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Salish Sea Ecosystem Conference

2014 Salish Sea Ecosystem Conference
(Seattle, Wash.)

May 1st, 1:30 PM - 3:00 PM

Modeling Wastewater Discharge with a Hybrid Nearfield and Farfield Approach

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Mark Toy

Washington (State). Department of Health

Andrew Jones

Washington State University

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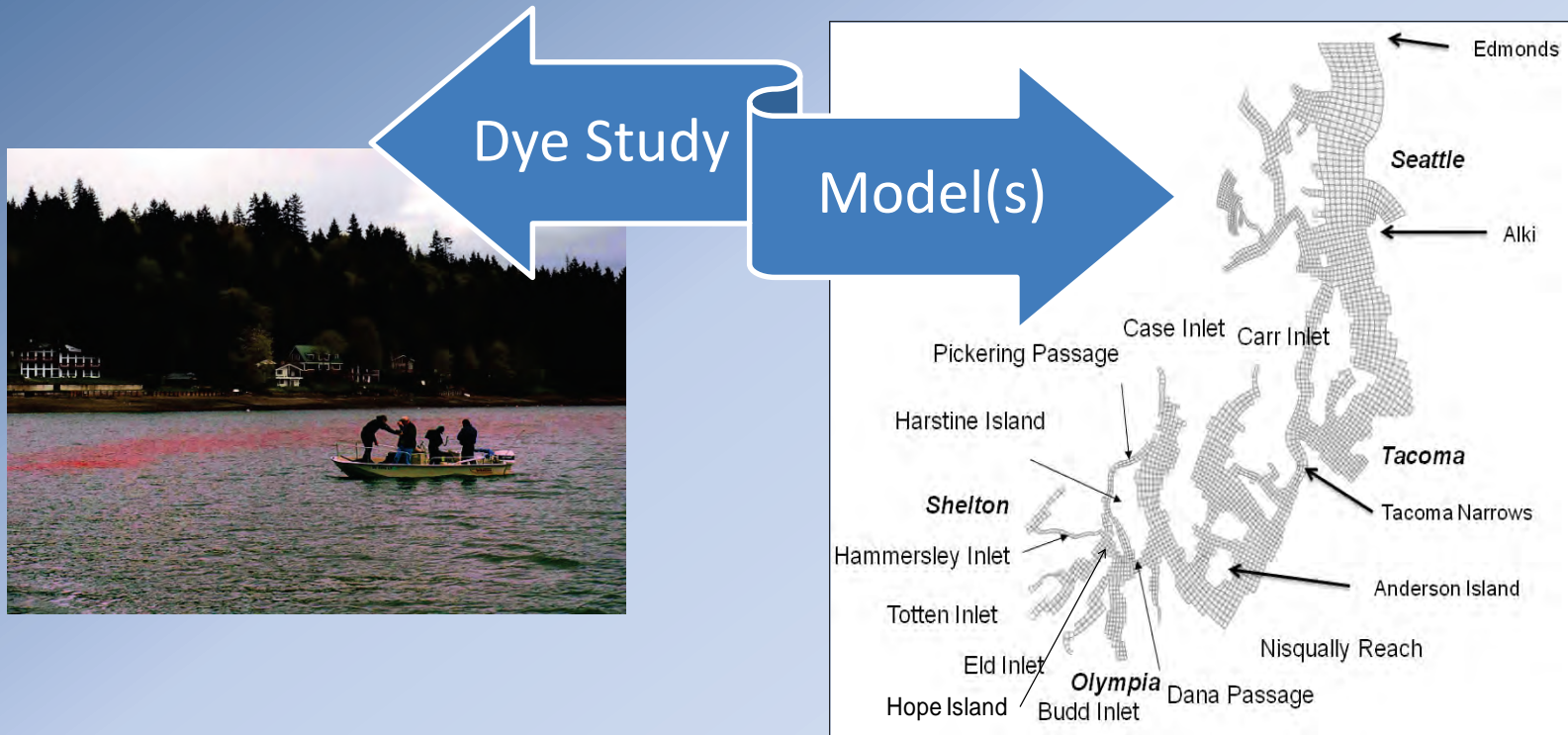
Albertson, S. L.; Toy, Mark; and Jones, Andrew, "Modeling Wastewater Discharge with a Hybrid Nearfield and Farfield Approach" (2014). *Salish Sea Ecosystem Conference*. 192.

<https://cedar.wwu.edu/ssec/2014ssec/Day2/192>

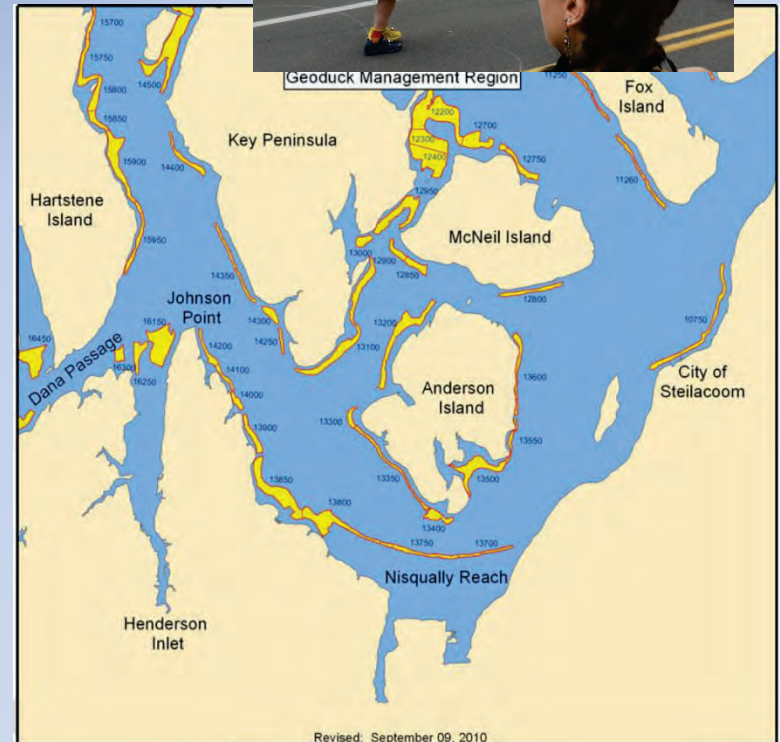
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Modeling Wastewater Discharge with a Hybrid Nearfield and Farfield Approach

- Skip Albertson (Ecology), Mark Toy and Andrew Jones (Health)

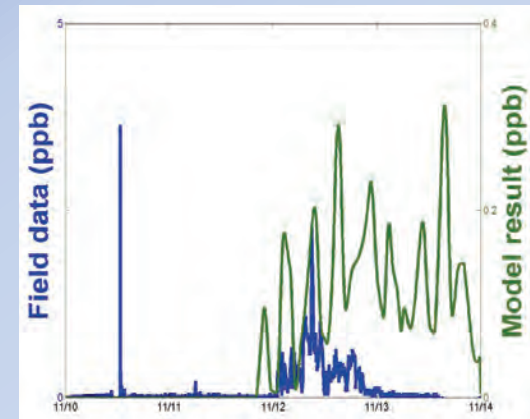
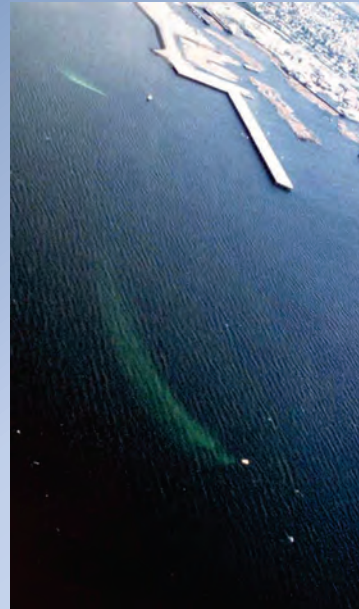
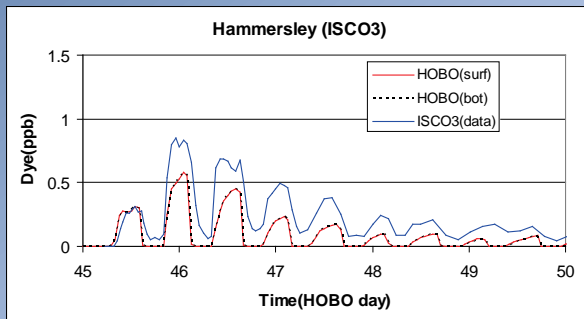
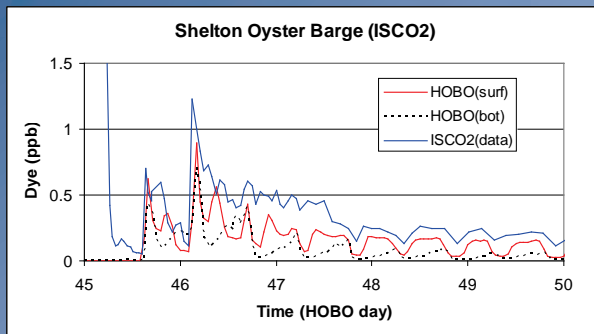


Study Location



Geoduck Tracts

Dye release in Closed Bays versus Open Waters



Dye study in an enclosed bay with 50-m grid cells - completely saturated with dye!

Chambers Creek dye flows into more open waters with 500-m grid cells – \$24.29/lb. x 10 lbs/gallon x 40 gallons = \$9717.78

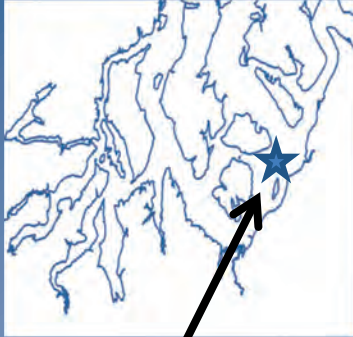
What does the farfield model offer?

- Can fill in the spatial and temporal gaps.
- Can reveal the worst-case conditions.
- Can track low levels of effluent that are way below detection limits.
- Can be used to evaluate alternate scenarios.

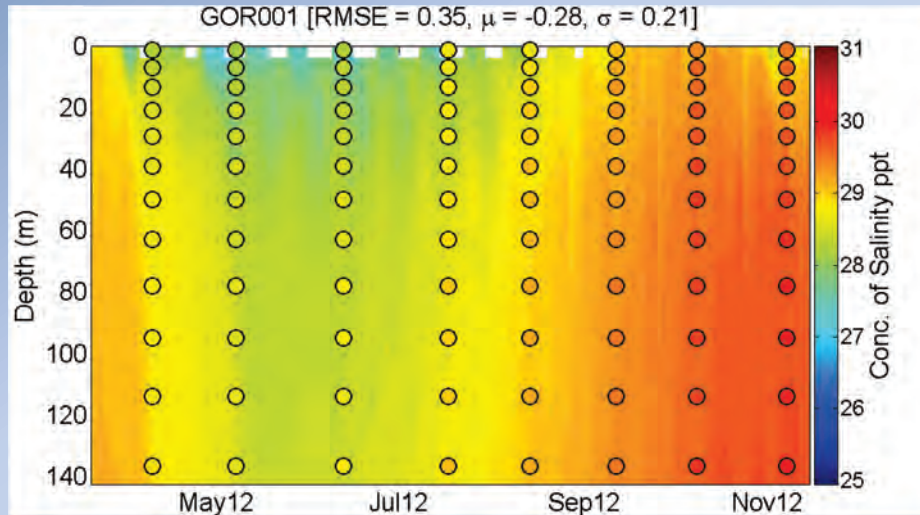
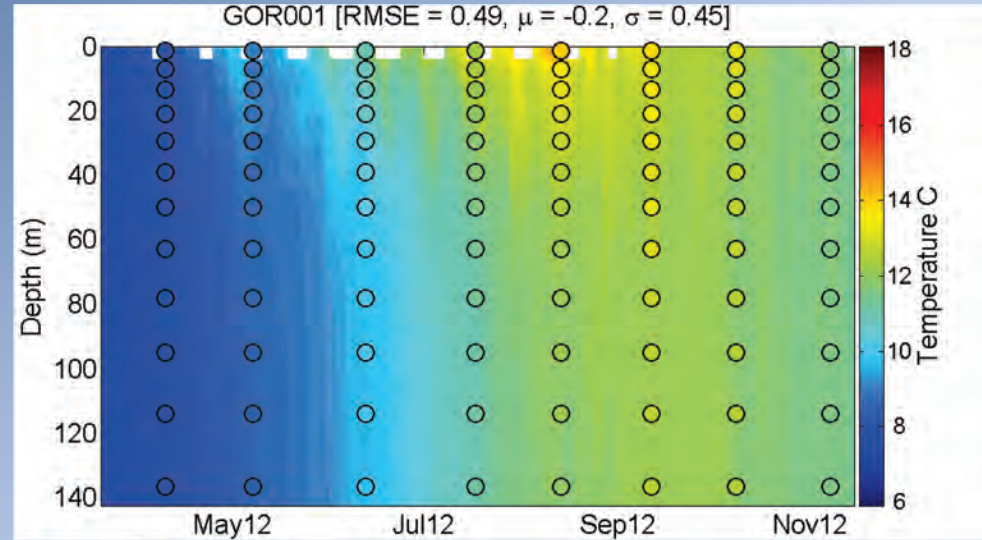
Near- to far-field hand off

Time	Deep layer...			Shallow	Tide
45.2113	0	0	0	0	
45.2114	0	0.0569	0.0569	0	high
45.2844	0	0.0569	0.0569	0	
45.2845	0	0.0569	0.0569	0	
45.3573	0	0.0569	0.0569	0	
45.3574	0	0.0569	0.0569	0	ebb
45.4302	0	0.0569	0.0569	0	
45.4303	0	0	0.0569	0.0569	
45.5031	0	0	0.0569	0.0569	
45.5032	0	0	0	0.1138	low
45.5676	0	0	0	0.1138	
45.5677	0	0	0.0569	0.0569	
45.6235	0	0	0.0569	0.0569	
45.6236	0	0.0569	0.0569	0	flood
45.6794	0	0.0569	0.0569	0	
45.6795	0	0.0569	0.0569	0	
45.7353	0	0.0569	0.0569	0	
45.7354	0	0.0569	0.0569	0	high
45.7531	0	0.0569	0.0569	0	
45.7532	0	0	0	0	
etc.	0	0	0	0	

Model accurately replicates conditions for 2012



GOR001



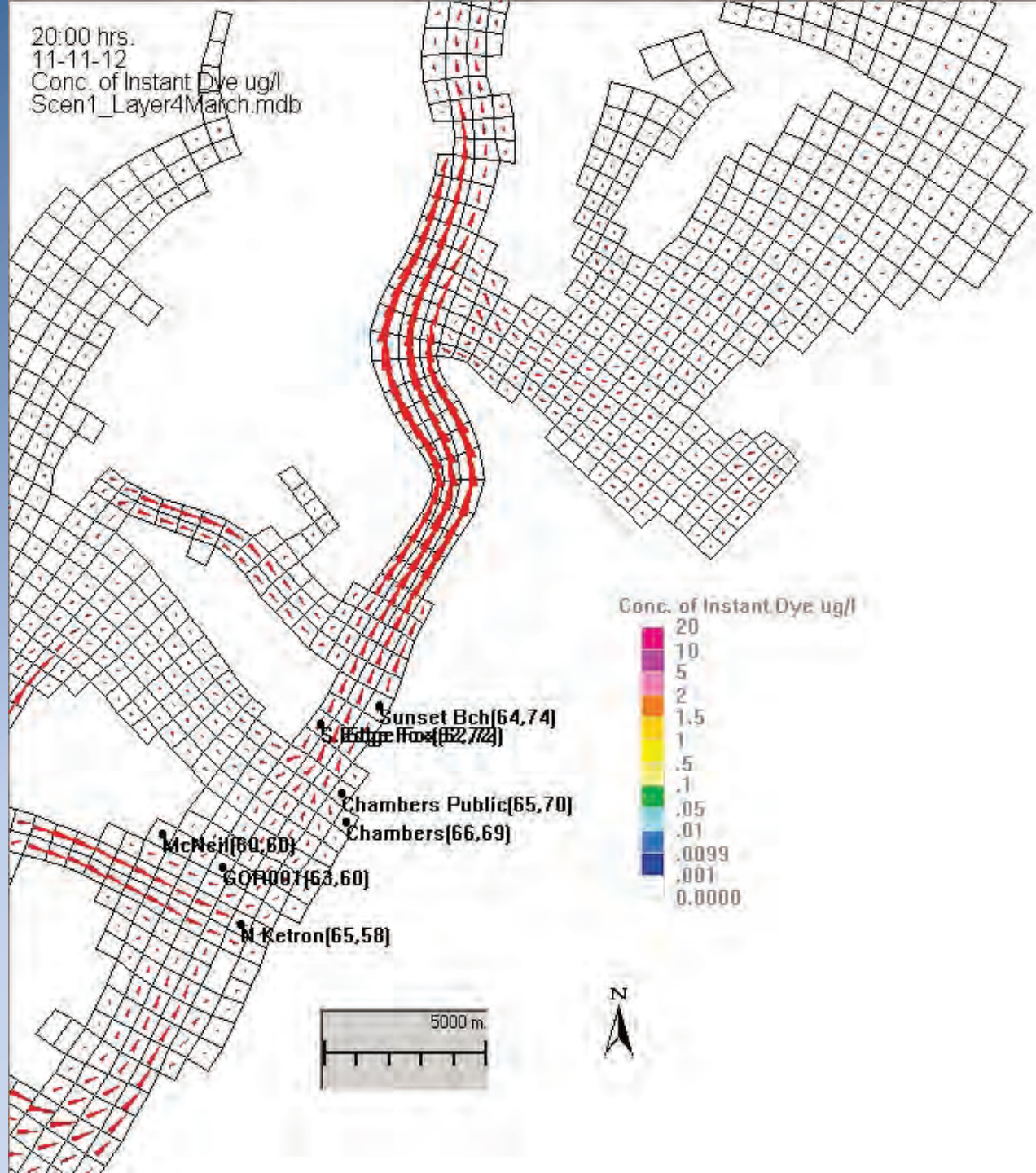
Modeled
Temperature &
Salinity (color
contours) vs. field
data (circles)

Nov
11

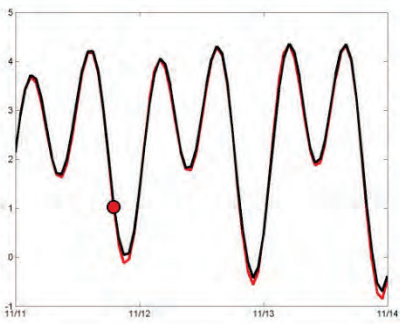
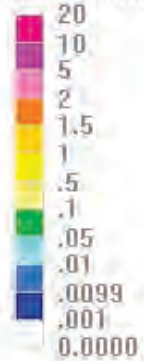


8PM

20:00 hrs.
11-11-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

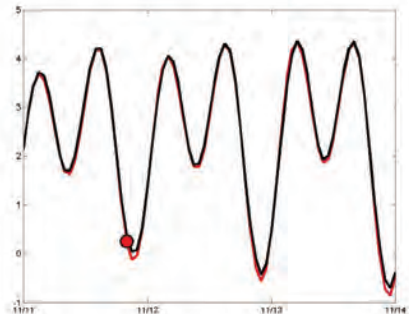
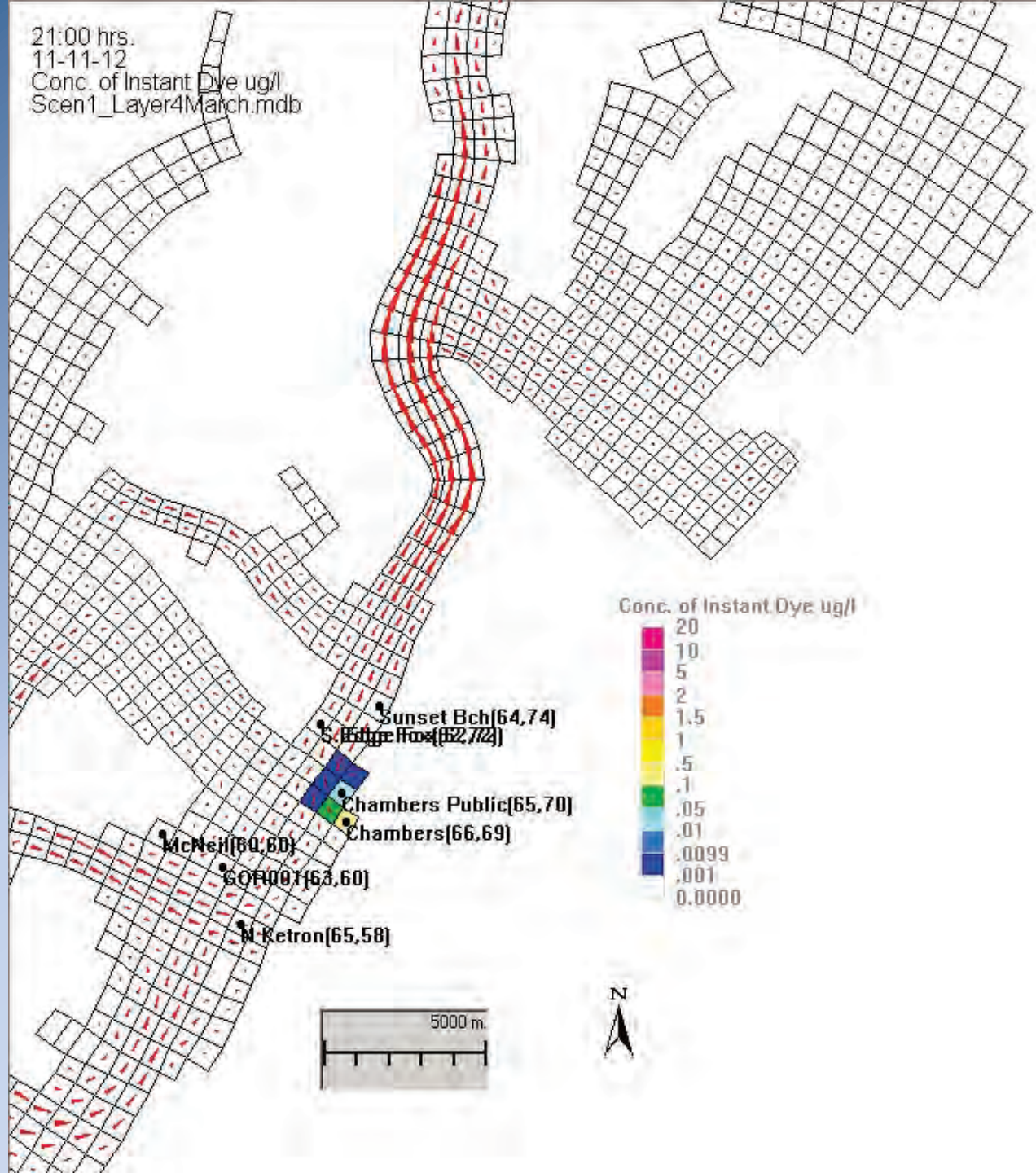


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9PM

21:00 hrs.
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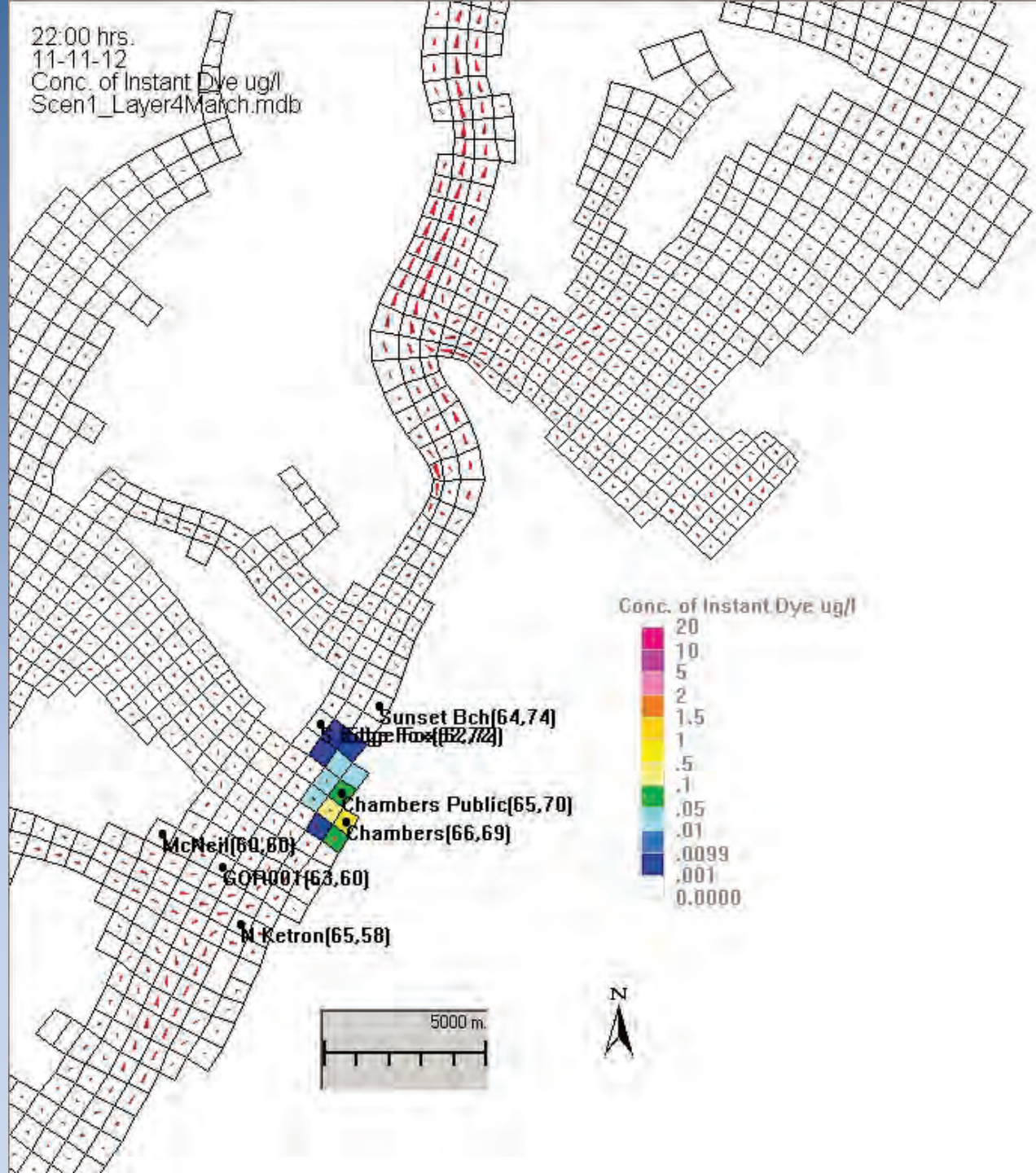


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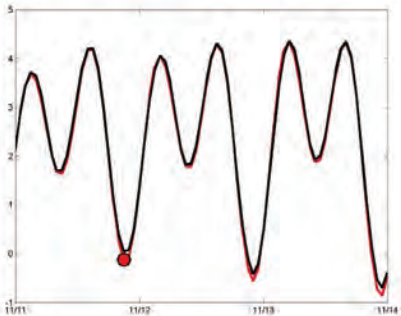
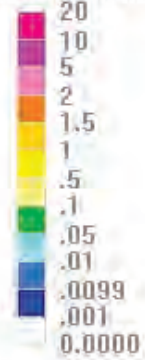


10PM

22:00 hrs.
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Scen1_Layer4March.mdb



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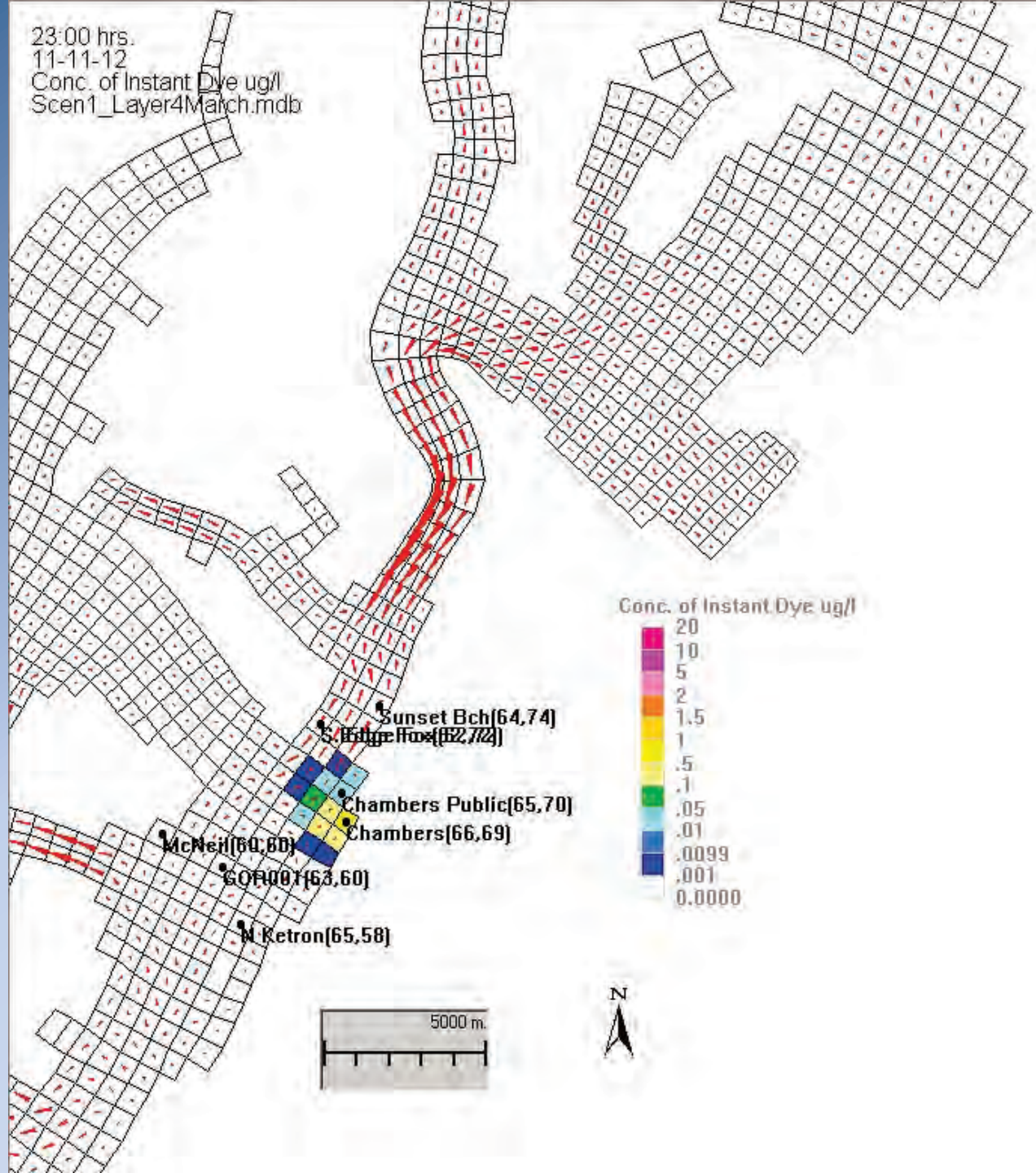


