

**FLUX FROM MANGROVE TIDAL CREEKS AT THE L-31E FRESHWATER
REDISTRIBUTION PILOT PROJECT SITE: BISCAYNE BAY, FLORIDA**

by

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ABSTRACT

Flux of major nutrient species (NH_3 , NO , NO_3 , TN , SRP , TP , TOC) and particulate organic carbon between two tidal creeks and Biscayne Bay was measured in December 1996 and April 1997. Two complete consecutive tidal cycles were measured (24.3 hr period) during each sampling period at two stations along both tidal creeks. Sampling stations are located near the mouths of the tidal creeks in the fringing red mangrove community and approximately 250 m inland near the boundary between the mixed mangrove and scrub mangrove communities.

In all cases, there was a net movement of water into the coastal mangrove ecosystem over two tidal cycles. In one case, December TS, a single tidal cycle had more water moving towards Biscayne Bay than landward. This case is explained by a combination of three factors: 1) the TS station is a topographic basin, 2) change in wind direction, and most importantly 3) the preceding tide was very high, moving water well into the basin, which did not all drain out during the following low tide.

Net movement of water landward is indicated by the coastal mangrove surface water and soil salinities. The flux of water landward is explained by several factors: 1) Evaporation of surface waters, 2) transpiration (water use by plants), 3) resaturation of soils, and 4) spring tide events.

Our results are based upon four tidal cycles during or close to spring tide for the two sampling periods. In addition, the most important aspect of calculating flux is also the least precise, that is, measuring water volumes. However, our methodologies were applied uniformly and some major differences documented. The major differences between the Dec and April flux is the result of the December tide range being higher than in April and incoming waters always being higher in December, than in April, in concentrations of TP , $\text{N} + \text{N}_\text{d}$ and NH_4 , while TOC concentrations were higher in April than in December. Considerably more water was exchanged in the Treatment Block than in the Control Block and nutrient concentrations were usually higher in the Control Block than in the Treatment Block. Finally, the volume of water exchanged was considerably higher at the fringe sites than the scrub sites.

In summary, we have documented that there is a net movement of Biscayne Bay water and water borne nutrients into the coastal wetlands. This is in contrast to most previous works in South Florida that report an average of $1.0 \text{ g/m}^2/\text{day}$ outwelling from coastal mangrove wetlands. We report influx of as high as $0.5 \text{ g/m}^2/\text{d}$ assuming that the incoming nutrients that are left behind are evenly spatially distributed. Three major reasons for import rather than export from the wetlands exists: 1) freshwater sheet flow has been eliminated, 2) The effects of Hurricane Andrew producing extreme loads of detritus and soil destabilization, and 3) nearshore waters that move into the wetlands with tidal action are composed of nutrient rich canal and groundwater.

INTRODUCTION

One of the pioneer works on mangrove distribution and relationship to coastal processes was completed in South Florida (Davis, 1943). However, the real importance of the mangrove ecosystem in estuarine processes was not recognized until the 1960's (Odum and Heald, 1964). Many workers in the two decades following Odum and Heald's description of nutrient outwelling from the mangrove ecosystem also documented nutrient outwelling from the mangroves and the value of the mangrove ecosystem as nursery grounds for numerous important sports and commercial fishers species.

However, a few observations also suggest that mangroves are an important nutrient sink operating on several time scales. Many flux studies have been based upon carbon budget models. As many problems as actual field measurements incur, the results must be at least as reliable as most modeling approaches can offer.

The major problem with flux studies is the application of the data to broader or larger scales than those measured. For example, we measured tidal flux only during high tide cycles when the most water was exchanged and the greatest area of adjacent mangrove forest is inundated. This increased the likely hood of the export of forest materials and influx of marine origin material. Most average tide days transport much less material and, in fact frequently do not ingress further inland than the interior stations and don't leave the tidal creek banks. Exchange during major rainfall and hurricane events have never been documented although they are probably responsible for the most movement of organic derived materials. In addition, no two tidal creek-watersheds are the same in drainage area, rainfall, or discharge and comparison from one tidal creek watershed to another is limited.

This experiment was designed to document the flux of material between Biscayne Bay and the lowest reach of the two tidal creeks with highly modified watersheds. Watershed impacts include the loss of most of the interior marshlands by development, loss of freshwater sheet flow, and Biscayne tidal waters being diluted with canal discharge waters. In addition, the exchange between the fringing mangrove community and the less productive interior scrub mangrove community will also be addressed.

