and landward levee sections is impaired around the homes and condominiums. Additionally, seepage issues will be more difficult to detect visually due to the structures and paved areas on the landward side. Inspections should place additional emphasis on pavement deformation and the visible areas of exposed soil. Homeowners should be encouraged to report any observed seepage or settlement around the home.

One section of the PEN 2 levee has an oversteepened riverward slope which allows for additional parking along the levee crest for houseboat owners. Modeling performed on an encroachment at station 43+80 resulted in a riverward slope stability factor of safety (FS) of 1.3 using the USACE design flood level. USACE guidelines recommend a minimum FS of 1.4. The engineering consultant recommends inspections focus on riverward slope performance in addition to public communication to users of the parking area. Slumping failures during normal wintertime river water level conditions occurred recently at station 46+50 in February of 2016, though these failures have not regressed to the point of affecting the pavement at the top of the slope. Removing this hazard is possible by grading the overbuilt, oversteepened riverward levee slope to a flatter angle, though this would result in a reduced parking area. The engineering consultant (CCI) does not believe regrading is necessary at this time if additional reconnaissance and inspection during flooding is implemented by MCDD.

How you can Prepare for High Water Events

The following table includes general actions to prepare for and inspect your property before and during a high water event. Call MCDD for any of the issues noted below. **Remember, in the event of an emergency, CALL 9-1-1**

ISSUE	ACTION
<p>Levee Stability Concerns: Could result in sloughing or levee failure if not addressed properly.</p>	<p>Please report any of the following observations: Wide deep cracks in the riverbank or levee crest; In the case of levees, these cracks may also extend down the slope of the levee. Movement of the material along the crack. Remember that this movement may be very obvious or very subtle, if the stability problem is just starting to develop. If the slope has slumped or is starting to slump, please contact MCDD for inspection. In many cases there will be a noticeable bulge in the slope or riverbank. Report anything else unusual, like ponding, unusual wetness, ground settlement, or levee sloughing. Report all observations to MCDD or call 9-1-1 in the event of an emergency.</p>
<p>Seepage Monitoring and Inspections Issues: Seepage can potentially pull out levee material and put the levee at risk of failing if seepage is not addressed properly.</p>	<p>Watch your property for ponding, unusual wetness, and sand boils. Because there may be something blocking seepage pathways, the sand boils or ponding may seem unusually far away from the levee. Any basement or similar depression near the levee should be closely watched for heaving of floors, caving of walls, and boil activity. When seepage exits landward of the levee toe at a pressure that creates a sensation like the soil is fluid, the levee and foundation become susceptible to sliding and/or sloughing which can lead to an embankment failure. Report any landward levee bank sloughing. Report all observations to MCDD or call 9-1-1 in the event of an emergency.</p>
<p>Access Issues, Possibly Impeding Monitoring or Flood Fighting: Possibly Impeding Monitoring or Flood Fighting</p>	<p>See Seepage and Monitoring Inspections. On the levee and 15 feet from the landward toe, keep the surface clear and visible for easy inspection. This includes free of trash, vehicles, or stockpiled materials (soil, sand, etc.). If woody debris fall onto the levee, contact MCDD to remove debris. Do not remove, change, or severely damage vegetation that the District uses to prevent levee erosion from runoff and seepage. In addition, if an issue arises on your property, flood fighting actions may need to happen very close to your structure. Report all observations to MCDD or call 9-1-1 in the event of an emergency.</p>



Flood Preparation and You!

Risks and safety

It is easy to take the levees for granted, they are large earthen barriers that over the decades have become a familiar part of our environment. Over the decades, development has taken place on and around the levees. These structures built on and around the levees pose a threat to the levee, potentially damaging the levee's flood management functionality and increasing flood risk for people living in levee protected areas.

You are responsible to know the threats your property faces and poses to the levee during high water events. This guide and the staff at MCDD are here to help! Please do not hesitate to call, email, or stop by our offices to talk.

