Appendix 4A

Attachment 4: DSM2 PTM Documentation

4A-4.1 Introduction

Particle tracking models (PTM) are excellent tools to visualize and summarize the impacts of modified hydrodynamics in the Delta. These tools can simulate the movement of passive particles or particles with behavior representing either larval or adult fish through the Delta. The PTM tools can provide important information relating hydrodynamic results to the analysis needs of biologists that are essential in assessing the impacts to the habitat in the Delta.

4A-4.2 DSM2-PTM

DSM2-PTM simulates pseudo-3-D transport of neutrally buoyant particles based on the flow field simulated by HYDRO. The PTM module simulates the transport and fate of individual particles traveling throughout the Delta. The model uses geometry files, velocity, flow, and stage output from the HYDRO module to monitor the location of each individual particle using assumed vertical and lateral velocity profiles and specified random movement to simulate mixing. The location of a particle in a channel is determined as the distance from the downstream end of the channel segment (x), the distance from the centerline of the channel (y), and the distance above the channel bottom (z). PTM has multiple applications ranging from visualization of flow patterns to simulation of discrete organisms such as fish eggs and larvae.

The longitudinal distance traveled by a particle is determined from a combination of the lateral and vertical velocity profiles in each channel. The transverse velocity profile simulates the effects of channel shear that occurs along the sides of a channel. The result is varying velocities across the width of the channel. The average cross-sectional velocity is multiplied by a factor based on the particle's transverse location in the channel. The model uses a fourth-order polynomial to represent the velocity profile. The vertical velocity profile shows that particles located near the bottom of the channel move more slowly than particles located near the surface. The model uses the Von Karman logarithmic profile to create the velocity profile. Particles also move because of random mixing. The mixing rates (i.e., distances) are a function of the water depth and the velocity in the channel. High velocities and deeper water result in greater mixing.

At a junction the path of a particle is determined randomly based on the proportion of flow. The proportion of flow determines the probability of movement into each reach. A random number based on this determined probability then determines where the particle will go. A particle that moves into an open water area, such as a reservoir, no longer retains its position information. A DSM2 open water area is considered a fully mixed reactor. The path out of the open water area is a decision based on the volume in the open water area, the time step, and the flow out of the area. At the beginning of a time step the volume of the open water area the volume of water leaving at each opening of the open water area is determined. From that the probability of the particle leaving the open water area is calculated. Particles entering exports or agricultural diversions are considered "lost" from the system. Their final destination is recorded. Once particles pass the Martinez boundary, they have no opportunity to return to the Delta (Smith 1998; Wilbur 2001; Miller 2002).

4A-4.3 DSM2-PTM Metrics

Fate Mapping is an indicator of entrainment. It is the percent of particles that go past various exit points in the system at the end of a given number of days after insertion.

4A-4.4 PTM Period selection

PTM simulation periods for the fate computations were in January through June of the entire 100-year planning simulation period.

4A-4.5 PTM simulations

PTM simulations are performed to derive the metrics described above. The particles are inserted at the 39 locations listed in Table 4A-4-1. The locations were identified based on the 20-mm Delta Smelt Survey Stations. 20-mm Deta Smelt Survey Stations and particle insertion locations are display in Figure 4A-4-1.

A total of 39 PTM simulations are performed in a batch mode for each insertion period. For each insertion period, 4,000 particles are inserted at the identified locations over a 24.75-hour period, starting on the first of the selected month. The fate of the inserted particles is tracked continuously over a 92-day simulation period. The particle flux is tracked at the key exit locations—exports, Delta agricultural intakes, past Chipps Island, to Suisun Marsh and past Martinez and at several internal tracking locations. Generally, the fate of particles at the end of 30 days and 90 days after insertion is computed for the fate mapping analysis.

Table 4A-4-1. List of Particle Insertion Locations for Fate Computations

Location	DSM2 Node
San Joaquin River at Vernalis	1
San Joaquin River at Mossdale	7
San Joaquin River D/S of Rough and Ready Island	21
San Joaquin River at Buckley Cove	25
San Joaquin River near Medford Island	34
San Joaquin River at Potato Slough	39
San Joaquin River at Twitchell Island	41
Old River near Victoria Canal	75
Old River at Railroad Cut	86
Old River near Quimby Island	99
Middle River at Victoria Canal	113
Middle River u/s of Mildred Island	145
Grant Line Canal	174
Frank's Tract East	232

Location	DSM2 Node
Threemile Slough	240
Little Potato Slough	249
Mokelumne River d/s of Cosumnes confluence	258
South Fork Mokelumne	261
Mokelumne River d/s of Georgiana confluence	272
North Fork Mokelumne	281
Georgiana Slough	291
Miner Slough	307
Sacramento Deep Water Ship Channel	314
Cache Slough at Shag Slough	321
Cache Slough at Liberty Island	323
Lindsey slough at Barker Slough	322
Sacramento River at Sacramento	330
Sacramento River at Sutter Slough	339
Sacramento River at Ryde	344
Sacramento River near Cache Slough confluence	350
Sacramento River at Rio Vista	351
Sacramento River d/s of Decker Island	353
Sacramento River at Sherman Lake	354
Sacramento River at Port Chicago	359
Montezuma Slough at Head	418
Montezuma Slough at Suisun Slough	428
San Joaquin River d/s of Dutch Slough	461
Sacramento River at Pittsburg	465
San Joaquin River near Jersey Point	469

4A-4.6 Output Parameters

The PTM can be used to assist in understanding passive fate and transport, or through consideration of behavior or residence time. In, general the following outputs are generated:

- Fate of particles and cut lines or regions
- Time of travel breakthrough curves
- Residence time

For the purposes of this EIR, only particle fate outputs were assessed.

