DRAFT Dye Pilot Test Draft Scope, Tyco Fire Products LP, Marinette, Wisconsin

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This document was prepared to provide Tyco's recommendations for a pilot dye test in the Menominee River to assist in design of the proposed barrier wall dye testing included in the September 2015 *Revised Barrier Wall Groundwater Monitoring Plan Update* (CH2M 2015). Based on feedback from Wisconsin Department of Natural Resources (WDNR), the pilot test would occur following the August 16-18 2017 walleye fishing tournament, with the full-scale barrier wall dye test occurring in summer 2018.

Background/Rationale for Pilot Dye Test

- WDNR has requested refinement of calculations of potential Rhodamine WT dye concentrations in the Menominee River under a worst-case barrier wall seepage situation.
- Barrier wall dye test design required a number of assumptions including dye fate and transport in groundwater, hypothetical size (flow rates) of groundwater seepage rates through the wall, and dilution and dispersion of dye in the Menominee River. Conducting a pilot dye test in the Menominee River will enable refinement of required dye injection concentrations to achieve a balance between ensuring that a smaller seepage rate would be detectable in the river versus the potential visual impacts from a larger seepage rate.
- Proposed full-scale barrier wall dye testing includes 9 injection locations along the barrier wall in the Main Plant Area (Figure 1).
    - The original proposed Rhodamine WT injection concentrations ranged from 40 parts per million (ppm) to 150 ppm. Based on the Additive Use Approval letter received from WDNR on June 26, 2017 concentrations to be used during the full-scale barrier wall will not exceed the WDNR calculated Secondary Acute Value (SAV) for Keyacid Rhodamine WT Liquid of 64.9 ppm.
    - Sampling in vertical transects adjacent to injection location and 50 ft in either direction at 1-day post-injection, and 2, 4, 8, and 16 weeks post-injection.
    - Proposed monitoring equipment for the full-scale barrier wall test is a 10AU Field Fluorometer (detection limit of 0.01 ppb) and/or an Aquaflor handheld fluorometer (detection limit of 0.4 ppb), with initial screening using a YSI 6820 v2 sonde equipped with a Rhodamine WT detector.
- Key Rhodamine WT concentration values:

  - 64.9 ppm: WDNR approved SAV
  - 10 parts per billion (ppb): dye may be visible in a clear reservoir
  - 10 ppb: EPA recommended maximum concentration entering drinking water plant
  - 0.1 ppb: EPA recommended maximum concentration in drinking water and NSF recommended maximum use concentration
- It is anticipated that river flow (circulation) patterns vary between the Main Channel and Turning Basin areas, which would affect the dilution and dispersion of dye in the river.

Goals of Pilot Test

- Quantitatively and qualitatively assess dispersion and dilution of Rhodamine WT dye released in the Menominee River adjacent to the barrier wall
- Assess suitability of previously proposed fluorometers (10AU Fluorometer and Aquafluor fluorometer) for measuring dye concentrations in surface water samples
- Assess river background fluorescence and potential effects from turbid surface water
- Assess river flow dynamics along barrier wall at proposed injection locations, including in the Main Channel and the Turning Basin
- Model Rhodamine WT dye dispersion in surface water to demonstrate likely downstream extents of dye at concentrations of potential concern in “worst-case” scenario
- Use data collected and model results to refine dye test design, including refining groundwater dye addition concentrations to balance detectability of a low-rate wall seepage rate against surface water impacts from a “worst-case” high-seepage rate scenario

Proposed Methods

- Microsoft Excel-based model using standard river dispersion equations (Fischer 1979) to assist in design of pilot test (dye addition concentration/volume, deployment locations of fluorometers).
- Measure background fluorescence values in upstream Menominee River locations and in groundwater treatment plant effluent.
- Conduct 3 dye addition tests (see figure for potential dye test locations) to assess flow dynamics and dye dispersion at different locations along the wall by injecting a continuous slug of dye for 15-30 minutes at a known concentration and volume adjacent to the wall. Use submersible fluorometers deployed approximately 100 and 300 feet downstream of release point along two transects (each with a minimum of two fluorometers) to continuously measure dye concentrations through time (response curve). Collect surface water samples for testing/comparison of 10AU Fluorometer and Aquafluor fluorometer. Additionally, qualitatively assess visual extent of Rhodamine WT in river.
  - Test one in Turning Basin (with an additional fluorometer deployed in the South Channel area for this test)
  - Test two along Main Channel
  - Test three near eastern end of barrier wall, deploy submersible fluorometers both along Main channel and in Turning Basin
- Collect river velocity data near wall at dye release point, in the Turning Basin and near the South Channel, and in vicinity of the 9 proposed injection locations, to calculate river dilution potential and assess if different dye concentrations are appropriate at different areas.
- Use the Microsoft Excel-based model, river velocity data, and Rhodamine WT response curves to refine dispersion coefficients. If flow dynamics are deemed too complicated to be assessed by the Microsoft Excel-based model, the U.S. Army Corps of Engineers RMA2 hydraulic model and RMA4 constituent transport model may be used to model flow dynamics and dye concentrations in the area of the Turning Basin and the Main Channel.