What to do BEFORE a Flood Watch or Flood Warning

- ✓ Purchase flood insurance and be familiar with the National Flood Insurance Program
 - <https://www.floodsmart.gov/floodsmart/>
- ✓ Review emergency preparedness information pages
 - <https://www.fema.gov/information-property-owners>
 - <http://www.nwp.usace.army.mil/missions/emergency/before.aspx>
- ✓ Assemble an emergency supply kit
 - Find instructions on how to assemble a basic emergency kit here: www.ready.gov/kit
- ✓ Develop an emergency action plan for you, your family, and your community
 - Find instructions of how to prepare a household emergency action plan on the City of Portland's Bureau of Emergency Management's website: <https://www.portlandoregon.gov/pbem/53984>
- ✓ Be aware of your jurisdiction's evacuation plan. The City of Portland is responsible for evacuating their citizens.
 - See a specific evacuation plan to flooding of the Districts here: <https://www.portlandoregon.gov/pbem/65295>
- ✓ Sign up for Public Alerts for our area
 - <https://www.publicalerts.org/signup>
- ✓ Learn the Risks of Living On or Behind a Levee
 - <http://content.asce.org/files/pdf/SoYouLiveBehindLevee.pdf>
- ✓ Ensure your property is free of obstructions that would make emergency procedures and inspections difficult.
 - Clear the exterior walls of your basements/foundations so you can inspect for cracks and seepage.
 - Clear your yards of yard furniture or other objects that could obstruct viewing issues or block appropriate flood fighting response.
 - Keep vegetation well managed to ensure visibility of levee surfaces, as this can obstruct observing issues.



- ✓ Take a room-by-room inventory of your home. Take photographs or video. Inventory forms are available from most insurance companies or you can make your own.

What to do during a Flood Watch or Flood Warning

- ✓ Listen to the radio, TV, or check Internet warning sites to see whether a flood watch or flood warning has been posted for the area. Follow any warnings found via those locations.
 - A flood *watch* means the flooding is possible.
 - A flood *warning* indicates that flooding is expected or is occurring.
- ✓ Locate your pre-assembled emergency kit and prepare other items to take with you in the event of an evacuation.
- ✓ Turn off electricity at your breaker or fuse box and close your main gas valve. For fuel oil or propane tanks, turn off the fuel valve at the tank.
 - Before an emergency, label your breaker or fuse box so you can quickly shut-off the main power.
 - Attach a wrench to you main gas valve to allow quick shut-off.
- ✓ If possible: Bring outdoor possessions inside or secure them adequately.
- ✓ Place sandbags anywhere water may enter your home.
 - More information on accessing sandbags is available at <https://www.portlandoregon.gov/transportation/article/319872>
 - In the event of a flooding emergency, sandbagging stations may also be set up in additional locations. Look for notices regarding sandbagging locations during a flood event through public alerts or from communications from the Districts.
- ✓ Review the City's evacuation plan to re-familiarize yourself with the plan. If instructed to do so, leave immediately.
 - Avoid areas of high or moving water and downed power lines along your evacuation route.
 - Follow the instructions of all emergency responders.
- ✓ If floodwaters enter your home or business before you can leave safely, move to the highest level, including the roof. It may take hours or even days before help can arrive, so be sure to have your emergency kit prepared and accessible.

Figure 10 Terminology Reference Guide

Term	Definition
Accreditation	Accreditation means recognition by the Federal Emergency Management Agency (FEMA) that a levee provides protection for the base flood (1-percent-annual-chance) event, based on certification provided by a registered Professional Engineer or a federal agency with responsibility for levee design.
Breach	A breach is a levee failure where part or all of the levee gives way, allowing previously contained water to flood leveed land.
Certification	Levee certification is the process that deals specifically with the design and physical condition of the levee, and is the responsibility of the levee owner or community in charge of the levee’s operations and maintenance. Certification must be completed for the levee to be eligible for accreditation by FEMA. Certification documentation demonstrates that a registered Professional Engineer or federal agency with responsibility for levee design certified the levee, and meets the specific criteria and standards to provide risk reduction from at least the 1-percent-annual-chance flood. Once certified, FEMA can accredit the levee and show the area behind it as being a moderate-risk area on a Flood Insurance Rate Map as part of the National Flood Insurance Program.
Ground Surface Elevation	The elevations, or contours, of the earth. For this analysis, ground surface elevations and elevations where buildings meet the ground were used.
Design Water Surface Elevation	Water level used to design the levee, for most of PEN 2 it is for about a 470-year flood.
Emergency	Is a sudden, generally unexpected event which does or could do harm to people, the environment, resources, property, or institutions.
Encroachment	Encroachments are defined, broadly, as elements built or growing in or on the levee (pipes, sign poles, trees, houses, roads, etc.).
Failure Modes	A failure mode is the term sometimes used to describe the mechanisms by which a levee can fail. These may happen as a single mode or several different types of failure modes can act in unison. Generally, levees fail as a result of damage