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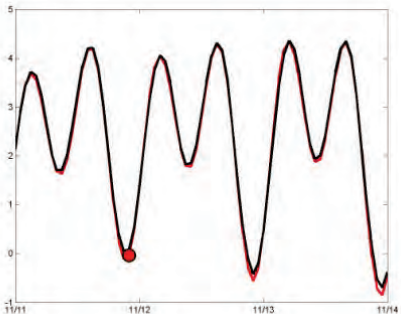
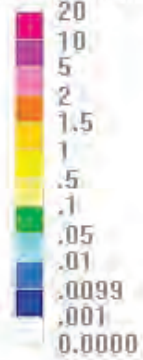


11PM

23:00 hrs.
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Scen1_Layer4March.mdb



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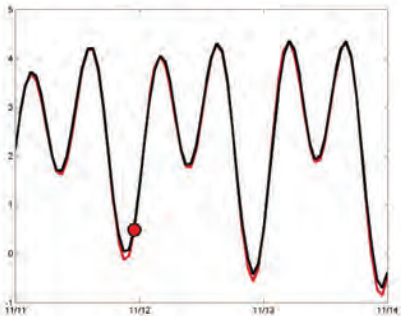
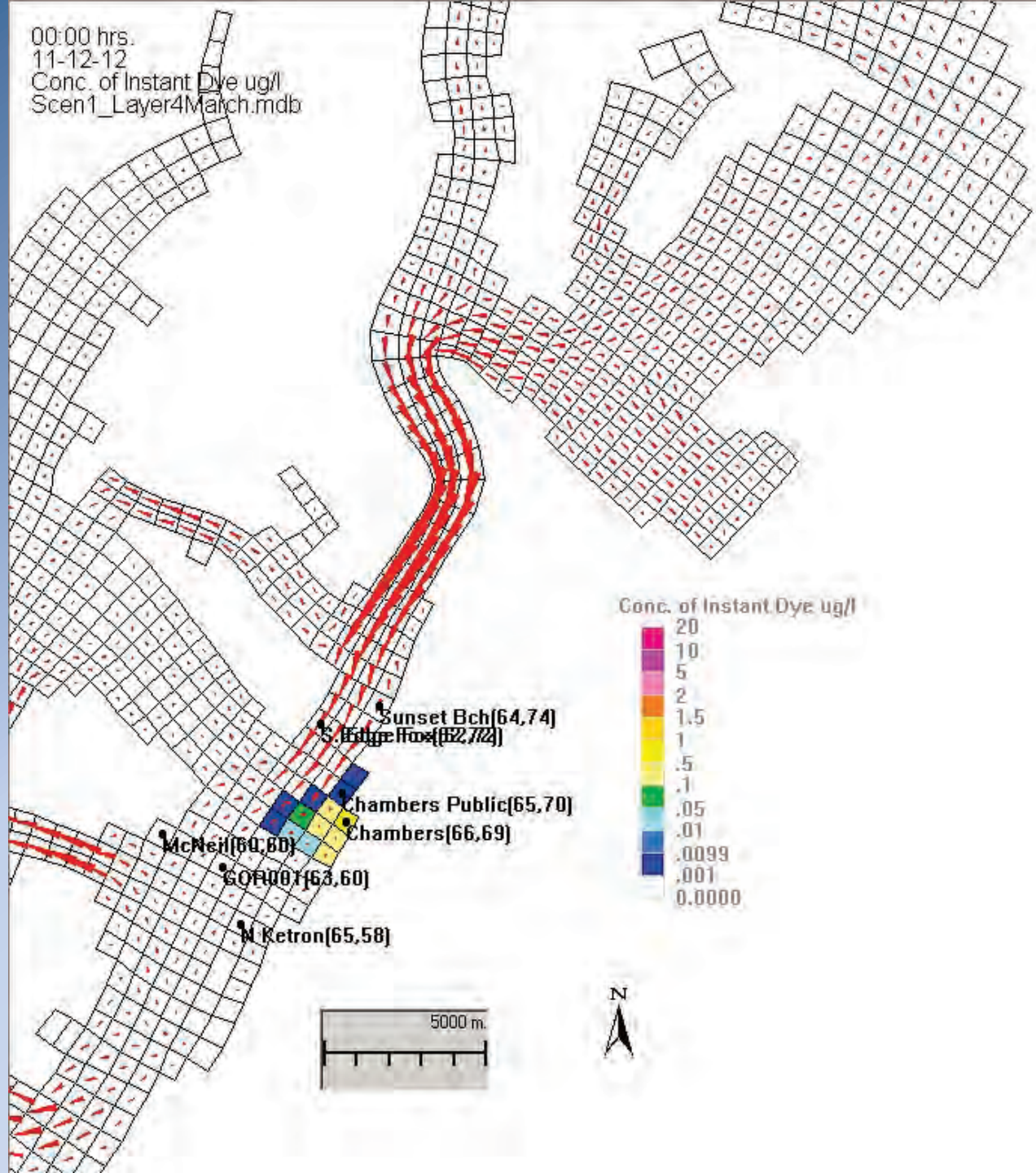


Nov
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12AM

00:00 hrs.
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Scen1_Layer4March.mdb

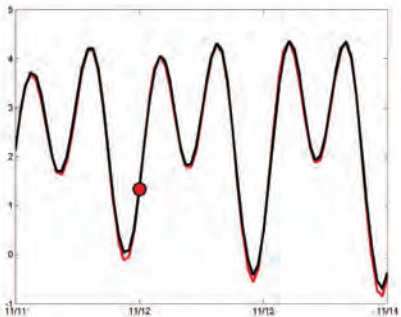
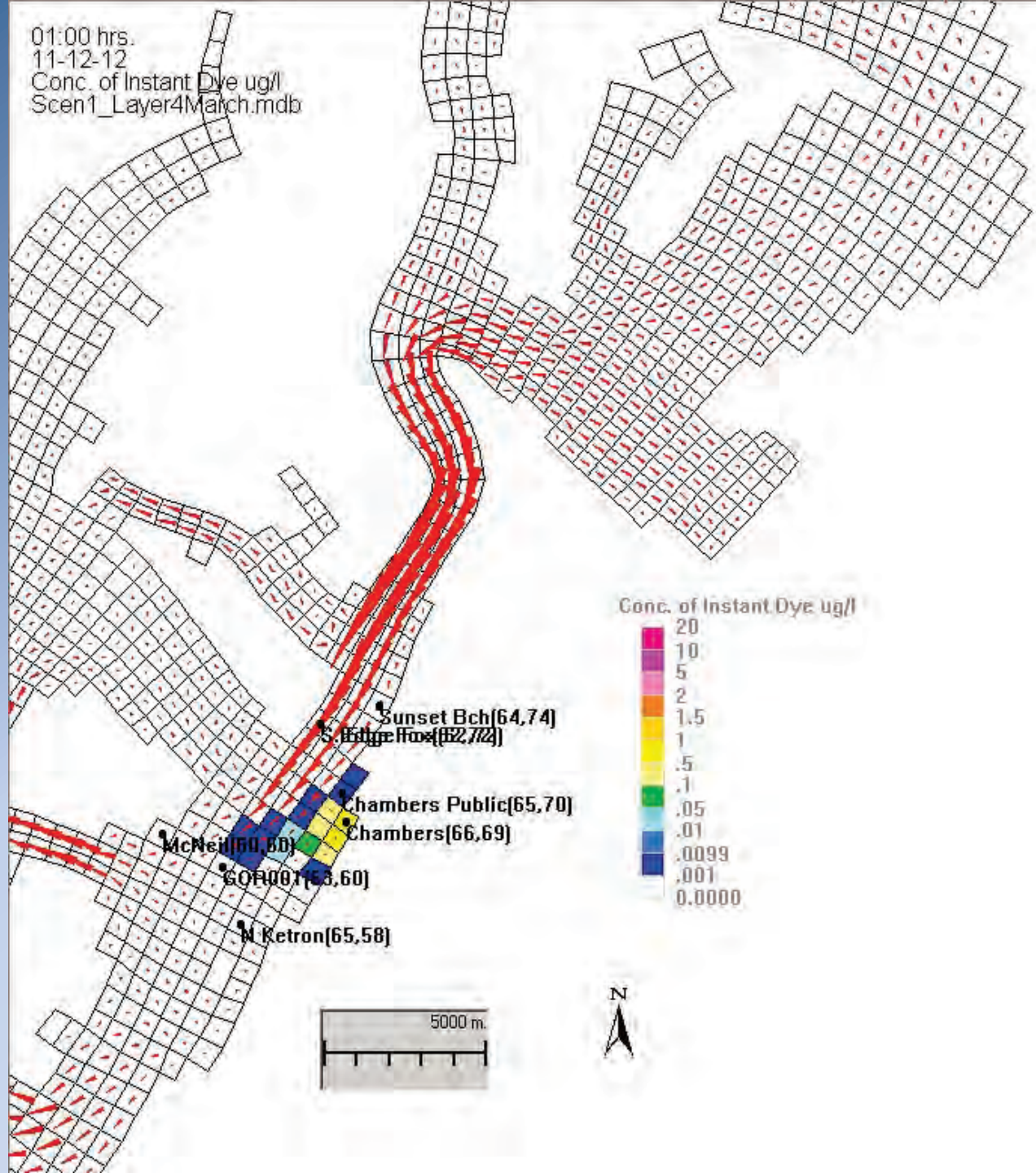


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1AM

01:00 hrs.
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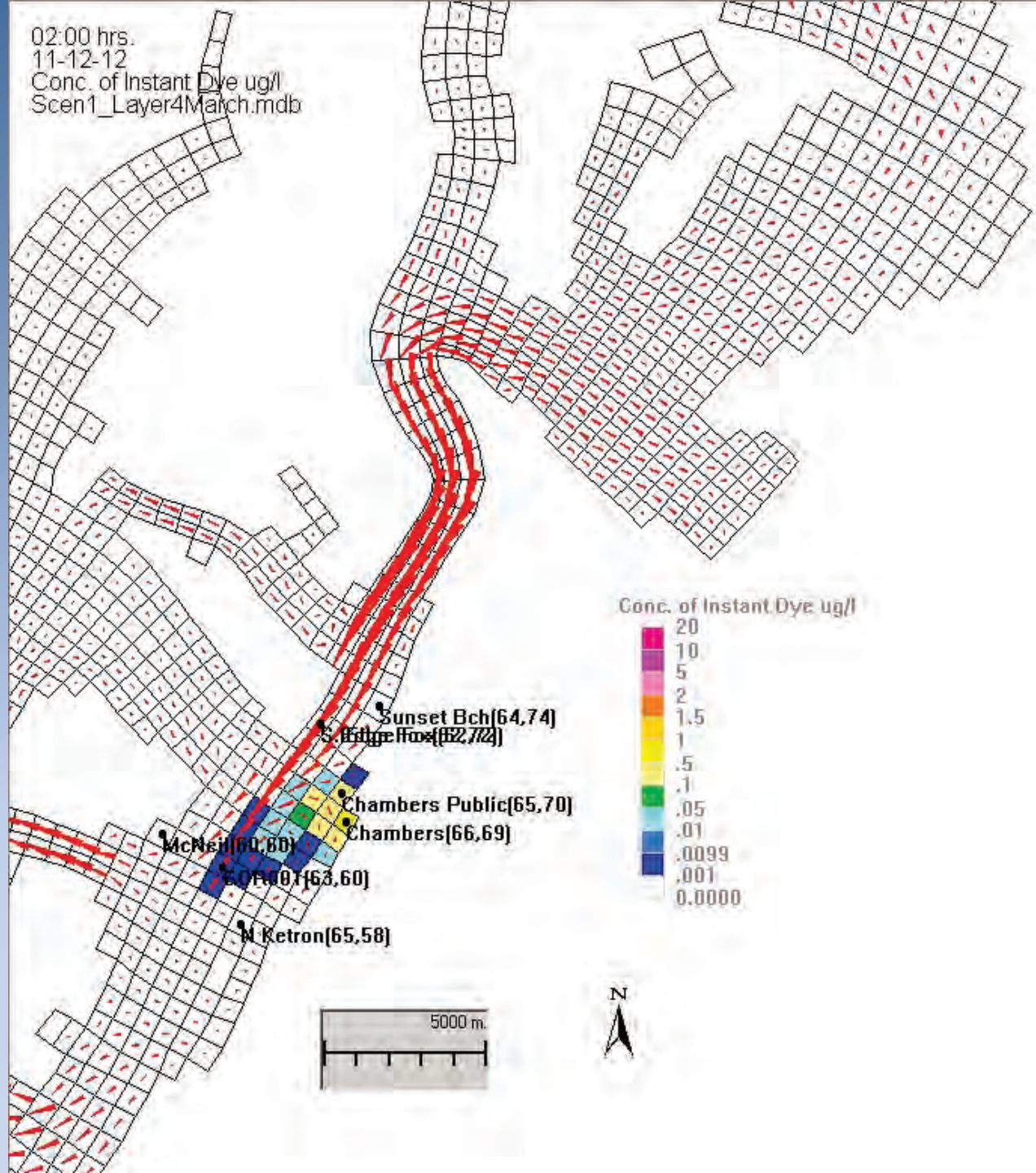


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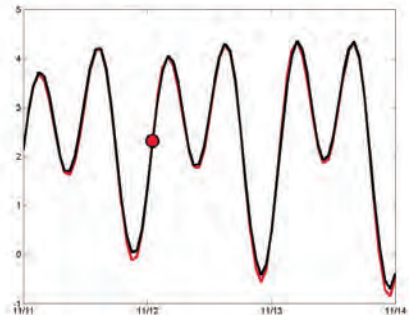
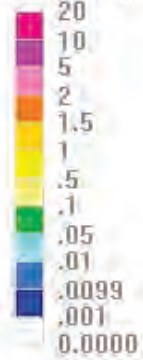


2AM

02:00 hrs.
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Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

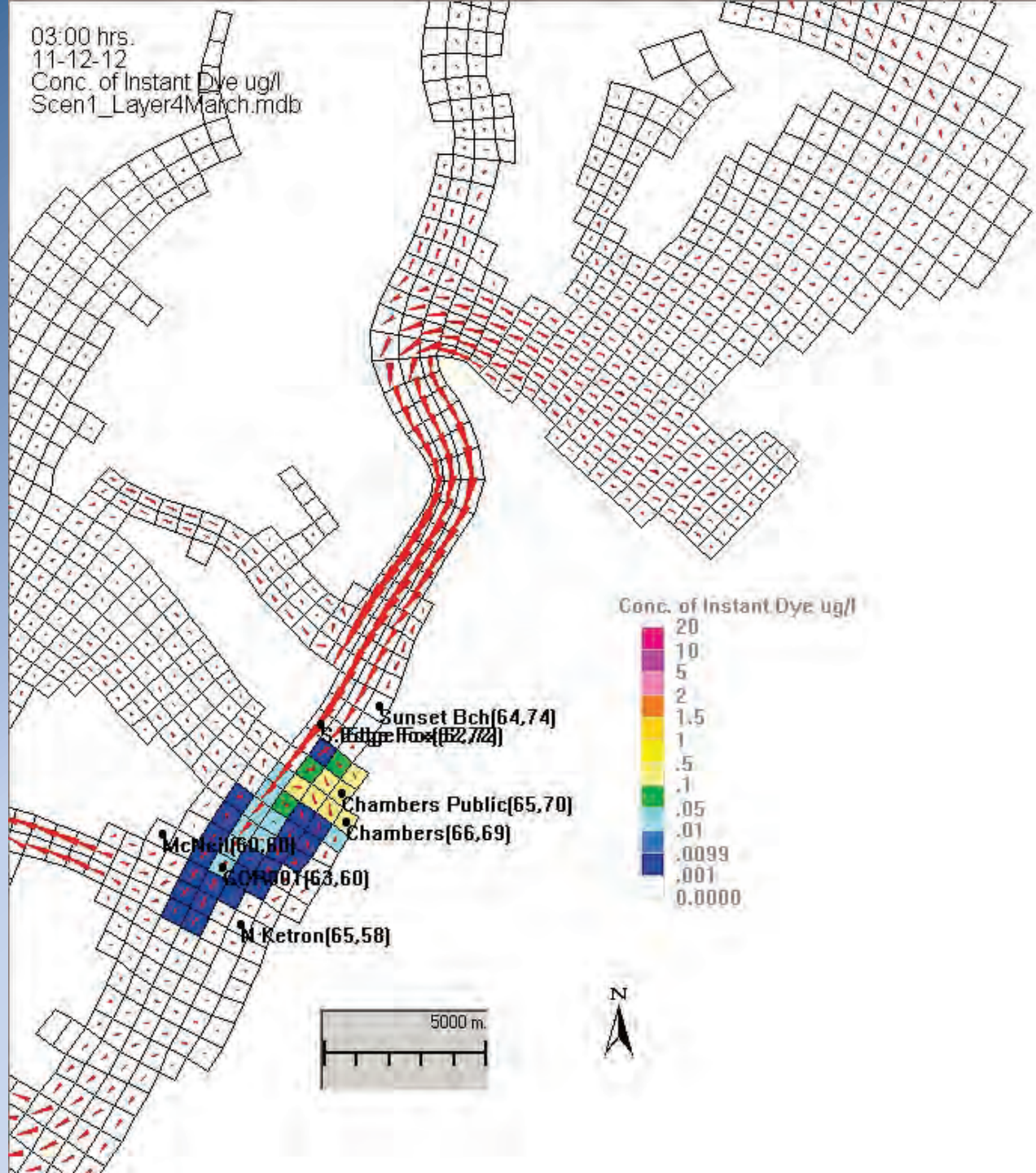


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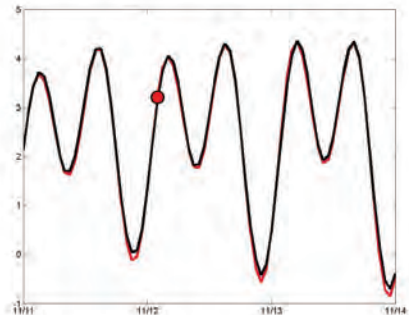
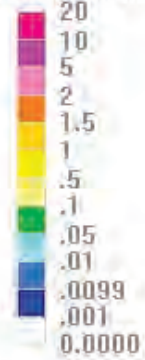


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03:00 hrs.
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Scen1_Layer4March.mdb



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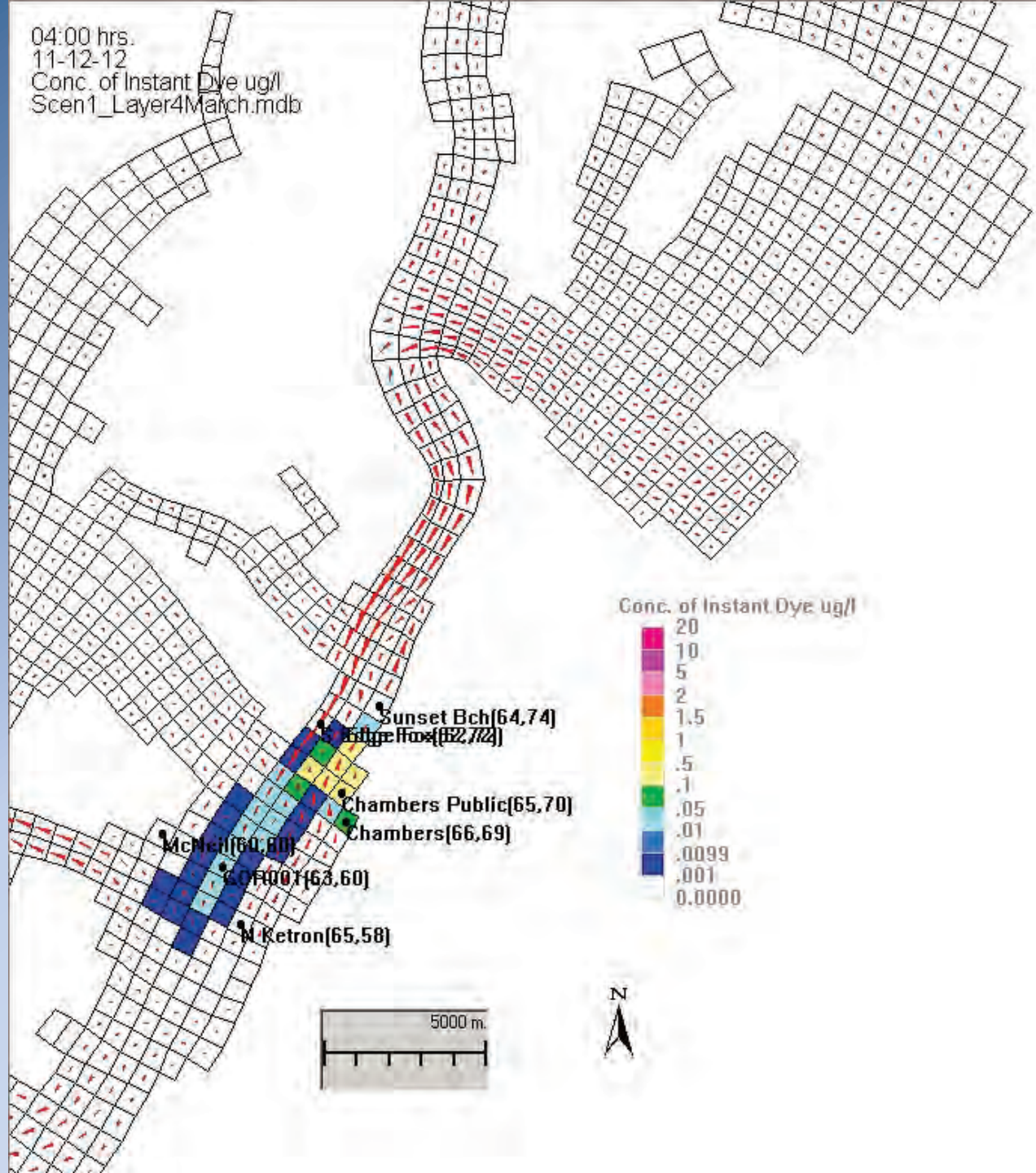


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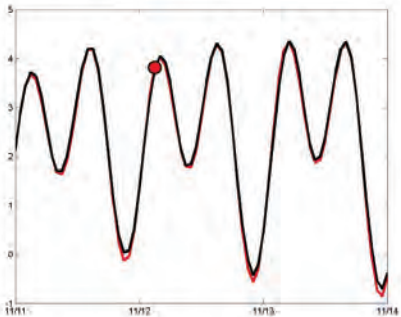
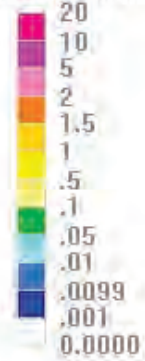


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04:00 hrs.
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Scen1_Layer4March.mdb



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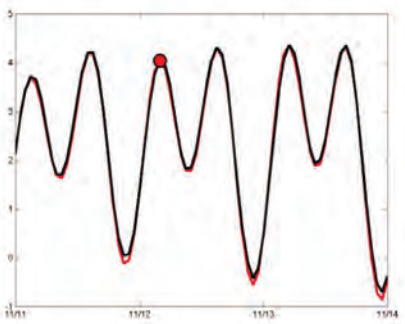
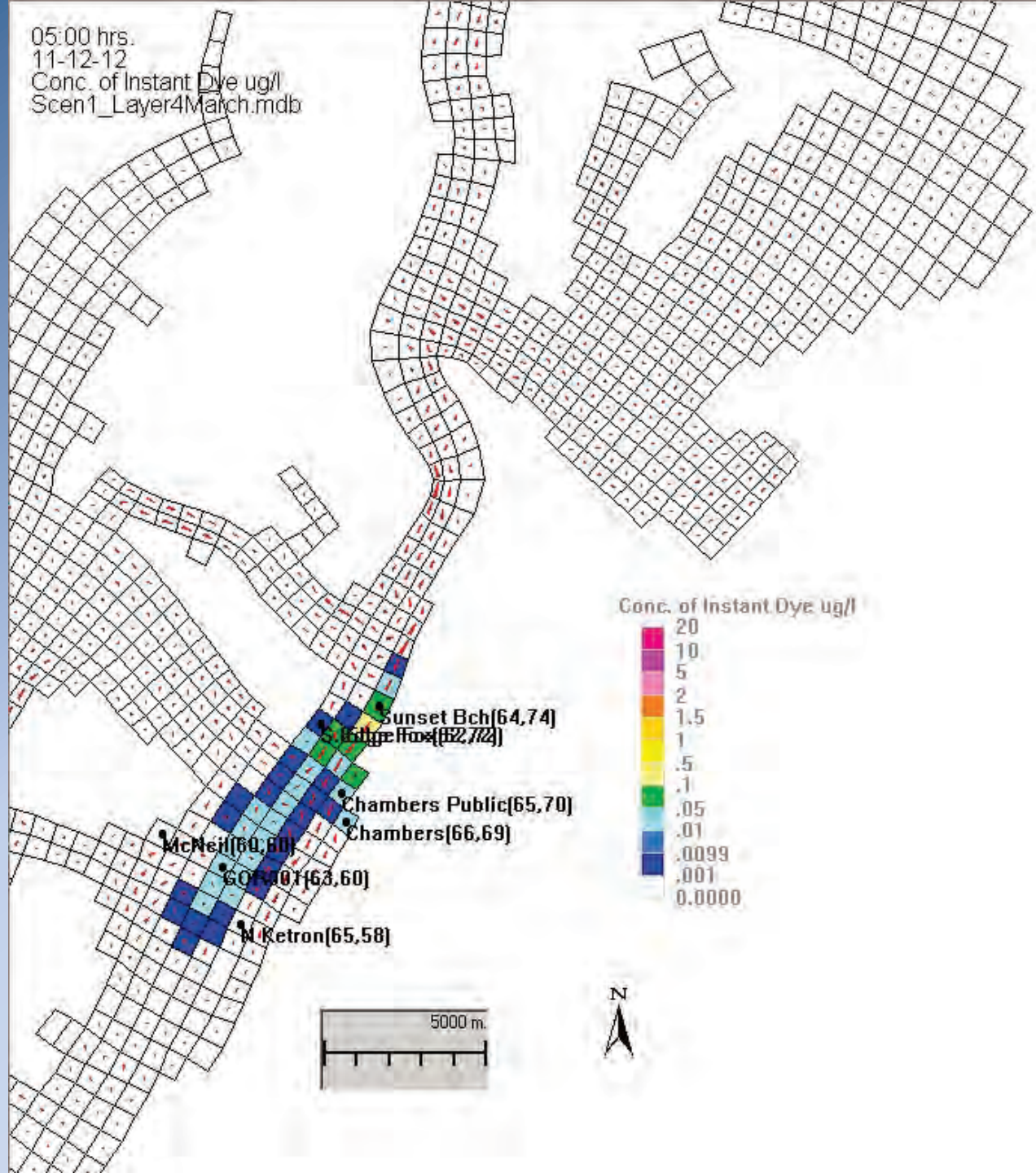


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5AM

05:00 hrs.
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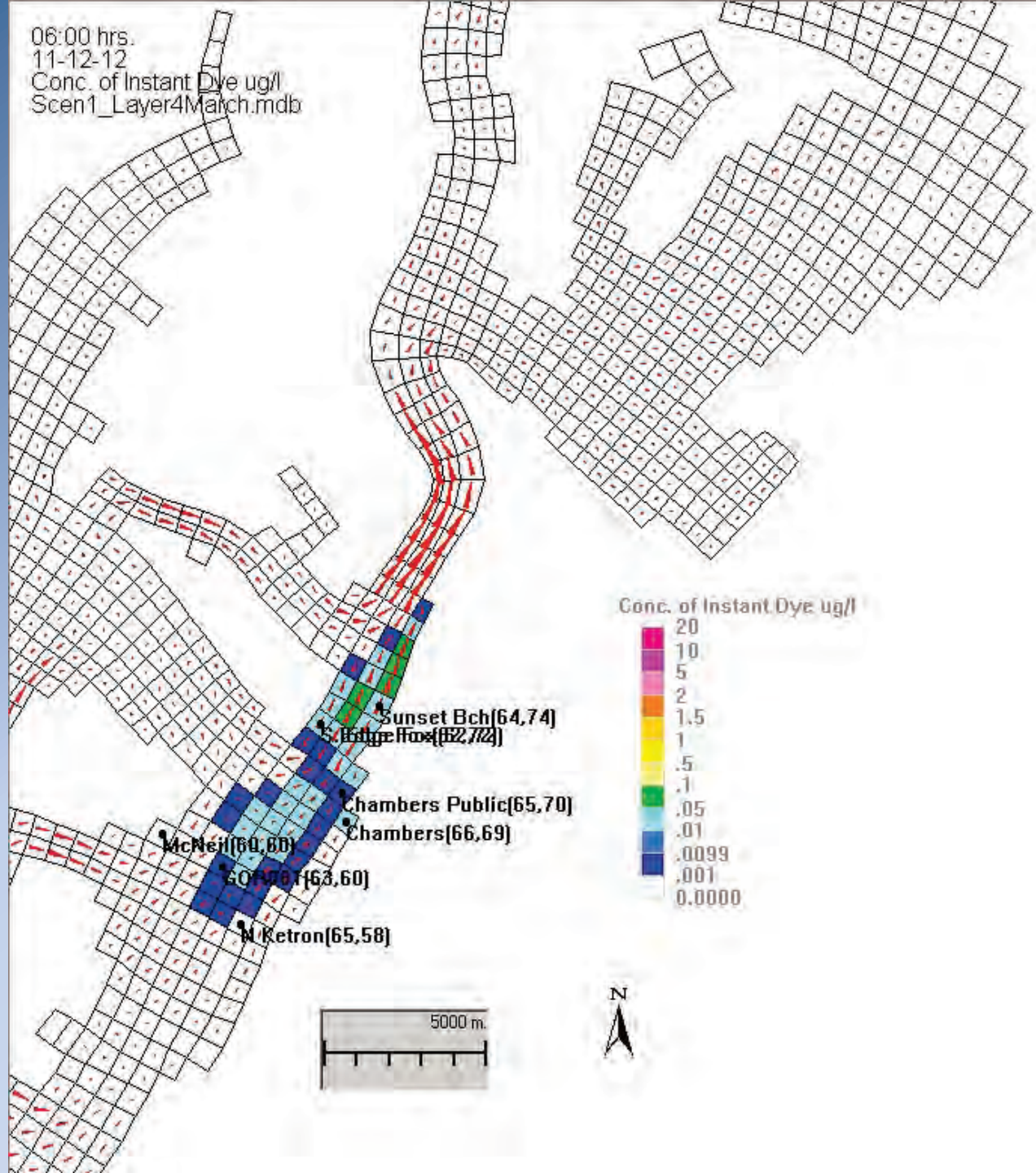


