The City of Seattle has designed its on-going IDDE screening and source tracing program to meet the 2007 NPDES Phase I Municipal permit requirement to screen 60% of the municipal separated storm sewer system (MS4) and to employ a systematic approach to finding illicit discharges and illicit connections using dry weather field screening and source tracing at key locations in the MS4. Field screening is designed to identify and characterize dry-weather flows and attempt to identify pollutants which may indicate illicit discharges or connections. The dry weather field screening element attempts to find illicit discharges/connections by:

1. Prioritizing basins based on existing data and drainage basin characteristics
2. Identifying screening parameters to use as indicators
3. Performing field screening which consists of characterization and chemical screening at key locations within selected basins
4. Conducting data review to compare screening results to action levels
5. Source tracing where the comparison suggests that problems exist
6. Identifying and removing sources of illicit discharges and connections when found

Prioritization of Drainage Basins

Drainage basins are prioritized for field screening using existing data to weight the potential for illicit discharges and illicit connections. Factors considered during prioritization include: drainage basin size, previous data collection efforts, areas of the MS4 that discharge to 303(d) listed water bodies, areas of the MS4 that discharge in the vicinity of public water access, and areas where storm drain separation projects have occurred in the past. These screening factors are tabulated and weighted by drainage basin to generate a priority list for IDDE screening.

Screening Parameters

The field screening consists of visual observations, field measurements, and laboratory analysis of chemical and biological parameters to characterize flowing discharges. When flow is not present, the field screening element relies on visual observations, such as damage or staining of the MS4 infrastructure as an indication of the presence of intermittent or transitory discharges. Table 1 details the parameters used to identify and characterize flow types and to determine if an illicit discharge or illicit connection is suspected at each sample location.

Table 1: IDDE Screening Parameters and SPU Trigger Levels

Screening Parameter	SPU Trigger Levels	Analysis Location
pH	<5.5 or >9	Field
Conductivity	>400 µS/cm	Field
Turbidity	> 100 NTU or Severity Index 3	Field
Temperature	>80° F	Field
Odor	Severity Index of 3	Field
Color	Severity Index of 3	Field
Floatables	Severity Index of 3	Field
Surfactants	> 1 mg/l	Field
Ammonia	> 5 mg/l	Field
Dissolved oxygen	NA	Field
Estimated flow	NA	Field
Fecal coliform	> 5000 cfu/100ml	SPU Water Quality Laboratory
Fluoride	> 0.3 mg/l	SPU Water Quality Laboratory
Potassium	> 5 mg/l	SPU Water Quality Laboratory
Ammonia/Potassium ratio*	>1 = wastewater, <1 = washwater	None

*Note: the ammonia/potassium ratio is used to differentiate between source types, not as a trigger

Literature has indicated that these screening parameters have been useful for identifying and characterizing residential, commercial, and industrial discharges (Brown, Caraco & Pitt, 2004). Most of the City's drainage basins consist of mixed land uses and are highly variable. For this reason, SPU will utilize the screening parameters at all sample locations. Additional parameters may be added in response to specific situations.

The dry weather field screening program uses a trigger method as the primary action level for source tracing. The trigger method uses field and laboratory screening parameters to prioritize investigations for source tracing. Trigger levels are estimates that are greater than what is encountered in natural systems. SPU has not set trigger levels for dissolved oxygen or estimated flow because they are not key parameters; however, these parameters are relatively easy to obtain in the field and are indicators of environmental health and extreme values may indicate illicit discharges or other detrimental conditions.

Field Screening

The general approach to field screening is to begin at an accessible location at or near the discharge point of a drainage basin, such as an outfall, key maintenance hole, ditch, or other structure. Field screening is performed at multiple key locations in most drainage basins instead of relying on elevated concentrations to be found only at the downstream discharge point. The size of the drainage basin is used to determine the number of locations screened. Key upstream maintenance holes representing major branches of the conveyance system are screened in larger basins in order to decrease

the size of the area screened by an individual sample. The purpose of this approach is to help detect discharges that may be diluted and, therefore, masked by groundwater intrusion or blended flows.

SCM staff will be performing the field sampling and analyses for all parameters except fecal coliform, potassium, and fluoride, for which the SPU Water Quality Laboratory will perform the analysis. Most of the samples collected will be grab samples of flowing water. In rare cases, it may be necessary to take composite samples or standing water samples. Most field screening will occur during the summer months during dry weather conditions. For the purposes of the IDDE program, dry weather means:

- 0.01 inch of rainfall in a one hour period,
- 0.05 inch or less of rainfall in a six hour period followed by a six hour period of no measurable rainfall (<0.01 inch), or
- 0.10 inch or less of rainfall in a six hour period followed by a twenty-four hour period of no measurable rainfall (<0.01 inch).