Term	Definition
	to the levee itself or the foundation which the levee is constructed upon. Structural causes include damage caused by encroachments, slope failures, sliding, seepage, erosion, piping, liquefaction, overtopping, and other modes.
Flood	A flood is an inundation of land not normally covered by water and that is used or is usable by man. A flood has two essential characteristics: (1) The inundation is temporary; and (2) The land is adjacent to or inundated by the overflow from a river, stream or lake.
Flood Management System	A flood management system is a system which was designed and constructed to have appreciable and dependable effects in mitigating damages from flood events. Levees are components of a flood management system.
Flood Insurance Rate Maps	<p>Flood Insurance Rate Maps are created by FEMA to show the flood risk in your area as part of the National Flood Insurance Program. These are adopted by the local jurisdiction to become the official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community.</p> <p>Be aware that levees are not always depicted on flood maps. Also, if a system is accredited, FEMA identifies the area behind the levee as a moderate- to low-risk area (typically depicted as Zone X), and thus the risk of being flooded is reduced, but not completely removed. Flood insurance is not federally required in moderate-to-low areas, but it is recommended for all property owners and renters.</p>
Freeboard	Height of the levee above the water surface. Freeboard changes with river elevation changes, but is designed to be a certain distance above design flood elevation to prevent overflow from wave wash and other factors.
Levee	FEMA defines a levee as a “man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection for temporary flooding.” Levees are also known as dikes.
National Flood Insurance Program	A program created by the Congress of the United States in 1968 through the National Flood Insurance Act of 1968. The National Flood Insurance Program allows property owners in participating communities to buy insurance to protect against flood losses.

Term	Definition
Overtop	When the river elevation rises and water comes over the top of the levee.
Penetration	An object that has pierced or passed through the levee. This can be caused by roots, pipelines, animals, poles, and other incursions into the levee.
Piping	Internal erosion on the landward side of the levee caused by seepage moving too quickly through the levee.
Sand Boil	<p>Sand boils are locations where water and sand forced through the levee bubbles up on the landward side of the levee. Sand boils can be an indicator of levee failures, contributing to liquefaction and other internal erosion. Boils remove important structural material and pipe away the material that composes the levee.</p> <p>Sand boils usually occur within 10 to 300 feet from the landside toe of the levee and, in some instances, have occurred up to 1,000 feet away.</p>
Scour	Holes and other erosion caused by fast-moving water. Scour weakens the levee and may lead to future levee failures. Encroachments may expedite scour.
Seepage	Our levees are designed to seep, meaning, they are designed to allow a certain amount of water to pass through. The slope stability of levees is largely a function of seepage. Excess seepage can lead to internal erosion to the levees, piping and sand boils, and possibly levee failure. Encroachments alter the “exit gradient” and may accelerate the erosion—and failure—of the levee.
Sloughing	A slough (pronounced “sluff”) is due to the levee becoming so saturated that the saturation appears on the landward side. When this slope cannot hold its own weight, it slides out, or sloughs, weakening the levee.
Stability	The ability of the levee slopes to withstand forces from various factors, including rise in river elevation.
Subsidence	The sinking or shearing of the levee that is the result of various influences such as internal erosion, seepage, and slope stability failures. This can also be termed as slope failure.



Term	Definition
USACE Rehabilitation and Inspection Program	Also known as Public Law 84-99, the USACE's Rehabilitation and Inspection Program is the discretionary authority given to the USACE by Congress to act and react to emergencies caused by floods, contaminated water sources, drought, or dam failures. This authority allows USACE to repair and/or rehabilitate any qualified flood management project (levees), whether federally constructed or privately owned.



Contact Information

In the event of an emergency call 9-1-1

MCDD

Multnomah County Drainage District #1
1880 NE Elrod Drive
Portland, OR 97211

www.leveereadycolumbia.org

www.mccd.org

503-281-5675

Joel Schoening, Community Affairs Manager
Angela Carkner, Emergency Planning Manager
Sara Morrissey, Levee Ready Columbia Program Manager
Colin Rowan, Levee Ready Columbia Project Manager