The two tidal creeks are located in the control and treatment blocks of the L-31 E freshwater rediversion pilot project. The purpose of this project is to determine the feasibility of reestablishing sheet flow to Biscayne Bay through the mangroves in a natural like manner with the objects of reestablishing a more permanent brackish water estuarine zone along the coast and to tertiary treat some of the canal water prior to reaching the Bay. The observations reported here are results prior to freshwater diversion. The purpose of this study is to document the present flux rate of important nutrient species and types of organic mater in order to establish a baseline for determining the effects of freshwater rediversion on the flux rates of nutrient species between the mangroves and Bay.

METHODS

Study area.-

Location. Two tidal creek basins on the western shore of Biscayne Bay between the Military and Mowry Canals were selected for study (Figure 1). The mouth of the upper (freshwater) portions of both of these tidal creek basins were cut off by the construction of the L-31 E storm protection levee which ranges from 620 to 700 m from the Biscayne Bay shoreline. The control tidal creek originally reached much further westward than did the treatment tidal creek and merged with a freshwater slough that ran inland for several miles. The treatment tidal creek reaches inland only 320 m. The major topographic features of the two tidal creek basins are compared (Figure 1). The major difference between the two sites is that the control site is slightly higher in elevation, has a much smaller interior basin than the treatment site, and is dominated by the large single surface drainage feature. The treatment site interior is dominated by a scrub mangrove topographic basin.

Vegetation. The dominant plant associations in both sites are the: 1) coastal red mangrove fringe, 2) mixed forest, and 3) scrub mangrove. The coastal area was severely impacted by Hurricane Andrew in 1992 with major tree mortality in the mixed and fringe forest and little recognized mortality in the scrub mangrove habitat. The major difference between the vegetation of the two sites is the much larger area of scrub mangrove habitat (approximately one half of the 25 hectare site) in the treatment site which corresponds to the interior topographic basin.

Site history. The width of the mangrove zone along this part of the coastline was considerably less than at present (Meeder et al 1996). The rate of mangrove expansion westward increased at the beginning of this century associated with coastal drainage for the recovery of farm land and mosquito control. By the 1930's salt water encroachment became a problem and water control structures were completed in the 1950-60's. A second major saltwater encroachment event occurred in the decade following the construction of the L-31E levee (1965-1975) which terminated with salt water encroachment to the foot of the levee. Associated with this increased salinity regime was the loss of freshwater sheet flow and change in vegetation from *Eleocharis* and *Cladium* to *Rhizophora* and from marl soil to peat soil forming processes.

Site selection. The control and treatment sites were selected out of six available blocks of coastal wetlands based upon ownership questions and the lack of secondary manmade drainage features. Observation platforms were installed near the mouths of both tidal creeks (TF and CF) and midway between the Bay and levee (TS and CS). The TS site was within 30 m of its terminus at the rim of the interior topographic basin which it drains. The CS site was placed just downstream from the drainage way of the scrub area.

Stage-discharge curves.-

Staff gauges were placed in the tidal creek adjacent to each station platform and surveyed to the nearest BM. In addition, tidal creek cross sections were measured at the platform sites and tied to the staff gauge (Appendix 1). This permitted the calculation of the channel cross-sectional area at any given stage. In order to more accurately calculate both cross sectional area and

stream discharge, the channels were subdivided into segments based upon profile characteristics (Appendix 1). Stream flow measurements were made for each segment (velocity-area station, Wisner and Brater, 1959) within a five minute period. Stream flow was measured at least three times and averaged at each segment by measuring the travel time of a neutrally buoyant float down 50 cm of channel. Several water current velocity measurement techniques were attempted with limited success. Pygmy current meters did not work because water velocities were frequently below instrument threshold to measure and therefore floats were utilized. Comparisons between surface, midwater and near bottom float measurements indicate a rather flat vertical velocity curve, therefore surface float method was utilized. In addition, the frequent shallow depths and constantly changing water depths prevent the more standard application of the Two point, two-tenths or six-tenths methods (Corbett, 1945). The float was placed at least 1m above the start time line to insure it reached flow equilibrium with ambient water prior to timing. The average float time (cm/sec, after calculation from sec per meter) was multiplied by the cross sectional area for each stream segment and the products for each segment summed resulting in the calculation of instantaneous channel discharge(l/sec) for that stage. At least three such series of measurements were taken for each stage of the tide during spring or near spring tides and used to construct the stage discharge curve for each station. Stage discharge curves for both incoming and outgoing tides were constructed by using a best fit equation. In some cases, because channels are asymmetrical, the upper and lower portions of the data set require separate equations to fit the data best.

