

Levee Threat Monitoring Guidelines



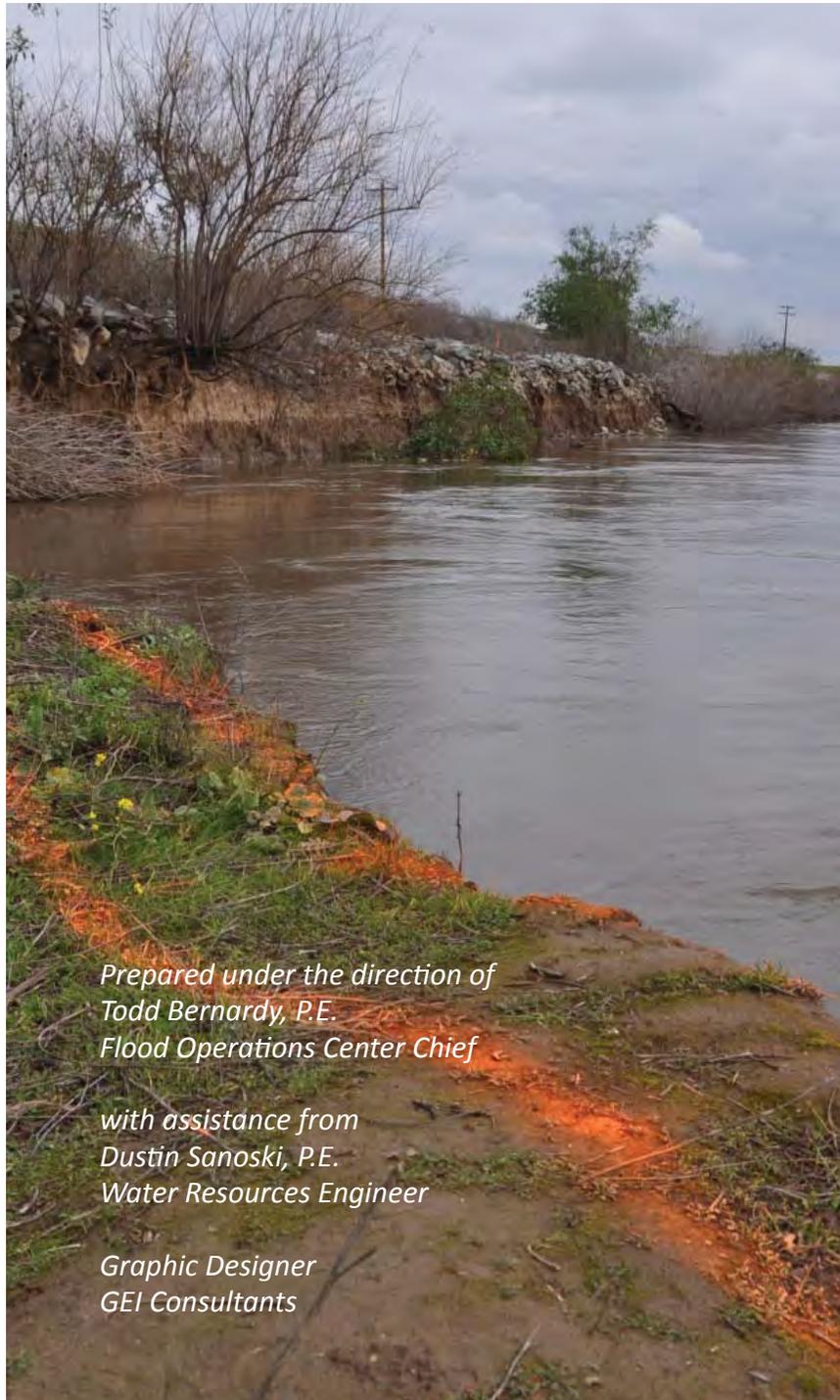
State of California
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Levee Threat Monitoring Guidelines

State of California
California Natural Resources Agency
Department of Water Resources



Division of Flood Management
Flood Operations Branch
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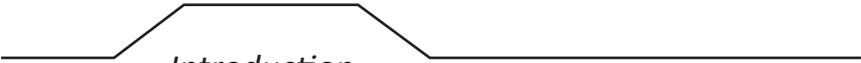
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Introduction

The purpose of the Levee Threat Monitoring Guidelines is to establish a set of “Best Practices” based on field-tested techniques used by levee maintaining agencies, their engineers, flood fight specialists, and levee inspectors to mark and monitor a levee threat.

These guidelines seek to “standardize” levee threat monitoring techniques and are NOT to be taken as requirements. This standardization will help ensure the threat is properly communicated to the appropriate groups, such as emergency responders and the Flood Operations Center. Particularly when there are multiple threats during a high water event, the ability to communicate effectively becomes especially important when the number of potential threats exceeds the available (limited) resources to respond, and a priority must be placed on which threat to mitigate first.

The Levee Threat Monitoring Guidelines presented in this field book were developed by the Department of Water Resources (DWR) Division of Flood Management in cooperation with the local maintaining agencies, experienced consultant engineers, and DWR maintenance yards.

Levee and Embankment Threats

The main causes of levee failure or flood related problems due to high water are:

- **Seepage** of water carrying material through or under the levee heavy enough to cause a "boil".
- **Erosion** of the levee or embankment due to swift moving water or wave action.
- **Overtopping** resulting from water-surface elevations higher than the levee or embankment.

Patrolling

The best defense against flood related issues or levee failure is to identify problems early and repair them immediately. Levee inspections and effective high water patrolling make this possible. The following suggestions will help in organizing patrol teams for this work:

- Operate under the SEMS/ICS system and report to the appropriate section chief.
- Provide a sufficient number of workers for two 12-hour shifts.
- Provide each worker with a copy of the DWR "Flood Fighting Methods" handbook.
- Assign two people to each mobile patrol.
- Advise the officials of the district or agency responsible for emergency assistance in the area, and if necessary request the help from their Operational Area.

Terminology

Boil	Also known as "sand boil", is caused by water flowing through or under a levee, possibly carrying eroded levee material, and surfacing on the land side of the levee.
Cracking	Fracture on the top or slope of a levee caused by displacement of the embankment material. Excessive cracking can lead to slipping/sliding (clay soils) or sloughing (silty or sandy soils).
Erosion	Removal of levee material from the toe or slope of the levee due to swift moving water or wave action possibly resulting in bank caving, section loss, or levee break.
Flood Fighting	An effort made to prevent or mitigate the effects of flood waters.
Hub	A wooden stake (1-1/2"x1-1/2"x8") that is pounded into the ground as a place-holder (optional) for lath with only a few inches exposed and sprayed at the top with high visibility marking paint.
Lath	Long, narrow wooden stakes (1/4"x1-1/2"x33") used to mark problem areas during high water patrolling. A brief description of the problem along with the date, time, and patroller's initials are written on the lath with a permanent ink marker. Brightly colored survey ribbon is attached to the lath for easy identification.
Levee	An earthen structure that parallels a river or stream designed to prevent high water flows from inundating urban and/or agricultural land.
Levee Break	A point in the levee system that has failed to perform its designed function, has eroded away and is allowing water to inundate land.

Levee Breach	The same as "Levee Break" but can sometimes describe a section of levee that has been intentionally broken. If intentional, also known as a relief cut.
Overtopping	When water has risen higher than the banks of a waterway or the top of a levee.
Plastic Sheeting	Made of polyethylene; these 100'x20'x10-mil rolls are sometimes referred to as visquine and are commonly used for erosion control.
Relief Cut	Intentionally removed section of levee to relieve hydrologic pressure upstream and downstream of the levee section.
Sack Ring	Multiple sandbags used to encircle a boil, slow the flow of water, and stop the erosion of levee material.
Sandbag	An 18"x30" bag (burlap or plastic) filled with sand or other appropriate material intended for use as a temporary flood fighting measure.
Scarp	A steep slope or long cliff that occurs from erosion or faulting and separates two relatively level areas of differing elevations.
Seepage	Water traveling under or through a levee in the void spaces of the soil.
Slope Instability	Soil movement or slip/slides often caused by over-saturated levee slopes or hillside slopes. Can also be referred to as "sloughing" or "mud slides".
"U" Shaped Sack Ring	A sandbag structure used on levee slopes to control boils.