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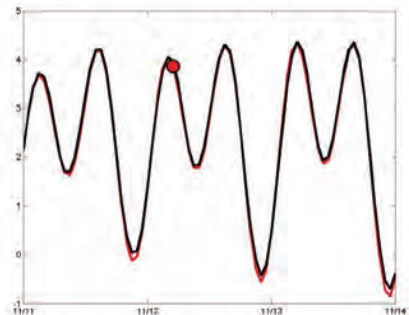
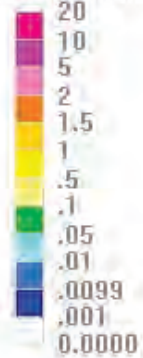


6AM

06:00 hrs.
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Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

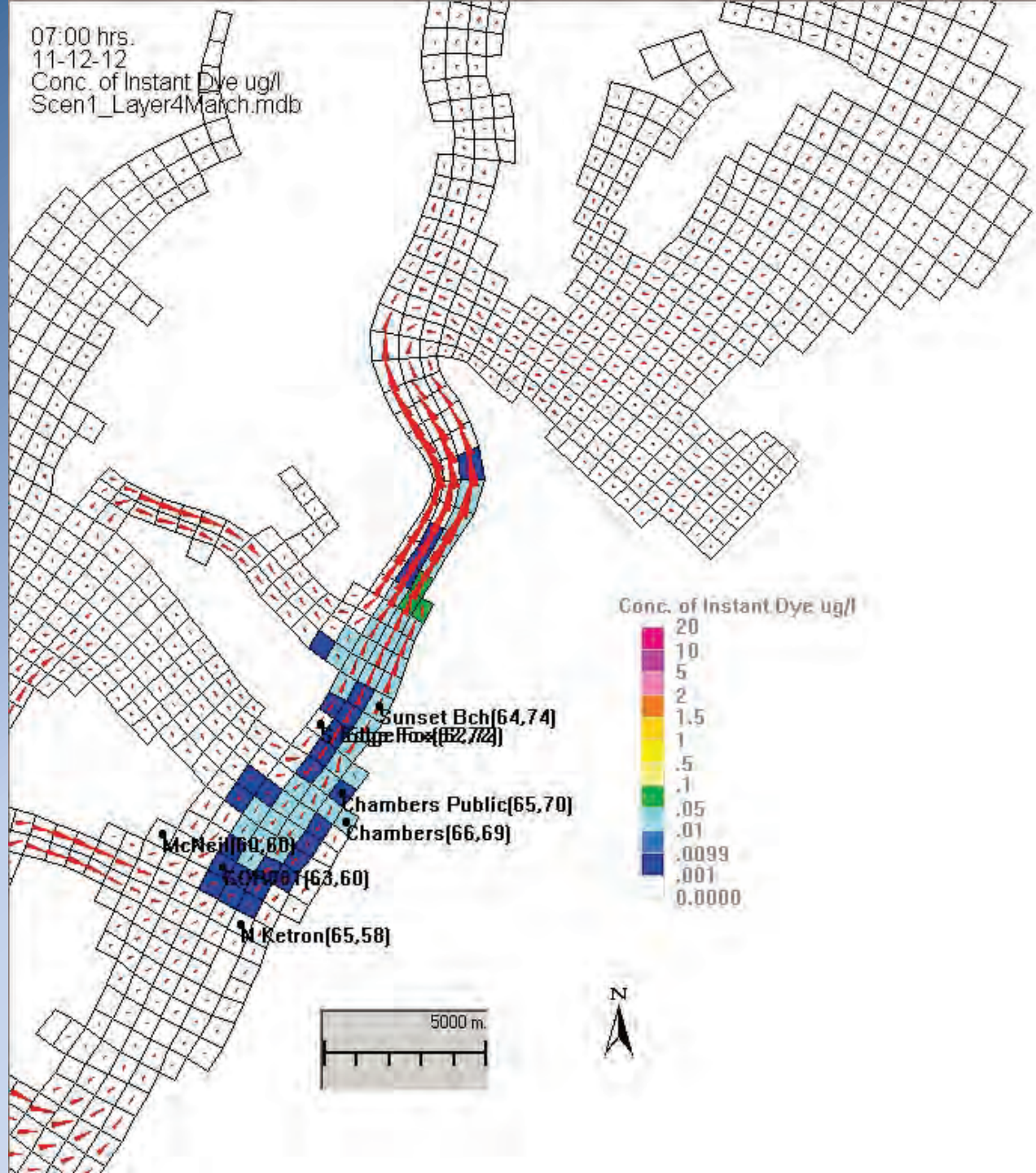


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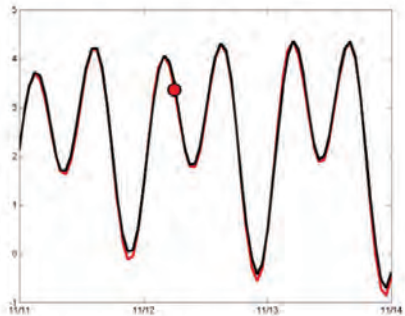
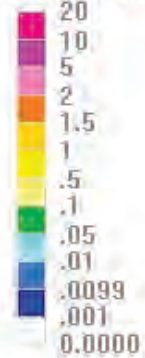


7AM

07:00 hrs.
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Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

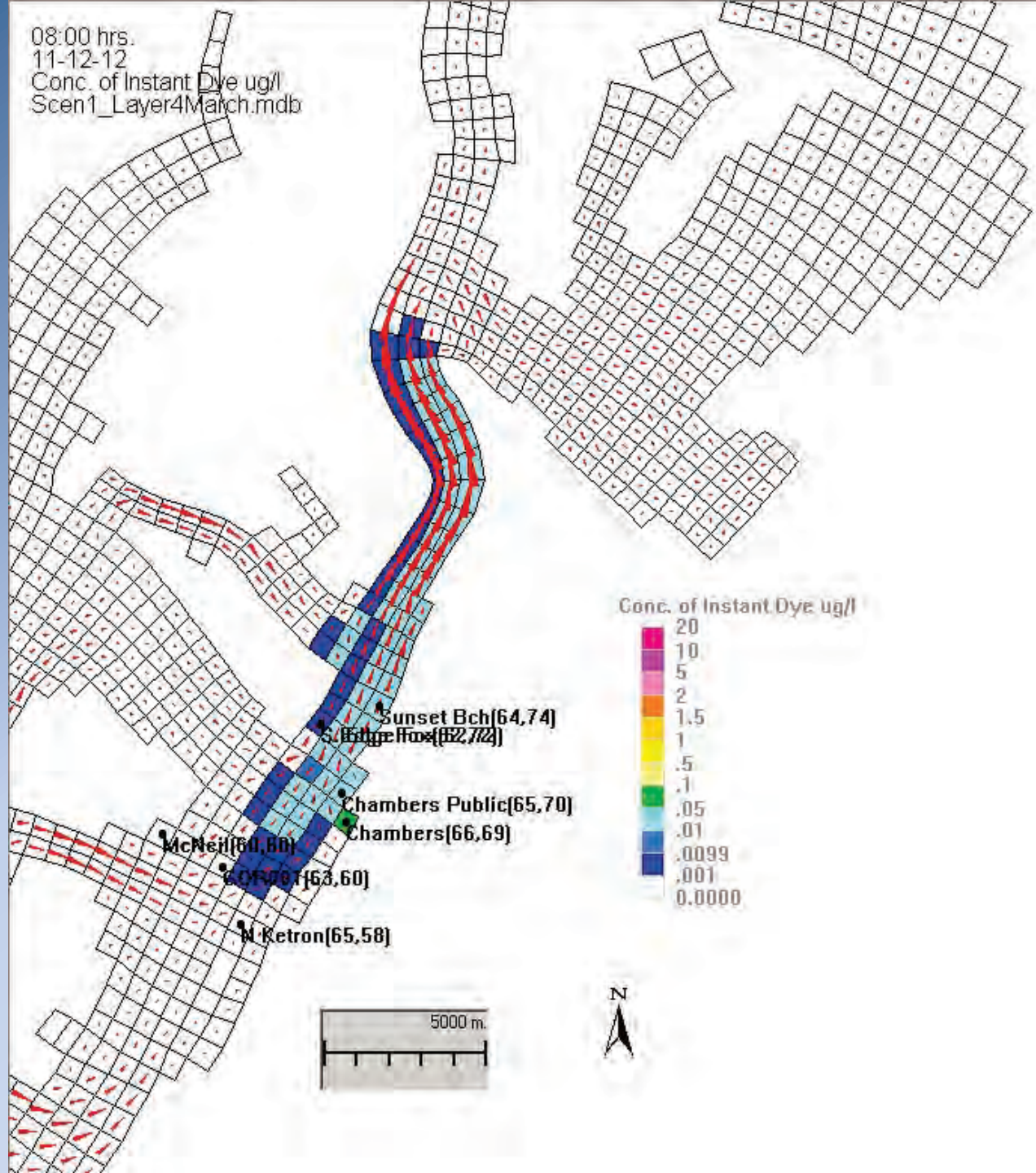


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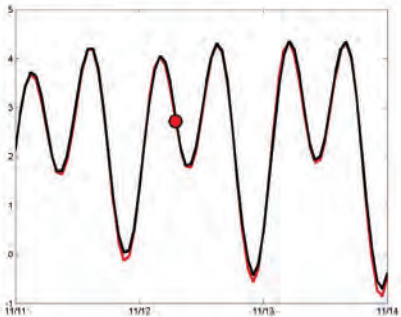
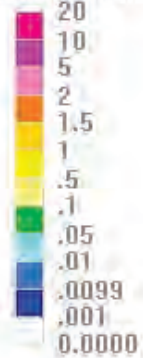


8AM

08:00 hrs.
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Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

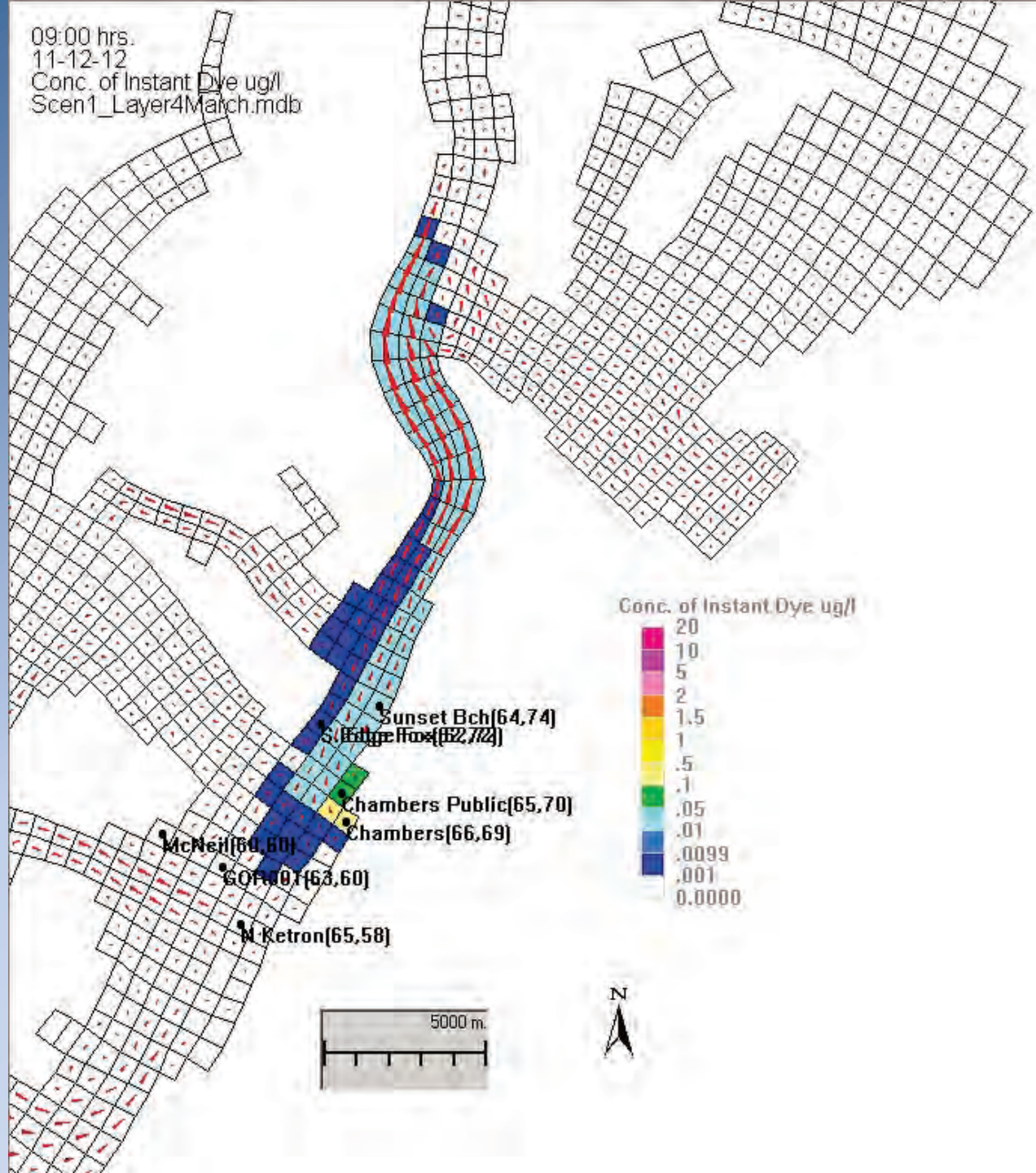


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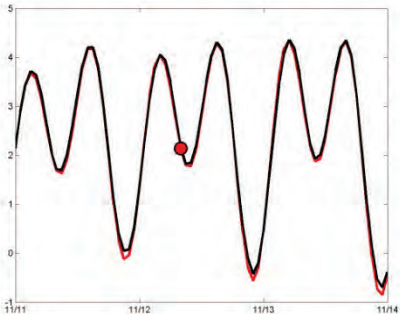
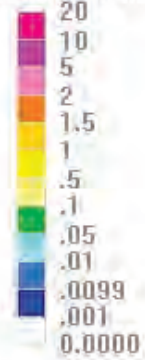


9AM

09:00 hrs.
11-12-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



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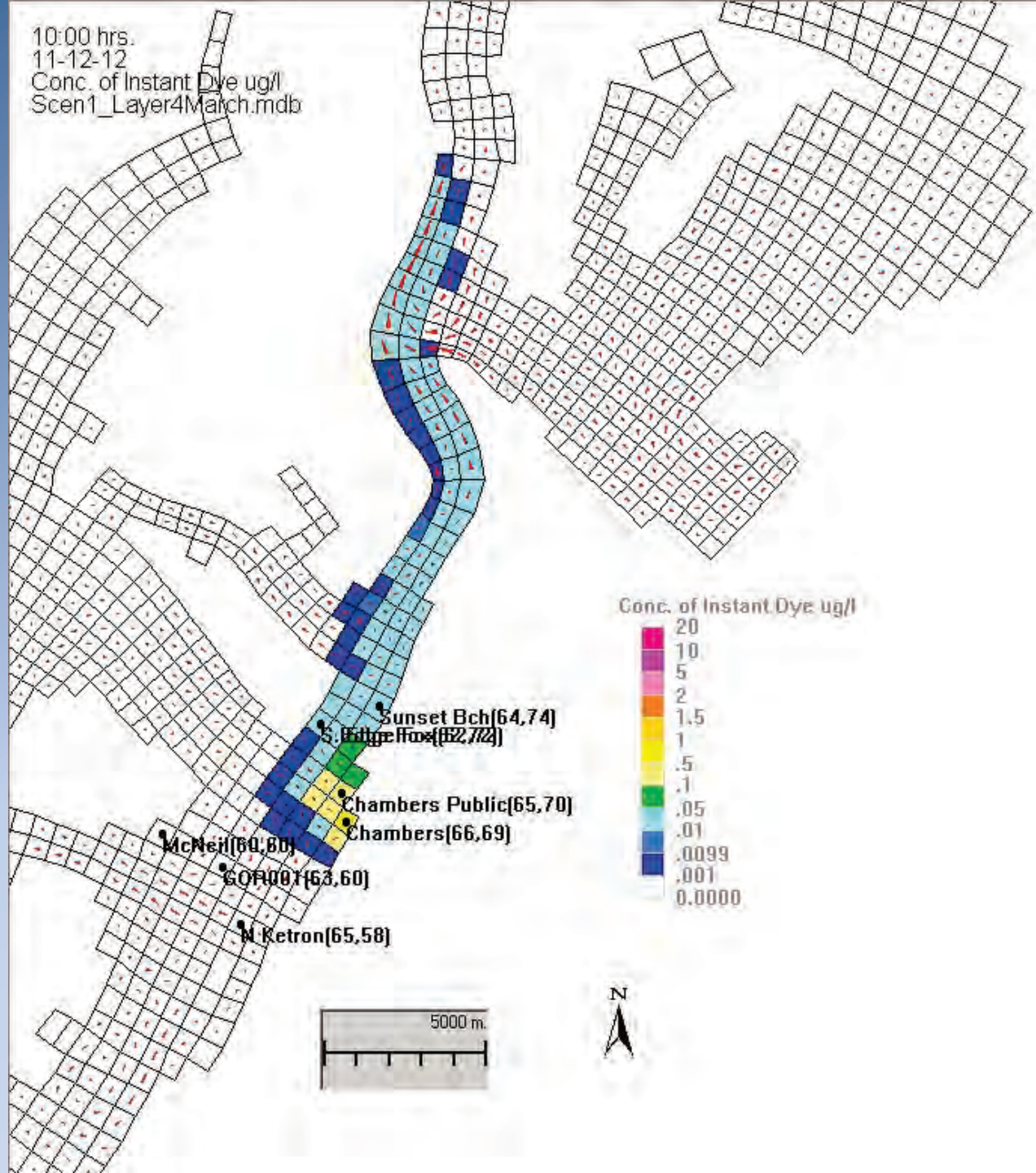


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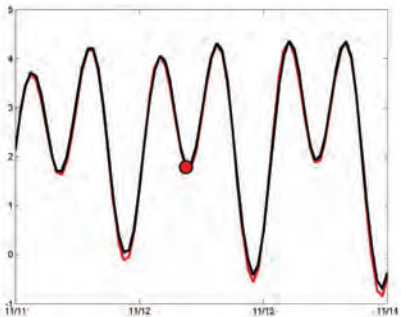
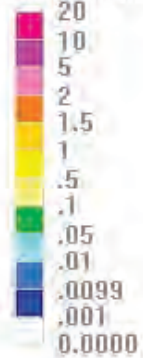


10AM

10:00 hrs.
11-12-12
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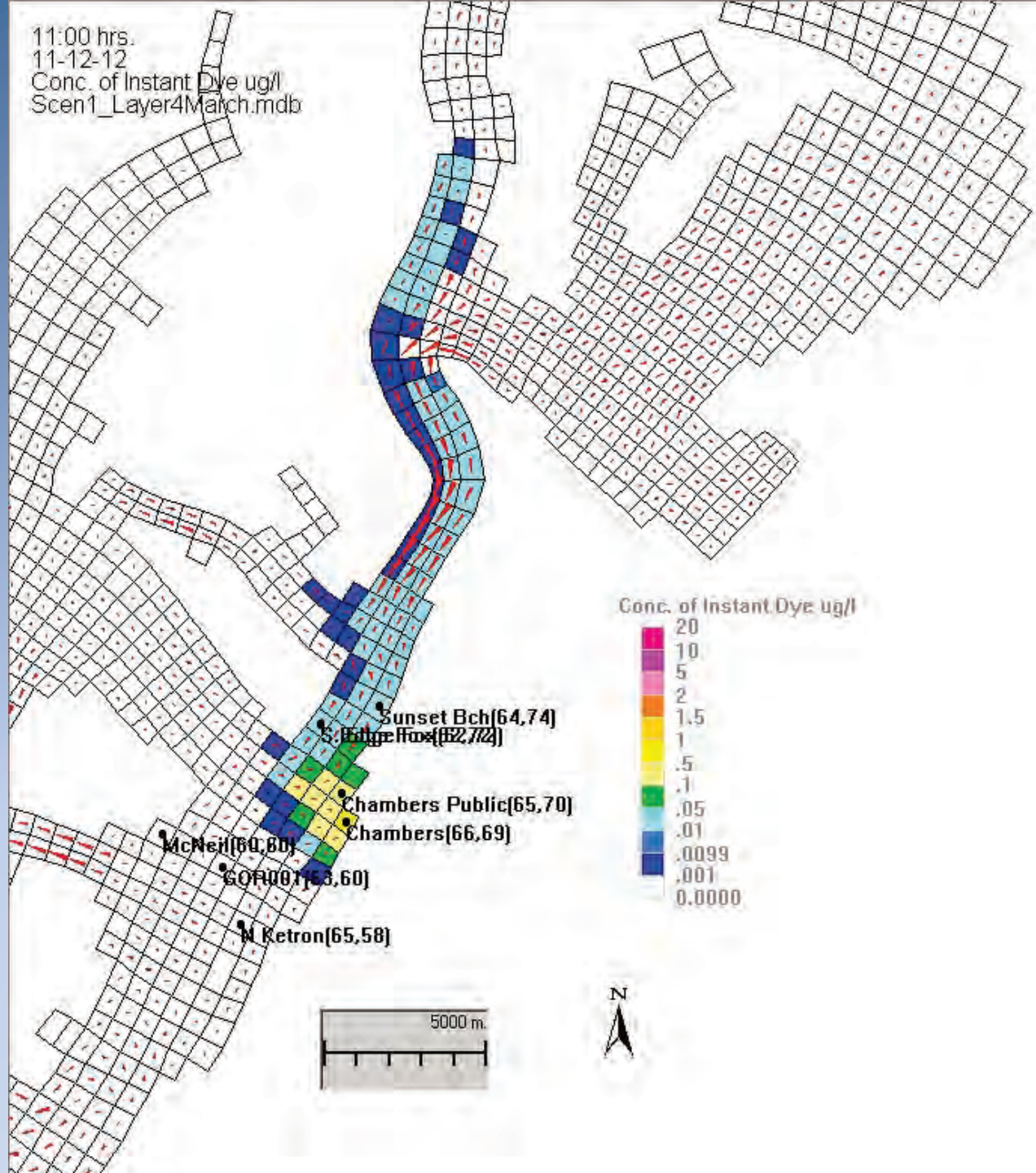


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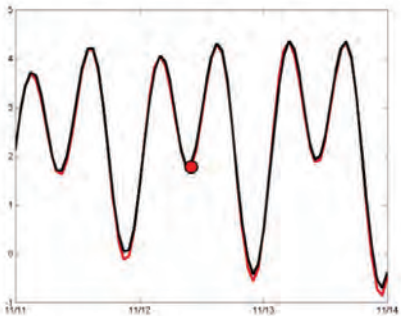
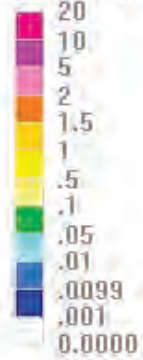


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11:00 hrs.
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Scen1_Layer4March.mdb



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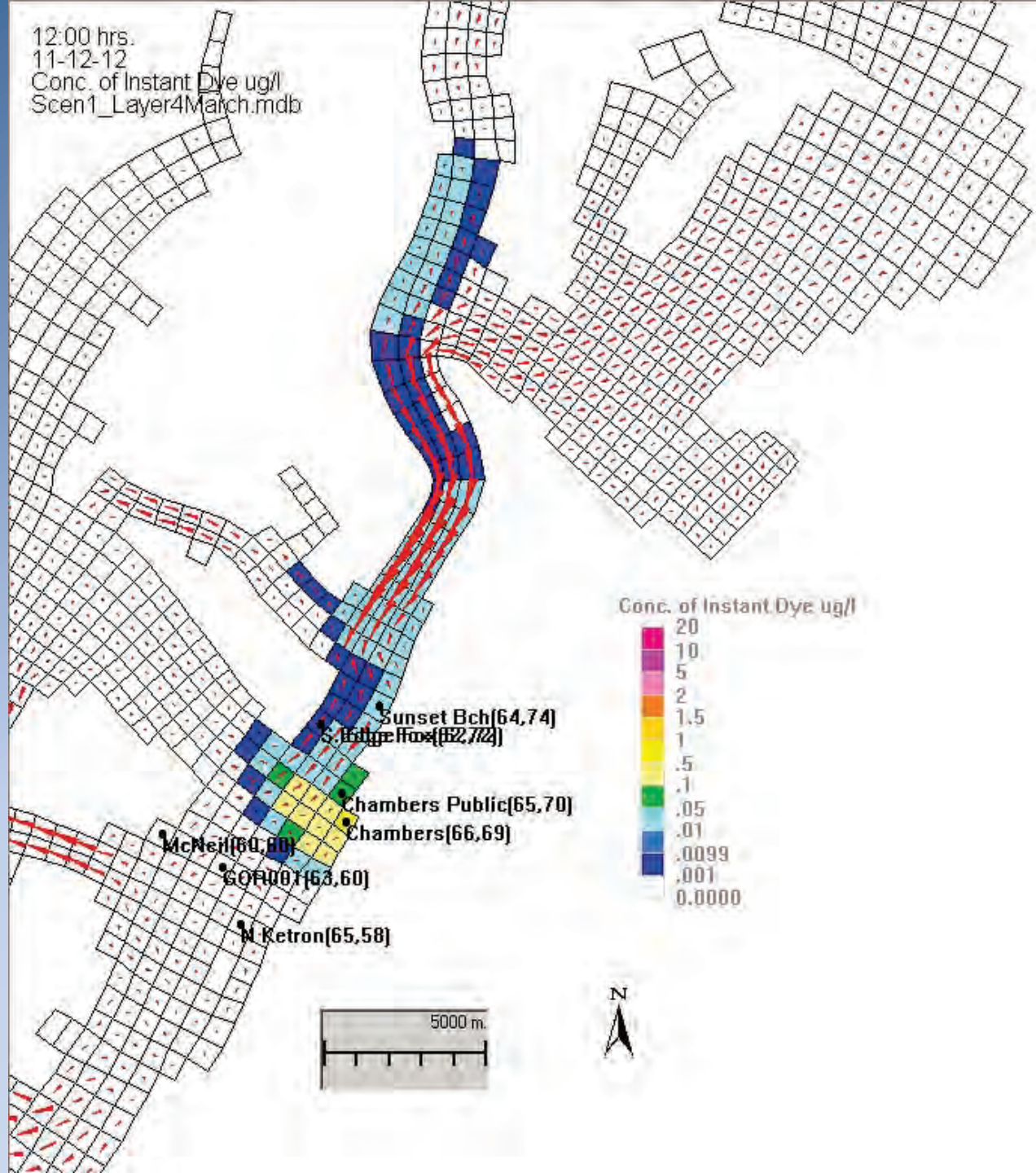


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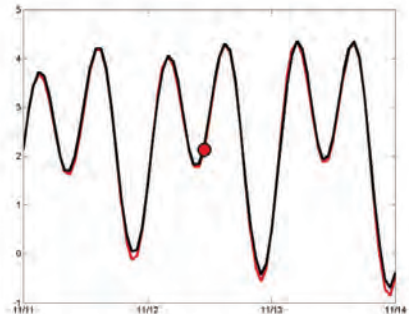
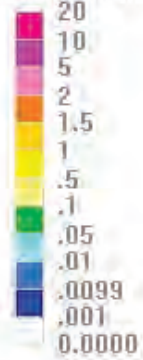


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12:00 hrs.
11-12-12
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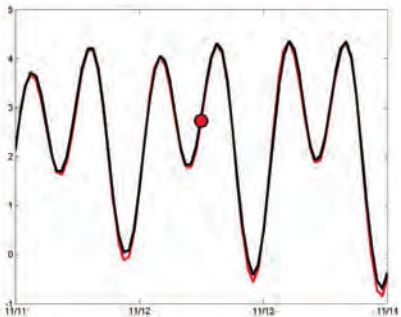
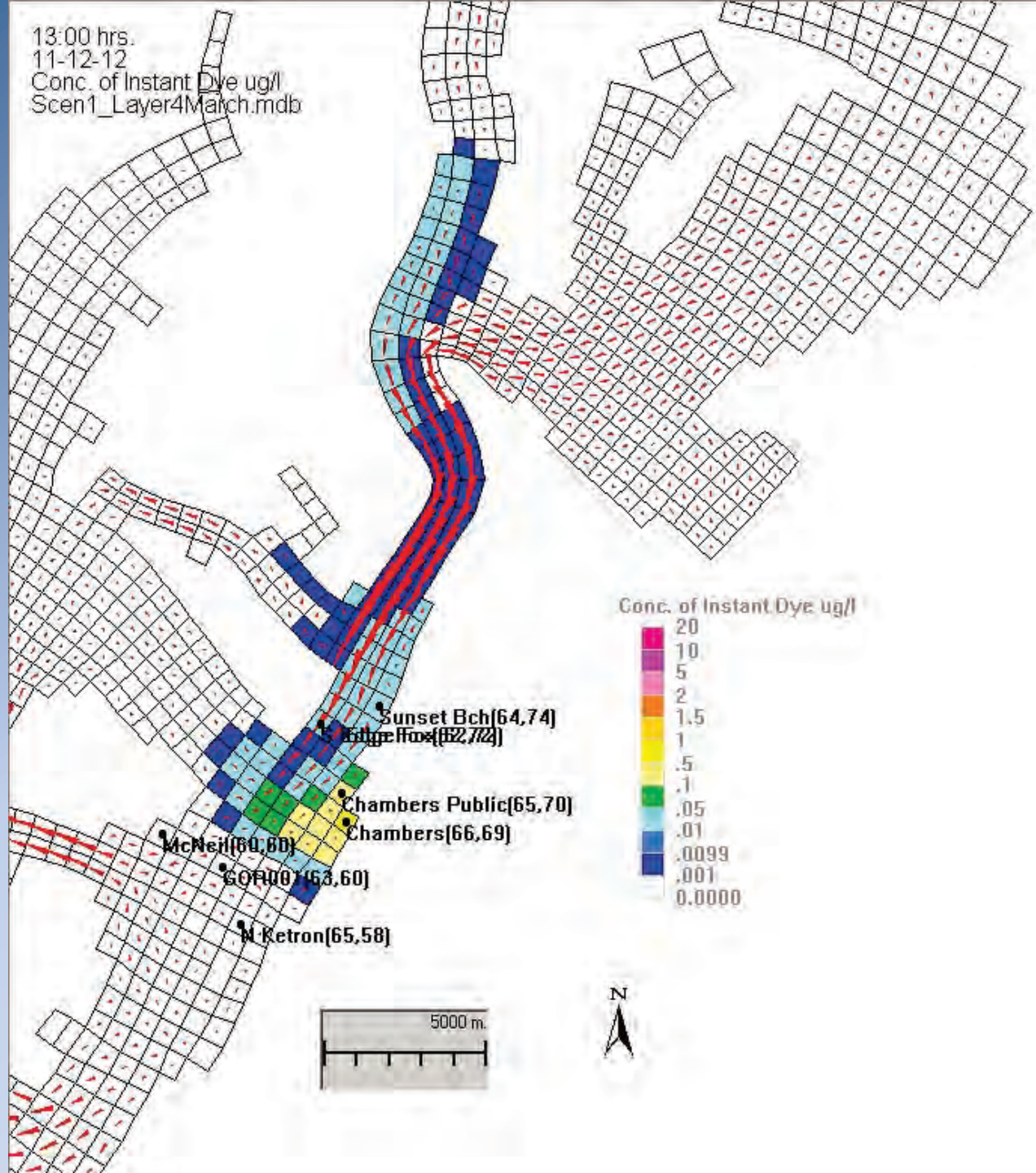