At the scrub sites V-notched weirs were installed to be able to measure flow in the smaller tidal creek during low discharge periods. We used a 90 degree V-notch weir to minimize flow restriction and pool size. The low gradient prevented the establishment of a minimal nappe of the recommended 10 cm without creating a large pool in the upstream area and therefore standard tables could not be used. Instead manual current readings were made at different tide stages and stage discharge curves created for both incoming and outgoing tides.

Diurnal measurements.-

Two person teams occupied each site for a continuous 24 hr period (December 13, 1996 and April 29, 1997). Water samples were collected every two hours and analyzed according to SERP Lab Comp QAP # 94-0107 (April 3, 1998 FL DEP approved). The following analyses were performed: N + N, NO₃, NH₃, TN, SRP, TP, and TOC. Data was reported in mg/l.

At the same time water was collected, the staff was recorded. A 3/16 " mesh seine was placed in the channel after water sampling and fished for one hour. All material collected in the net was preserved and later sorted, dried, counted and weighed. The following categories were measured: mangrove leaves, stems, propagules, and total mangrove, *Thalassia*, *Halodule*, marine algae, total marine, and other. Organic detritus categories were reported in gm/hr.

Calculation of instantaneous load.- At the time of each water sampling the staff was recorded. From the Stage-Discharge curves the instantaneous discharge (discharge in liters/second) was determined for the time of water sampling. This discharge value was then multiplied by the concentration (mg/l) of each nutrient species. Values are reported as mg/l/sec.

Calculation of hourly load (creation of steps). Instantaneous loads for sample periods (every two hours) at each station were plotted and intermediate values (hourly) mathematically

calculated. These calculated values are referred to as step values. Calculation of hourly step values makes the calculation of flux more conservative by reducing the significance of very high or low values which would be projected for two hours instead of one hour. All the instantaneous values (actual measured and calculated values) were then multiplied by 3600 sec/hour to produce hourly load values.

Calculation of flux. Flux was then calculated by the summation of hourly load values where negative values were assigned to incoming tide and positive values for outgoing tide hourly loads.

RESULTS

Stage-Discharge curves.- Stage-discharge curves were made for both incoming and outgoing tides for each sampling station (Figures 2-5). Data was collected during high tide cycles over a period of 9 months. Spring tides were used because sampling is also limited to spring tides.

Treatment Fringe Site. Figure 2 contains stage-discharge curves for both incoming (triangles) and outgoing tidal waters. Outgoing current data is subdivided into two best fit curves because of the nature of the data. Rarely does discharge data from a natural channel conform to a simple relationship in respect to stage. The R^2 calculated for each curve are more than adequate for field data of this kind. Discharges for outgoing tide waters for stages in the lower and mid range stages was generally higher than for incoming tide (diamonds and squares), however, the rates of discharge for incoming tidal water in the higher stages is much greater than for outgoing tidal waters. Reasons for this might be that resistance to flow is much less once the tidal creek channel is nearly full and that the rate of rising tide (from the moon traction and local winds), which determines surface water slope and ultimately the flow rate, is greater than the energy associated with gravity flow out which is controlled by how fast the tide drops and resistance to flow once waters are constrained to the lower portion of the channel.

Treatment Scrub Site. Figure 3 contains stage-discharge curves for both incoming and outgoing tidal waters passing through a 90o V-notch weir. Data from both incoming and outgoing tides were divided into two segments. R^2 values were quite strong as indicated.

Control Fringe Site. Figure 4 displays the stage-discharge curves for both incoming and outgoing tidal waters. A single equation was adequate and R^2 values are excellent.

Control Scrub Site. Data collected from the CS site is illustrated (Figure 5). At this site, both incoming and outgoing tidal discharge data fit a single curve. This is probably a result of the tidal creek being overgrown reducing the rate of ingress and only a small topographic basin is able to hold water.

Stage-Time curves for diurnals.- Stage data collected from each station was plotted against time (Figures 6-13). Observed and calculated stage data is used in conjunction with the Stage-Discharge curves to determine both instantaneous and hourly flow volumes, and are summarized in the first four columns in Tables 1-8. As illustrated, both diurnals covered two tidal cycles.