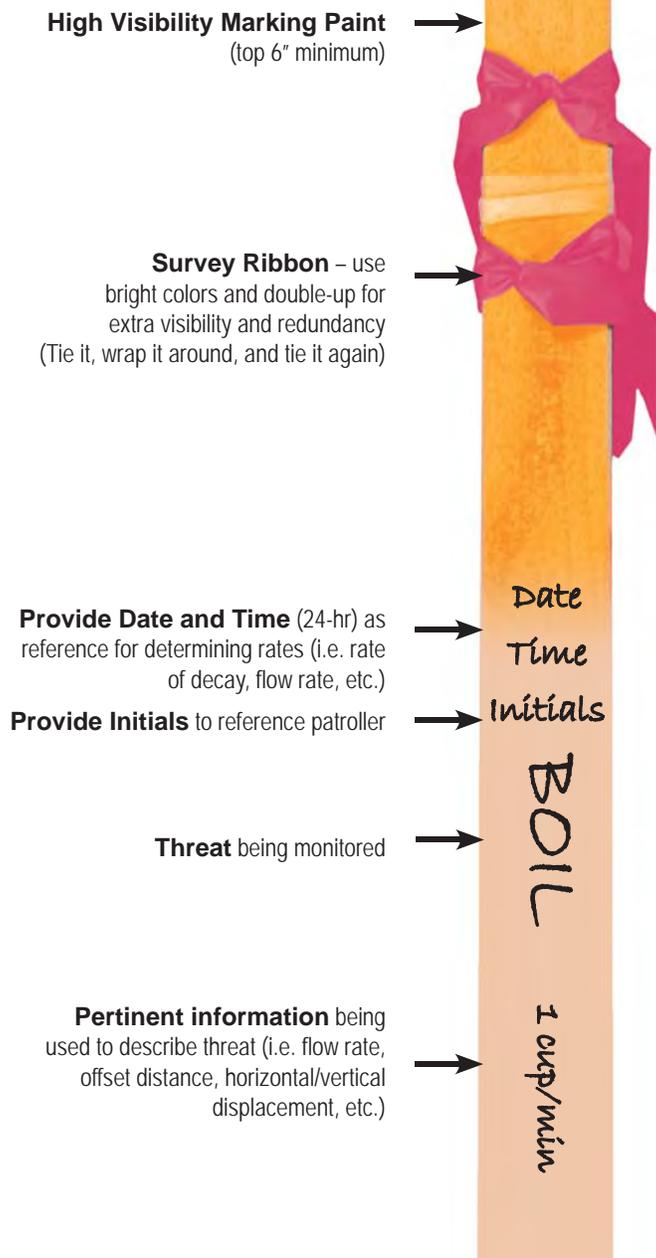
Material Supplies Checklist:

- Lath (1/4"x1-1/2"x33")(25)
- Stakes (3/4"x1-1/2"x17")(25)
- Hubs (1-1/2"x1-1/2"x8")(10)
- 6' Rebar w/ Plastic Caps (2 No. 4 Rebar)
- Tie Wire
- Survey Ribbon (Bright Colors, Multiple Rolls)
- Sandbags (approximately 50 empty)
- Plastic Sheeting (Visquine) (1 roll)
- Box Twine (250lb tensile strength)
- Tie Down Buttons (approximately 100)
- Barricade or Safety Cones (Fluorescent Orange)
- Permanent Ink Markers
- High Visibility Marking Paint (17.0 oz)

Gear Checklist:

- First Aid Kit
- Personal Flotation Device
- Throw Rope
- Directory of Flood Officials & Flood Emergency Phone Card
- Log Book
- GPS
- Phone or Radio
- Rain Gear
- Boots or Rubber Boots
- Hard Hat
- Safety Glasses or Goggles
- Gloves
- Hip Waders
- Spot Light
- Pliers
- Tape Measure (100')
- Bolt Cutter
- Tow Chain
- Chain Saw or Axe
- Flashlight w/ Batteries
- Shovels, Long Handle (#2 Mud Shovel)
- Sledge Hammer (5 or 8 lb)
- Camera

Lath Labeling Example



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Field Safety Measures

- **Check Weather Patterns:** Always know weather forecasts and how it affects the vulnerable areas.
- **Changing Water Patterns:** The rise and fall of water can occur gradually or very quickly. Knowledge of high water and how it relates to your sites/levees is essential. Continuous monitoring and communication of water level influences, (i.e. reservoir releases, tides, and drainage inflow) is very important. Always know your area and its flood history.
- **Swift Water:** High velocities of water are common during high water events. Extreme caution should be used when anyone is exposed to high water. Workers must have personal flotation devices, throw ropes, and lifelines in the immediate area. Each staking crew must be composed of at least two individuals when staking swift water areas. Use common sense and sound judgment around swift water. Know your resources and how to activate them prior to the event. Swift water rescue teams may be available.
- **Temperature Related Illness:** Weather patterns can change constantly. Changes in temperature present the potential for hypothermia and heat exhaustion/stroke. Levee monitors should know the signs of distress for these types of illnesses and how to treat them. During cold, wet weather, it is recommended that workers layer clothing to stay warm and dry. A dry blanket and warm clear fluids should be on the work site for emergency use. In warm/hot weather lightweight clothing is recommended. If skin is exposed, a sun block agent may need to be applied. Plenty of drinking water should be on site and consumed regularly. Headgear is recommended in both hot and cold situations.
- **Insect/Animal Exposure:** Flooded areas force a variety of animals to evacuate to high ground. Workers in these areas should be aware of these animals and not handle them. If animal removal is needed, contact a local professional. Stinging and biting insects are prominent in certain flood-prone areas. Chemical repellents can be useful as a deterrent. A complete first aid kit should be on site.

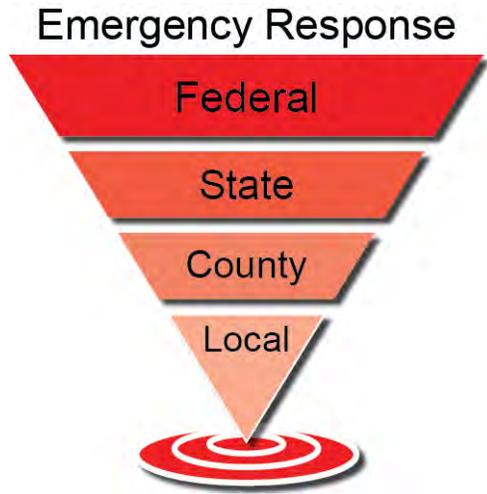
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- **Vegetation:** Noxious plants such as star thistle, stinging nettle, and poison oak are commonly found along rivers, streams, and levees. Avoid direct contact with this type of vegetation to prevent itching and rash. Consult medical personnel if symptoms persist. Individuals with history of allergic reaction should consider carrying an EpiPen.
 - **Contamination:** Flooded areas can potentially carry high levels of contaminants. Common contaminants include fuel, sewage, and pesticides. Local Haz-Mat teams should be contacted if needed. Always wear protective clothing to help limit contact with water. Carry antibacterial hand soap and wash thoroughly after working around flood water.
 - **Construction Equipment:** There are times when equipment and people will occupy the same work area. Workers should wear safety vests and hard hats and be aware of their surroundings. Safety warning devices (i.e. backup alarms and lights) should be intact and working on all equipment. Keep a battery-operated flashlight and radio on hand. Communication and alertness are vital! All operators must be certified for their equipment.
 - **Boat Travel:** Materials and/or personnel will sometimes need to be transported to work sites by boat. Operators of the watercraft must be certified. Personal flotation devices must be available for every passenger. Extreme care should be taken while loading and off loading.
 - **Patrolling:** Patrols will identify, mark, and monitor trouble spots in affected areas. Vehicle patrols should travel in two person teams with dependable communication devices. Lifelines, personal flotation devices, and a blanket should be in the vehicle for possible water-related accidents. Foot patrols should also have the same considerations. Extreme caution should be exercised when travelling saturated, cracked, or sloughing areas. Learn first-aid and have a first-aid kit with you at all times. Never turn your back on the water - work facing the water whenever possible or have a spotter monitor it for you if necessary. Do not take actions that would put an individual in harm's way.

- **Structure Considerations:** When working around structures be aware of downed power lines, natural gas or propane leaks, and unstable structure supports. Communicate with the structure owner if possible.
- **Vehicle Considerations:** Vehicles along the levee should remain parked on high ground; this is usually the crown of the roadway. Vehicles should also be parked facing their access point to allow for a quick exit (if possible). An escape plan should be communicated to all flood workers prior to heading out into the field. Do not drive through floodwaters during high water events. Remember, two feet or less of water can cause a car to be swept away.



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Preparedness



Every emergency begins at the local level. Be prepared and have an emergency action plan!

- Patrol plan & schedule
- Emergency contacts & calling tree
- Emergency response protocols for monitor, flood, danger stage, and incident
- Location and quantities of flood fight materials
- Location and type of equipment available
- Evacuation plan and rally point
- List of critical sites that need extra attention
- Location & contact information for county Emergency Operations Center (EOC)

Share your emergency action plan with your local county Office of Emergency Services and DWR Flood Operations Center.

SEEPAGE

Considerations Around Seepage

1. Do not park directly above the area of seepage.
2. Do not tread unnecessarily near the area of seepage.
3. The sensitive zone may be saturated—do not walk directly from the road straight down to the area of seepage.
4. Confirm the seepage is NOT caused by an irrigation pipe.