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1PM

13:00 hrs.
11-12-12
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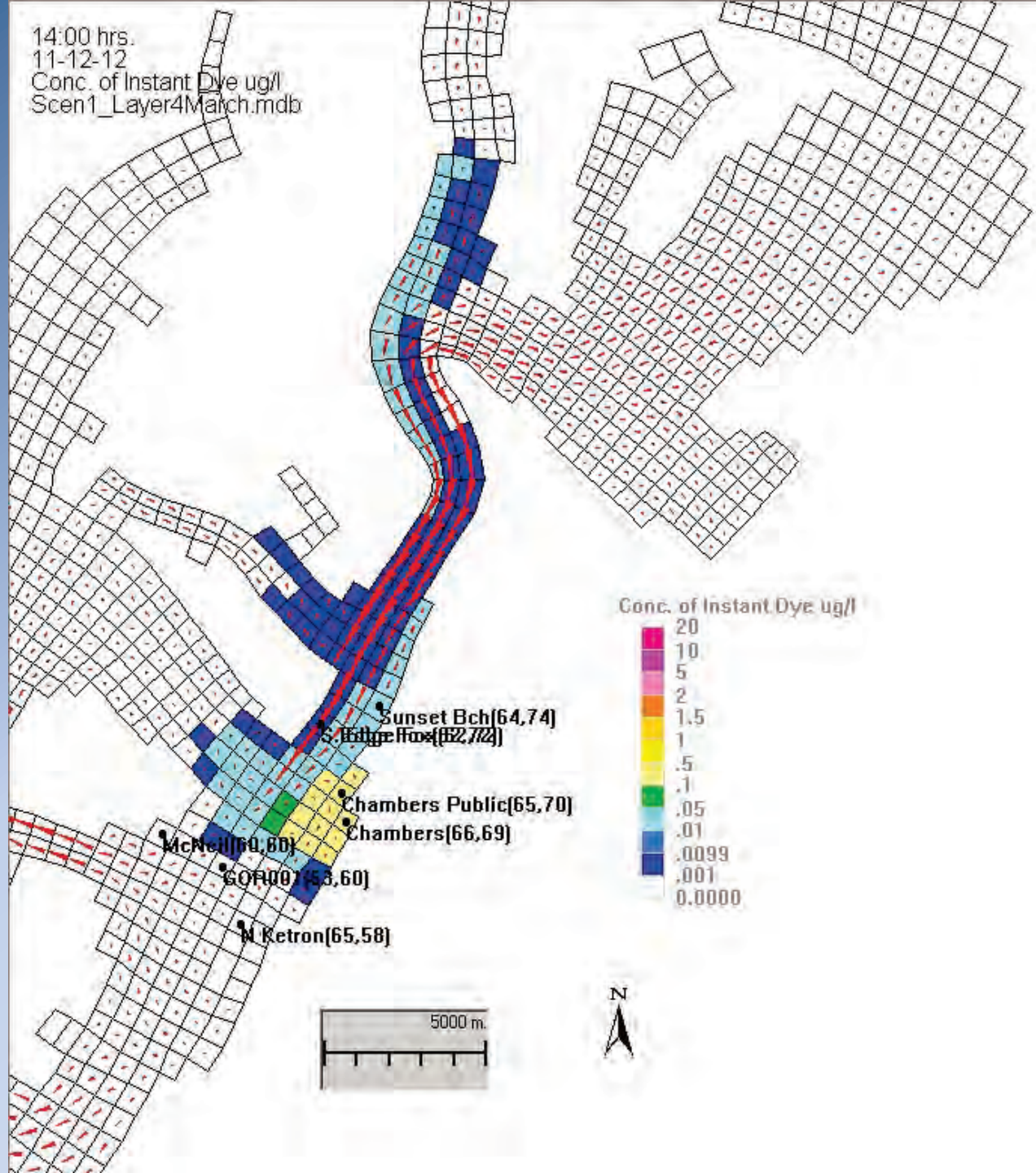


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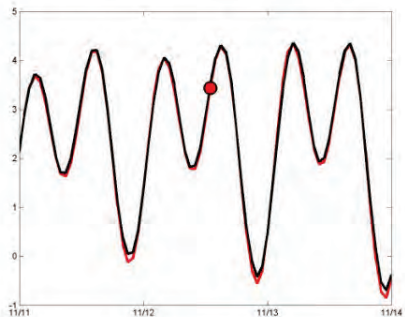
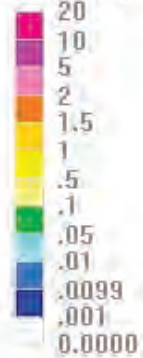


2PM

14:00 hrs.
11-12-12
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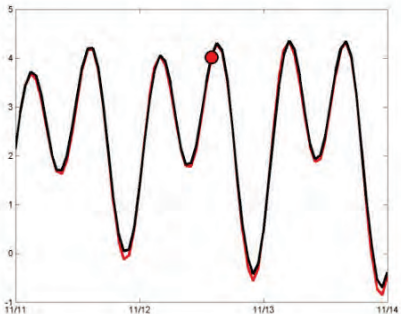
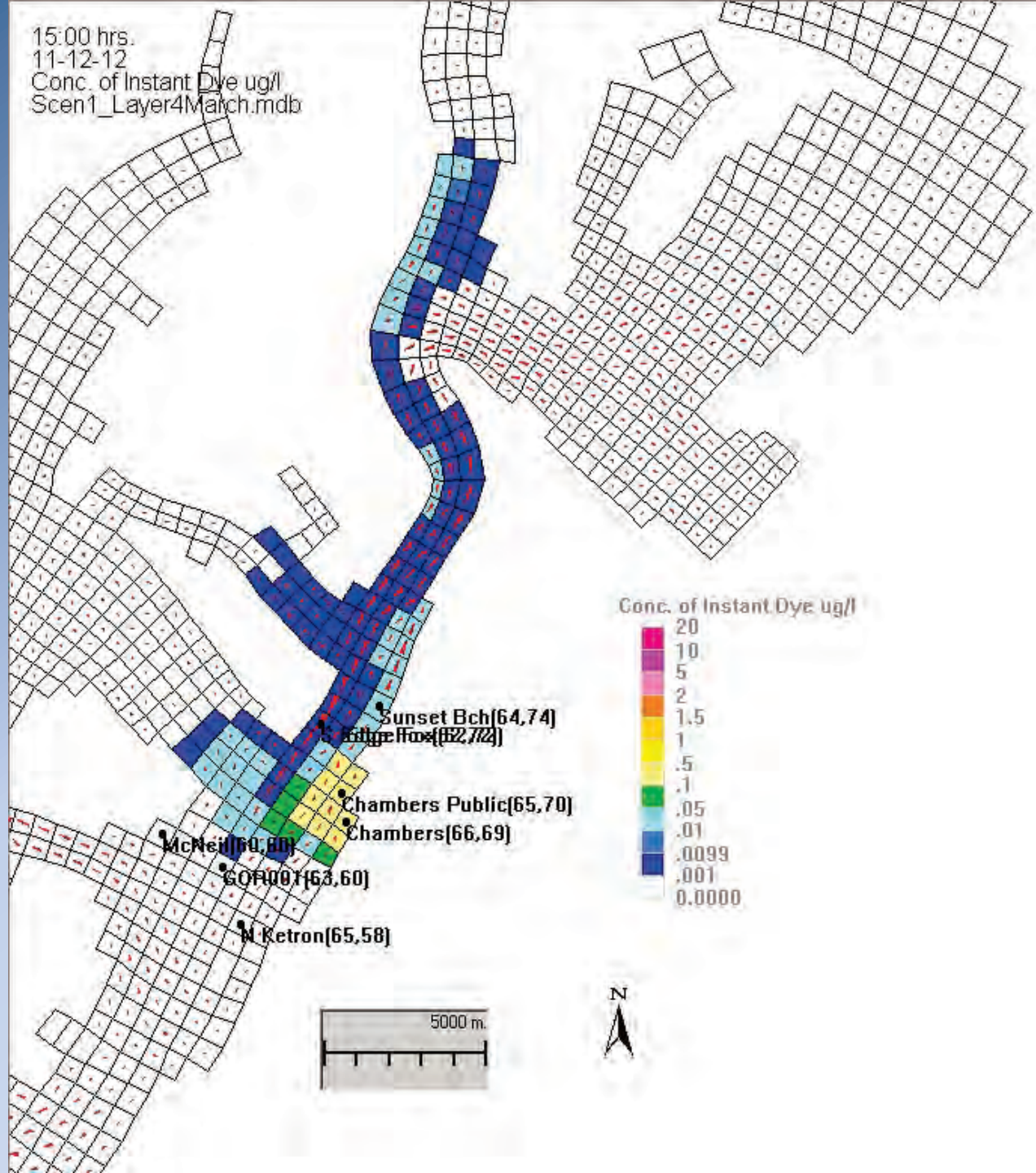


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3PM

15:00 hrs.
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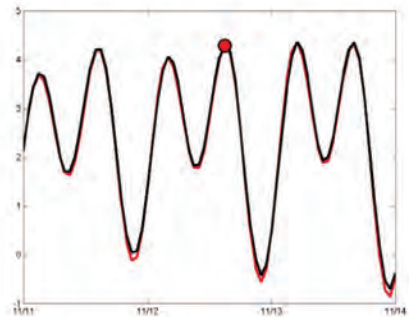
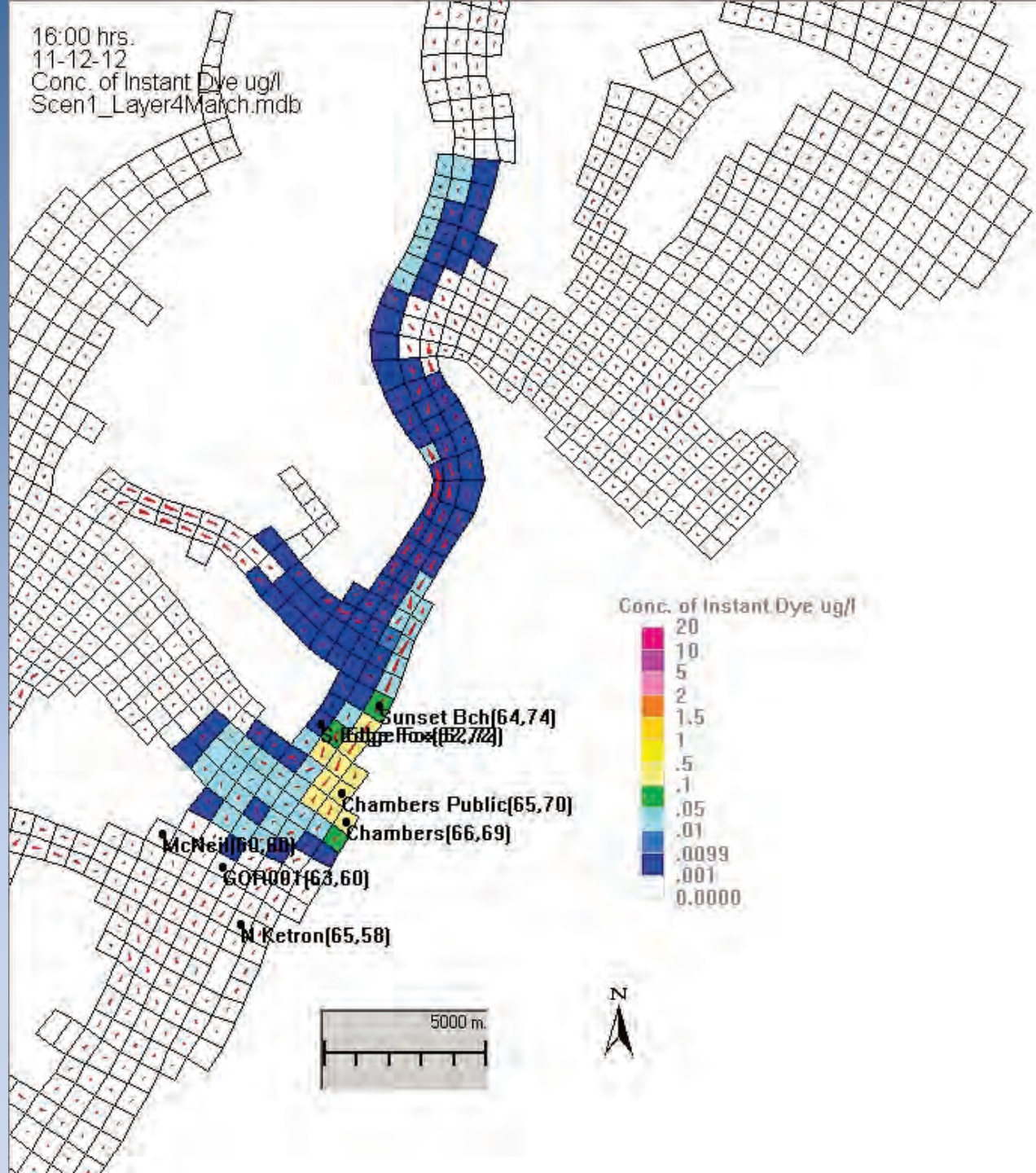


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4PM

16:00 hrs.
11-12-12
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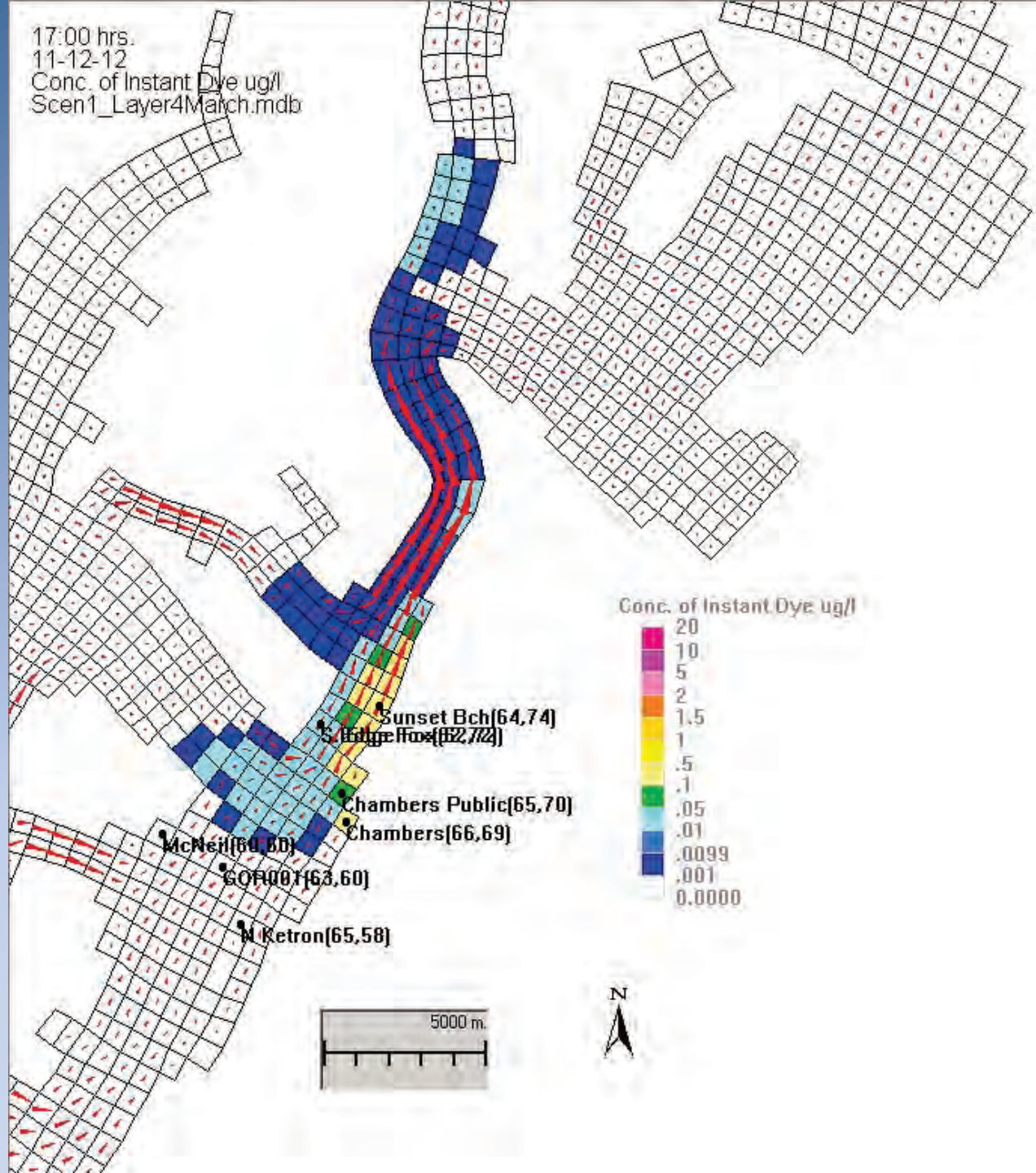


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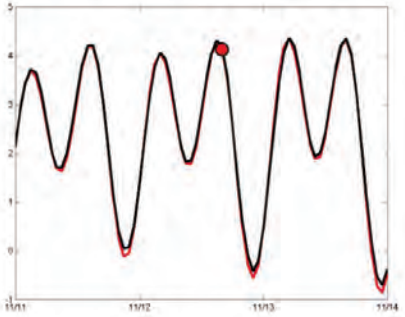
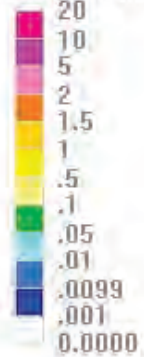


5PM

17:00 hrs.
11-12-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

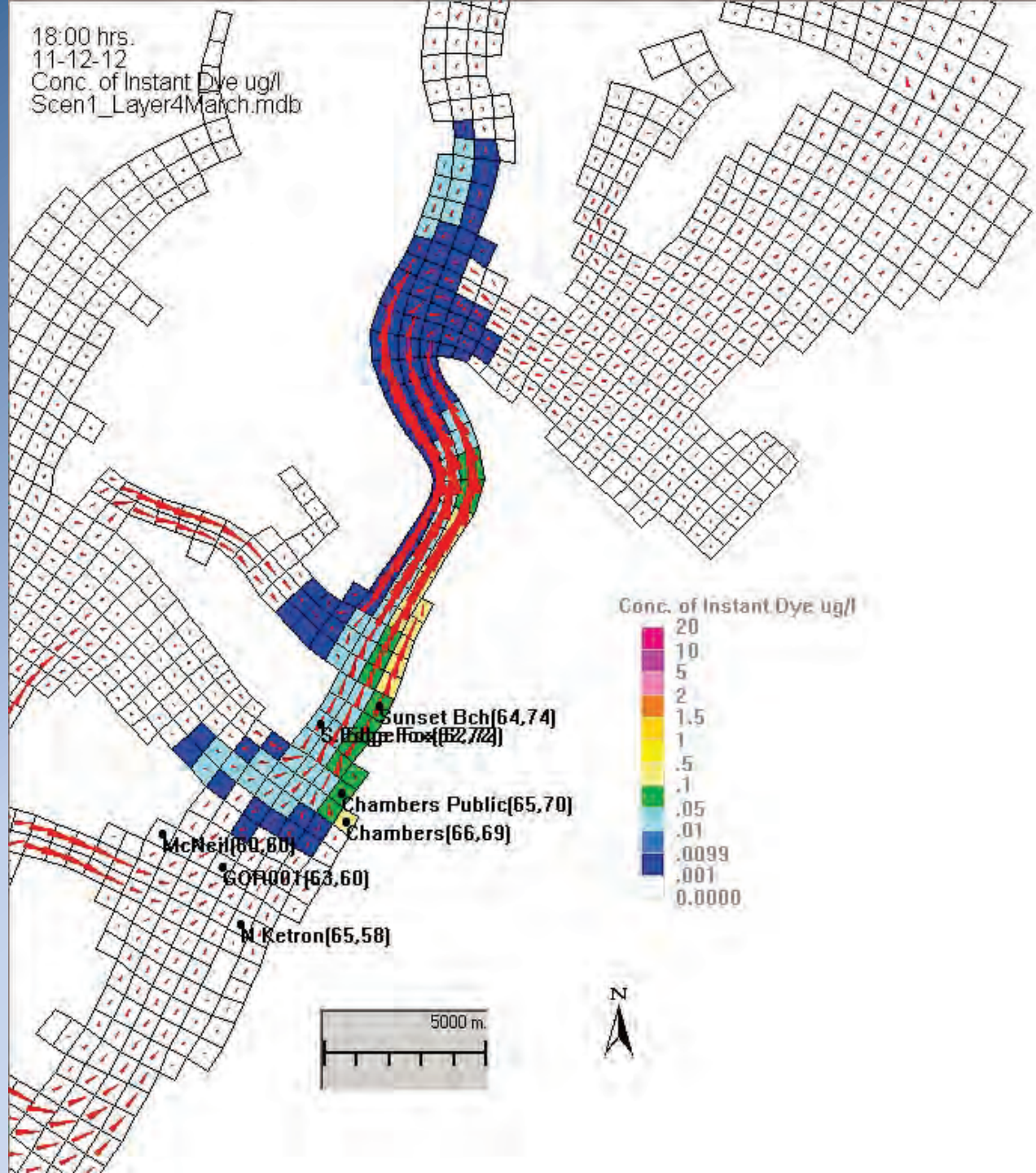


Nov
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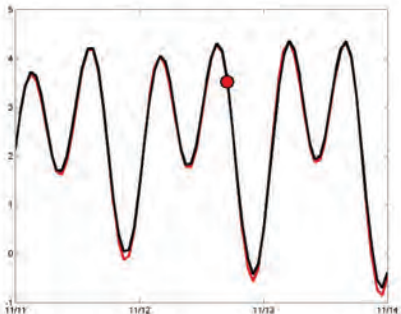
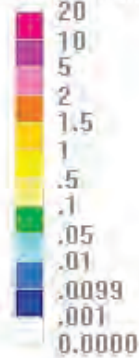


6PM

18:00 hrs.
11-12-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

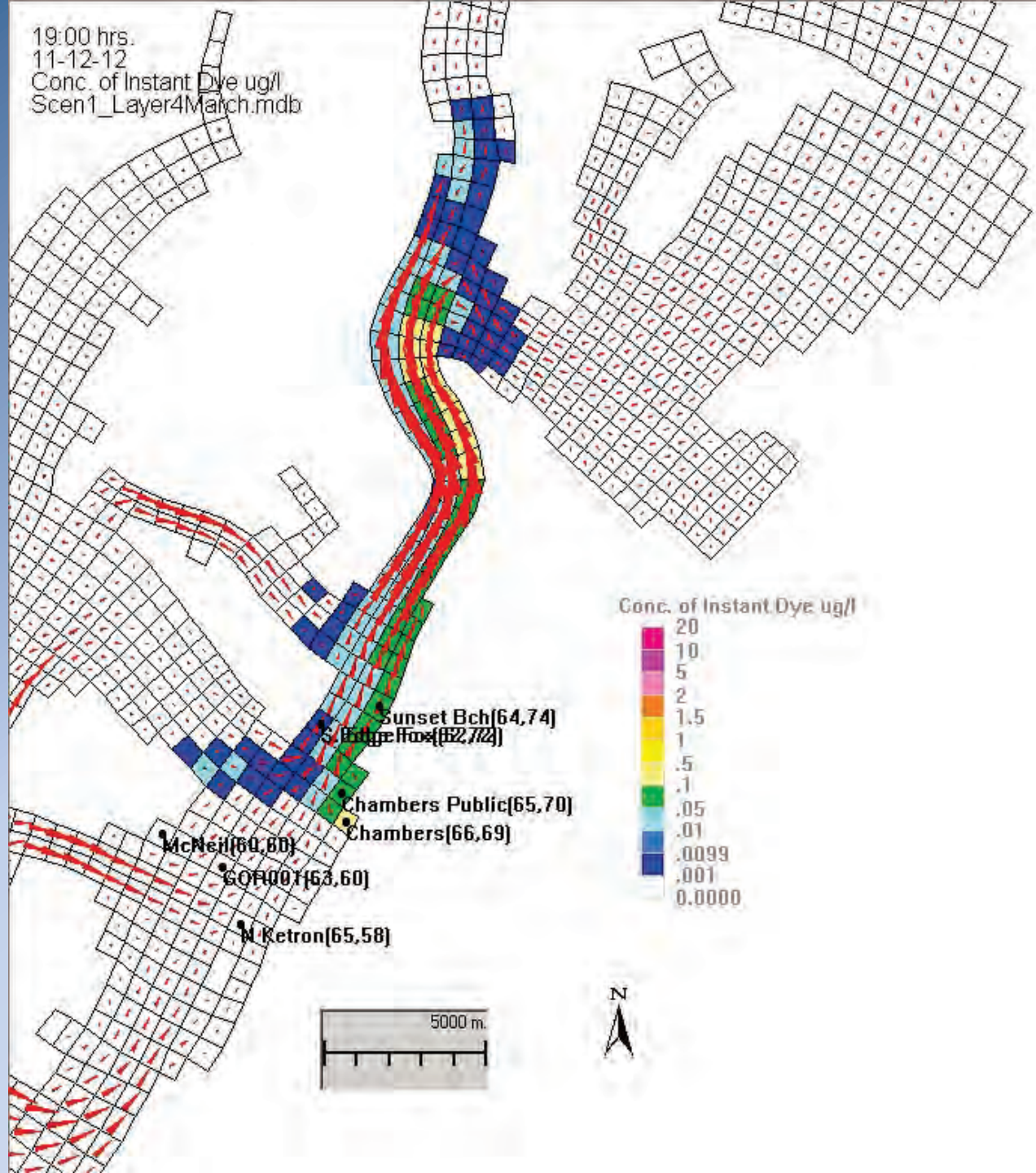


Nov
12

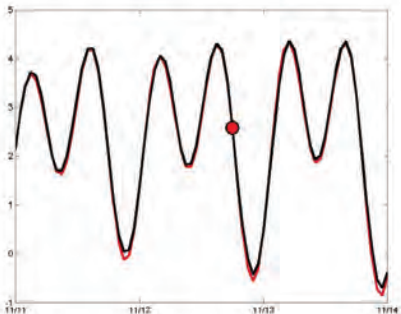
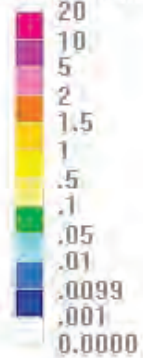


7PM

19:00 hrs.
11-12-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

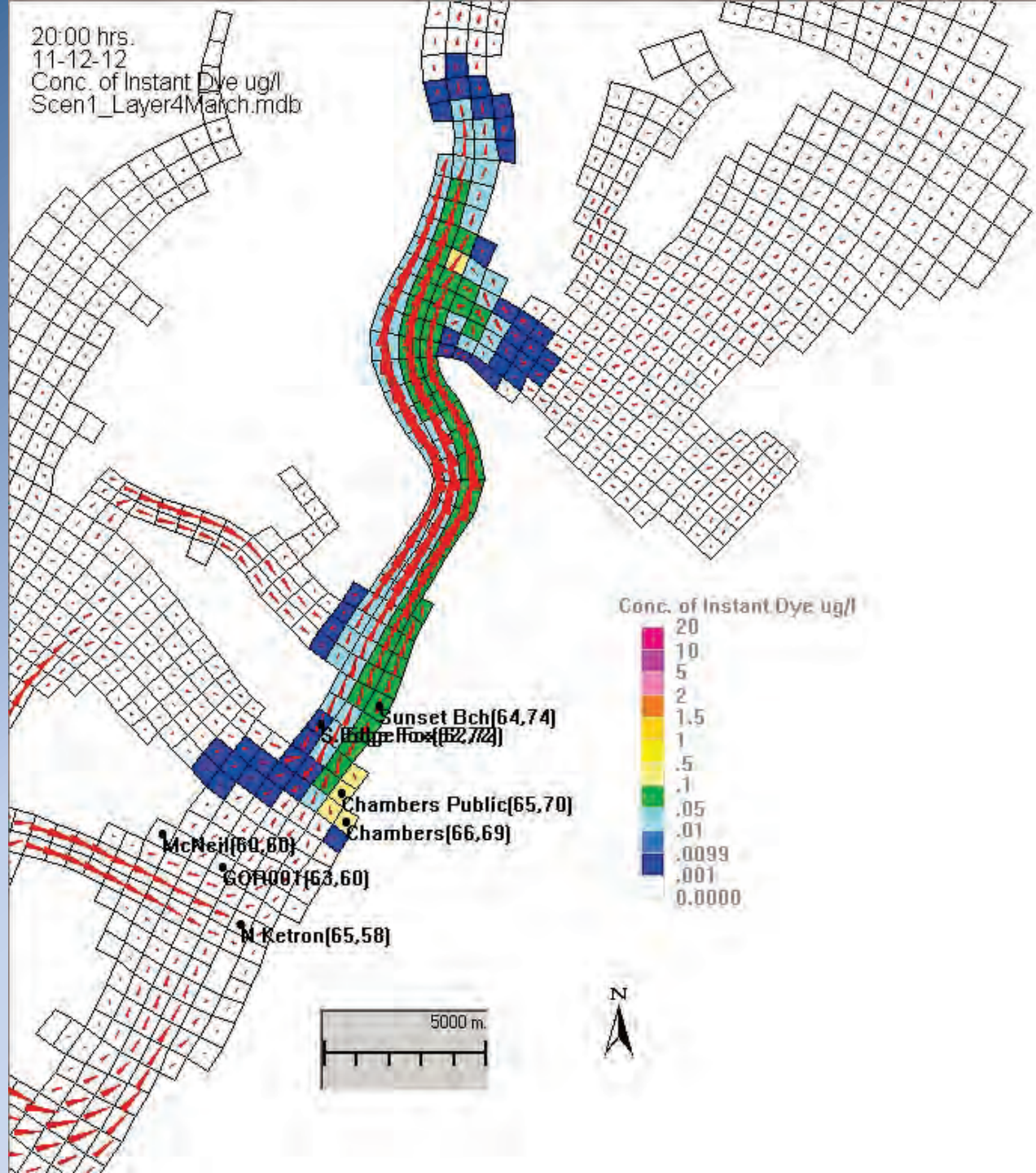


Nov
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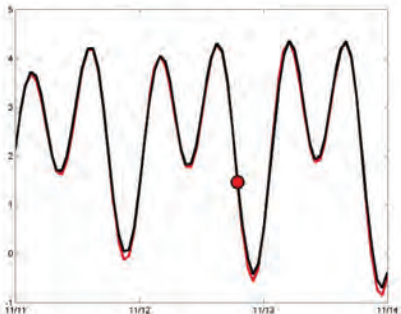
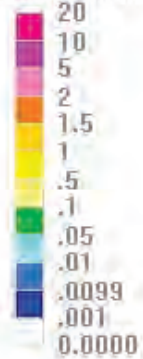