Nutrient concentrations-Time and POC-Time curves for diurnals.- Laboratory concentrations for each station and sample period were plotted against time and used to calculate intermediate values, termed steps. Both laboratory and calculated values used for flux calculations are listed in columns 5, 7, 9, 11, 13, 15, and 17 (Tables 1-8). Table 9 summarizes the nutrient data and compares inflowing and outflowing water nutrient concentrations. POC data was also plotted vrs time and the data summarized in Table 10. Nutrient and POC data will be summarized by site.

December 1996 Sampling Period

Treatment Fringe. The instantaneous nutrient concentrations (mg/l/sec) for the diurnal period are plotted against time in the following order: NH_4 , NO_2+NO_3 , NO_2 , TN, SRP, TP, and TOC found in the respective figures (Figures 14-20). Particulate organic carbon (POC) load (gm/hr) for the diurnal period are plotted against time in the following order: POC, Total mangrove, Mangrove leaf, Total marine grass and algae, *Thalassia*, *Halodule*, and Marine algae found in the respective figures (Figures 21-27).

Treatment Scrub. The instantaneous nutrient concentrations (mg/l/sec) for the diurnal period are plotted against time in the following order: NH_4 , NO_2+NO_3 , NO_2 , TN, SRP, TP, TOC found in the respective figures (Figures 28-35). Particulate organic carbon (POC) load (gm/hr) for the diurnal period are plotted against time in the following order: POC, Total mangrove, Mangrove leaf, Total marine grass and algae, *Thalassia*, *Halodule*, and Marine algae found in the respective figures (Figures 36-41).

Control Fringe. The instantaneous nutrient concentrations (mg/l/sec) for the diurnal period are plotted against time in the following order: NH_4 , NO_2+NO_3 , NO_2 , TN, SRP, TP, TOC found in the respective figures (Figures 42-49). Particulate organic carbon (POC) load (gm/hr) for the diurnal period are plotted against time in the following order: POC, Total mangrove, Mangrove leaf, Total marine grass and algae, *Thalassia*, *Halodule*, and Marine algae found in the respective figures (Figures 49-55).

Control Scrub. The instantaneous nutrient concentrations (mg/l/sec) for the diurnal period are plotted against time in the following order: NH_4 , NO_2+NO_3 , NO_2 , TN, SRP, TP, TOC found in the respective figures (Figures 56-62). Particulate organic carbon (POC) load (gm/hr) for the diurnal period are plotted against time in the following order: POC, Total mangrove, Mangrove leaf, Total marine grass and algae, *Thalassia*, *Halodule*, and Marine algae found in the respective figures (Figures 63-69).

April 1997 sampling Period

Treatment Fringe. The instantaneous nutrient concentrations (mg/l/sec) for the diurnal period are plotted against time in the following order: NH_4 , NO_2+NO_3 , NO_2 , TN, SRP,

TP, TOC found in the respective figures (Figures 70-76). Particulate organic carbon (POC) load (gm/hr) for the diurnal period are plotted against time in the following order: POC, Total mangrove, Mangrove leaf, Total marine grass and algae, *Thalassia*, *Halodule*, and Marine algae found in the respective figures (Figures 77-83).

Treatment Scrub. The instantaneous nutrient concentrations (mg/l/sec) for the diurnal period are plotted against time in the following order: NH_4 , $\text{NO}_2 + \text{NO}_3$, NO_2 , TN, SRP, TP, TOC found in the respective figures (Figures 84-90). Particulate organic carbon (POC) load (gm/hr) for the diurnal period are plotted against time in the following order: POC, Total mangrove, Mangrove leaf, Total marine grass and algae, *Thalassia*, *Halodule*, and Marine algae found in the respective figures (Figures 91-97).

Control Fringe. The instantaneous nutrient concentrations (mg/l/sec) for the diurnal period are plotted against time in the following order: NH_4 , $\text{NO}_2 + \text{NO}_3$, NO_2 , TN, SRP, TP, TOC found in the respective figures (Figures 98-104). Particulate organic carbon (POC) load (gm/hr) for the diurnal period are plotted against time in the following order: POC, Total mangrove, Mangrove leaf, Total marine grass and algae, *Thalassia*, *Halodule*, and Marine algae found in the respective figures (Figures 105-111).