What to Measure and Record in Log Book

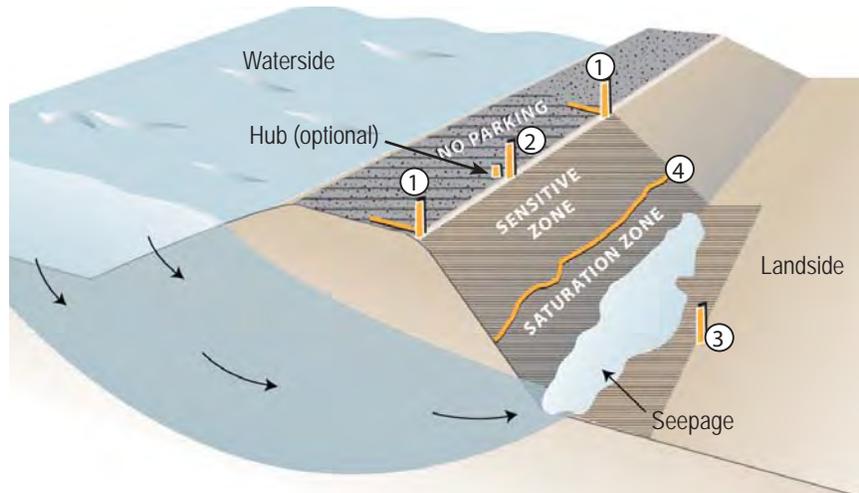
Monitor changes in the extent of seepage and transport of material.

- Date, Time, Person's Name
- Location along levee (GPS coordinates, levee mile, or approximate description) – use lath ② for reference
- Description of threat:
 - » Offset distances from lath
 - » Approximate longitudinal length along levee
 - » Approximate pond width into field
 - » Material transport: flowing clear or carrying material
 - » Note if the water appears to be ponded or is flowing
 - » Extent of soil saturation up the levee toe
 - » Note signs of slope instability
 - » Approximate water surface elevation relative to crown
 - » Note forecast point staff gage reading
 - » Note past performance history of site
- Note surrounding ground conditions & signs of poor drainage
- Take photos or draw schematic for records



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How to Mark Seepage



- ① Place one lath at the beginning of the ponding location and one at the end. Mark each lath with an arrow pointing inwards toward the location of ponding. Mark whether the water appears to be clear or carrying material. Add lath as the threat grows (do NOT remove old lath). Paint can be used as an alternative to placing lath.



- ② Mark the longitudinal length and width of the ponding along the levee. Place an optional hub at the base of the lath to identify the location of the threat in case the lath becomes lost or stolen.



- ③ Lath alternative: Place an additional lath in the landside field at the extent of ponding.



- ④ Saturation zone (if weather permits): Draw a line up and along the levee slope using high visibility marking paint to display the edge of the saturation zone. Paint date next to line.

****Replace lath if lost or stolen****

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BOIL

Considerations Around Boil

1. Do not park directly above the boil.
2. Do not tread unnecessarily near the boil.
3. The sensitive zone may be saturated–do not walk directly from the road straight down to the boil.
4. Confirm the boil is NOT caused by an irrigation pipe.

What to Measure and Record in Log Book

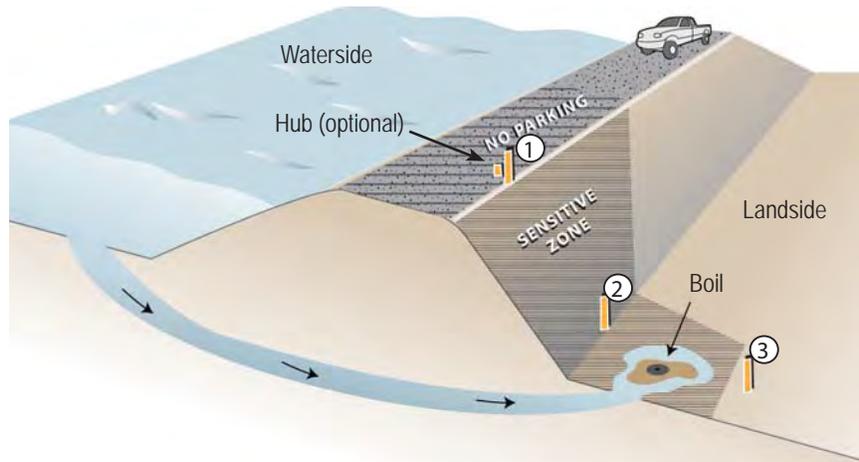
Monitor changes in water flow rate and transport of material.

- Date, Time, Person's Name
- Location along levee (GPS coordinates, levee mile, or approximate description) – use lath ① for reference
- Description of threat:
 - » Located on levee slope or ground adjacent to slope
 - » Offset distances from lath
 - » Distance from levee toe
 - » Diameter of boil(s) & total number of boils
 - » Material transport: water flowing clear or carrying material
 - » Approximate flow rate (i.e. 1 cup/min, 1 coffee can/min, 5-gallon bucket/min)
 - » Approximate water surface elevation relative to crown
 - » Note forecast point staff gage reading
 - » Note past performance history of site
- Note surrounding ground conditions & signs of poor drainage
- Take photos or draw schematic for records



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How to Mark a Boil



- ① Mark the diameter of the boil and the approximate flow rate. Place an optional hub at the base of the lath to identify the location of the threat in case the lath becomes lost or stolen.



- ② Measured from the levee toe, mark the distance to the edge and to the center of the boil. Place this lath when boil is located far from toe.



- ③ Lath alternative: Place an additional lath in the landside field at a minimum distance of 10' from the boil edge to show extent of ponding.



Optional measure: If there is a question about source of boil, use environmentally safe dye in adjacent irrigation channels to confirm water flow is from river.

****Replace lath if lost or stolen****

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SINK HOLE

Considerations Around Sink Hole

1. Do not park directly adjacent to sink hole.
2. Be cautious of collapse around sink hole.
3. Be cautious around toe of levee slope.
4. Confirm the sink hole is NOT caused by an irrigation pipe.

What to Measure and Record in Log Book

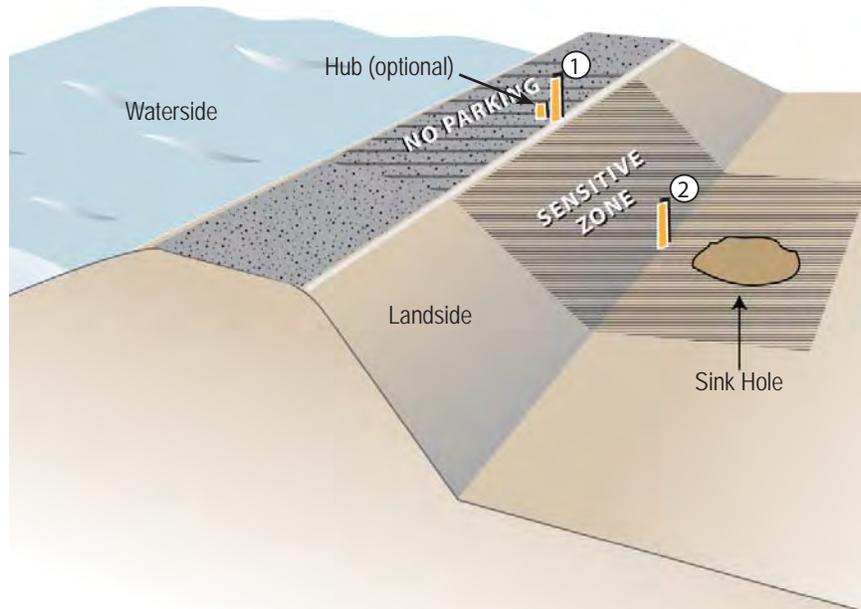
Monitor changes in diameter, depth of sink hole, and water level.

- Date, Time, Person's Name
- Location along levee (GPS coordinates, levee mile, or approximate description) – use lath ① for reference
- Description of threat:
 - » Location of threat (landside, waterside, crown, slope, toe)
 - » Offset distances from lath
 - » Diameter of sink hole
 - » Note if sink hole is dry or filled with water
 - » Use a lath to approximate the depth of water
 - » Note if pipes, risers, valves or other appurtenances are present.
 - » Approximate water surface elevation relative to crown
 - » Note forecast point staff gage reading
 - » Note past performance history of site
- Take photos or draw schematic for records



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How to Mark Sink Hole



- ① Mark the diameter of the sink hole. Place an optional hub at the base of the lath to identify the location of the threat in case the lath becomes lost or stolen.



- ② Measured from the levee toe, mark the distance to the edge and to the center of the sink hole. Place this lath when sink hole is located far from toe.



