Illicit Discharge Detection and Elimination: Field and Lab Assessment Protocols
Washington State permits require:

- Regulations to prohibit illicit discharges and connections
- Procedures to find and eliminate them
- Map of MS4
- Field assessments
- Staff training
- Public education and hotline
IDDE Guidance Manual
8 Program Components

1. Audit Existing Resources & Programs
2. Establish Responsibility, Authority & Tracking
3. Complete a Desktop Assessment of Illicit Discharge Potential
4. Develop Program Goals & Implementation Strategies
5. Search for Illicit Discharge Problems in the Field
6. Isolate & Fix Individual Discharges
7. Prevent Illicit Discharges
8. Evaluate the Program
Dry Weather Outfall Screening Procedure

- Visual inspection of the outfall
- Qualitative assessment of any flow present, including examination of water color, odor, turbidity, floatables, & sedimentation
- Follow-up grab sample for quantitative analysis, either using more sophisticated field
IDDE Monitoring Framework

- In-stream Monitoring [optional]
- ORI
  - Non-Flowing
    - Transitory
    - Intermittent
      - OBM
      - Caulk Dam
      - Off Hours
  - Source Area Data

  - Flowing
    - Flowchart
    - Industrial Benchmark
    - Chemical Library

  - Obvious
  - Find and Fix Immediately

Chemical Mass Balance Model

☐ Denotes a monitoring method
Look, Look! Signs of flow!

Hone Your Detective Skills
Look, Look!
Signs of flow!

Cross-Train Your Staff

1964
Outfall Reconnaissance Inventory (ORI)
Map, Mark & Photograph Outfalls

- Assign unique ID to each outfall
- Physically mark each outfall
- Use a GPS unit to record outfall locations
- Take a photograph

Source: Robert Pitt, University of Alabama
# Outfall Reconnaissance Inventory / Sample Collection Field Sheet

## Section 1: Background Data

<table>
<thead>
<tr>
<th>Subwatershed: Scotts Level Branch</th>
<th>Outfall ID: SC-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today’s date: 4/03/03</td>
<td>Time (Military): 9:45</td>
</tr>
<tr>
<td>Investigators: PES, EWB</td>
<td>Form completed by: EWB</td>
</tr>
<tr>
<td>Temperature (°F): 50</td>
<td>Rainfall (in.): Last 24 hours: 0.1 Last 48 hours: 1</td>
</tr>
<tr>
<td>Latitude: 39.1727</td>
<td>Longitude: 76.4150</td>
</tr>
<tr>
<td>Camera: KODAK</td>
<td>GPS Unit: SLL GPS LMK #: LMK 1</td>
</tr>
<tr>
<td>Photo #: 1</td>
<td>GPS LMK #: LMK 1</td>
</tr>
</tbody>
</table>

**Land Use in Drainage Area (Check all that apply):**

- [ ] Industrial
- [ ] Open Space
- [ ] Ultra-Urban Residential
- [ ] Institutional
- [x] Suburban Residential
- [ ] Commercial

**Other:**

**Known Industries:**

**Notes (e.g., origin of outfall, if known):**
Outfall Reconnaissance Inventory (ORI)
Record Basic Characteristics

- Dimensions of pipe or ditch
- Material – concrete, metal, plastic, etc.
- Whether or not outfall is flowing
## Section 2: Outfall Description

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>MATERIAL</th>
<th>SHAPE</th>
<th>DIMENSIONS (IN.)</th>
<th>SUBMERGED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Pipe</td>
<td>□ RCP</td>
<td>□ Circular</td>
<td>Diameter/Dimensions:</td>
<td>In Water:</td>
</tr>
<tr>
<td></td>
<td>□ PVC</td>
<td>□ Single</td>
<td>42</td>
<td>□ No</td>
</tr>
<tr>
<td></td>
<td>□ HDPE</td>
<td>□ Double</td>
<td></td>
<td>□ Partially</td>
</tr>
<tr>
<td></td>
<td>□ Steel</td>
<td>□ Triple</td>
<td></td>
<td>□ Fully</td>
</tr>
<tr>
<td></td>
<td>□ Other:</td>
<td>□ Other:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open drainage</td>
<td>□ Concrete</td>
<td>□ Trapezoid</td>
<td>Depth:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Earthen</td>
<td>□ Parabolic</td>
<td>Top Width:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ rip-rap</td>
<td>□ Other:</td>
<td>Bottom Width:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- □ In-Stream (applicable when collecting samples)
  - Flow Present? □ Yes  □ No  *If No, Skip to Section 5*
  - Flow Description (If present) □ Trickle  □ Moderate  □ Substantial
  - With Sediment: □ No  □ Partially  □ Fully