8PM

20:00 hrs.
11-12-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

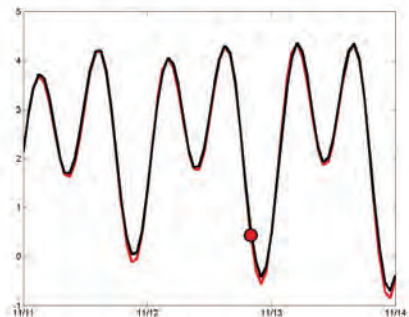
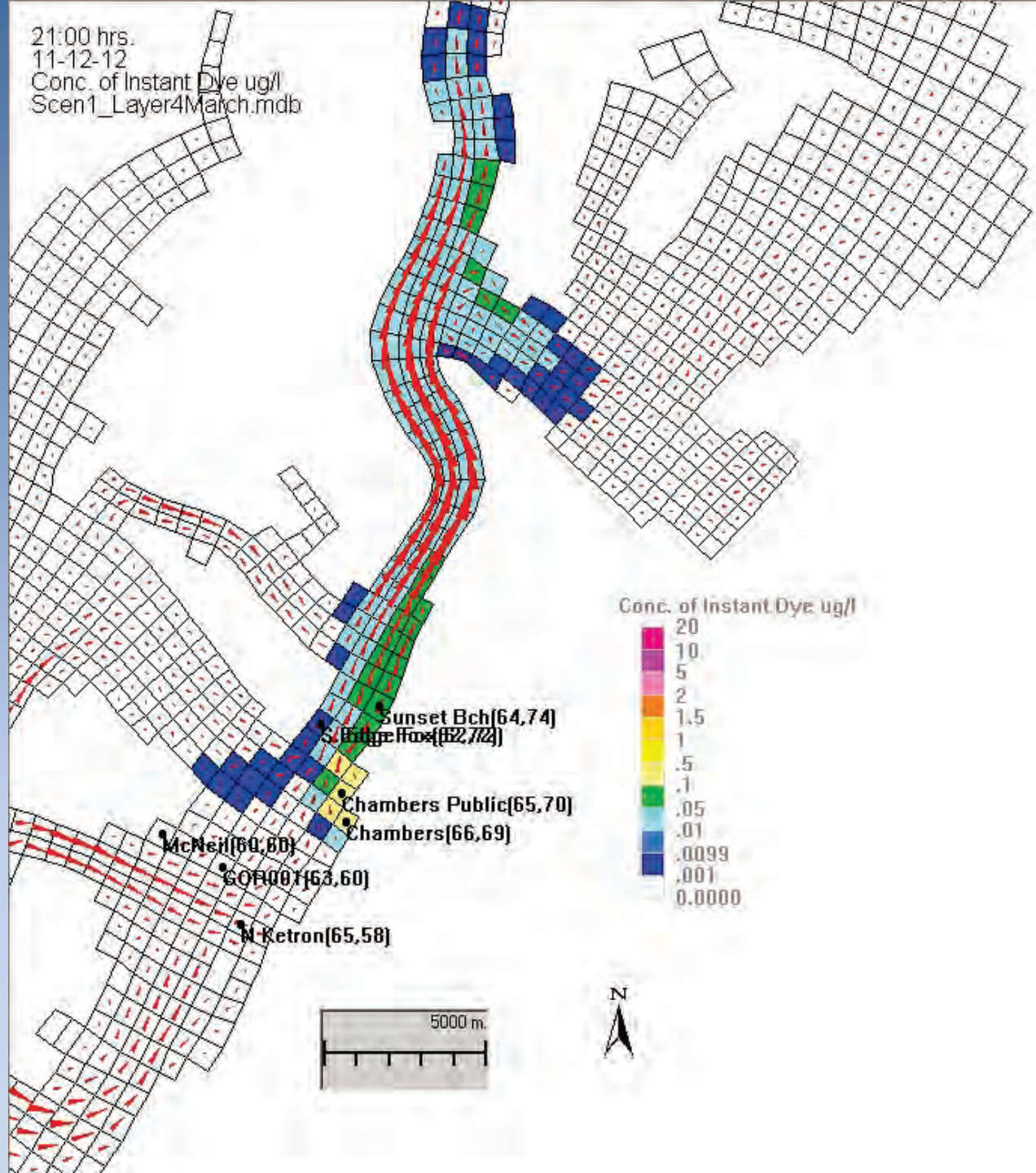


Nov
12



9PM

21:00 hrs.
11-12-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

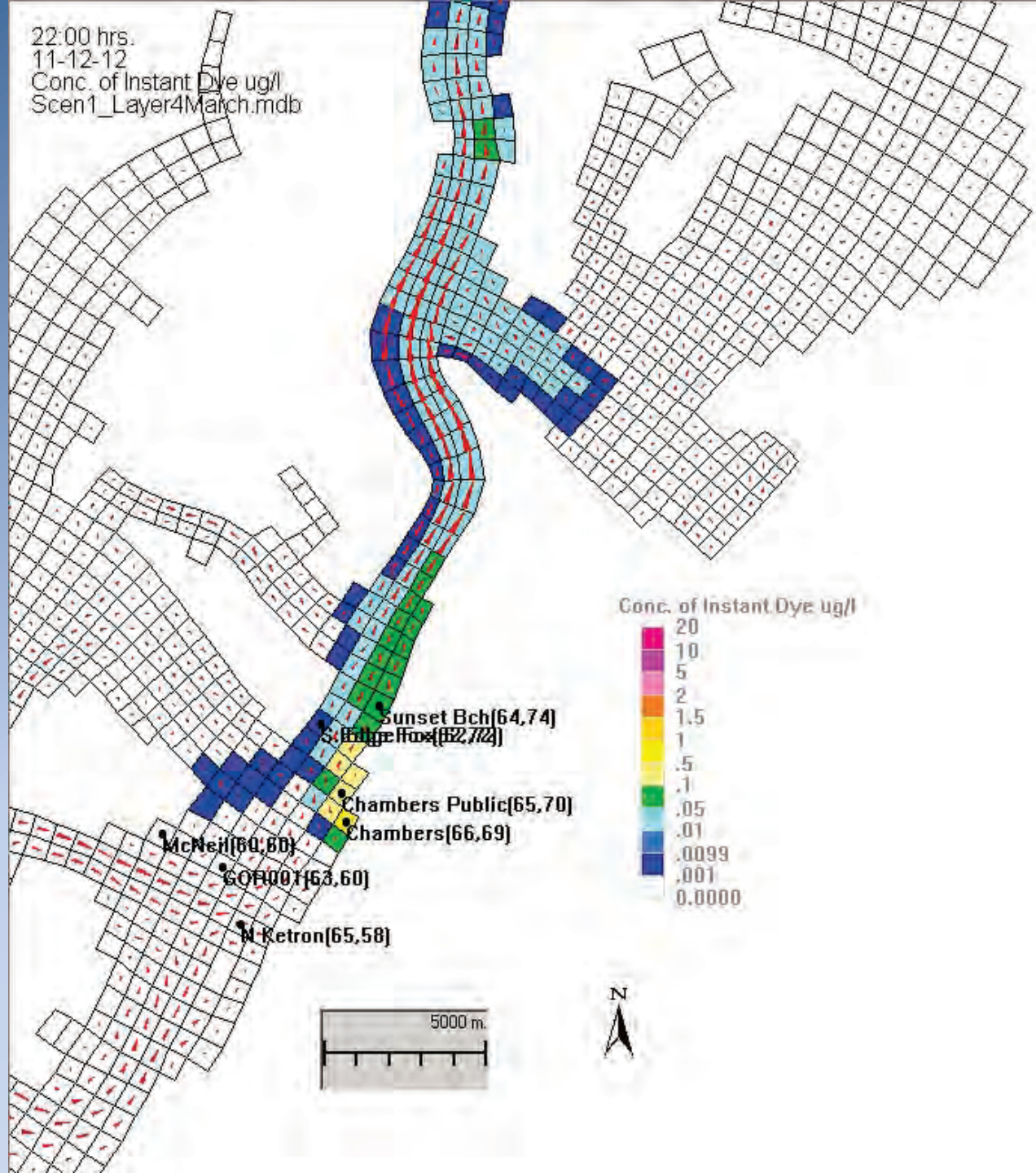


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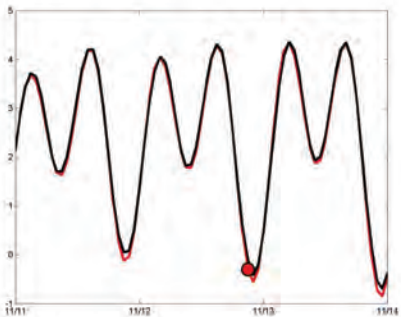
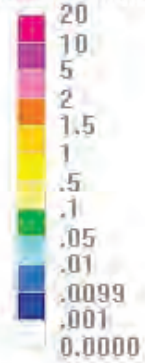


10PM

22:00 hrs.
11-12-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

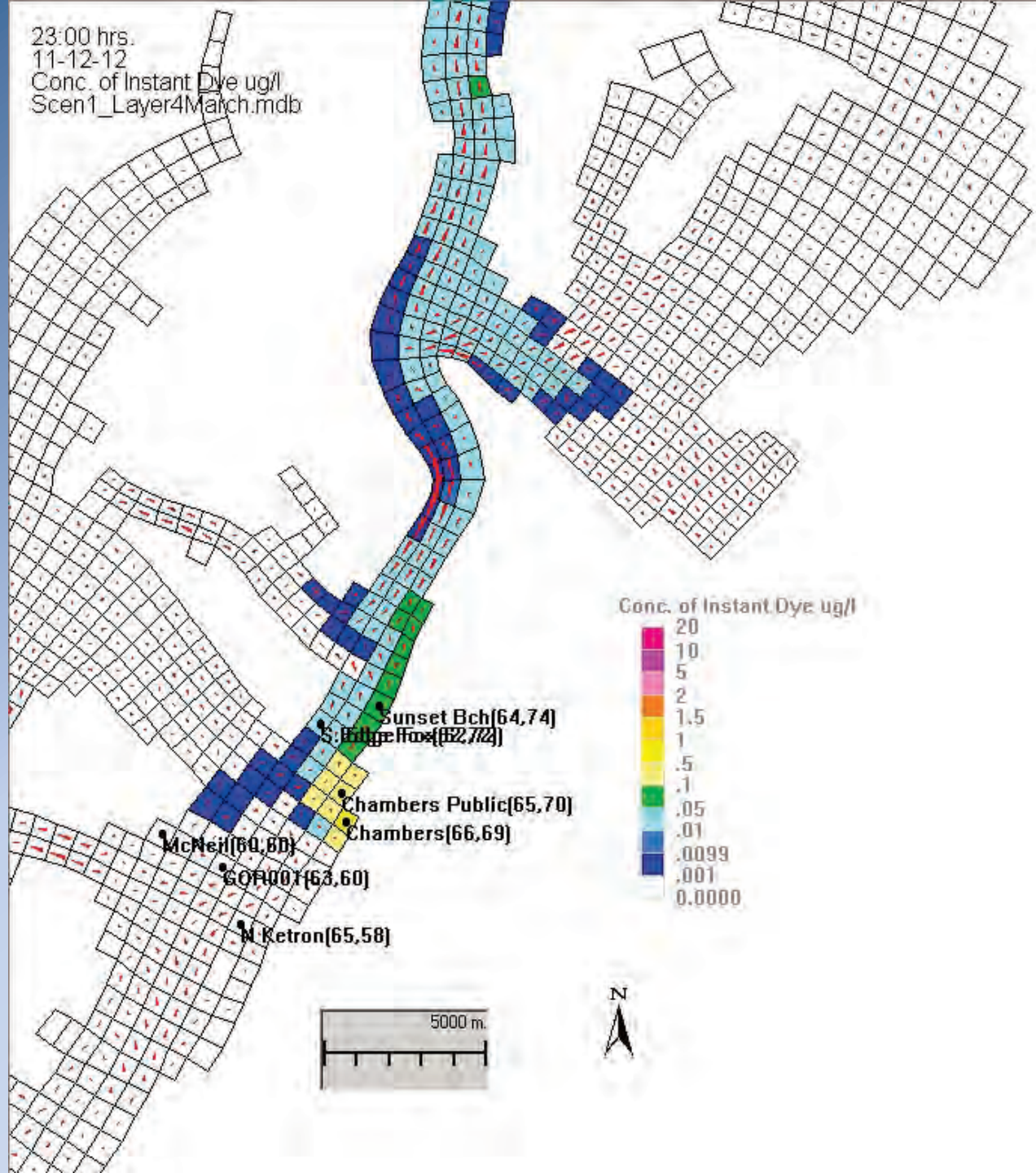


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12

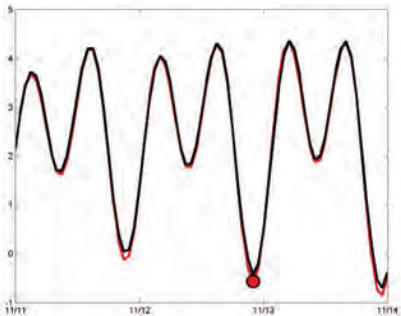
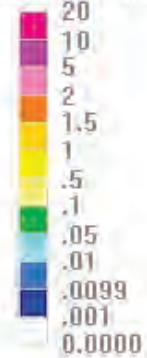


11PM

23:00 hrs.
11-12-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

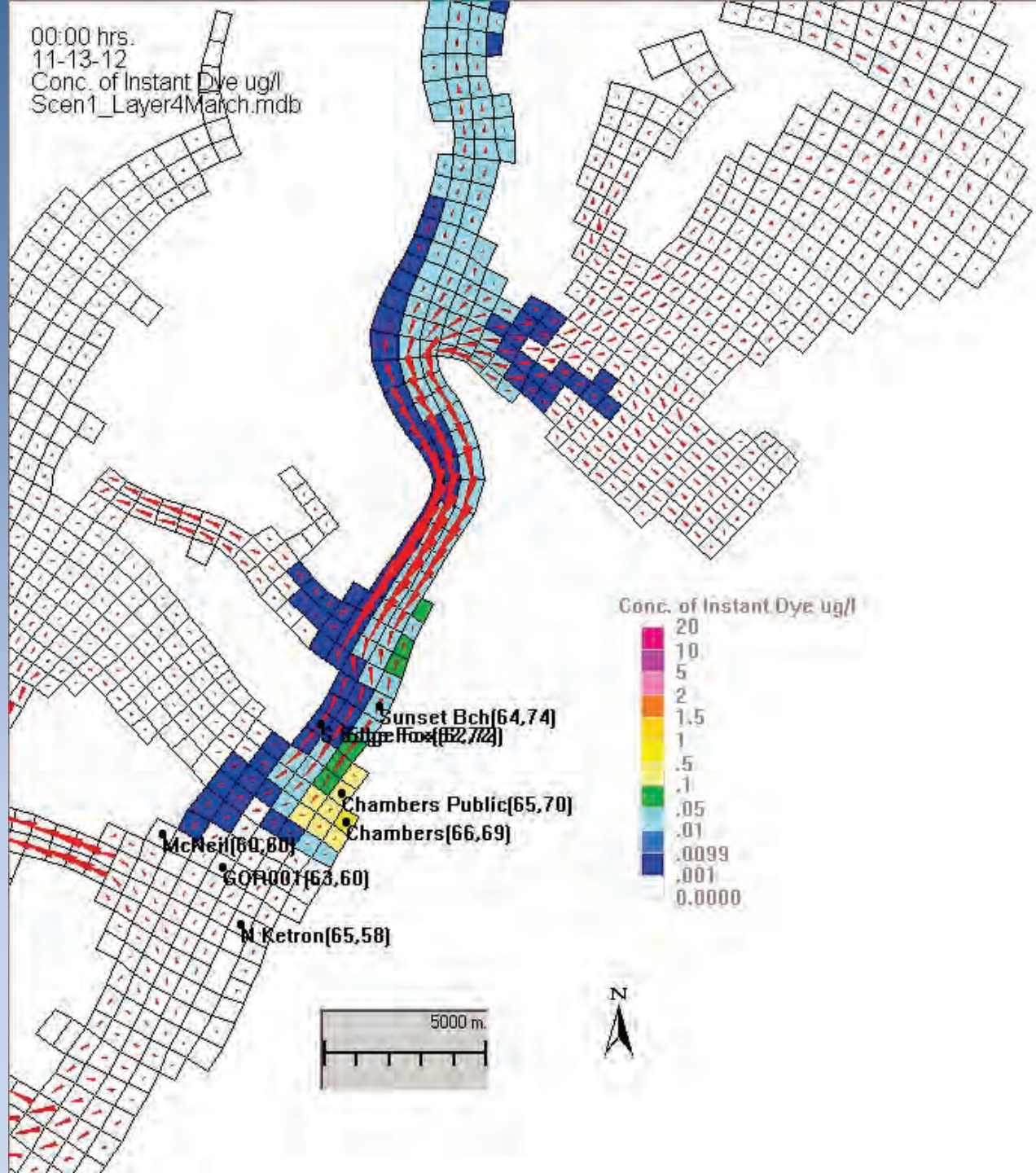


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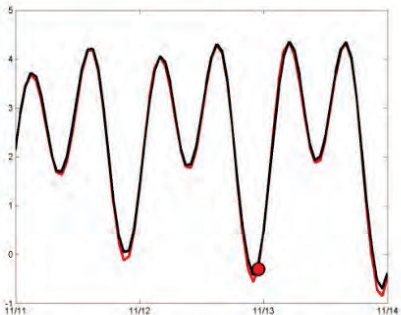
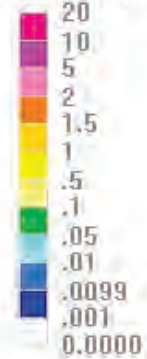


12AM

00:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

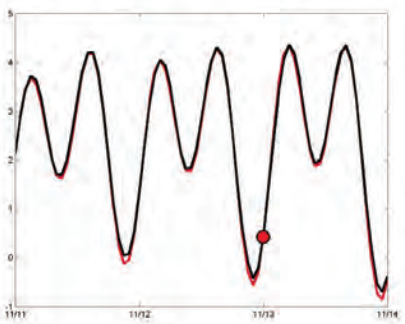
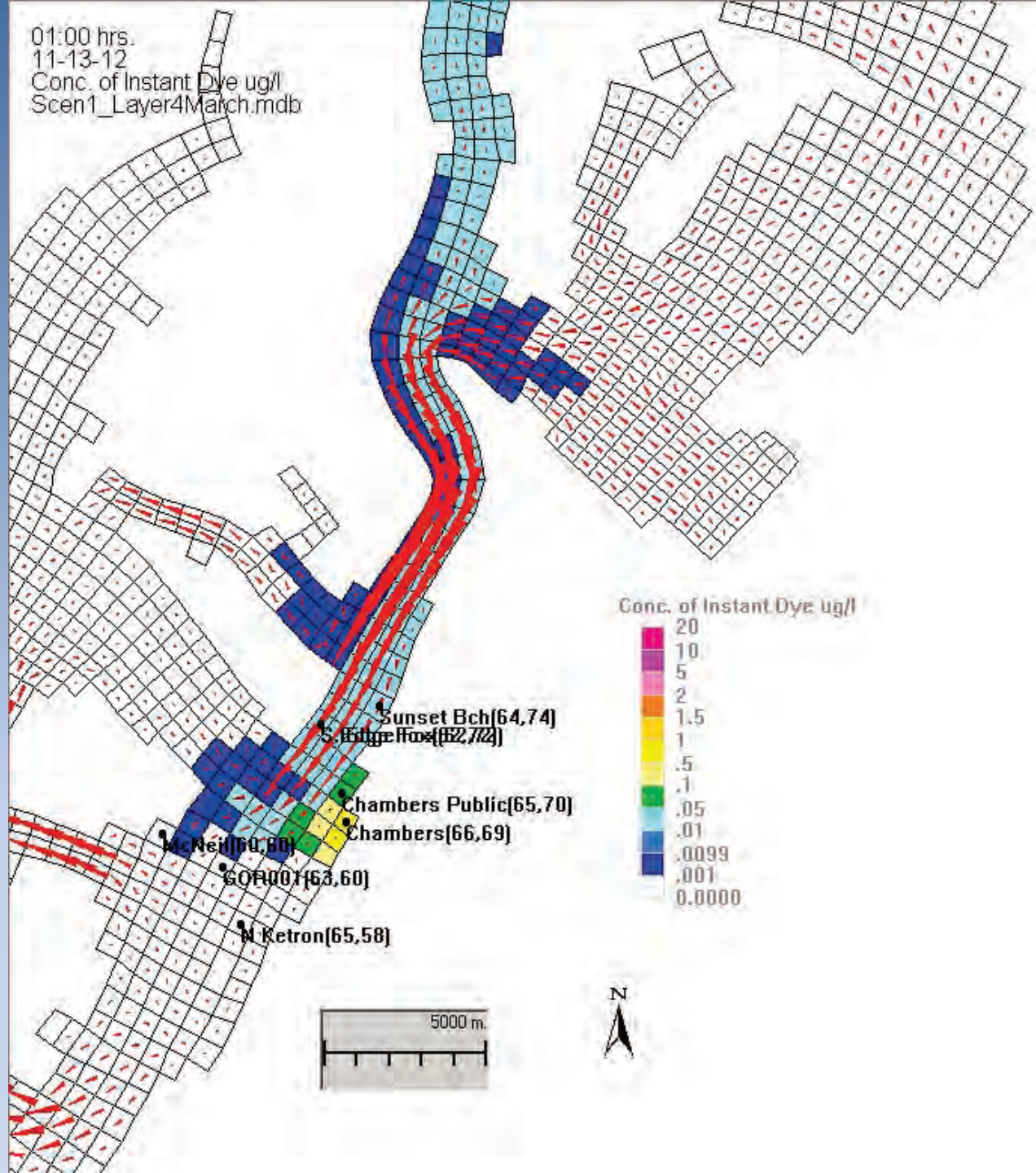


Nov
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1AM

01:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

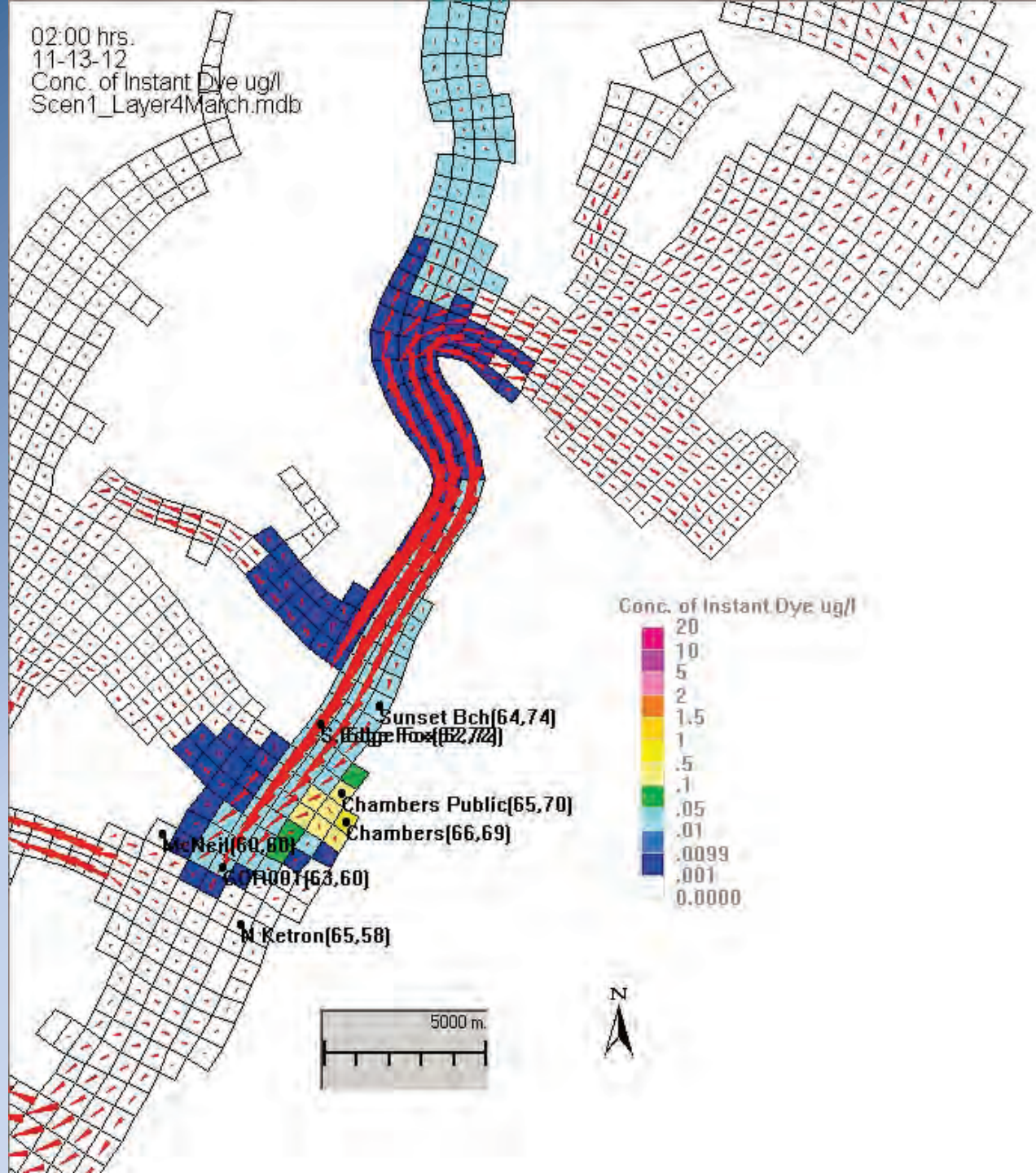


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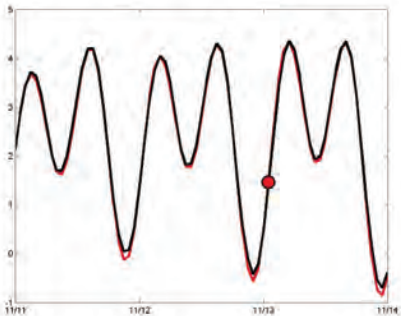
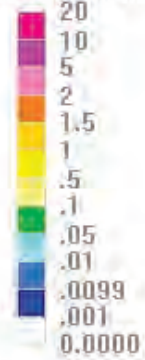


2AM

02:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

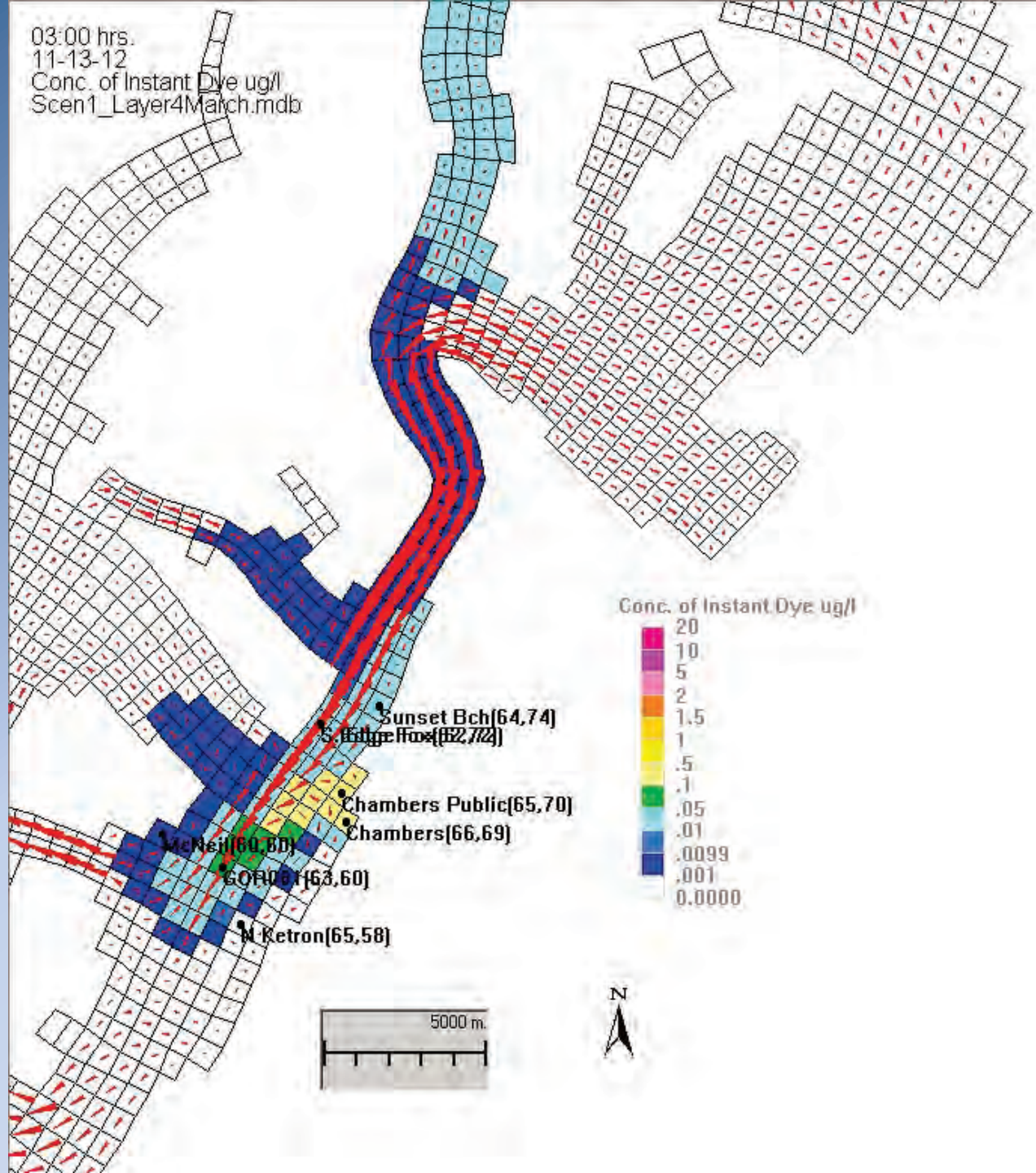


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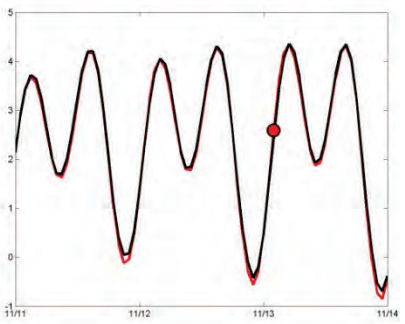
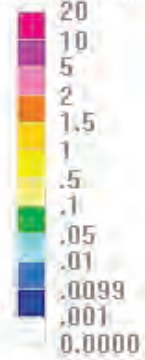