****Replace lath if lost or stolen****

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CRACKING

Considerations Around Cracking

1. Do not park directly on the cracks.
2. Place lath 1' offset from cracks (typical).

What to Measure and Record in Log Book

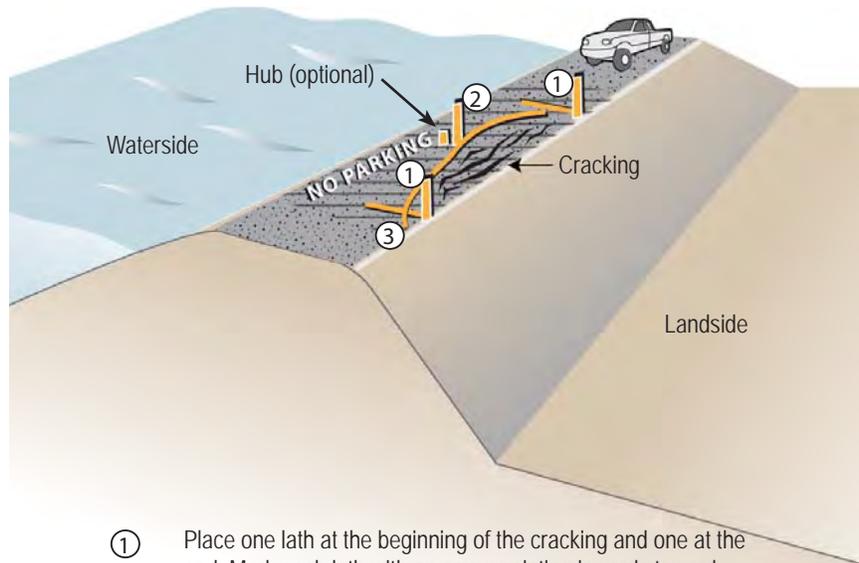
Monitor change in length, width, depth, and extent into crown.

- Date, Time, Person's Name
- Location along levee (GPS coordinates, levee mile, or approximate description) - use lath ② for reference
- Description of threat:
 - » Location of threat (landside, waterside, crown, slope)
 - » Offset distances from lath or paint
 - » Longitudinal length of cracking
 - » Width of cracking into crown
 - » Largest crack width
 - » Largest depth in crack
 - » Note bulging or instability on levee slope
 - » Approximate water surface elevation relative to crown
 - » Note forecast point staff gage reading
 - » Note past performance history of site
- Take photos or draw schematic for records



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How to Mark Cracking



- ① Place one lath at the beginning of the cracking and one at the end. Mark each lath with an arrow pointing inwards toward the location of the threat. Mark the largest width and depth of cracking. Add lath as the threat grows (do NOT remove old lath). Paint can be used as an alternative to placing lath.



- ② Place one lath at the center location of cracking- beyond the area of cracking and adjacent to the affected area of the levee. Mark the longitudinal length of cracking; also mark the extent onto the crown if the cracking is occurring on the crown. Place an optional hub at the base of the lath to identify the location of the threat in case the lath becomes lost or stolen.



- ③ Paint alternative (if weather permits): Draw a line adjacent to the cracking using high visibility marking paint. This will aid in visually displaying the area of cracking. Paint date next to line. Use in addition to the placing and marking of lath.

****Replace lath if lost or stolen****

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SLOPE INSTABILITY

Considerations Around Slope Instability

1. Do not park directly above unstable slope.
2. Barricade/cone the area if more than ¼ crown width (horizontally) or more than 2' of vertical displacement has occurred (severe case). Place lath 2' offset from threat (typical).
3. Tread lightly in sensitive zone to prevent causing additional levee damage or injury to individual.

What to Measure and Record in Log Book

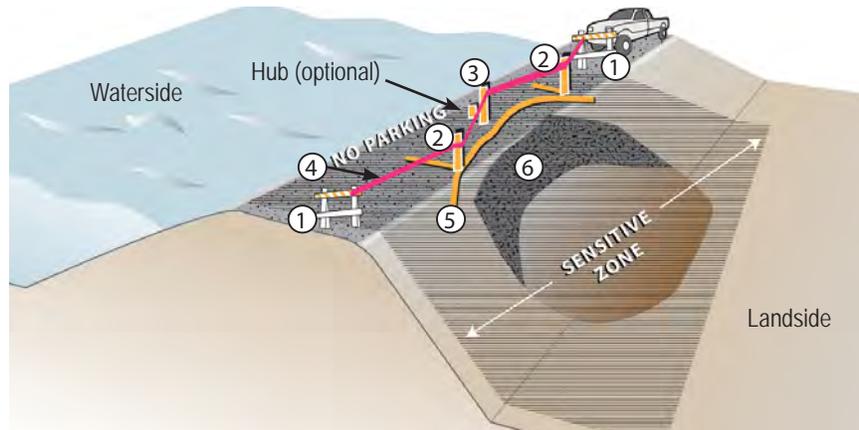
Monitor movement of levee slope and record changes in horizontal and vertical displacement.

- Date, Time, Person's Name
- Location along levee (GPS coordinates, levee mile, or approximate description) – use lath ③ for reference
- Description of threat:
 - » Location of threat (landside crown, slope, toe)
 - » Offset distances from lath
 - » Longitudinal length
 - » Extent into crown
 - » Vertical displacement
 - » Horizontal displacement
 - » Note any bulging on levee slope
 - » Approximate water surface elevation relative to crown
 - » Note forecast point staff gage reading
 - » Note past performance history of site
- Take photos or draw schematic for records



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How to Mark Slope Instability



- ① Place barricade/cones 8' offset (minimum) from lath
- ② Barricade/cones prevent vehicles from entering "danger zone" and are to be used in severe cases of horizontal and vertical displacement.
- ③ Place one lath at the beginning of the slope instability (write "slip" on lath as a generic term to describe slope instability) and one at the end. Mark each lath with an arrow pointing inwards toward the location of the threat. Add lath as the threat grows (do NOT remove old lath). Paint can be used as alternative to placing lath.



- ③ Place a lath at the center location of slope instability. Mark the longitudinal length of the threat. Place an optional hub at the base of the lath to identify the location of the threat in case the lath becomes lost or stolen.



- ④ Ribbon connects the barricades to lath and encloses the "danger zone" from one side of the slope instability site to the other. Use bright colored ribbon to help make the site more visible.
- ⑤ Paint alternative (if weather permits): Draw a line adjacent to the edge of displacement using high visibility marking paint. This will aid in visually displaying the unstable site. Paint date next to line. Use in addition to the placing and marking of lath.
- ⑥ See page 22 for marking horizontal and vertical displacement.

****Replace lath if lost or stolen****

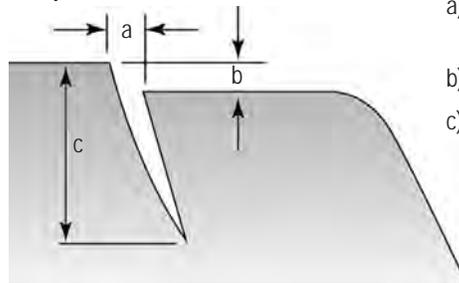
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SLOPE INSTABILITY

How to Monitor Horizontal & Vertical Displacement

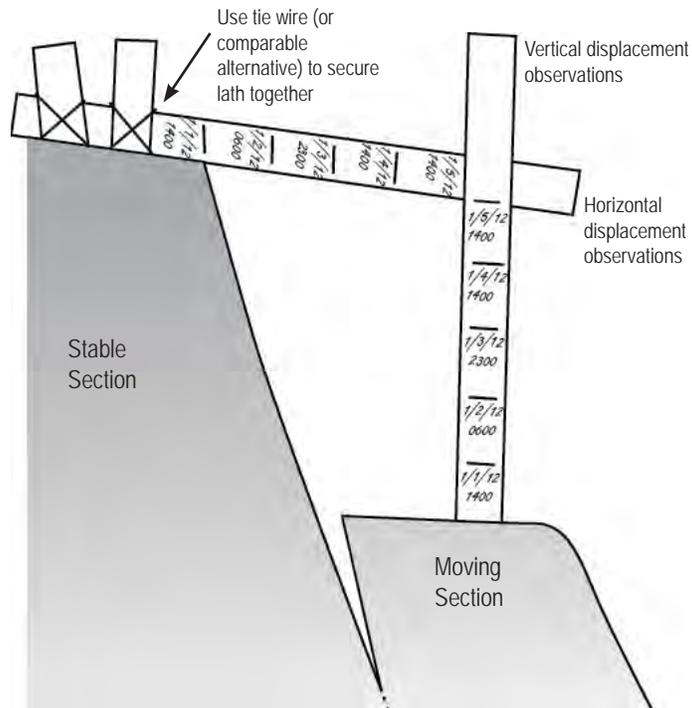
1. Pound two laths vertically into stable section at a 1' offset from the moving section, 6" deep minimum, and space them 6" apart.
2. Secure one lath horizontally to the two lath on the stable section (as shown on next page) using tie wire or a comparable alternative. Stabilize lath using ground surface.
3. Pound one lath vertically into moving section approximately 6" deep, and offset 6" from the stable section. Place lath so that it rests against horizontal lath.
4. Draw a line on the vertical lath at the bottom of where it intersects with the horizontal lath. [This identifies the "baseline" for where to begin measuring vertical displacement]. Mark the date and time below this line.
5. Draw a line on the horizontal lath at the bottom of where it intersects with the vertical lath. [This identifies the "baseline" for where to begin measuring horizontal displacement]. Mark the date and time below this line.
6. Come back (some time later) and mark on the horizontal lath where it intersects with the vertical lath, and mark on the vertical lath where it intersects with the horizontal lath. Repeat this step over time as slope continues to displace.
7. Rate of horizontal & vertical displacement is the distance measured between observations divided by time.