- □ In Water: □ No  □ Partially  □ Fully
Outfall Reconnaissance Inventory (ORI)
Simple Monitoring at Flowing Outfalls

- Flow
- pH
- Temperature
- Ammonia
pH testers
Conductivity meter (and you get a thermometer!)
Conductivity

water's ability to conduct electricity
The higher the number, the poorer the quality.
### Section 3: Quantitative Characterization

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>RESULT</th>
<th>UNIT</th>
<th>EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flow #1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td>1 L</td>
<td>Liter</td>
<td>Bottle</td>
</tr>
<tr>
<td>Time to fill</td>
<td>4.0</td>
<td>Sec</td>
<td></td>
</tr>
<tr>
<td><strong>Flow #2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow depth</td>
<td></td>
<td>In</td>
<td>Tape measure</td>
</tr>
<tr>
<td>Flow width</td>
<td>_____”</td>
<td>_____”</td>
<td>Tape measure</td>
</tr>
<tr>
<td>Measured length</td>
<td>_____”</td>
<td>_____”</td>
<td>Tape measure</td>
</tr>
<tr>
<td>Time of travel</td>
<td></td>
<td>S</td>
<td>Stop watch</td>
</tr>
<tr>
<td>Temperature</td>
<td>58.2</td>
<td>°F</td>
<td>Thermometer</td>
</tr>
<tr>
<td>pH</td>
<td>7.2</td>
<td>pH Units</td>
<td>Test strip/Probe</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.1</td>
<td>mg/L</td>
<td>Test strip</td>
</tr>
</tbody>
</table>
Outfall Reconnaissance Inventory (ORI)
Physical Indicators for Flowing Outfalls

- Odor
- Color
- Turbidity
- Floatables

Source: Fort Worth DEM
Turbidity meter, imhoff cones, and secchi disk for measuring suspended solids & water clarity
Suds/ Foam
Oil Sheen
Section 4: Physical Indicators for Flowing Outfalls Only

Are Any Physical Indicators Present in the flow? ☒ Yes  ☐ No  (If No, Skip to Section 5)

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>CHECK if Present</th>
<th>DESCRIPTION</th>
<th>RELATIVE SEVERITY INDEX (1-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odor</td>
<td>☒</td>
<td>□ Sewage</td>
<td>☒ 1 – Faint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Rancid/sour</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Petroleums/gas</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Sulfide</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>☒ Other: Slight Chemical</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>☐</td>
<td>□ Clear</td>
<td>☐ 1 – Faint colors in sample bottle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Brown</td>
<td>☐ 2 – Clearly visible in sample bottle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Gray</td>
<td>☐ 3 – Clearly visible in outfall flow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Yellow</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Green</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Orange</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Red</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>☒ Other:</td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>☐</td>
<td>See severity</td>
<td>☐ 1 – Slight cloudiness</td>
</tr>
<tr>
<td>Floatables</td>
<td>☐</td>
<td>□ Sewage (Toilet Paper, etc.)</td>
<td>☐ 1 – Few/slight; origin not obvious</td>
</tr>
<tr>
<td>-Does Not Include Trash!!</td>
<td>☐</td>
<td>□ Suds</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Petroleum (oil sheen)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>☒ Other:</td>
<td></td>
</tr>
</tbody>
</table>
Digital dissolved oxygen probes
Many jurisdictions bypass the quantitative tests and immediately go “up the trunk” to find the source of the discharge.
Outfall Reconnaissance Inventory (ORI)
What to do when obvious illicit discharge encountered?

- STOP the ORI
- Track the source
- Contact appropriate water pollution agency
- Photo document, estimate flow, and collect a sample – if safe

Photo Source: R. Frymire
Outfall Reconnaissance Inventory (ORI)

Physical Indicators for Flowing and Non-Flowing Outfalls

- Outfall Damage
- Deposits/Stains/Colors
- Abnormal Vegetation
- Poor Pool Quality
- Pipe Benthic Growth
- Odors, Residue
- Oil and/or Grease
Pool Quality
Benthic Indicators
**Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls**

Are physical indicators that are not related to flow present?  
☐ Yes  ☑ No  
*(If No, Skip to Section 6)*