3AM

03:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

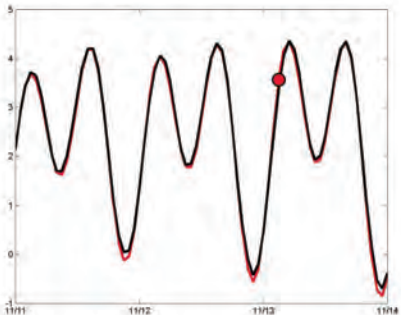
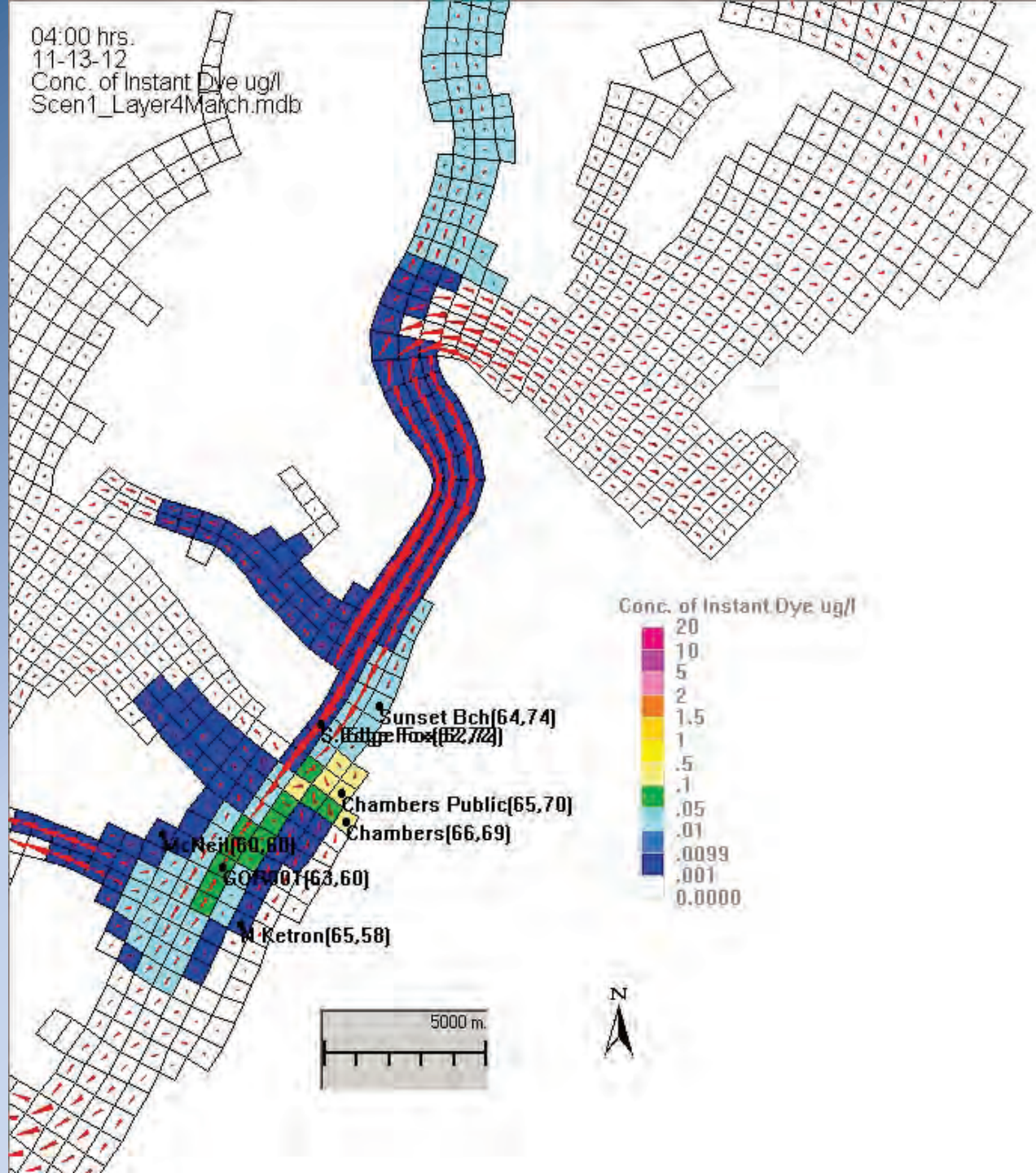


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4AM

04:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

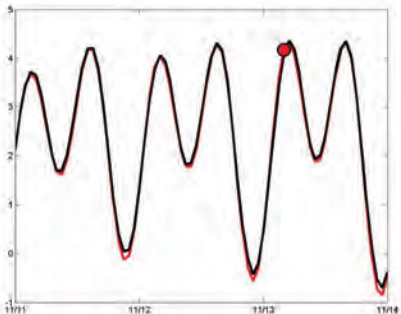
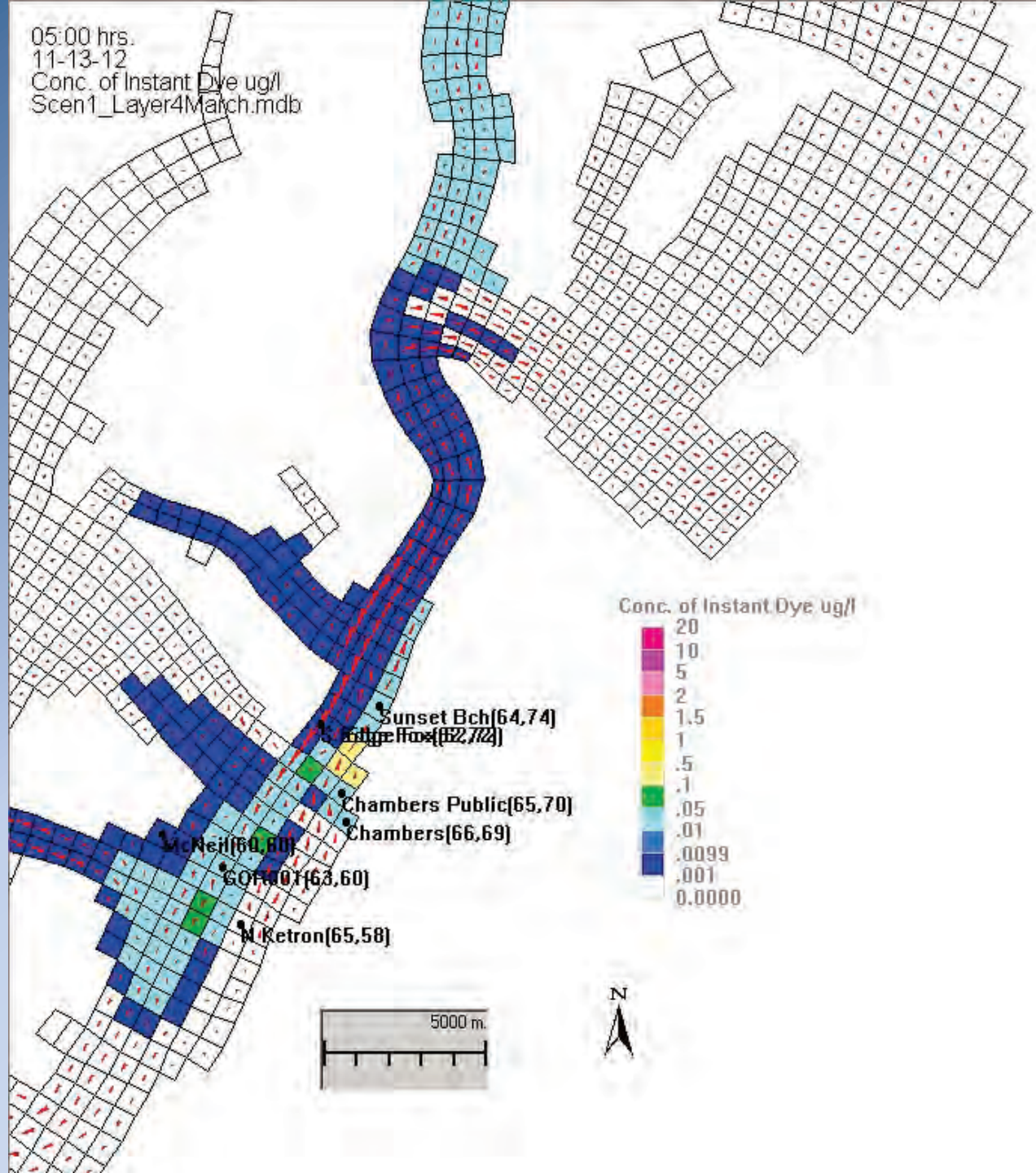


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5AM

05:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

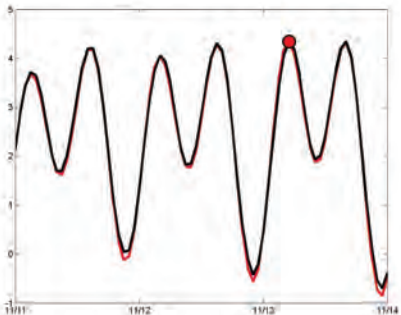
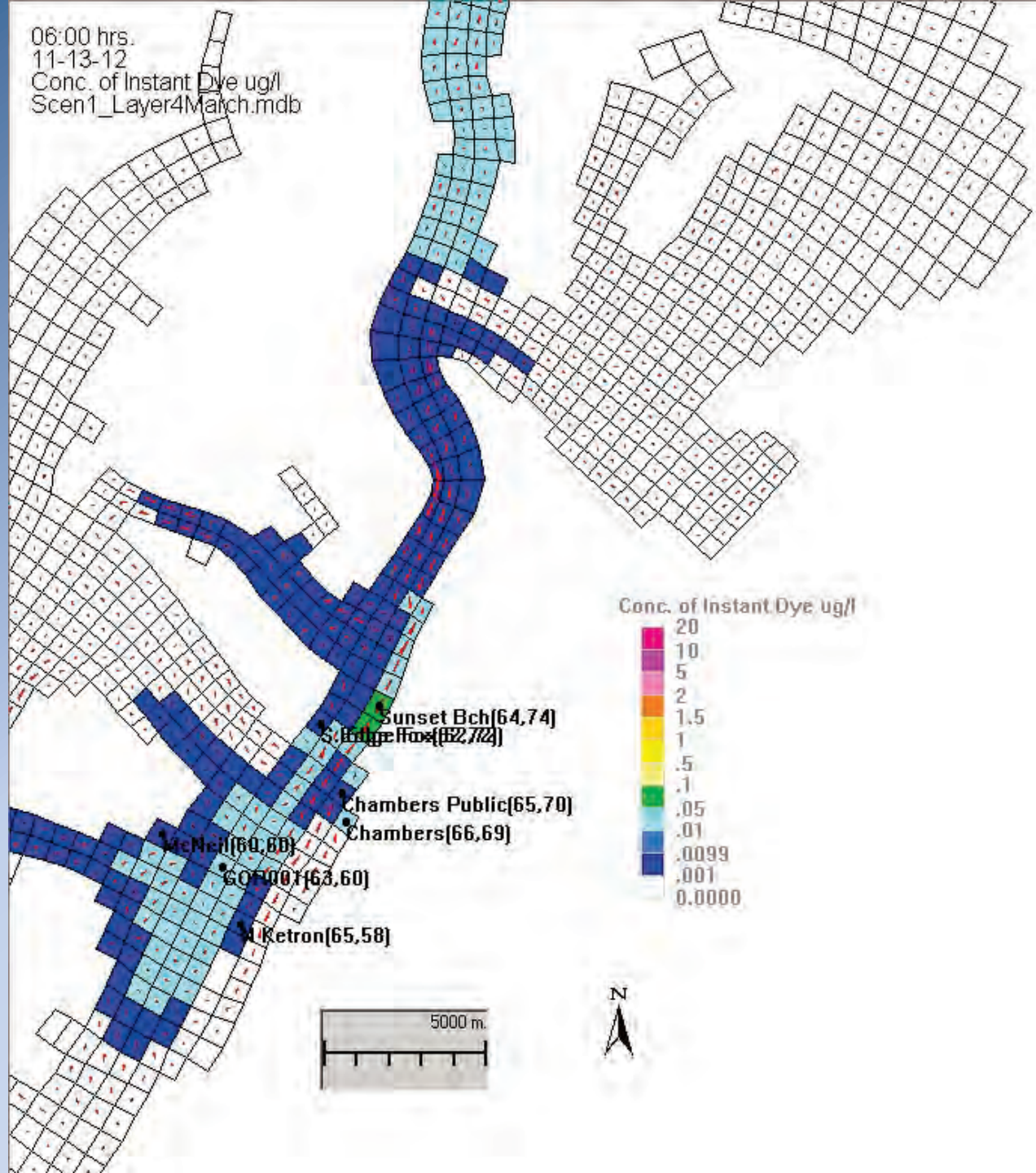


Nov
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6AM

06:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

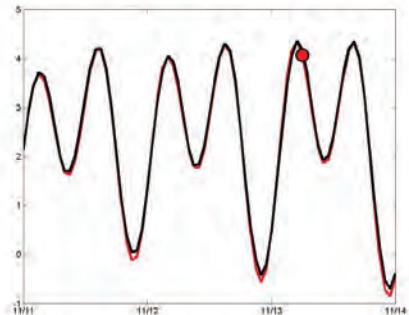
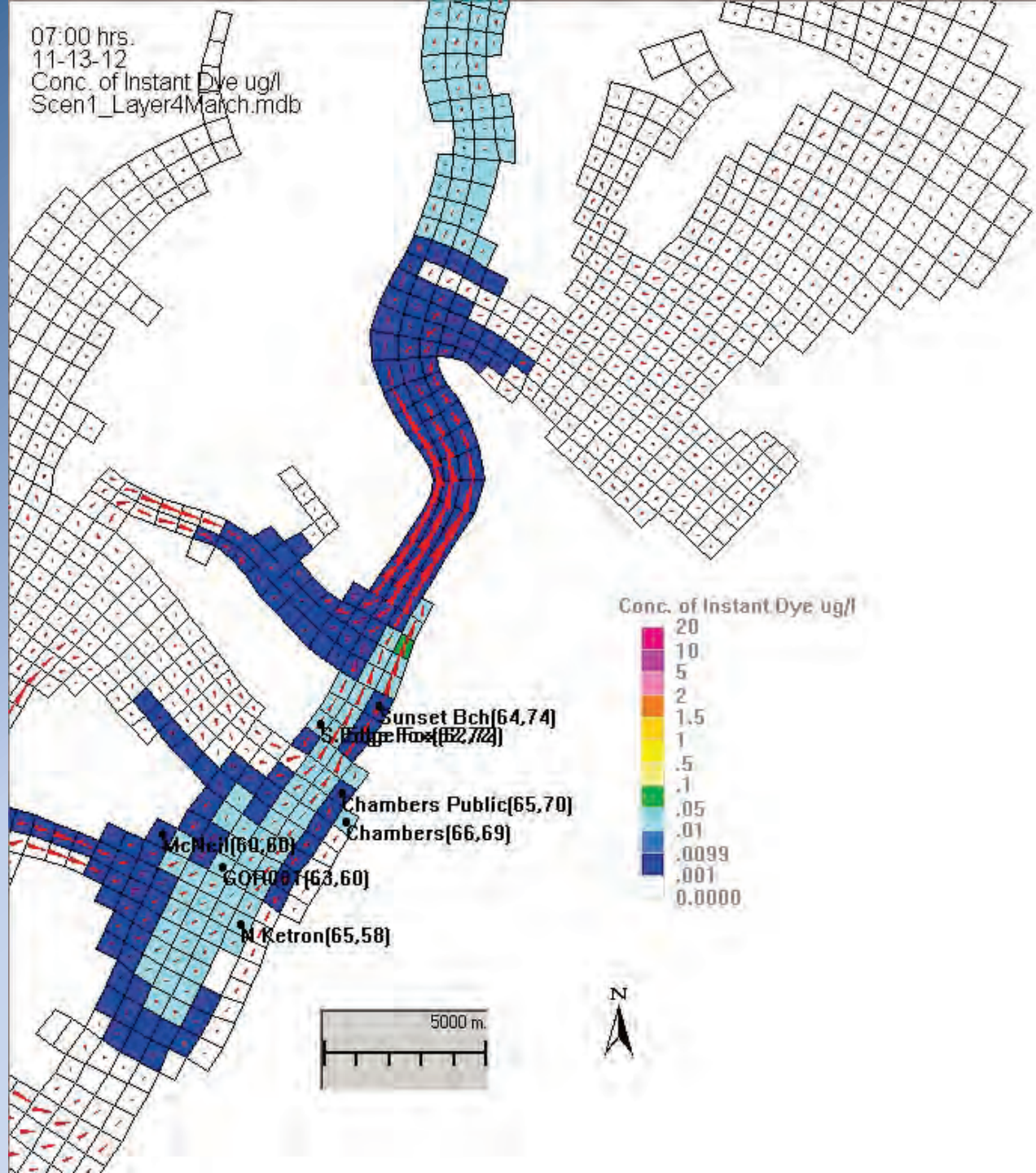


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7AM

07:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

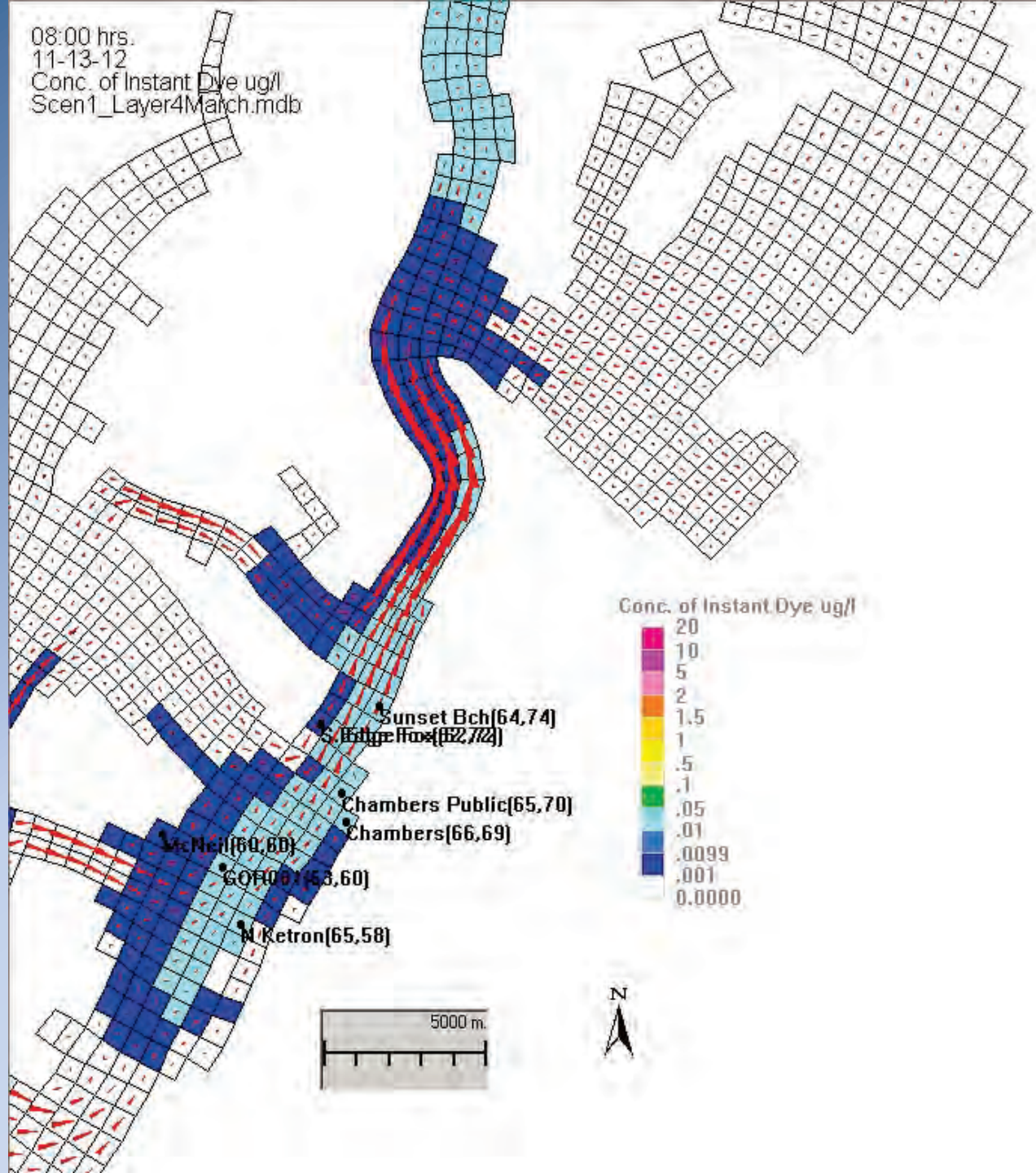


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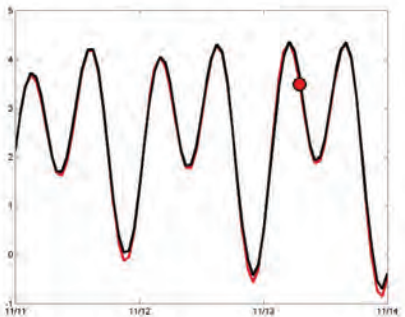
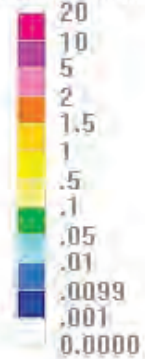


8AM

08:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

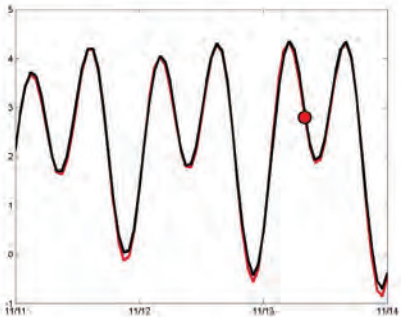
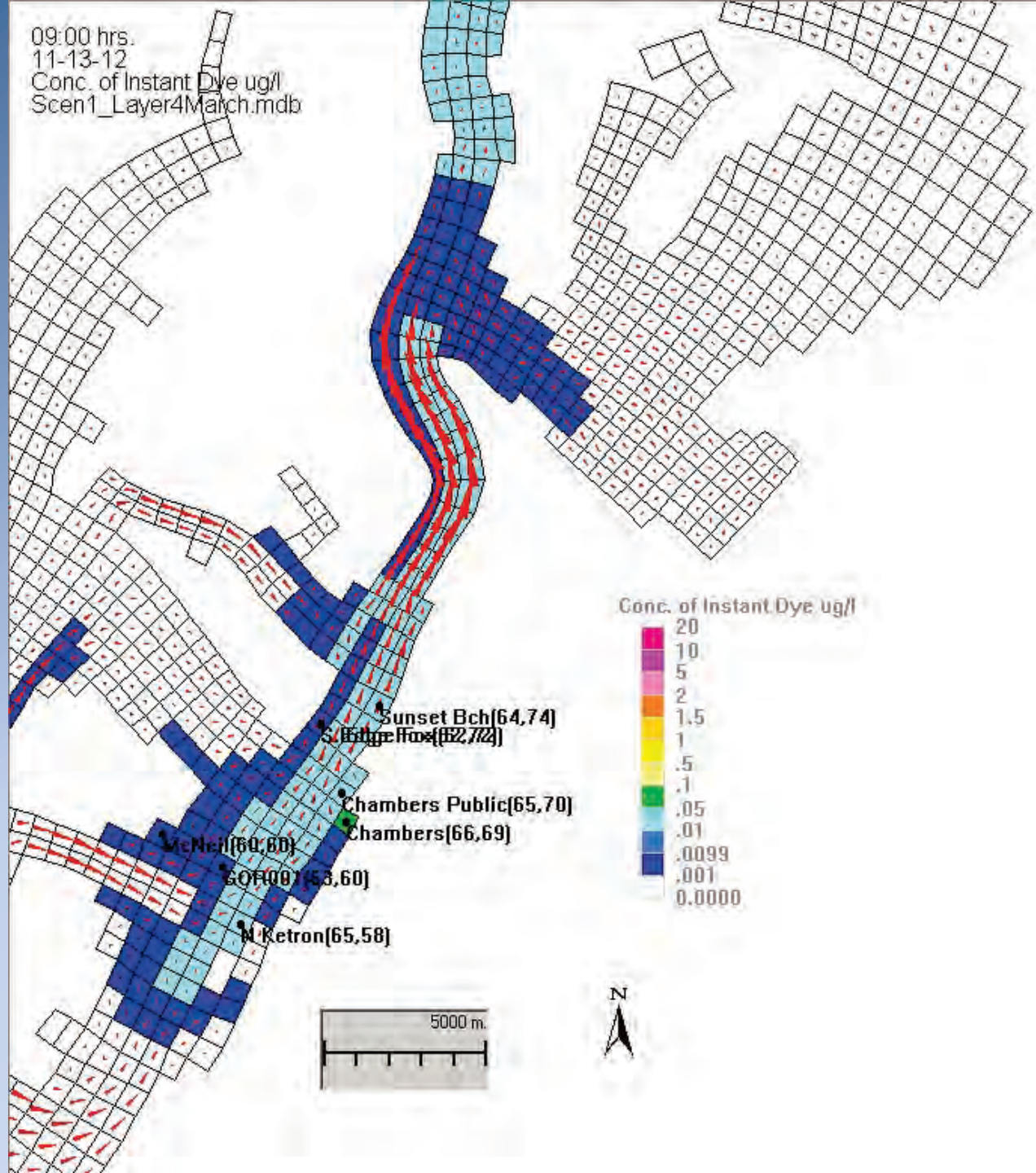


Nov
13



9AM

09:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

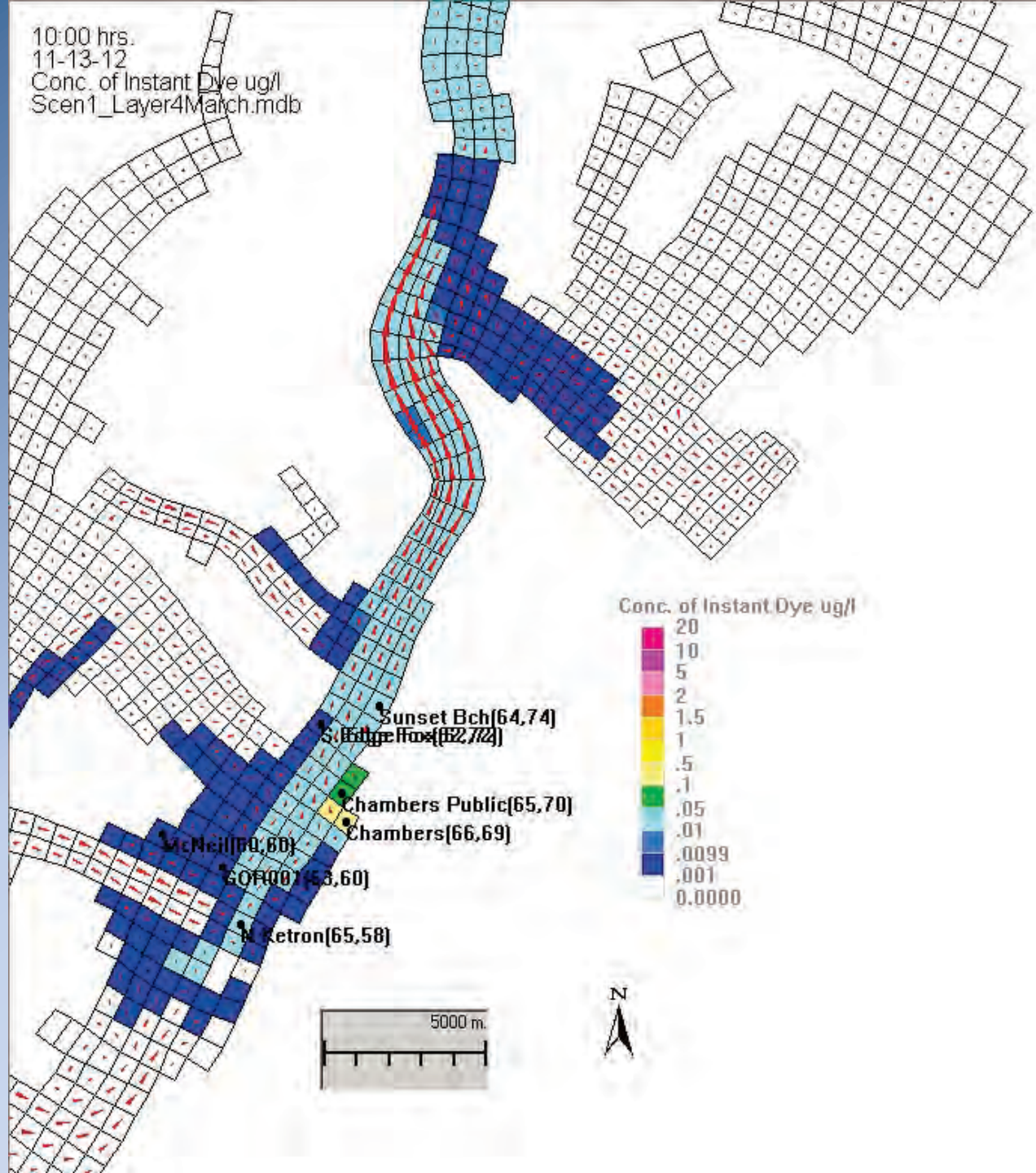


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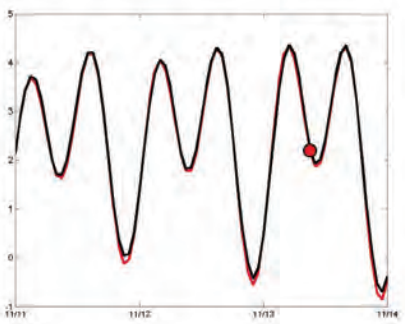
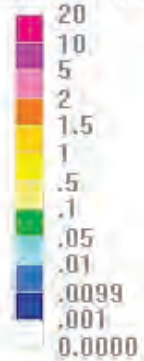