Early Stage Horizontal and Vertical Displacement



- a) Horizontal displacement
- b) Vertical displacement
- c) Crack depth

Late Stage Horizontal and Vertical Displacement



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WAVE WASH

Considerations Around Wave Wash

1. Walk and drive carefully around areas subject to wave wash.
2. If wave wash results in erosion that encroaches into the levee prism it could lead to rapid levee failure.

What to Measure and Record in Log Book

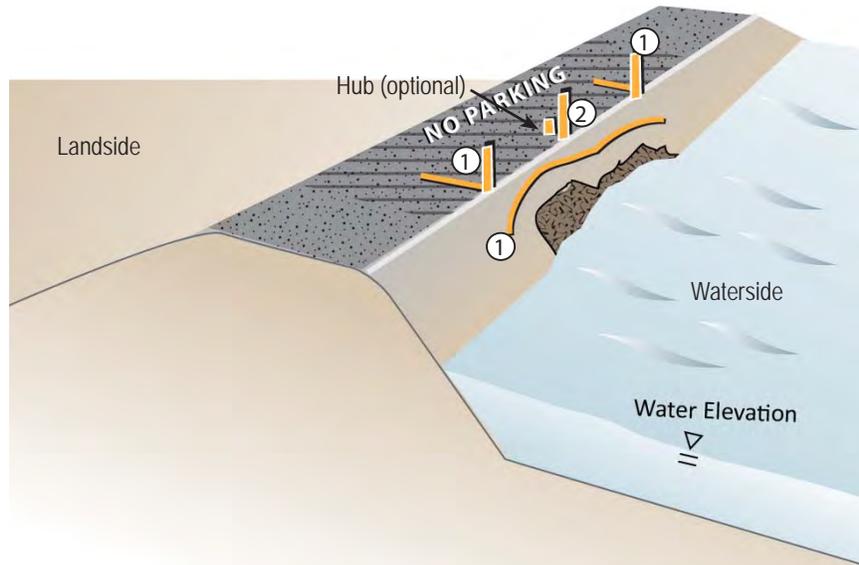
Monitor changes in length and expansion of erosion toward crown.

- Date, Time, Person's Name
- Location along levee (GPS coordinates, levee mile, or approximate description) – use lath ② for reference
- Description of threat:
 - » Distance down slope relative to crown
 - » Length and width(s) of erosion
 - » Height and depth of scarp
 - » Approximate water surface elevation relative to crown
 - » Note forecast point staff gage reading
 - » Note past performance history of site
- Take photos or draw schematic for records



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How to Mark Wave Wash



- ① Place one lath at the beginning of the area experiencing wave wash and one at the end. Mark each lath with an arrow pointing inwards toward the location of the threat. Add lath as the threat grows (do NOT remove old lath). Paint can be used as an alternative to placing lath.



- ② Mark the longitudinal length and width of the wave wash extent. Place an optional hub at the base of the lath to identify the location of the threat in case the lath becomes lost or stolen.



****Replace lath if lost or stolen****

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EROSION

Considerations Around Erosion

1. Walk and drive carefully around erosion site—loose soil could collapse and cause injury to person and/or vehicle.
2. If erosion encroaches into levee prism (see diagram) it could lead to rapid levee failure.
3. Be cautious near edge of erosion; eddy may have undermined bank integrity and may cave in unexpectedly.

What to Measure and Record in Log Book

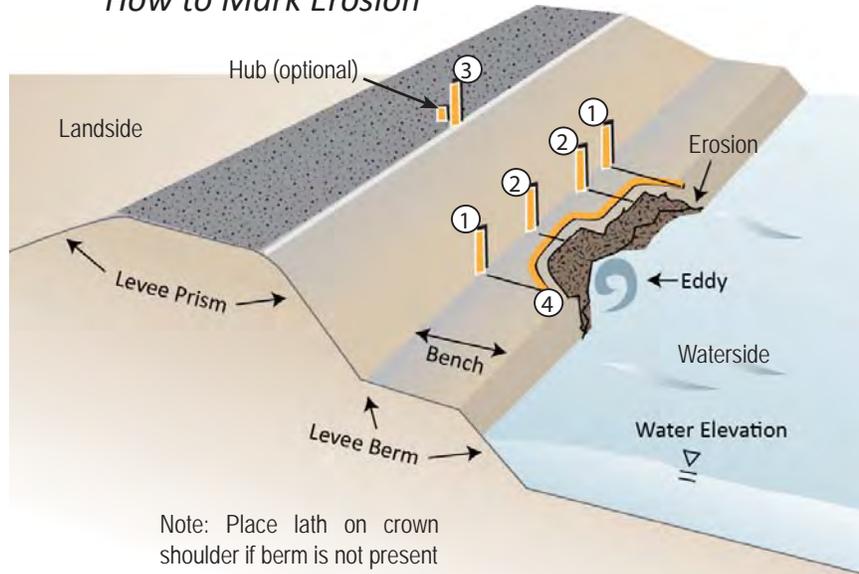
Monitor changes in length and expansion of erosion toward crown.

- Date, Time, Person's Name
- Location along levee (GPS coordinates, levee mile, or approximate description) – use lath ③ for reference
- Description of threat:
 - » Site relative to bend (straight, inside/outside)
 - » Offset distances from lath or paint
 - » Length and width(s) of erosion
 - » Height and depth of scarp
 - » Note if eddy has formed
 - » Approximate water surface elevation relative to crown
 - » Note forecast point staff gage reading
 - » Note past performance history of site
- Take photos or draw schematic for records



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How to Mark Erosion



Note: Place lath on crown shoulder if berm is not present

- ① Mark offset distance from levee toe to edge of berm where no erosion has occurred – shows "normal" bench width and the extent of erosion. Place additional lath at levee toe as threat grows (do NOT remove old lath).



- ② Mark offset distance from levee toe to edge of erosion – shows depth of erosion into berm. Place lath at levee toe.



- ③ Place lath at levee crown shoulder and center it longitudinally across erosion site. Mark the longitudinal length of erosion. Place an optional hub at the base of the lath to identify the location of the threat in case the lath becomes lost or stolen.



- ④ Paint alternative (if weather permits): Draw a line adjacent to the erosion, and several more in 4' increments away from the erosion, using high visibility marking paint. This will aid in visually displaying the rate of the erosion over time. Paint date next to line. Use in addition to the placing and marking of lath.

****Replace lath if lost or stolen****

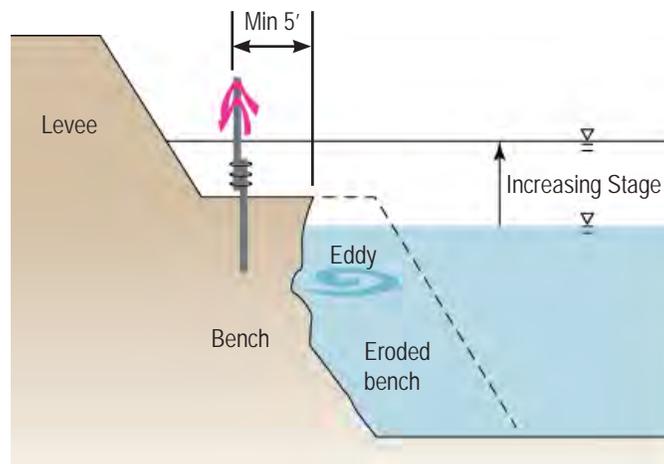
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EROSION

Monitor Erosion When Berm is Obscured

If there is concern that the erosion site may be obscured due to water surface/stage increase, the berm can be monitored by placement of rebar. If rebar is gone, there is high likelihood that the erosion has grown to rebar location. One technique to monitor erosion when berm is obscured by water surface is described below:

1. Drive No. 4 rebar 2'-3' into ground no closer than 5' from current erosion edge.
 - » Be aware of potential for undercutting by eddys.
 - » Note location of rebar relative to levee toe and erosion edge.
2. Attach second No. 4 rebar to first rebar using tie wire so that the combined height of the two rebar are at least 6' above bench surface.
3. Attach 2 survey ribbons at the top of the second rebar.
4. To help protect the monitoring rebar against debris floating downstream, place three rebar upstream of monitoring rebar in a diagonally staggered line so to best deflect debris.
5. Document rebar location and distance from rebar to edge of erosion in log book.
6. Take photos or draw schematic for records.