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>CHECK if Present</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outfall Damage</td>
<td>☐</td>
<td>□ Spalling, Cracking or Chipping</td>
<td>□ Feeling Paint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Corrosion</td>
<td></td>
</tr>
<tr>
<td>Deposits/Stains</td>
<td>☐</td>
<td>□ Oily</td>
<td>□ Flow Line □ Paint □ Other:</td>
</tr>
<tr>
<td>Abnormal Vegetation</td>
<td>☐</td>
<td>□ Excessive □ Inhibited</td>
<td></td>
</tr>
<tr>
<td>Poor pool quality</td>
<td>☑</td>
<td>□ Odors □ Suds □ Excessive Algae □ Floatables □ Oil Sheen □ Other:</td>
<td>Apparent suds may be natural from organic matter.</td>
</tr>
<tr>
<td>Pipe benthic growth</td>
<td>☐</td>
<td>□ Brown □ Orange □ Green □ Other:</td>
<td></td>
</tr>
</tbody>
</table>
Outfall Reconnaissance Inventory (ORI)
Section 6-8

Section 6: Overall Outfall Characterization

- Unlikely
- Potential (presence of two or more indicators)
- Suspect (one or more indicators with a severity of 3)
- Obvious

Section 7: Data Collection

1. Sample for the lab?  [X] Yes  [ ] No
2. If yes, collected from:  [ ] Flow  [ ] Pool
3. Intermittent flow trap set?  [X] Yes  [ ] No  [ ] If Yes, type:  [X] OBM  [ ] Culvert dam

Section 8: Any Non-Illlicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

- Illicit Discharge Severity?
- Sample taken at outfall?
- Note unusual conditions near the outfall
ORI Cost Considerations

- Equipment (relatively minor)
- Crew size (2 to 3 people per crew)
- Stream miles (~ 2-3 miles per crew per day)
- Pre- and post-processing data management (~ 3 person-days for each day spent in field)
Customizing the ORI

- Open channels
- Submerged or tidally influenced outfalls
- Cold climate/ ice
- Other local indicators (e.g., biological)
The ORI Cannot:

- Find all discharges (can sometimes lead to a “false positive” as well)
- Detect intermittent flows that leave no trace
- Quantify impacts definitively (no direct measure of relative problem)
- Define sources (except for some obvious indicators)
Top Problems in Identifying Inappropriate Discharge Sources

- The **source** of the discharge makes identification difficult
  - Periodic nature
  - Illegal dumping / one-time dischargers
  - Illegal connections
  - Inflow/infiltration from sanitary sewers
  - After-hours discharges
Chemical accident kills hundreds of fish
KAREN CIMINO
Betsy Anderson and her husband, Mel Battle, were walking on the Little Sugar Creek Greenway on Saturday morning when they noticed that nothing in the creek was moving.

"There were just dead fish all over the place," Anderson said.

Hundreds of them died, from Carolinas Medical Center toward Freedom Park, after chemicals that were being used in pressure-washing leaked into the creek, according to Charlotte-Mecklenburg Stormwater Management officials.

Charlotte-Mecklenburg police and the Charlotte Fire Department were alerted early Saturday; a hazardous-materials team tested the water and determined there was no immediate threat to the public, to workers or to nearby businesses, said Rob Brisley, spokesman for the Charlotte Fire Department.

The fish weren't so fortunate.

CMC had hired ValleyCrest Landscape Maintenance to pressure-wash new concrete on its property. ValleyCrest violated city and state laws by using an acidic chemical compound as part of its pressure-washing, said Rusty Rozzelle, water quality program manager with Charlotte-Mecklenburg Stormwater Management.

The acidic chemical lowered the pH levels in the water to 6 (7 to 9 is normal for the creek), killing the fish.

ValleyCrest agreed to remove the dead fish and could face up to a $10,000 fine, Rozzelle said.

ValleyCrest officials could not be reached for comment Saturday evening. CMC cooperated with authorities to determine the cause, said Debra Pierce, vice president of marketing for CMC.

Commercial pressure-washing is not a violation of drought-related city or county water restrictions, Rozzelle said. But the drought is an aspect of the incident: Low water levels in the creek added to the problem, Rozzelle said. The water flow was not sufficient to dilute the washing chemicals.

The pressure-washing lasted 11 hours, dumping the chemical from a stormwater drain near a CMC parking deck that faces the creek. Around noon Saturday, upstream from the drain, the water was clear and fish were alive; downstream, the water was clouded and the fish were dead.
Top Problems in Identifying Inappropriate Discharge Sources

- The MS4 infrastructure complicates the tracking of a discharge up the system
  - Accessibility (building, stream, outfall, traffic)
  - Complexity of network
  - Natural influences (tidal, groundwater)
  - Size of drainage basin
  - Multiple sources w/in system
Top Problems in Identifying Inappropriate Discharge Sources

- The IDDE program does not have the resources available to determine the potential source of the discharge
  - Maps are not accurate
  - Slow complaint response
  - Insufficient expertise
  - Slow laboratory analysis
  - Unreliable equipment
  - Use of unreliable indicators
Outfall Reconnaissance Inventory (ORI)
Data Management and Quality Control