- Use the Microsoft Excel-based model and/or RMA2/RMA4 models to model 1) worst-case scenario dye concentrations and 2) low-seepage rate scenario to refine dye injection concentrations and dye sampling strategy for full-scale dye test. Model runs will be conducted using measured river velocity data and the dispersion coefficients calculated from the dye tests. The following modeled information will be provided:
    - Expected river dye concentrations adjacent to seepage location under worst-case (64.9 ppm; SAV) and lower seepage rate scenarios
    - Expected downstream extent of dye concentrations above 10 ppb (visibility limit and recommended maximum concentration entering drinking water plant)
    - Expected downstream extent of dye concentrations above 0.1 ppb (recommended drinking water concentration)

Considerations

- Concentration and volume of dye added may either be a lower concentration that is less visible or not visible to naked eye but detectable by fluorometer, a concentration similar to proposed injection concentration (64.9 ppm, which would be highly visible), or an intermediate concentration (1 ppm is often the target injection concentration in wastewater outfall/river tracer studies).
- Proposed pilot test will not assess dye behavior in groundwater, so assumptions about groundwater system used in calculations will remain.
- Injection in late summer is preferable because of likely lower river flows during this time, which would reduce the diluting volume of the river and thus the initial dye injection concentration required.

References

CH2M HILL. 2015. *Final Revised Barrier Wall Groundwater Monitoring Plan Update.* September.

Fischer, H. B. 1979. *Mixing in Inland and Coastal Waters*. Academic Press, Inc.: New York, New York.

NOTES:

1. DYE ADDITIONS TO THE SUBSURFACE WILL BE CONDUCTED USING DIRECT PUSH TECHNOLOGY EQUIPMENT. DYE TESTING LOCATIONS MA… NDITIONS INCLUDING OBS… RIGATION LINES, OLD PIE… S.
2. LOCATIONS OF NEW STAFF GAUGE SG4 AND NEW MONITORING WELLS MAY BE ADJUSTED BASED ON FIELD CONDITIONS.

… REFUSAL IS ENCOUNTERED THREE TIMES WITH DIRECT PUSH …LOCATION WILL BE MOVED 50 FEET …T WILL BECOME THE NEW TEST

Expected flow direction

Expected flow direction

Test 3 fluorometer transect

Test 3: Dye addition location

Test 2 fluorometer transect

Test 3 fluorometer transect

Test 2 fluorometer transect

Test 1 fluorometer transect

Test 2: Dye addition location

Test 1 fluorometer transect

Test 1 fluorometer deployed near South Channel

Test 1: Add dye adjacent to wall

MW118S MW118D MW118M
MW107M MW107D
MW006S MW006M
MW045M MW045S
MW117D MW117S MW117M
MW-067S
MW-068S
MW003D MW003M MW003S
BT-02 MW106M MW106D
EW-7
MW008M MW008S
MW108D MW108M MW108S
EW-4
MW010S MW010M
MW029M MW029S
MW030M MW030S
EW-14 MW116S MW116P
EW-13 MW119D MW020D MW020S MW115S MW115P
MW007M
MW120D
EW-09 MW034M MW034S MW035M MW035S MW046S
MW031S MW031M MW032S MW032M EW-3
MW002S MW002M
MW009S MW009M
MW044M MW044S
EW-6
EW-5
MW114S MW114M EW-12
MW001S MW001M EW-10
MW052S
MW053S
MW012S MW012M
MW033M MW033S
MW040D MW040M MW040S
MW105S MW105M MW105D
MW042D MW042M MW042S
MW043S MW043M PZ10
MW011S MW011M
PZ09
PZ08
PZ07
PZ03
PZ06
PZ04
PZ02
PZ01
PZ05
MW062S MW062M
MW054S MW059M MW059S
MW060S MW060M
MW061S MW061M
MW066M MW066S
MW063M MW063S
MW064M MW064S MW064D
MW065M MW065D MW065S
MW050S MW050M
MW103S MW103M
MW104S MW104M
GROUNDWATER TREATMENT BUILDING
BLENDER/ VAPORIZER
PROPANE LOADING STATION
PROPANE TANK
BALLOON BLDG.
RESEARCH WELL
RAZED
VW-TB01
VW-TB02
VW-TA01
SG1
SG2
SG4
PZ-111C
PZ-111A
PZ-111B
MW111D
MW10…

LEGEND

- NEW WELLS INSTALLED IN 2014
- EW-5 OR BT-02 — EXTRACTION WELL OR TEST WELL
- MW002S OR MW115P — MONITORING WELL - SHALLOW OR PEAT
- MW002M — MONITORING WELL - MEDIUM
- MW002D — MONITORING WELL - DEEP
- PZ04 — PIEZOMETER
- VW-TB01 — VIBRATING WIRE PIEZOMETER
- SG1 — STAFF GAUGE
- WELLS PREVIOUSLY ABANDONED OR DESTROYED
- SHEET PILE WALL
- SLURRY WALL
- PROPOSED DYE TESTING LOCATION
- PROPOSED RIVER SAMPLE TRANSECT
- PROPOSED NEW WELLS AND STAFF GAUGE

N

0 60 120 180
SCALE IN FEET

FIGURE 1

POTENTIAL PILOT DYE TEST LOCATIONS

388522

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