28

A Special Thank You to:

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Phil Carey
Russ Eckman
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Jeff Van Gilder

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Flood Risk Assessment and Mitigation Office

Vincent Rodriguez

National Weather Service

Cindy Matthews

Reclamation District 900

Tony Schwall

San Joaquin County

Eric Ambriz
John Nelson

Reference Guide:

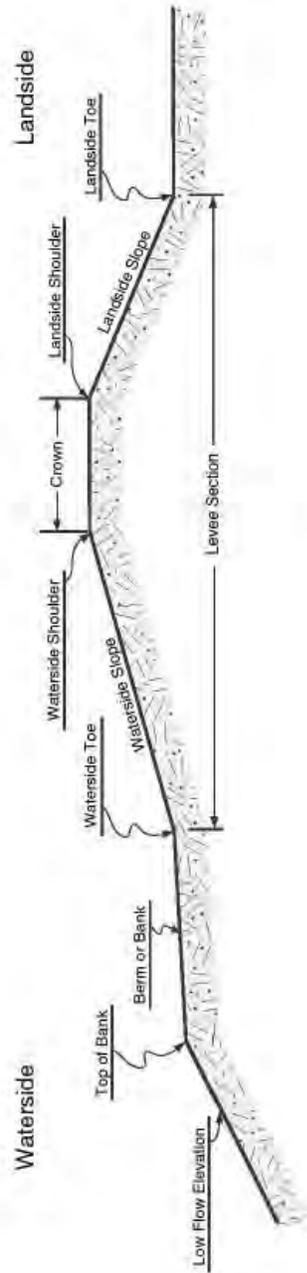
DWR Division of Flood Management:
www.water.ca.gov/floodmgmt

California Data Exchange Center (CDEC)
<http://cdec.water.ca.gov>

California Emergency Management Agency (CalEMA)
www.calema.ca.gov

National Weather Service
www.weather.gov

To request a copy of the Directory of Flood Officials or Flood Emergency Phone Card, contact the DWR Flood Operations Center at (916) 574-2619.



Levee Cross Section

State of California
 Department of Water Resources
 Division of Flood Management
 Flood Operations Branch

FLOOD
EMERGENCY RESPONSE



For all flood emergencies, questions, or
for additional information, please contact:

State-Federal Flood Operations Center

(916) 574-2619

(800) 952-5530

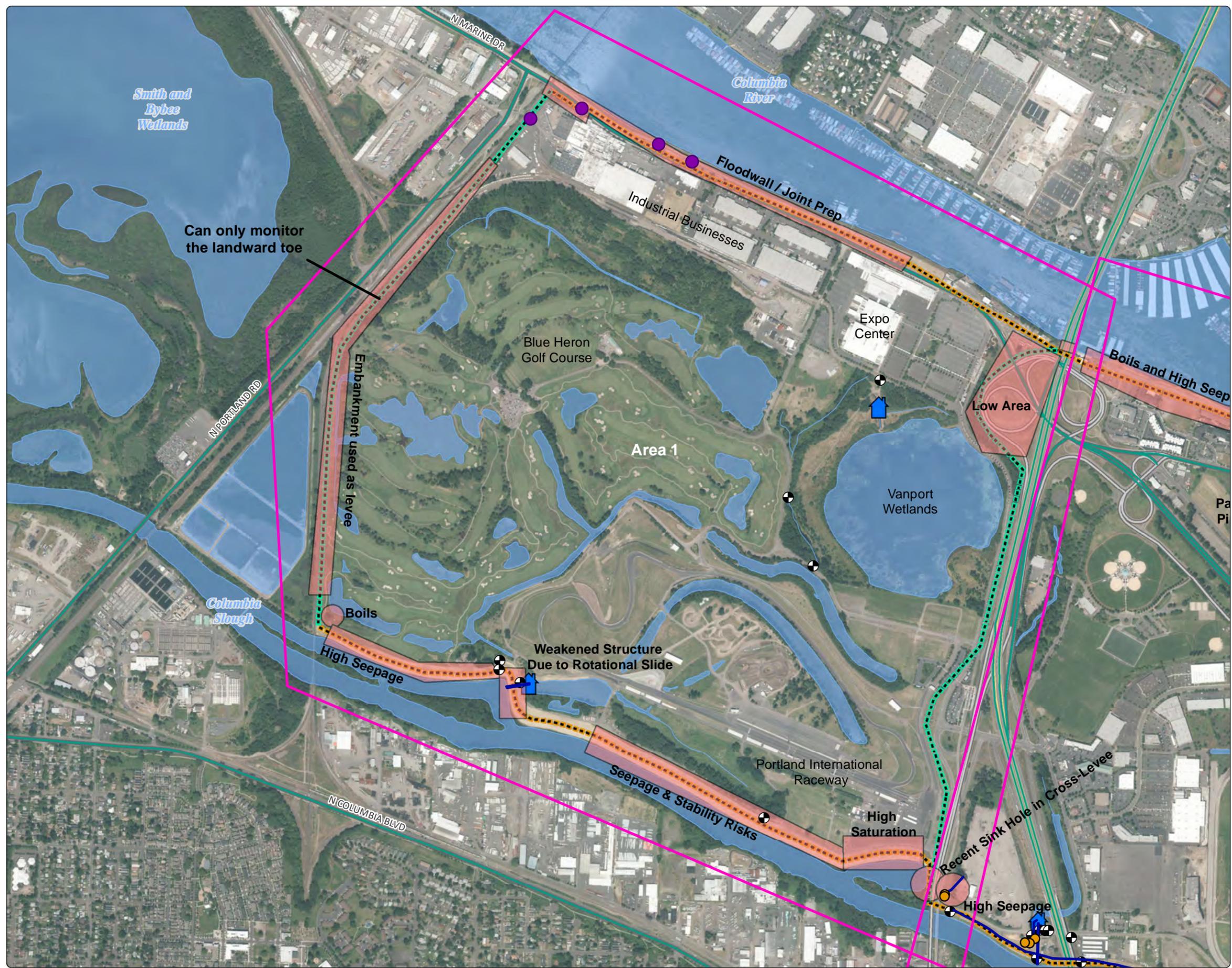
flood_center@water.ca.gov



version 1.1



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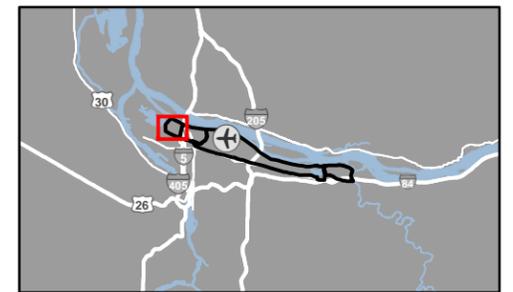


FEAP Appendix N: Levee Patrol Area 1 PEN 1

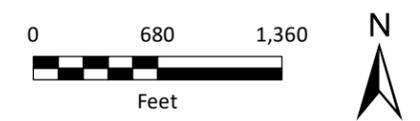
for levee monitoring
during a high water event

Legend

- - - - - Cross Levee/Embankment
- - - - - Levee
- Levee Pipe System
- Levee System Wells/ Drains/ Inverts
- ⊕ Gate
- Areas of Concern
- Emergency Transportation Routes
- ⬆ Pump Stations
- Freeway
- Arterial
- Levee Patrol Area
- Floodwall Closure Locations



MCDD Flood Emergency Action Plan.
This map shows the patrol areas for levee monitoring that will be used during a high water event in the Districts.