- **Field Quality Control**
  - Binder containing field sheets
  - Crew leader:
    - Confirm all reaches and outfalls surveyed
    - Consistency of forms

- **Office Quality Control**
  - Data entered into spreadsheet
  - Check quality of data
Post-Screening Prioritization

ORI, combined with other existing data, can help determine:

- Extent of the problem
- If problems are “clustered”
- Indicators of intermittent discharges
- Relative ranking of problem outfalls
Detailed Field Sampling / Lab Analysis

- More detailed sampling that includes:
  - Sampling to ID problem outfalls not apparent from physical indicators alone
  - Source identification
  - Potential intermittent monitoring
Factors to Consider

- Fraction flowing (from ORI)
- Number with physical indicators, and severity
- Indicators at dry outfalls
- Other existing monitoring data
- In-stream goals
- History of complaints
Forensics

- Run chemical tests
- Choose specific indicators depending on local “fingerprints” or based on land use in area
Key Features for Ideal Indicators

- Distinguishes a particular source
- “Tight” statistical distribution
- Precise measurement
- Safe
- Relatively inexpensive
- Simple to conduct
Key Lab Considerations

- Equipment cost
- Staff training
- Number of samples
- Safety
- Disposal
Typical Physical Indicators

- Color
- Odor
- Deposits and stains
- Floatable matter
- Temperature
- Turbidity
- Changes in flow
- Vegetation change
- Structural damage
- Grease / oil
Typical Chemical Indicators

- pH
- Chlorine
- Specific conductivity
- Ammonia / ammonium
- Surfactants
- Fecal coliform
- Fluoride
- Copper
- Florescence
- Phenols

- Potassium
- Detergents
- Dissolved oxygen
- Hardness
- Iron
Flow Chart to Identify Illicit Discharges in Residential Drainage Areas

Start

- Ammonia/Potassium ratio > 1.0
  - Yes: Possible sanitary wastewater contamination
  - No: Possible washwater contamination

- Surfactants > 0.25 mg/L or Boron > 0.35 mg/L
  - Yes: Likely tap and/or irrigation water source
  - No

- Fluoride > 0.25 mg/L
  - Yes: Likely natural water source
  - No
## Benchmark Concentrations to Identify Industrial Discharges

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Concentration</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia (mg/L)</td>
<td>≥50</td>
<td>• Existing “Flow Chart” Parameter&lt;br&gt;• Concentrations higher than the benchmark can identify a few industrial discharges</td>
</tr>
<tr>
<td>Potassium (mg/L)</td>
<td>≥20</td>
<td>• Existing “Flow Chart” Parameter&lt;br&gt;• Excellent indicator of a broad range of industrial discharges</td>
</tr>
<tr>
<td>Color (Units)</td>
<td>≥500</td>
<td>• Supplemental parameter that identifies a few specific industrial discharges</td>
</tr>
<tr>
<td>Conductivity (µS/cm)</td>
<td>≥2,000</td>
<td>• Identifies a few industrial discharges&lt;br&gt;• May be useful to distinguish between industrial sources</td>
</tr>
<tr>
<td>Hardness (mg/L as CaCO₃)</td>
<td>&lt;10&lt;br&gt;≥2,000</td>
<td>• Identifies a few industrial discharges&lt;br&gt;• May be useful to distinguish between industrial sources</td>
</tr>
<tr>
<td>pH (Units)</td>
<td>≤5</td>
<td>• Only captures a few industrial discharges&lt;br&gt;• High pH values may also indicate an industrial discharge but residential wash waters can have a high pH as well</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>≥1,000</td>
<td>• Supplemental parameter that identifies a few specific industrial discharges</td>
</tr>
</tbody>
</table>
Chemical Fingerprint Library

- Shallow Groundwater
- Spring Water
- Tap water
- Irrigation
- Sewage
- Septic Tank Discharge
- Common Industrial Discharges
- Commercial Car Wash
- Commercial Laundry
Most programs measure fecal coliform bacteria “colony-forming units” per 100 milliliters of raw water, or E. coli counts.
Fingerprints of Major Sources

Sewage
- E. Coli
- Detergents (various)
- High Ammonia/ Potassium Ratio

Wash Water
- Detergents (various)

Shallow Groundwater
- Hardness, pH

Tap Water
- Fluoride
- Sometimes Hardness

Septage
- E. Coli
- Fluorescence
- High Ammonia/Potassium
Special Indicators for Intermittent Discharges

- Optical brightener monitoring
- Toxicity testing
- Outfall damming
- Take a sample from the pool
Finding and Fixing

- Move up the pipe
- Use smoke or dye testing once narrowed
- Use enforcement or repair