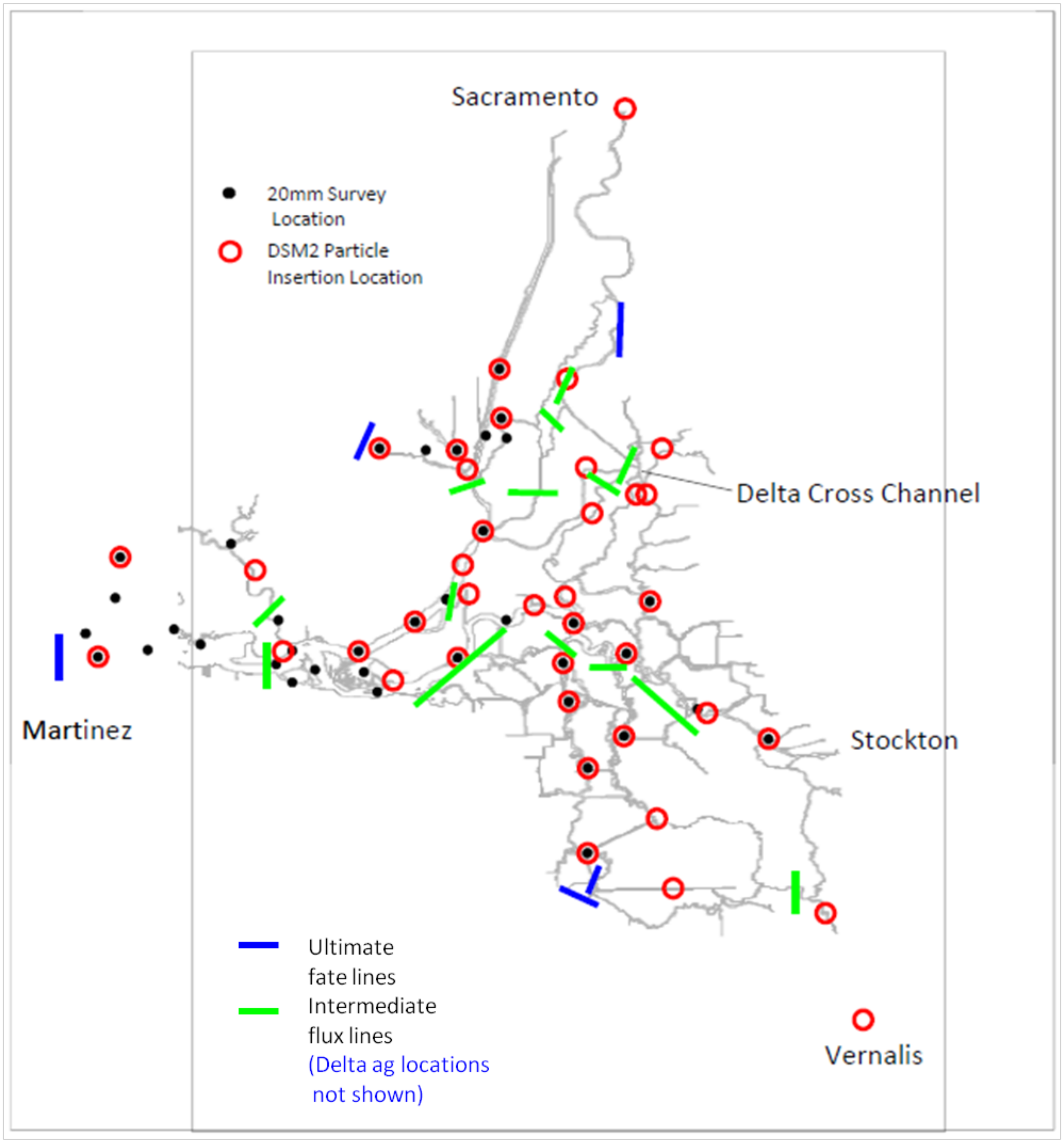

Figure 4A-4-1. Particle Insertion Locations for Fate Computations

4A-4.7 References

Miller, A. 2002. “Chapter 2: Particle Tracking Model Verification and Calibration.” Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 22nd Annual Progress Report to the State Water Resources Control Board. Sacramento, CA.

Smith, T. 1998. “Chapter 4: DSM2-PTM.” Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 22nd Annual Progress Report to the State Water Resources Control Board. Sacramento, CA.

Wilbur, R. 2001. “Chapter 4: Validation of Dispersion Using the Particle 13 Tracking Model in the Sacramento-San Joaquin Delta.” Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 22nd Annual Progress Report to the State Water Resources Control Board. Sacramento, CA.