Control Scrub. The instantaneous nutrient concentrations (mg/l/sec) for the diurnal period are plotted against time in the following order: NH_4 , $\text{NO}_2 + \text{NO}_3$, NO_2 , TN, SRP, TP, TOC found in the respective figures (Figures 112-118). Data for Particulate organic carbon (POC) load (gm/hr) for the diurnal period are plotted against time in the following order: POC, Total mangrove, Mangrove leaf, Total marine grass and algae, *Thalassia*, *Halodule*, and Marine algae are lost.

Trends in nutrient concentrations. For most nutrient species concentrations for inflowing waters were generally higher than outflowing waters. NH_4 exhibited this trend the strongest. Fringe sites had higher concentrations of $\text{N} + \text{N}$, NO_2 , NH_4 , and TP, than did the Scrub sites. However, the Scrub sites had higher concentrations of TN and TOC. December concentrations for TP, $\text{N} + \text{N}$, and NH_4 were higher than in April. In contrast TOC was greater in April than December (Table 9).

Fringe sites consistently had more POC movement in and out than did the Scrub sites (Table 10). Fringe sites also had one to two orders of magnitude greater marine POC influx than did the Scrub sites. Likewise the fringe sites exported 2 to 10 times more mangrove derived material than did the Scrub sites. Nearly 2 to 10 times as much material was transported in December as in April, with the Fringe sites moving more than the Scrub sites.

Load calculation and flux estimates.- Instantaneous nutrient species concentrations were then utilized to calculate instantaneous load for each station for both sample periods (rows 5-18 in Tables 1-8). Basically the load for each time period is the product of the discharge times the nutrient concentration. Table 11 is a comparison of flux data between stations.

The direction of water flux was landward (negative numbers) in all cases except for the second tidal cycle at TF in December. However, the flux for both tidal cycles making up the December diurnal was negative for NH_4 , TN, TP, and TC. At other stations, SRP (CS April, TF Dec and TF April), N + N (TF Dec), NO_2 (TF Dec), and NH_4 (TF April) loads were exported to Biscayne Bay. Very high concentrations of TOC during the 1st tidal cycle of the TF April diurnal period resulted in an export to the Bay of considerable magnitude and in opposition to the general trends discussed above.

Interestingly, NH_4 was usually imported into the coastal wetlands from the Bay. The reverse is usually considered the norm. However, in this area, nearshore groundwater discharge is high and the NH_4 load is considerable (Meeder et al, 1998) and may help to explain this phenomena.

Flux at both fringe sites was considerably greater than flux into the scrubs sites, usually by an order of magnitude, with the exception of a factor of two between TF and TS in Dec. Also TF April had a large export of POC probably associated with tidal water lag from previous high tide caused by strong onshore winds. Similar relationships exist with the POC (Table 10). Marine POC influx to the Treatment Fringe site was greater than for the export of mangrove POC, the reverse is true for the CF. Marine influx into the Scrub sites was minimal and export of mangrove POC usually one order of magnitude less than the corresponding Fringe site. December flux was greater than April flux in nearly all categories, except for TOC at the TS April period and for the major export event of the 1st tidal cycle of the TF April.

Based upon the area of drainage for the TF, TS, CF and CS areas the nutrient contribution per m^2 of wetlands is tabulated (Table 12). The mass of nutrients imported / m^2 is very low, especially into the scrub areas which may, in part, explain their restricted growth and productivity.

DISCUSSION

Comparison between tidal creek basins.

Although the study plots (treatment and control basins) are both very close in size (approximately 29.21 and 25.84 hectares, respectively) differences in topography, location and orientation, plant community species and structure, and site history between the two accounts for differences in tidal exchange and nutrient flux.

Comparison between sample periods

December tidal range was greater and so was import. Exceptions to this are explained by waters from previous tides being held over to the next low tide prior to outflow because of strong onshore winds. The Treatment site must be positioned in respect to the coastline and offshore topography and prevailing wind and current patterns so that more tidal waters are exchanged than in the Control Block.

Differences between scrub and fringe sites

Fringe site are exposed to much higher volumes of ingress and egressing tidal waters. Both import and export from the scrub sites (especially the TS site) is highly restricted because of the basin topography. Once basin is filled it does not drain rapidly.

Tide height and flux relationships

Figure 119 illustrates the relationships between tide height and flux. The greater the tide height the greater the flux. This relationship is much stronger for the fringe sites than the scrub sites.

Comparisons to other studies

Odum et al (1981) review carbon export studies for coastal mangroves and conclude that mangroves export approximately 1 gm/m²/yr. We find nearly the opposite, a net flux into the wetlands from the Biscayne Bay. Although this trend is well documented here, the concept was proposed that the coastal wetlands are a sink for marine derived carbon many years ago (Odum et al, 1981).