10AM

10:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

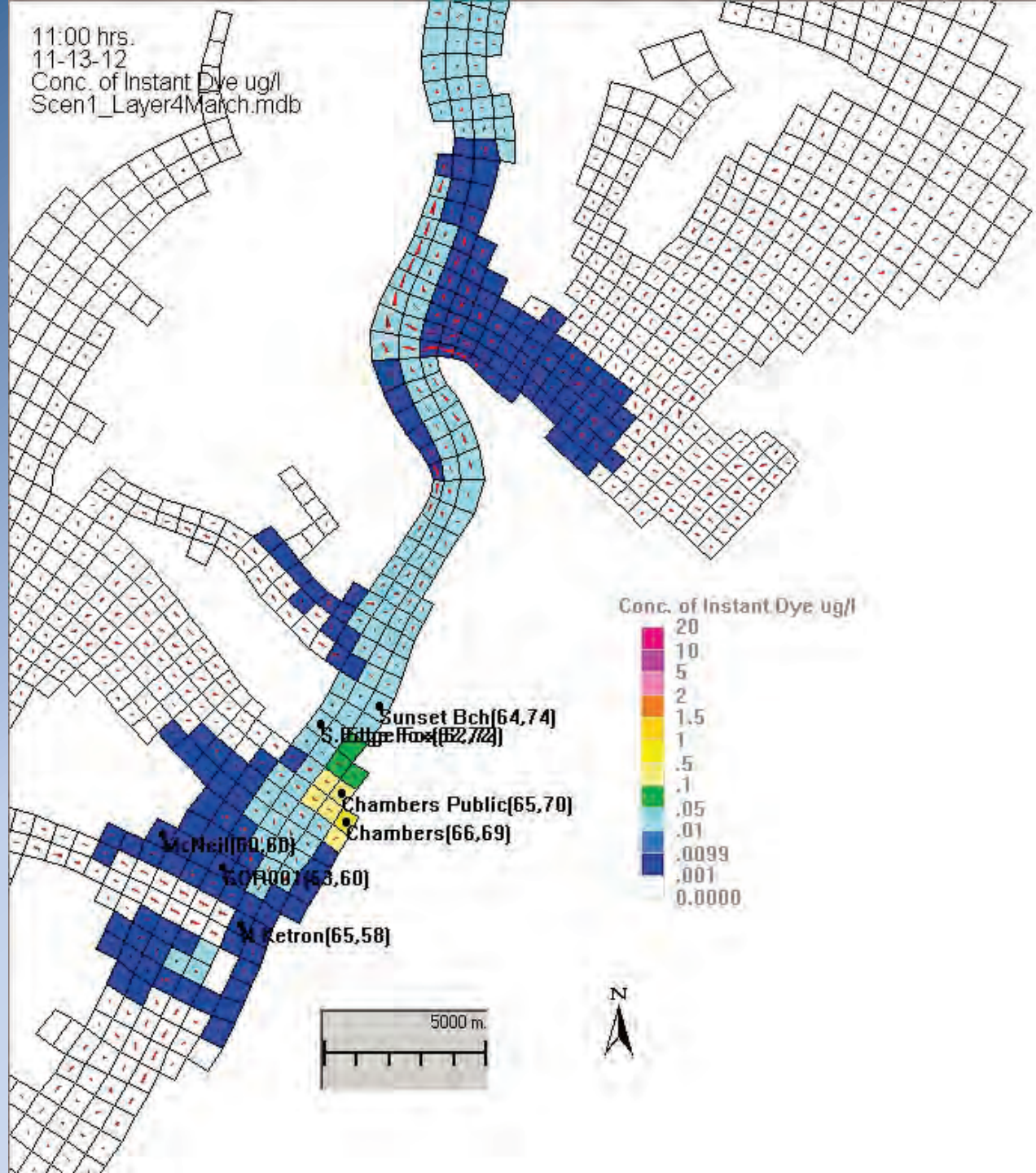


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13

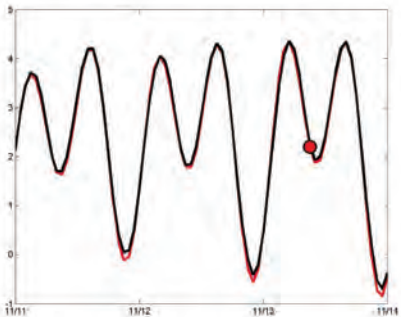
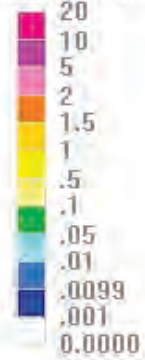


11AM

11:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

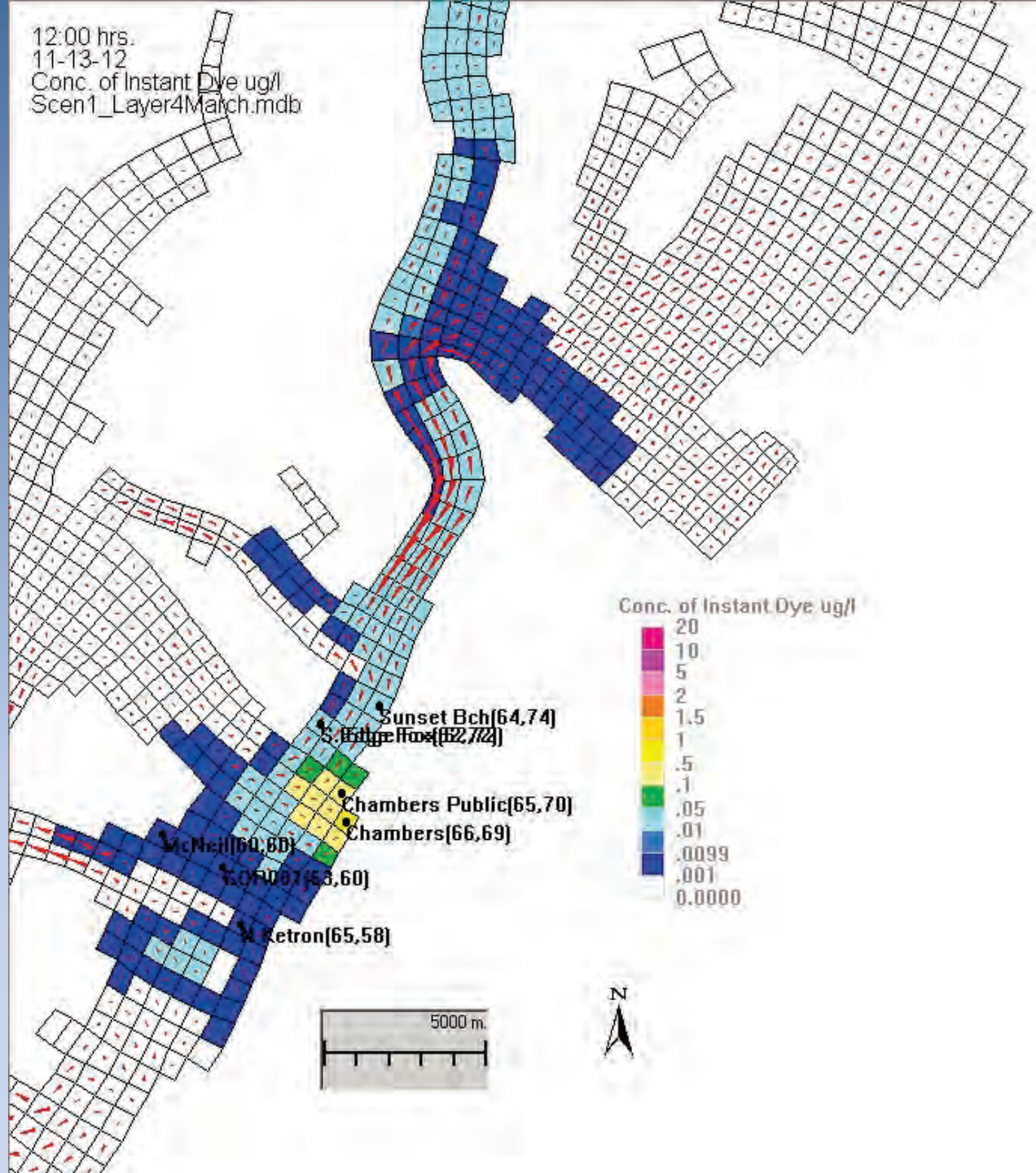


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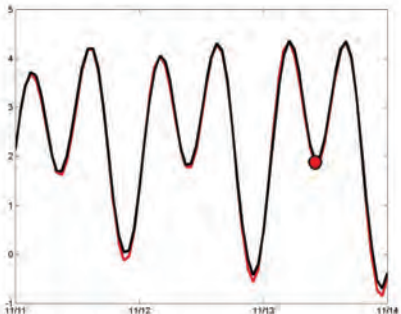
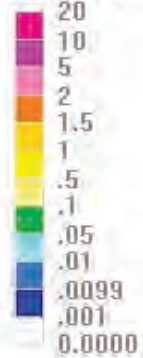


12PM

12:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb



Conc. of Instant Dye ug/l

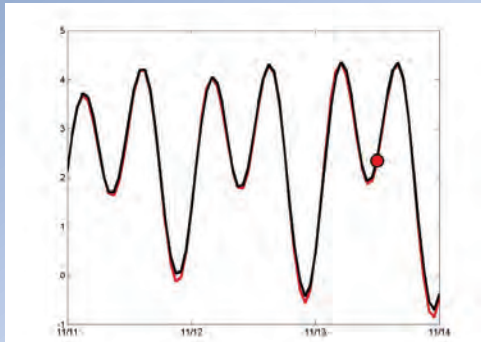
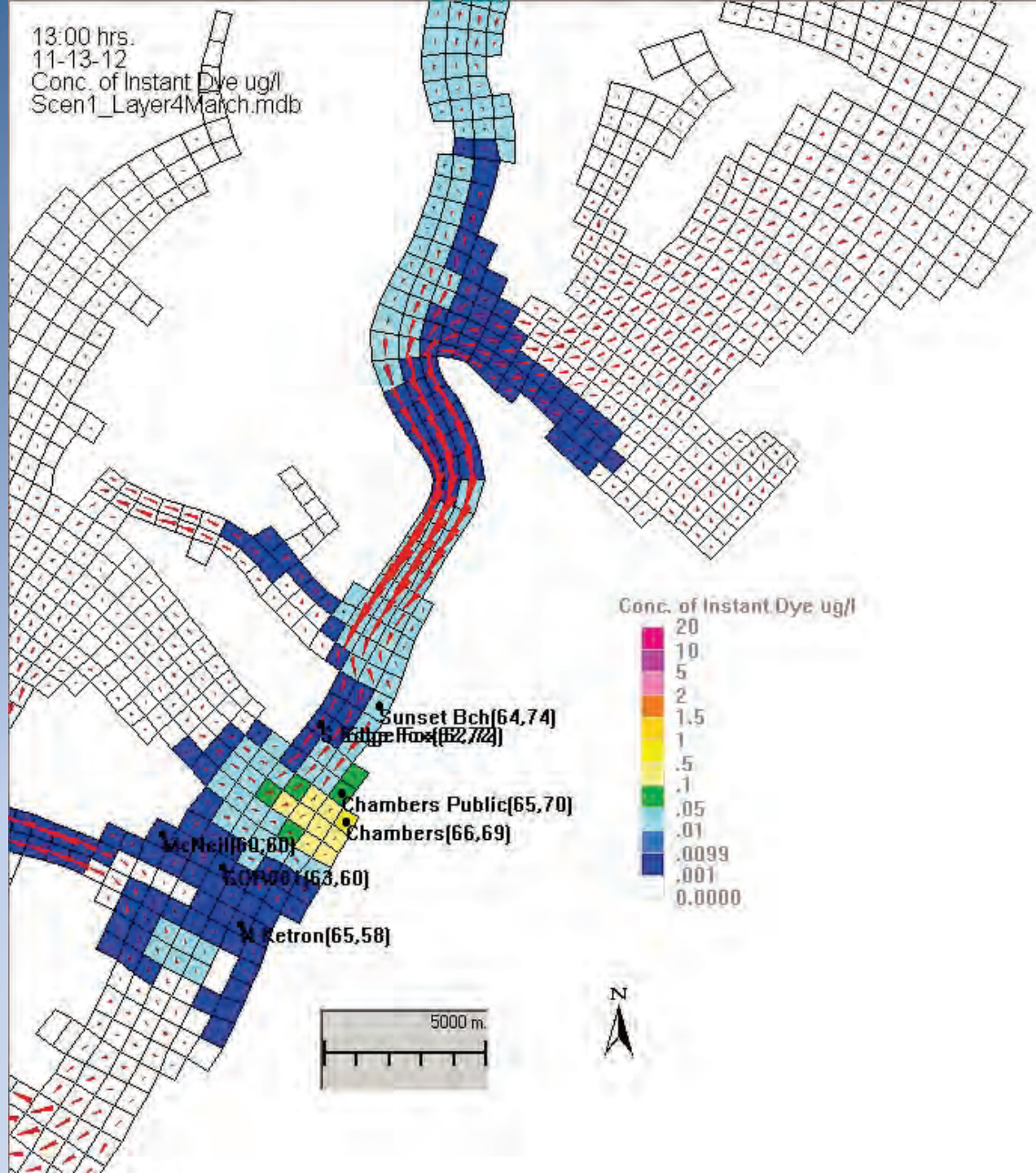


Nov
13



1PM

13:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

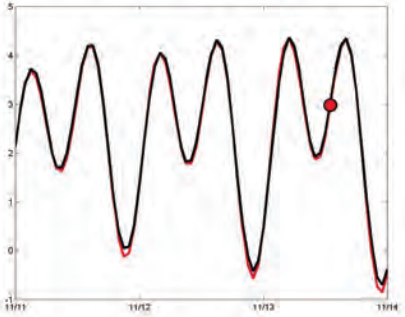
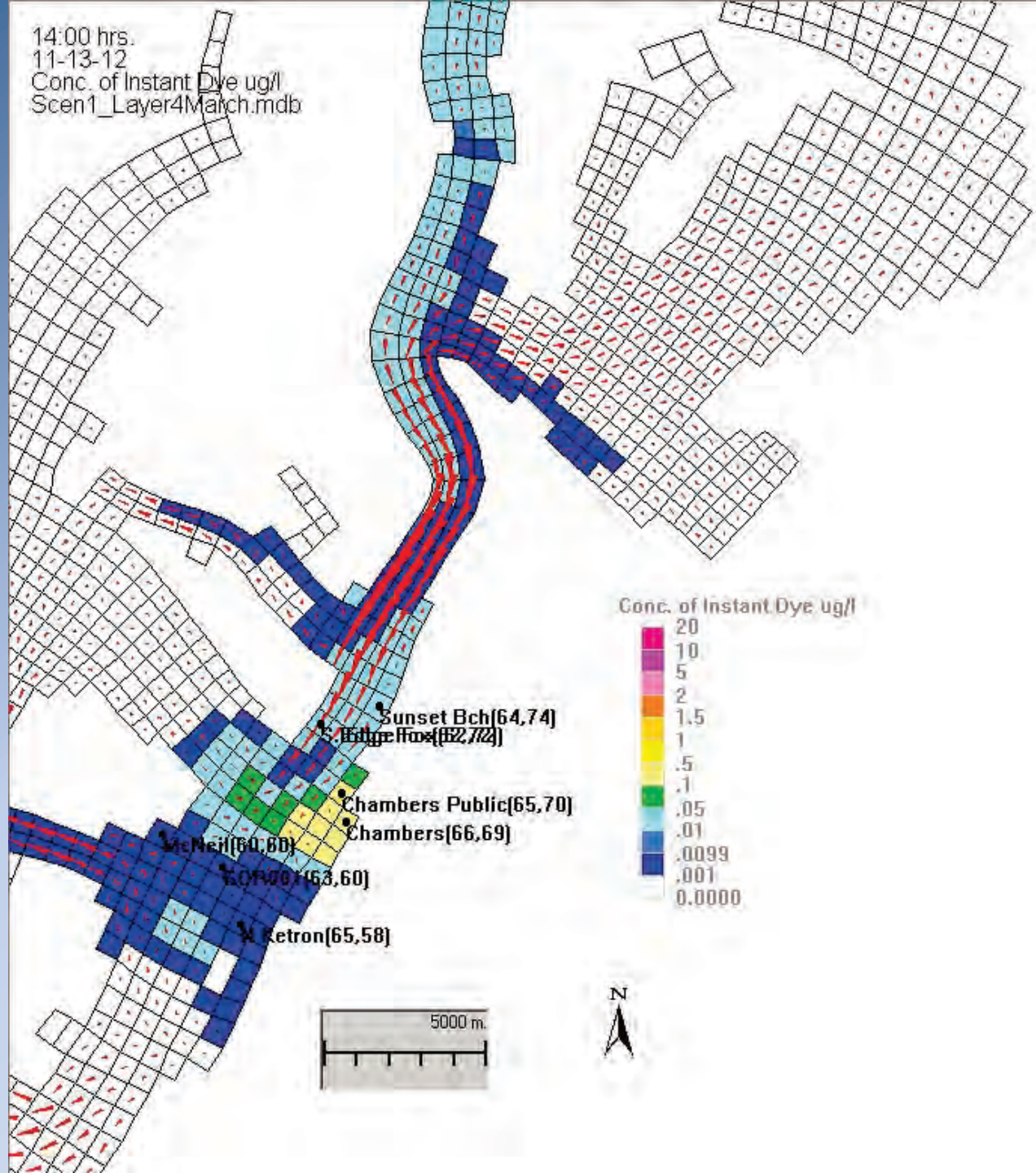


Nov
13



2PM

14:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

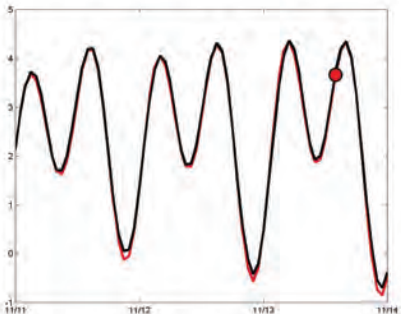
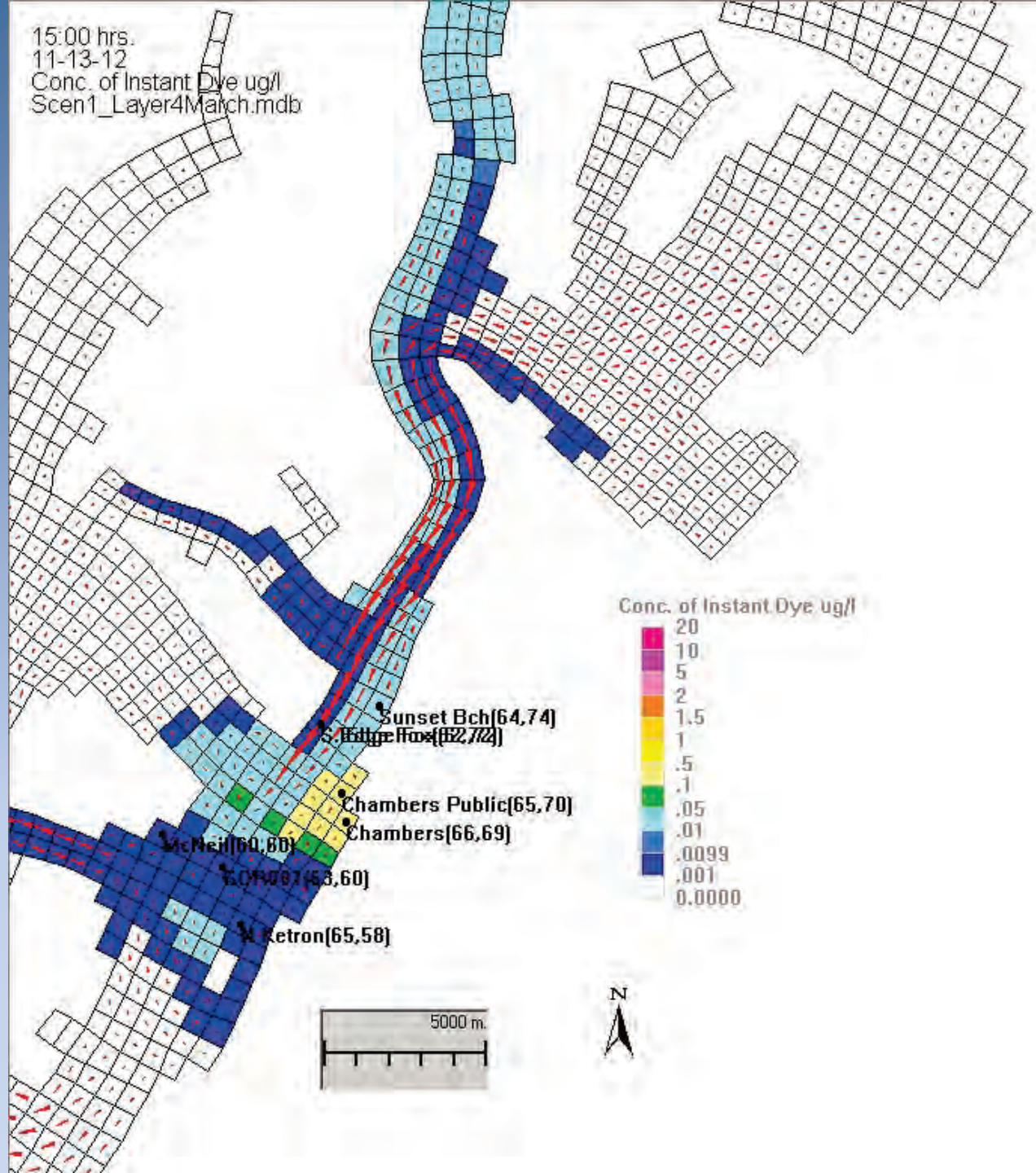


Nov
13



3PM

15:00 hrs.
11-13-12
Conc. of Instant Dye ug/l
Scen1_Layer4March.mdb

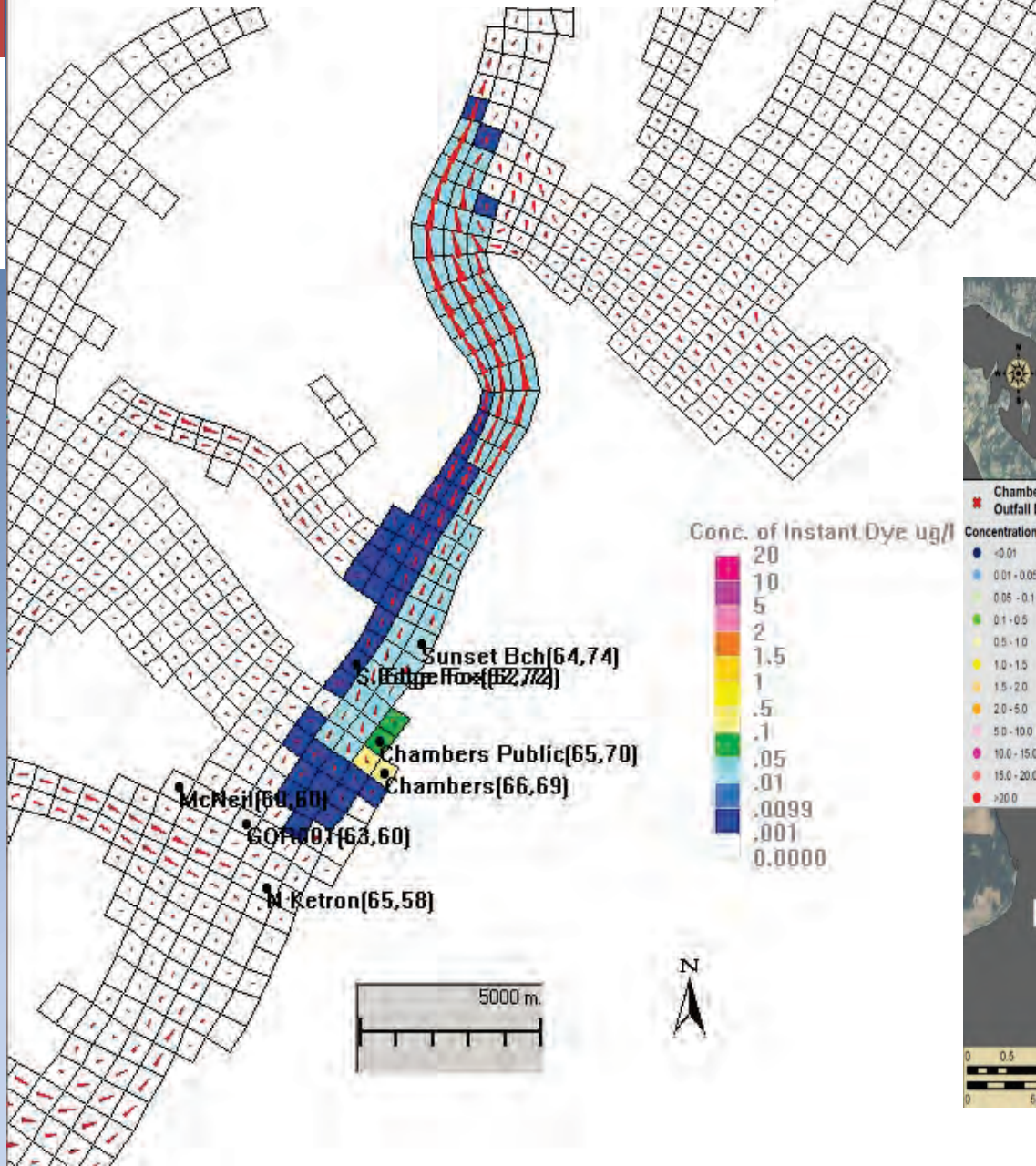
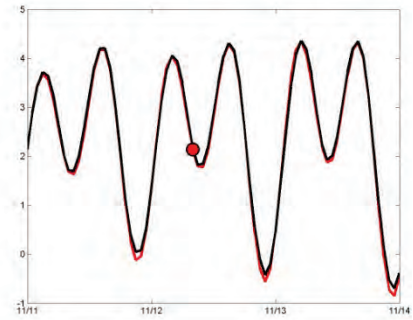


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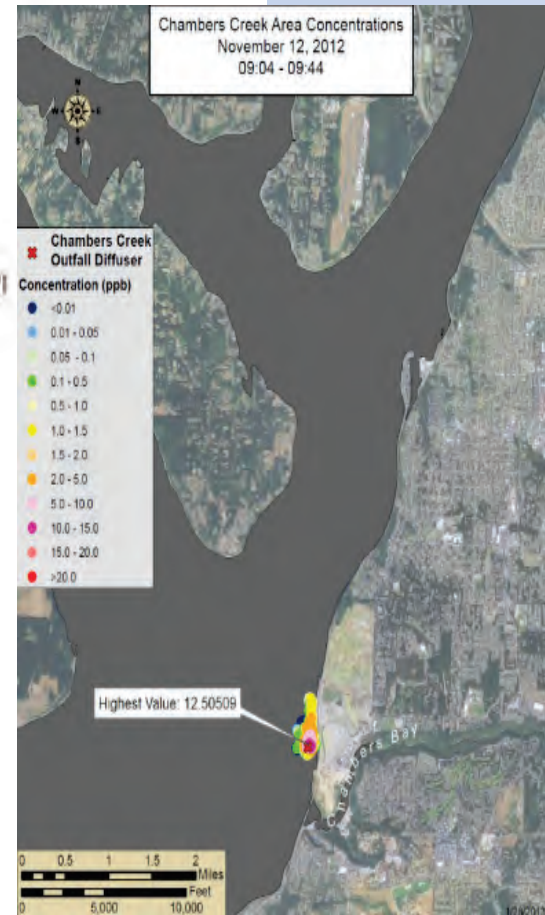
Model fills in gaps & what we cannot detect.



9AM



Minor Low Slack Tide

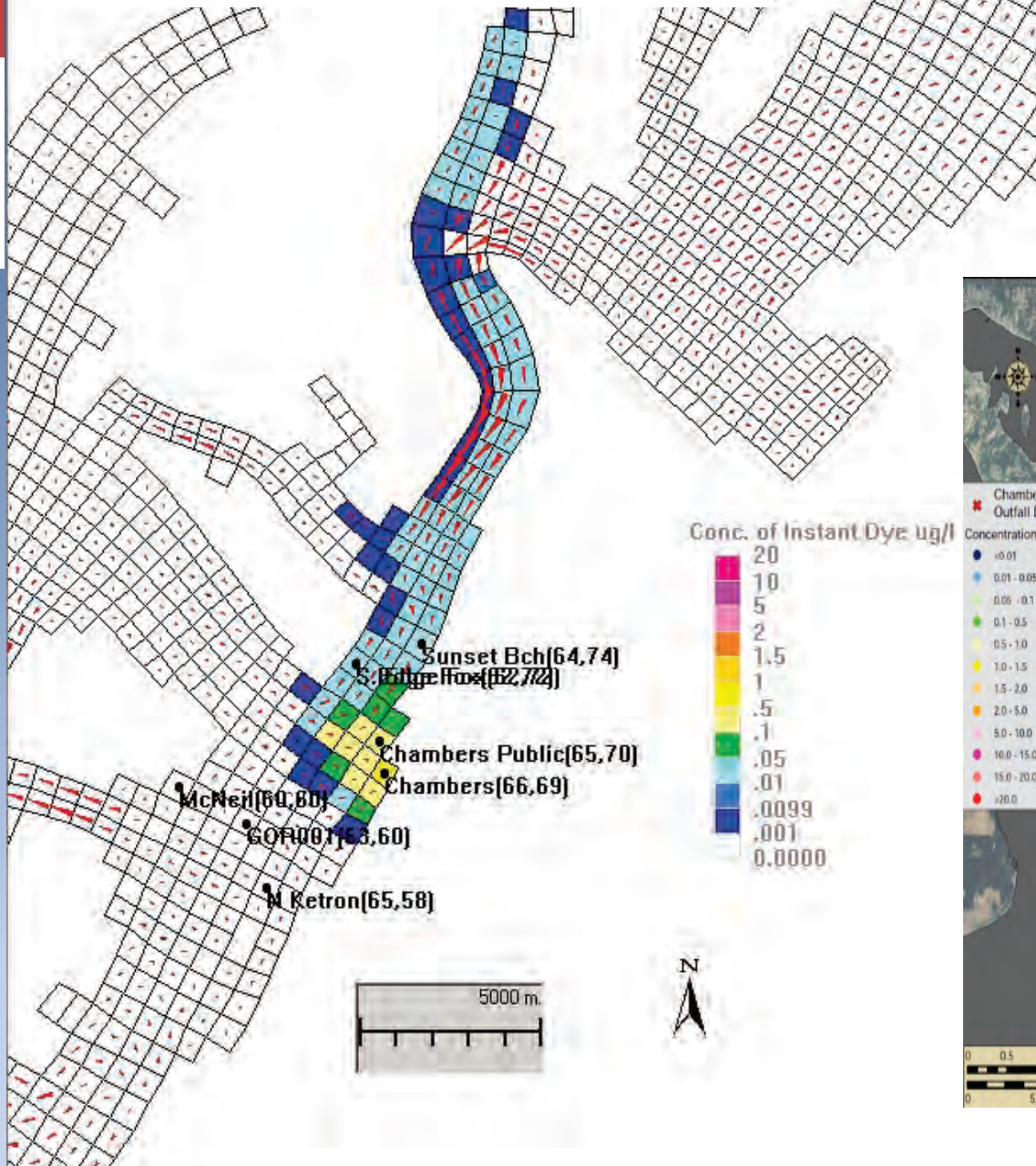
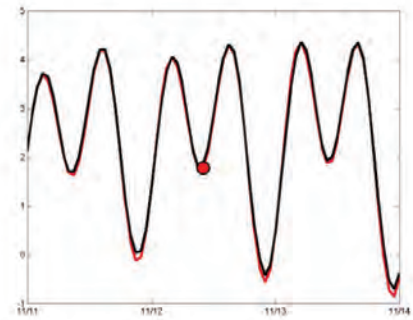


Nov 12

Model fills in gaps & what we cannot detect.