If runoff can be observed entering the drainage system samples cannot be collected, regardless of rainfall measured.

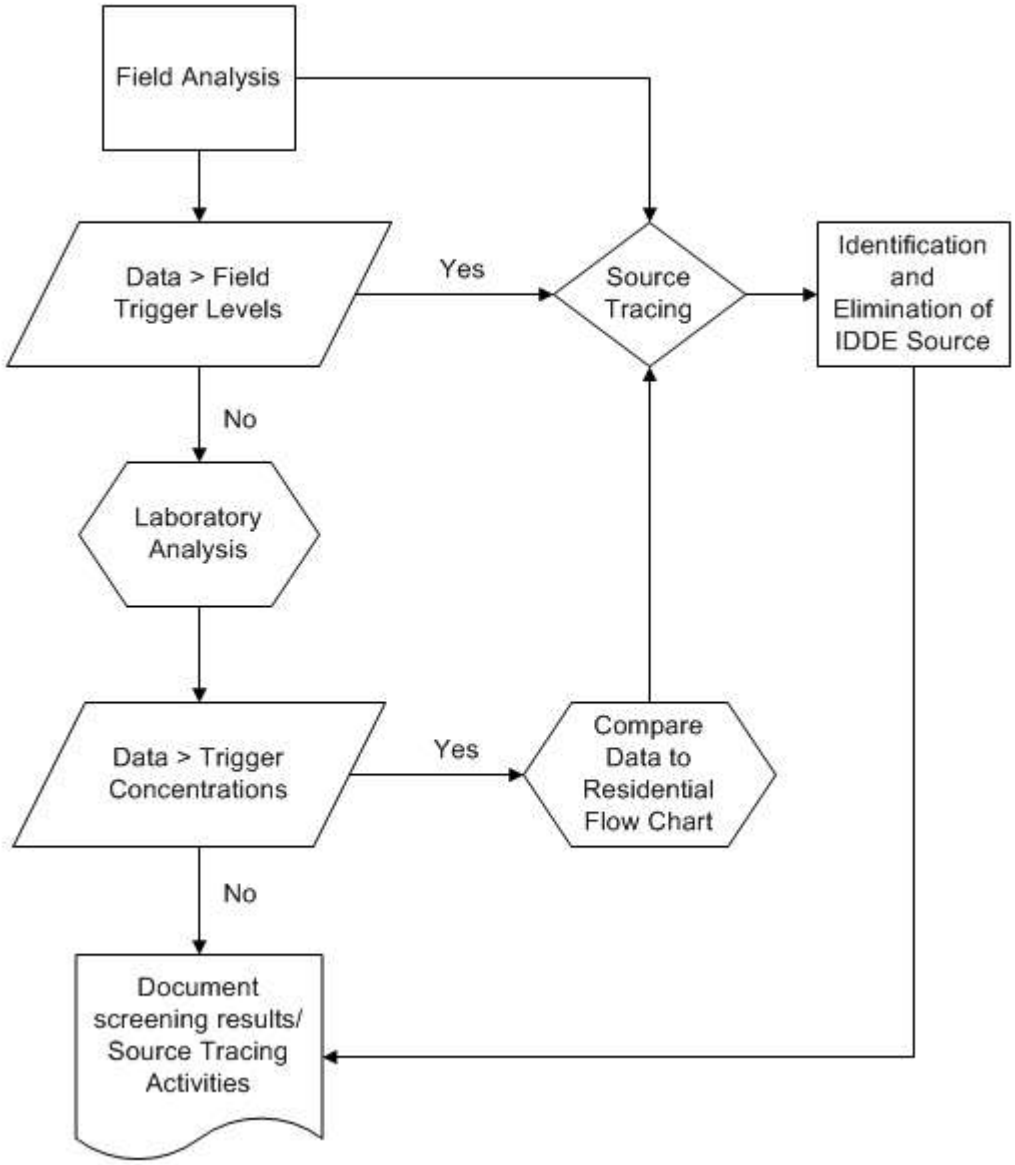
The City operates more than 20 rain measurement stations providing real-time data. Rainfall data will be obtained from the rain gauge station nearest the basin to be screened. The sampling schedule will also account for tidal intrusion in areas of the City influenced by tidal flows.

The principal components of the SPU's field screening element are:

- Field observations of the physical and environmental conditions at each site
- Field analyses by in-situ chemical screening
- Source tracing if illicit discharges or illicit connections are suspected based on the field observations or field analyses
- Laboratory analysis of the collected samples for the remaining chemical parameters
- Additional source tracing based on laboratory analyses

Figure 1 illustrates how these components work together to result in identification and elimination of illicit discharge sources.