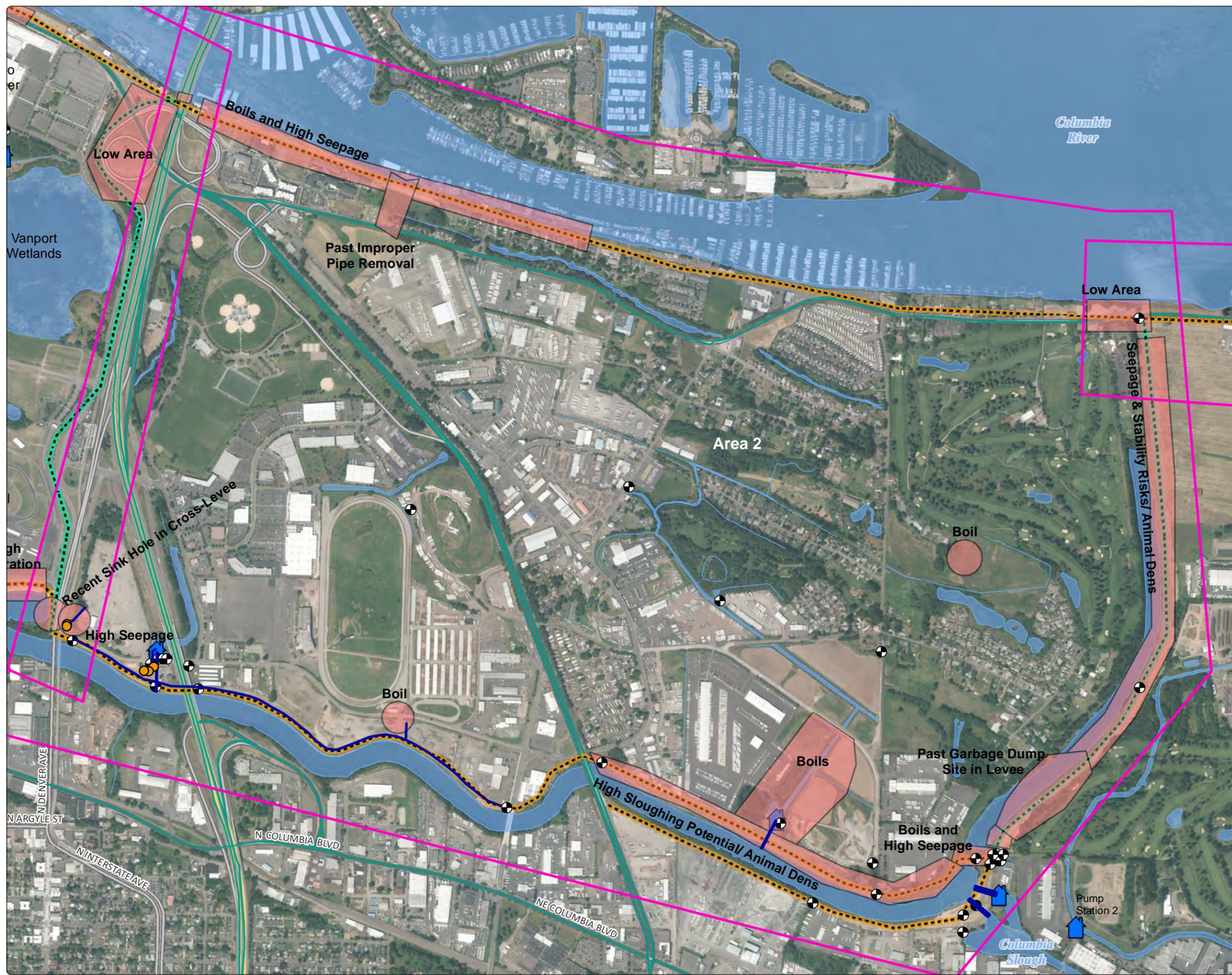


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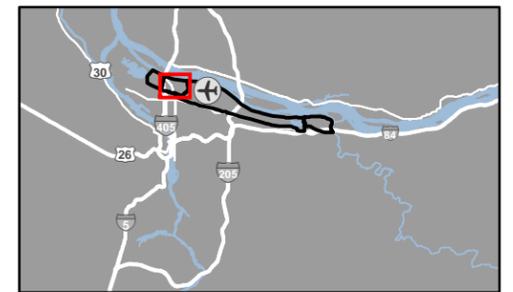
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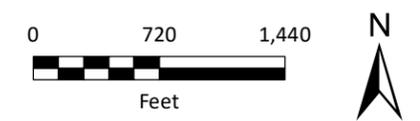


FEAP Appendix N: Levee Patrol Area 2 PEN 2 for levee monitoring during a high water event

- Legend**
- Levee System Wells/ Drains/ Inverts
 - Levee Pipe System
 - ⊙ Gate
 - Risk Driver
 - ↑ Pump Stations
 - - - Cross Levee/Embankment
 - - - Levee
 - Emergency Transportation Routes
 - Freeway
 - Arterial
 - Levee Patrol Area



MCDD Flood Emergency Action Plan. This map shows the patrol areas for levee monitoring that will be used during a high water event in the Districts.



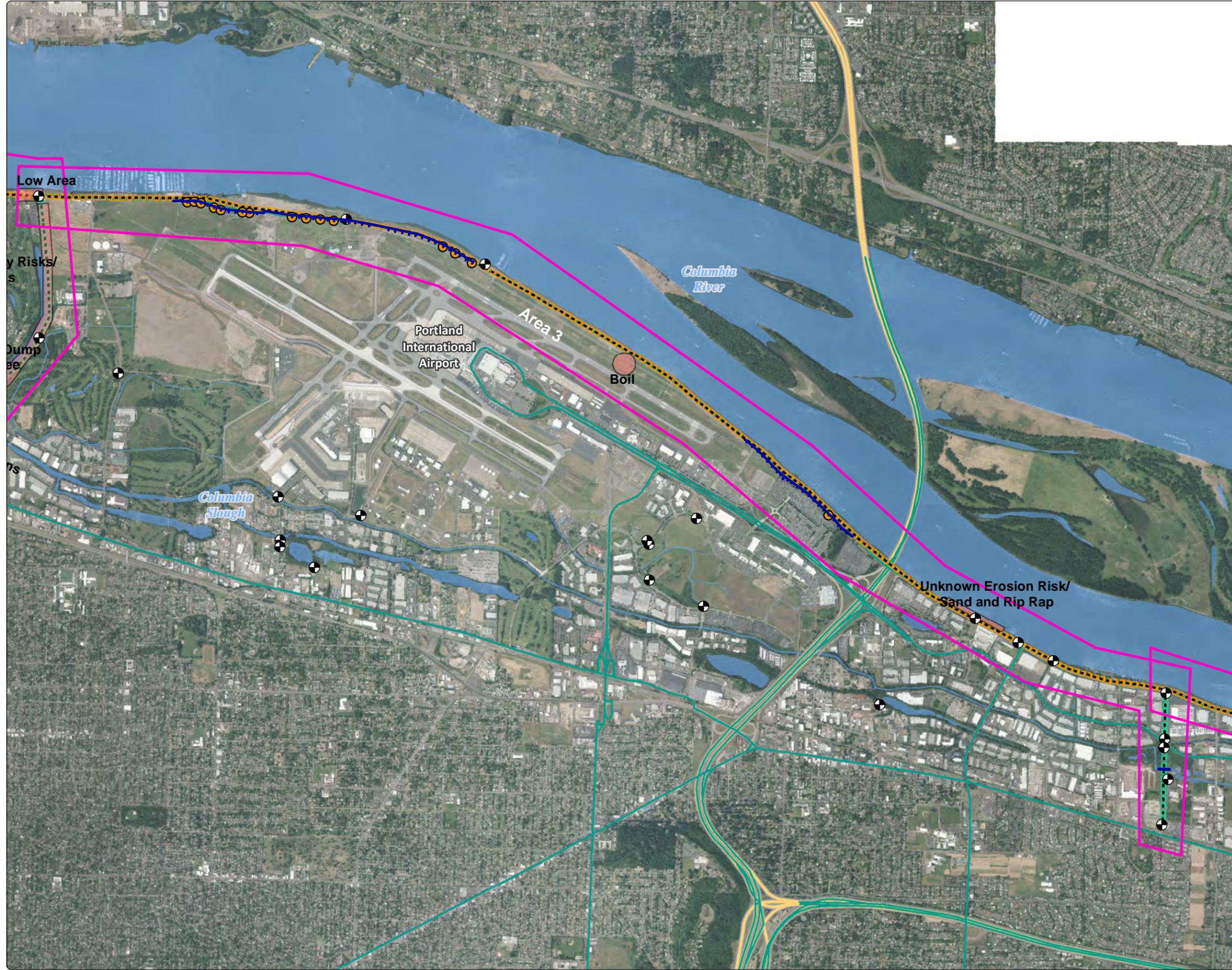
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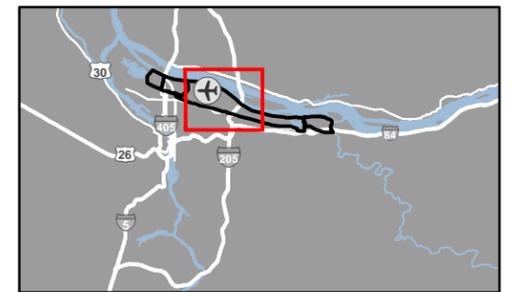
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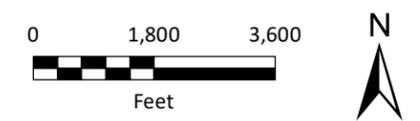


FEAP Appendix N: Levee Patrol Area 3 MCDD-West for levee monitoring during a high water event

- Legend**
- Levee Pipe System
 - Levee System Wells/ Drains/ Inverts
 - ⊕ Gate
 - Risk Driver
 - Cross Levee/Embankment
 - Levee
 - Emergency Transportation Routes
 - Freeway
 - Levee Parol Area



MCDD Flood Emergency Action Plan. This map shows the patrol areas for levee monitoring that will be used during a high water event in the Districts.