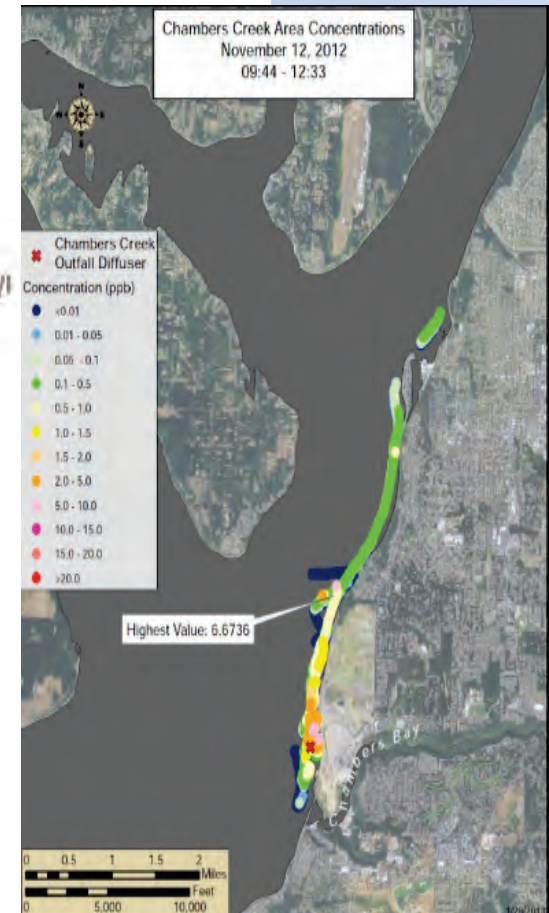
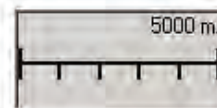
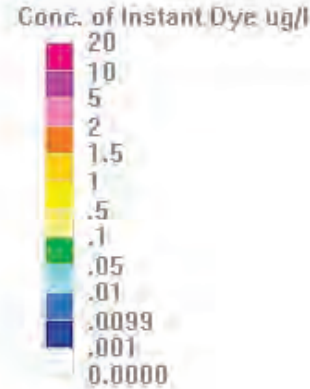


11AM



Beginning of Flood Tide

Sunset Bch(64,74)
S. Ridge Pkwy(65,72)
Chambers Public(65,70)
Chambers(66,69)
McNeil(60,60)
GORDON(66,60)
N Retron(65,58)

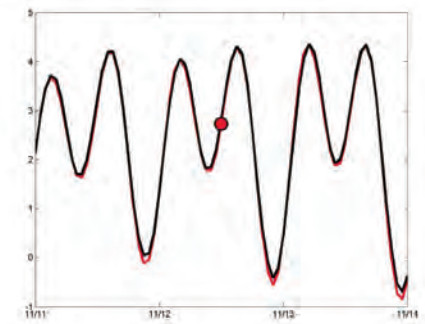
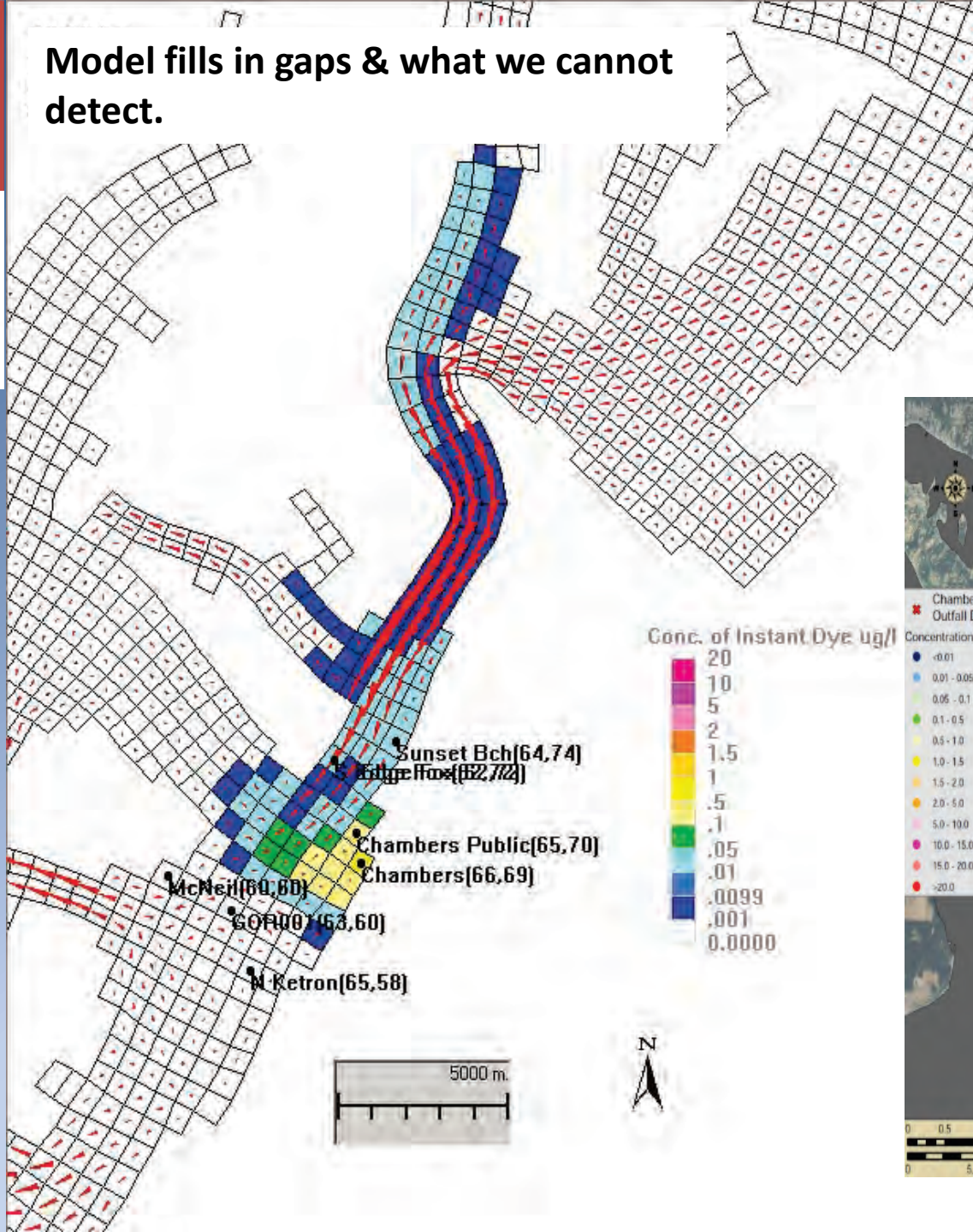


Nov 12

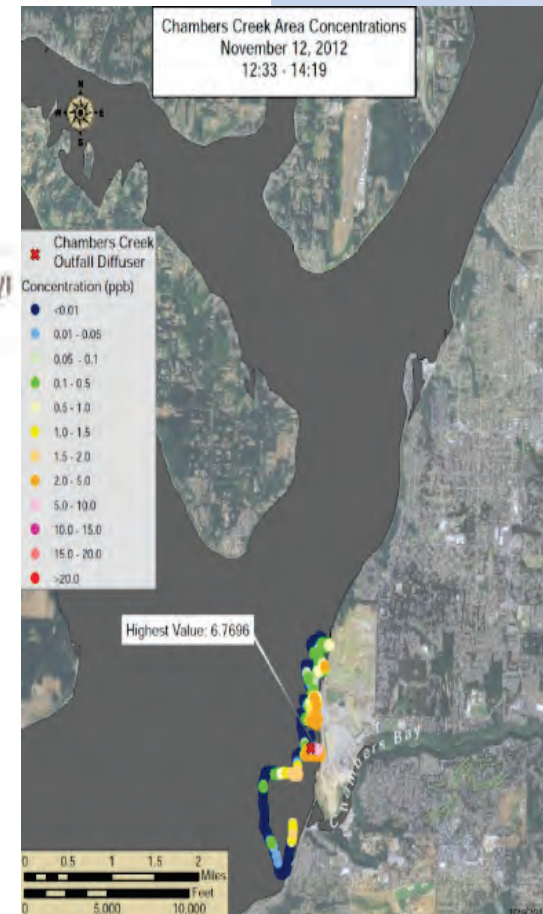
Model fills in gaps & what we cannot detect.



1PM



End of Flood Tide

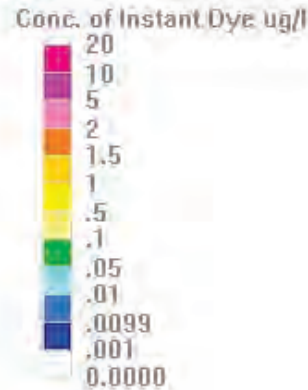
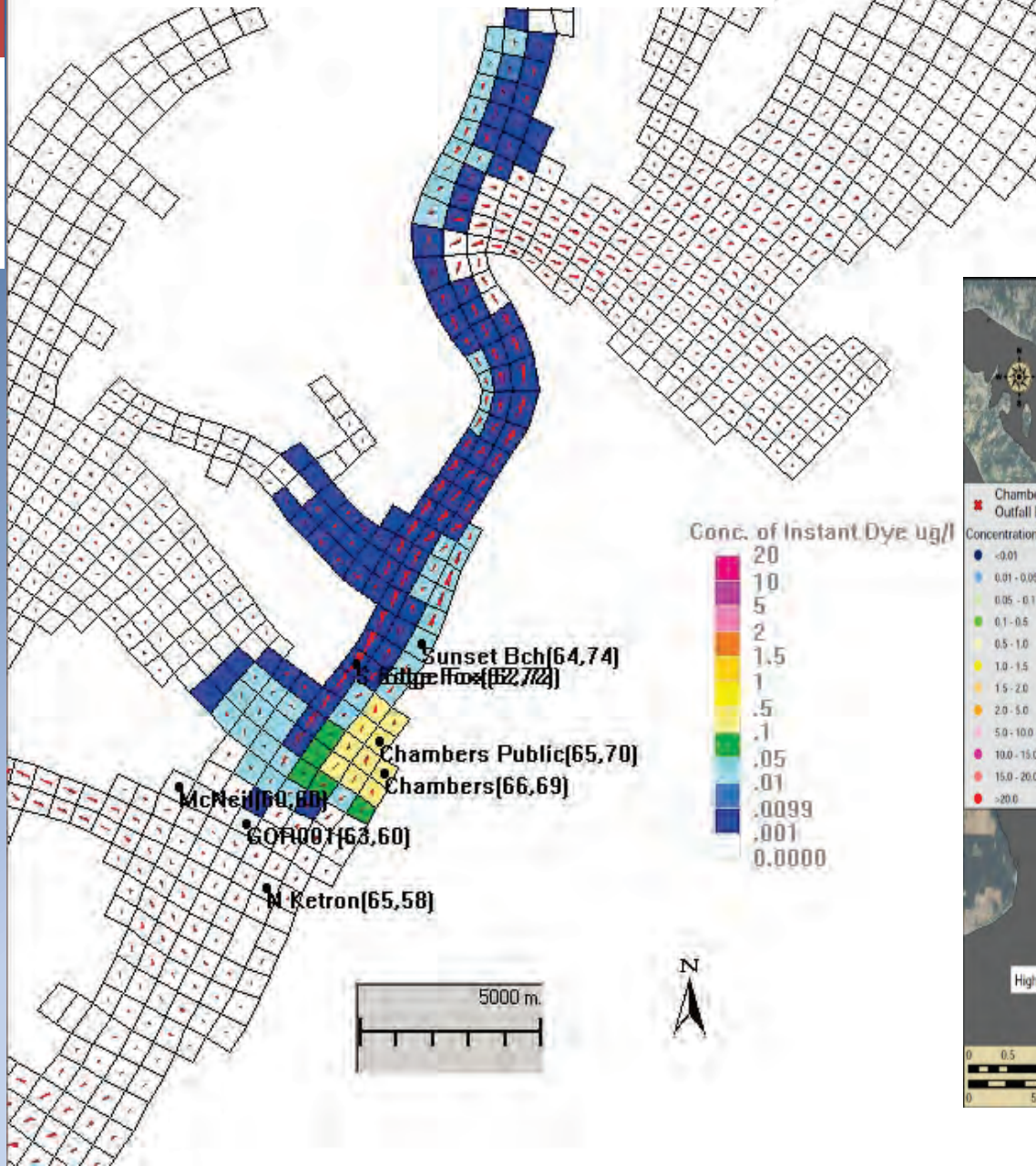
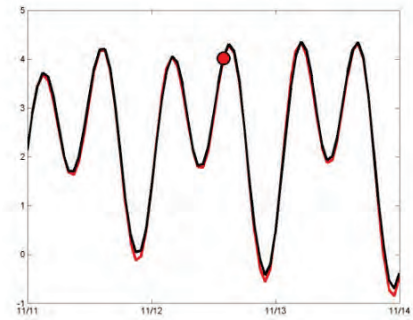


Nov 12

Model fills in gaps & what we cannot detect.



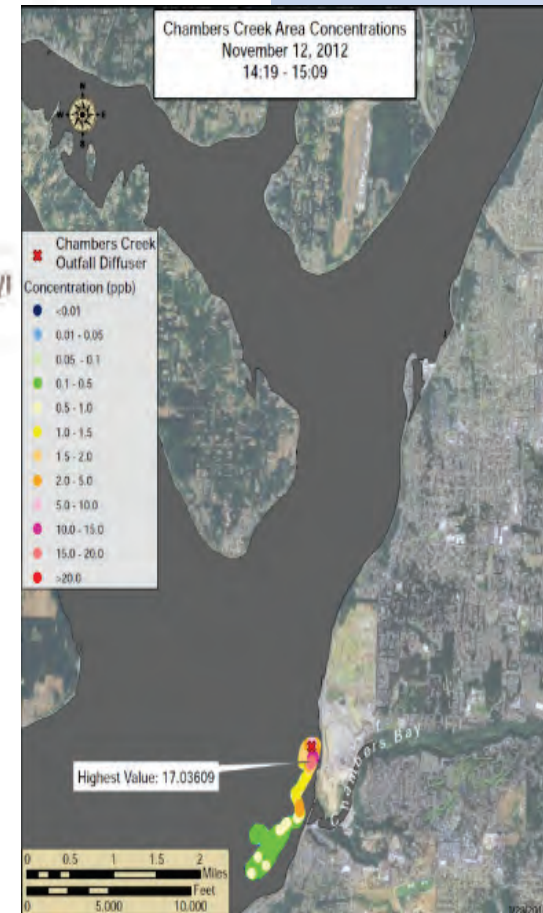
3PM



Sunset Bch(64,74)
Edge Fox(62,72)
Chambers Public(65,70)
Chambers(66,69)
McNeil(60,80)
GOF001(63,60)
N Retron(65,58)



Major High Slack Tide

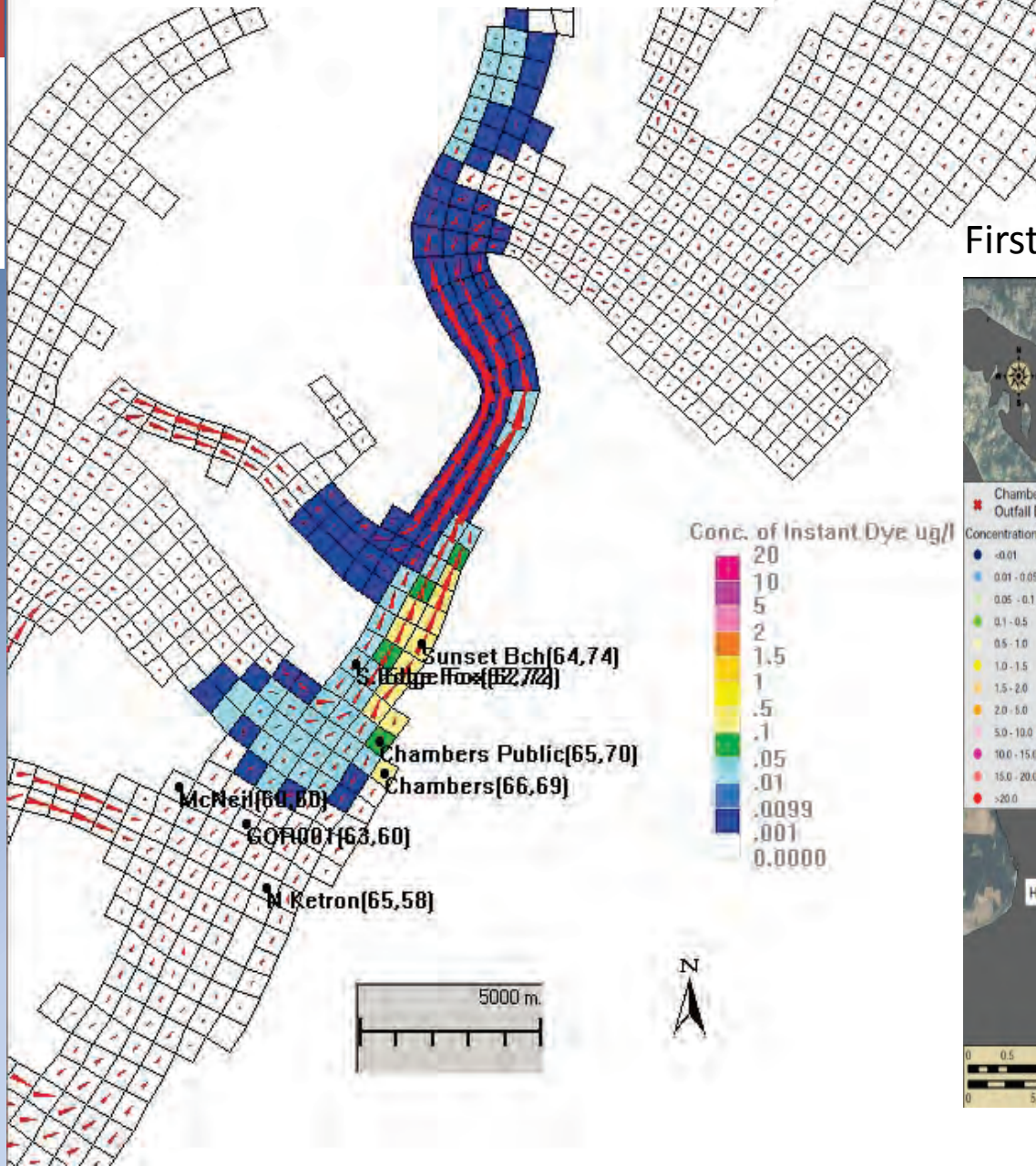
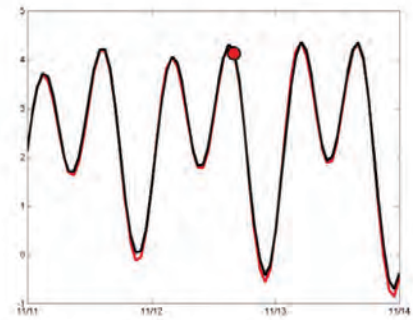


Nov 12

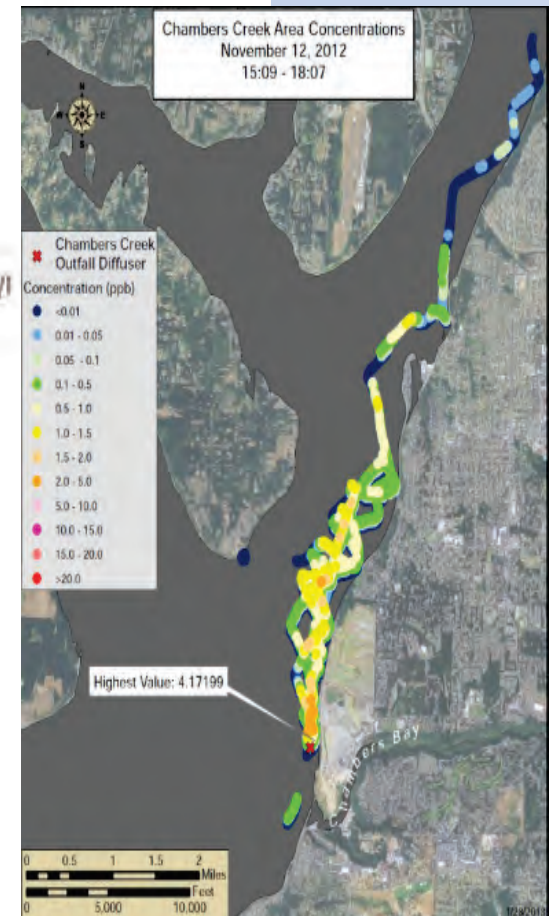
Model fills in gaps & what we cannot detect.



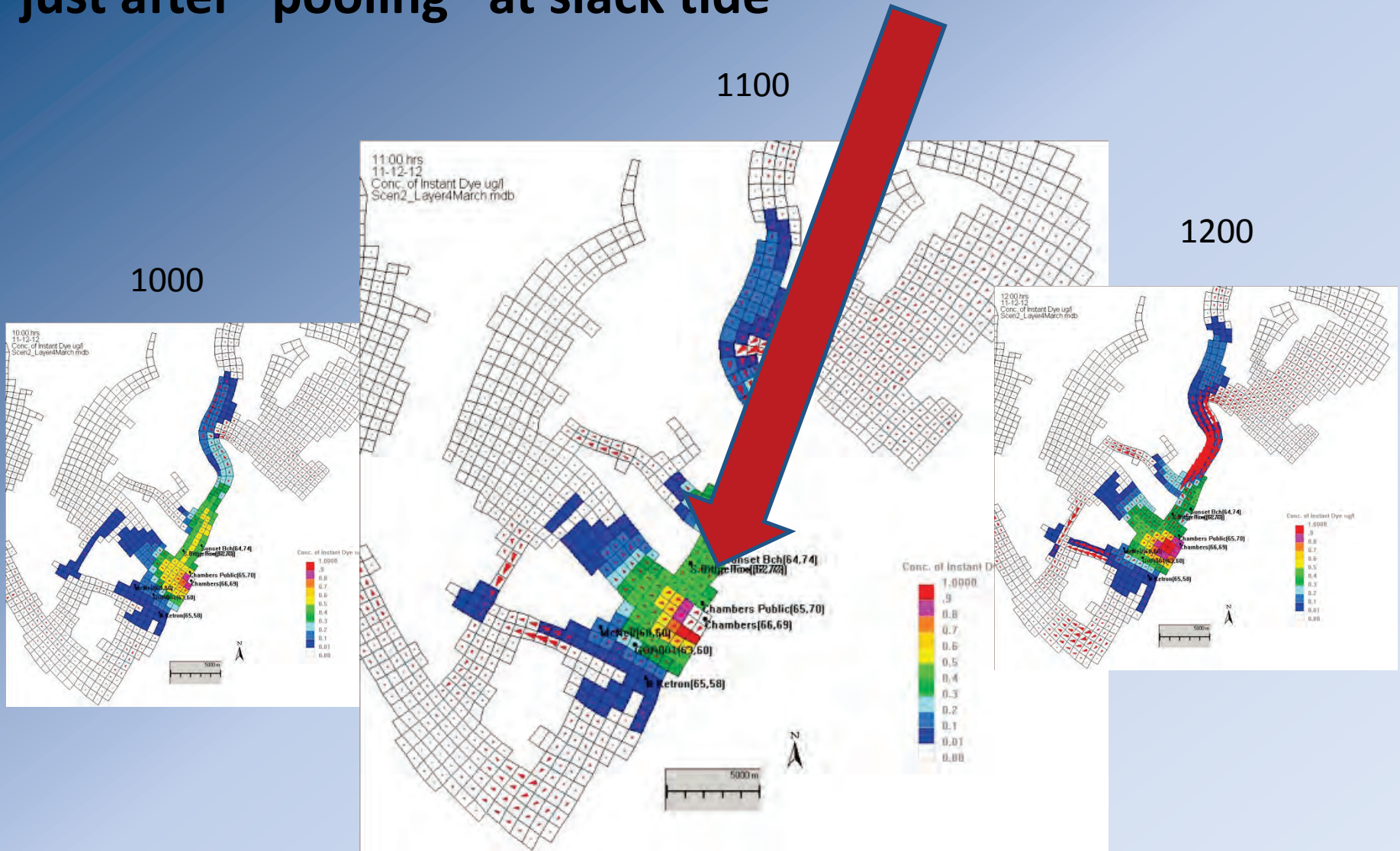
5PM



First part of Major Ebb Tide

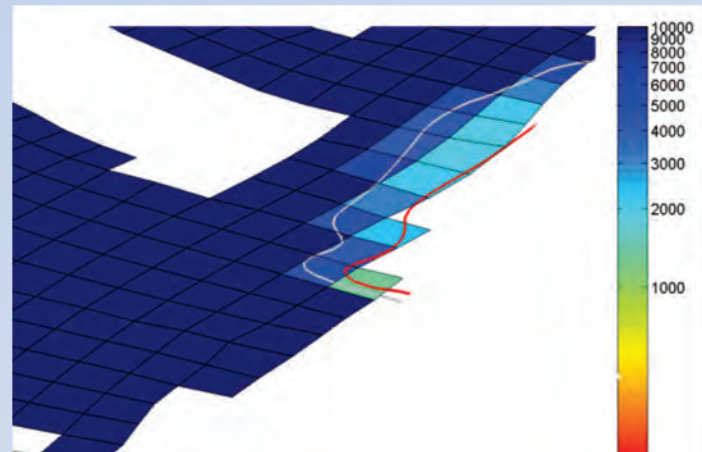
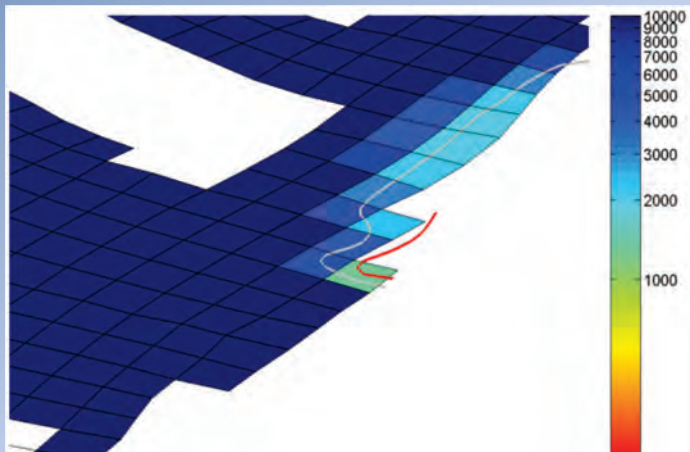
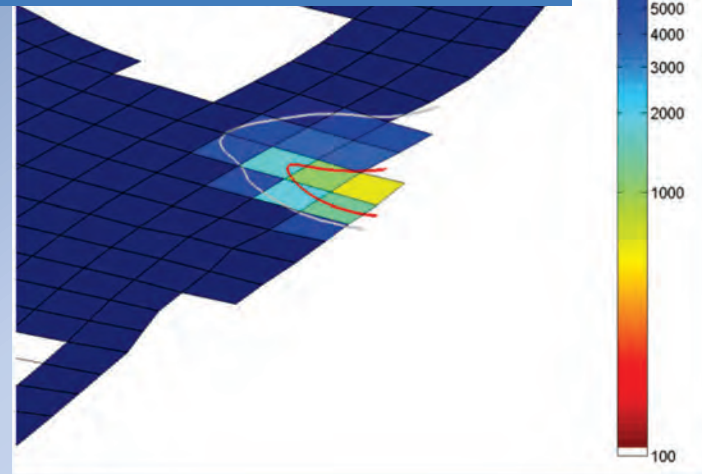


Minimum dilution, “Worst case for water quality” occurs just after “pooling” at slack tide



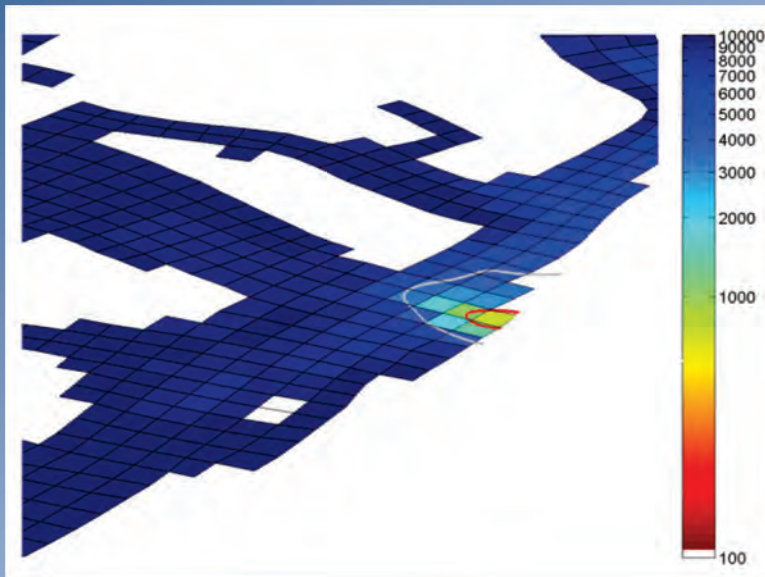
Worst-case minimum dilution ratios

low slack surface layer, day-long injection, worst-case for the southern line

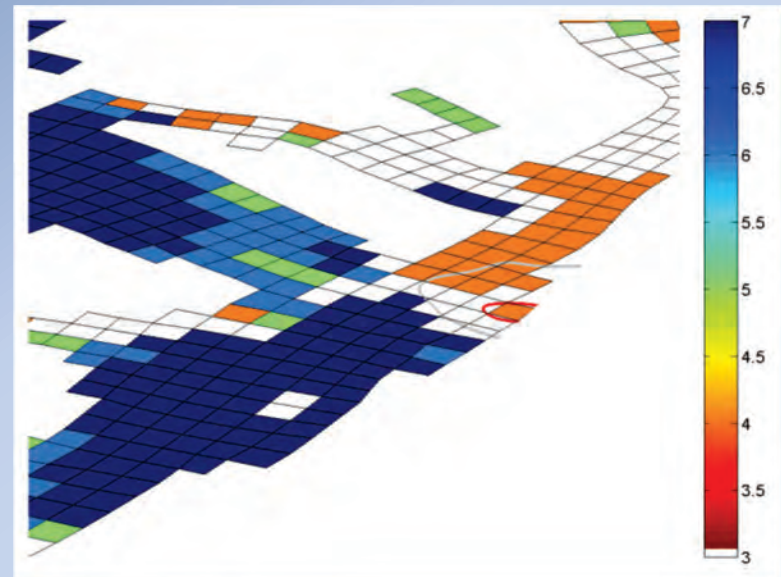


high slack surface layer, day-long injection, worst-case for the northern line

Steady-State (~ 5mos of injection)



**Minimum dilution ratio
(over all depths)**



Layer (depth) occurring

low slack tide, worst case all layers, 5-month injection

Summary Points

- Worst-case discharge in surface layers near Chambers Creek showing net motion exiting north through Tacoma Narrows along eastern shoreline.
- Refluxed dye worst at depth.
- Deep dye is below depths of geoducks, or so dilute that it doesn't pose a problem of and by itself, but what about cumulative effect of all the other sources?
- Fecal coliform bacteria decay with time, model dye tracer lasts forever... steady-state is reached over flushing time of South Puget Sound (~60 days).