Figure 1. IDDE Field Screening Flow Chart



Field Observations

IDDE staff gather field observations of the physical and environmental conditions of each field screening location. These observations are recorded using a geodatabase in ArcPad on a laptop. As noted in Table 1, SPU has set trigger levels for four primary field observations including color, odor, turbidity, and floatables. Field observations are rated by the relative severity index that uses a scale from 0 to 3. The SPU trigger level for each field observation is set at Severity Index 3, which indicates obvious signs of illicit discharges and connections.

Field Analyses

If flow is present, IDDE field crews conduct the following field analyses: temperature, pH, conductivity, turbidity, dissolved oxygen, ammonia, and surfactants. The field analysis results are recorded in a Field Log then transferred to the geodatabase using ArcPad on a laptop. If flow is present, a water sample is also collected for laboratory analysis of potassium, fluoride, and fecal coliform.

During the field analysis, crews will compare data to the field screening trigger levels in Table 1 to determine the potential presence of an illicit discharge or connection.

Immediate source tracing in order to follow a suspected illicit discharge or connection upstream will be initiated whenever field observation or data show that any of the trigger levels listed in Table 1 above have been reached. If the field analysis data are below trigger levels or inconclusive, follow-up will be delayed until lab test results are received.

Immediate source tracing may not require that a sample be collected at each location or that each sample be analyzed for all parameters due to the importance of tracking the discharge quickly and efficiently to locate the source, especially for intermittent and transitory flows. In these cases, SCM staff use field observations (color, odor, floatables, and turbidity) and field analyses (pH, conductivity, temperature, dissolved oxygen, ammonia, surfactants, and turbidity) as necessary to track the suspected illicit discharge or connection. It should be noted that turbidity is being measured by field observation and by field analysis.

Once the discharge source has been located or isolated to a smaller section of the drainage system, it may be necessary to use other source tracing methods such as additional water or sediment sampling, side sewer research, dye testing, smoke testing, business inspections, stream walks, or closed circuit TV of piped systems. Once the suspected source is identified, a source sample will be collected and analyzed for all parameters to compare with the downstream screening sample. The purpose of the source sample is to match the discharge types. In addition, the next upstream location will be sampled to confirm that there are no other suspected upstream illicit discharges or connections that may have been masked by the suspected source location.

If field screening activities identify an illicit discharge that requires immediate cleanup the City Spill Response Coordinator will be notified immediately.

Laboratory Analysis of Collected Samples

Samples collected for fluoride, potassium, and fecal coliform are transported to the SPU Water Quality Laboratory for analysis. SPU has set trigger levels for each of these parameters. These samples are submitted to the SPU Water Quality Lab the same day that samples are collected and are analyzed within the holding time for each parameter. Samples will be analyzed and results will typically be received within two weeks of

sample collection. Additional source tracing investigations will be initiated within 21 days of receiving any data above trigger levels where an immediate source tracing investigation was not conducted based on field data.

Data Review

Data review is performed on all collected data including field observations, field analyses, and laboratory analyses. The purpose of the data review is to:

- Confirm that source tracing has been initiated on all results from field screening that are over the trigger levels including field observations, field analyses, and laboratory analyses
- Use best professional judgment when the screening results are not over the trigger levels, but the data suggest the potential for an illicit discharge or connection
- Compare the screening results to the flow chart to identify the source type and to evaluate the effectiveness of the screening parameters as source indicators

Comparing Data to Trigger Levels

The data review process involves comparing all screening parameters from field observations, field analyses, and laboratory analyses to the trigger levels to verify that source tracing has been initiated for all results over the trigger levels. In some instances, source tracing may be recommended after the data review process when the screening results are not over the trigger levels, but the data suggest the potential for an illicit discharge or connection.

Comparing Data to the Flow Chart

The flow chart method is a tool that uses five of the SPU screening parameters to differentiate between potential sources. Details are available in the document “Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments” (Brown, Caraco and Pitt, 2004a,b). The City is using a modified version of one of the flow charts discussed in the guidance manual.

The purpose of the flow chart is to help identify the type of flow using five screening parameters: fecal coliform, surfactants, ammonia, potassium, and fluoride. SPU trigger levels correspond to the flow chart concentrations for identifying flow types. The purpose of the flow chart is to differentiate between the following flow types and assist with source tracing efforts:

- Sanitary wastewater contamination
- Washwater contamination
- Commercial or industrial sources
- Tap or irrigation water source
- Natural water source

Figure 2: IDDE Flow Chart