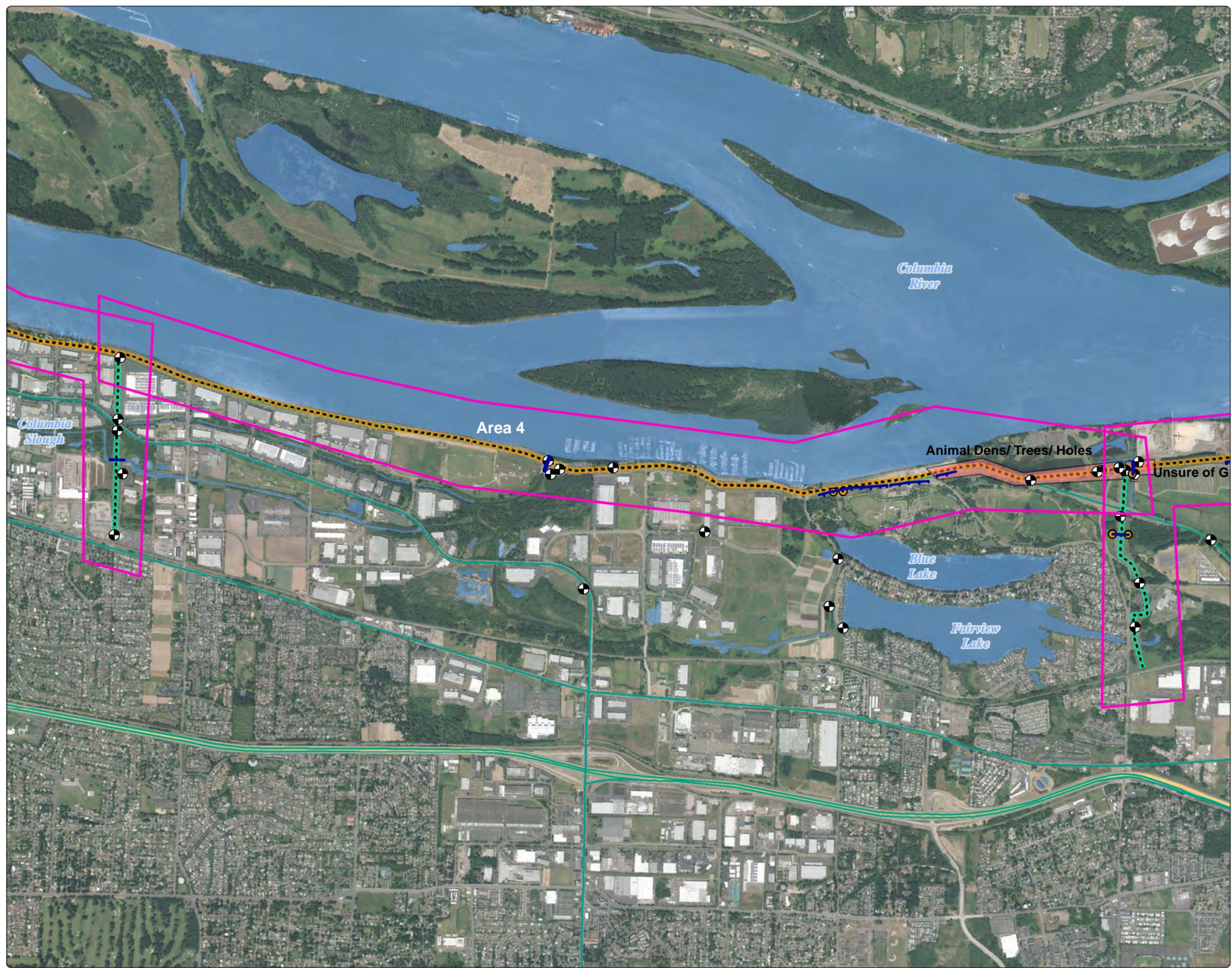


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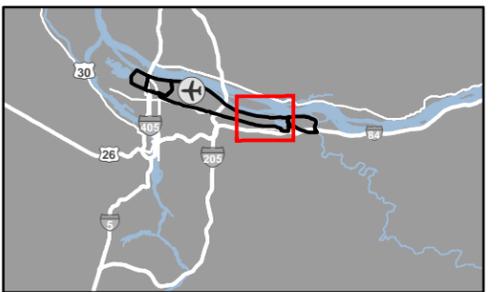
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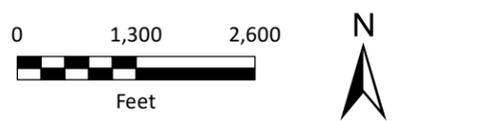
FEAP Appendix N: Levee Patrol Area 4 MCDD-East

for levee monitoring
during a high water event

- ### Legend
- Levee Pipe System
 - Levee System Wells/ Drains/ Inverts
 - Gate
 - Risk Driver
 - Cross Levee/Embankment
 - Levee
 - Emergency Transportation Routes
 - Freeway
 - Levee Patrol Area



MCDD Flood Emergency Action Plan.
This map shows the patrol areas for
levee monitoring that will be used during
a high water event in the Districts.

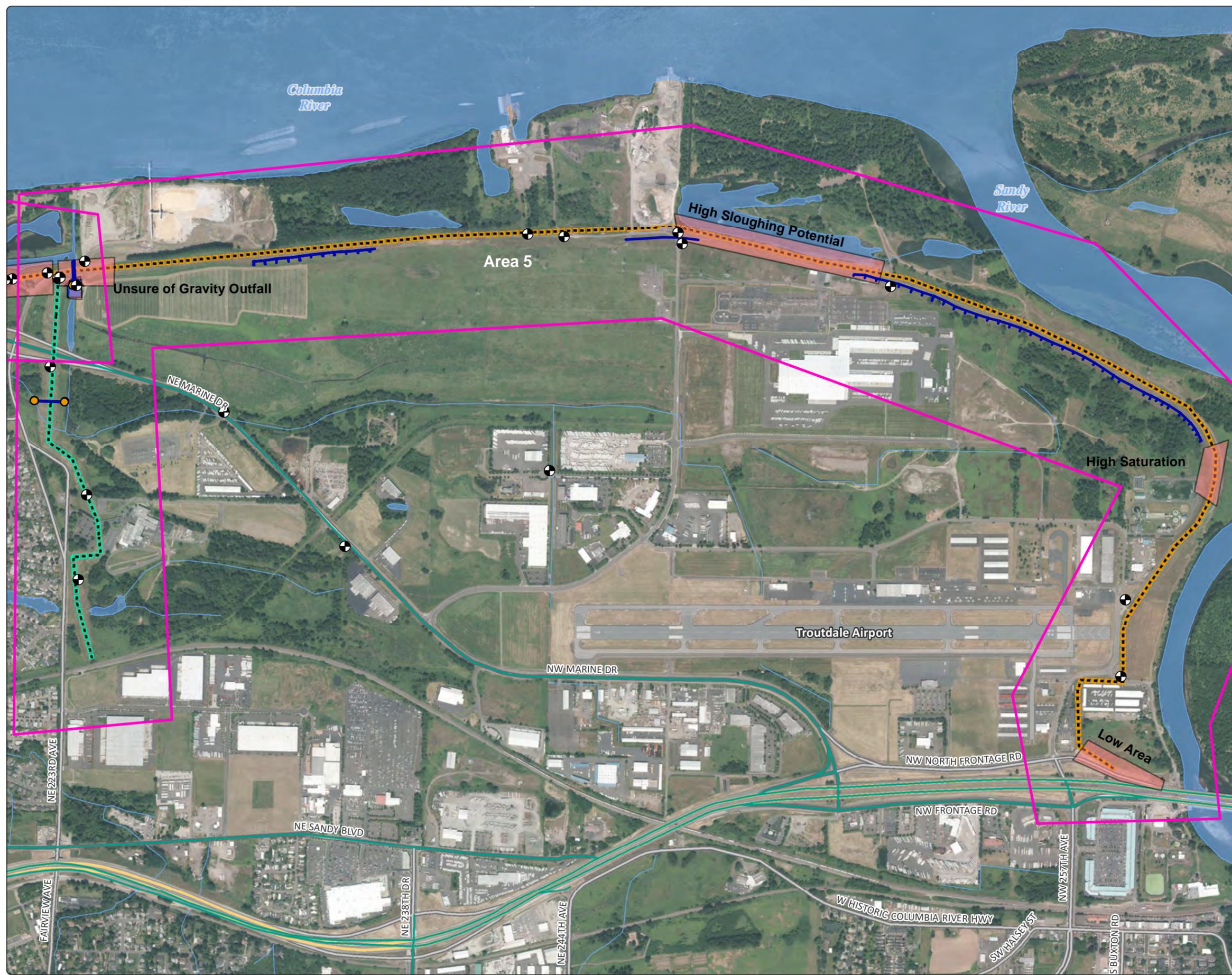


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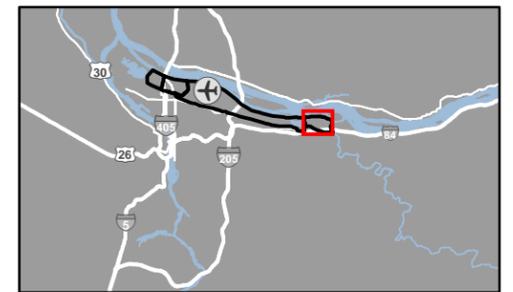


FEAP Appendix N: Levee Patrol Area 5 SDIC

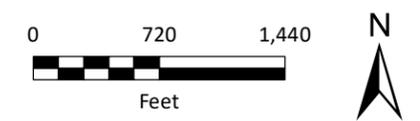
for levee monitoring
during a high water event

Legend

- Gate
- Levee System Wells/ Drains/ Inverts
- Levee Pipe System
- Risk Driver
- Cross Levee/Embankment
- Levee
- Pump Stations
- Emergency Transportation Routes
- Freeway
- Arterial
- Levee Parol Area



MCDD Flood Emergency Action Plan.
This map shows the patrol areas for levee monitoring that will be used during a high water event in the Districts.



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