Future Predictions

The basic prediction based upon these limited data is that increased freshwater delivery into the blocks will probably increase export to the coastal Biscayne Bay region.

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APPENDICES

Appendix 1. Tidal creek cross sectional areas.

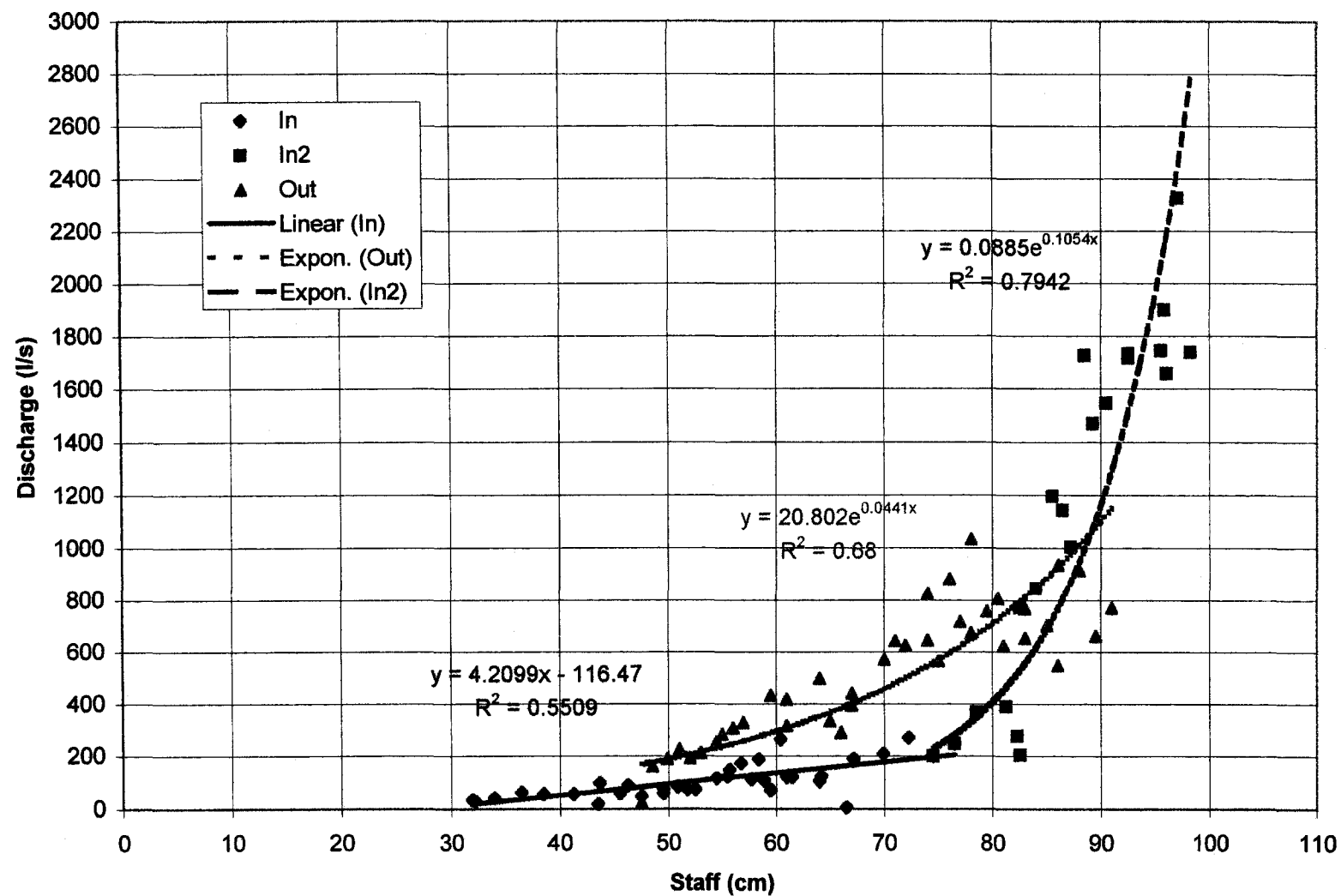


Figure 2. Treatment fringe stage-discharge curve for both rising and falling tides. Incoming tidal data was broken into two segments based on the characteristics of the data and two equations were generated.

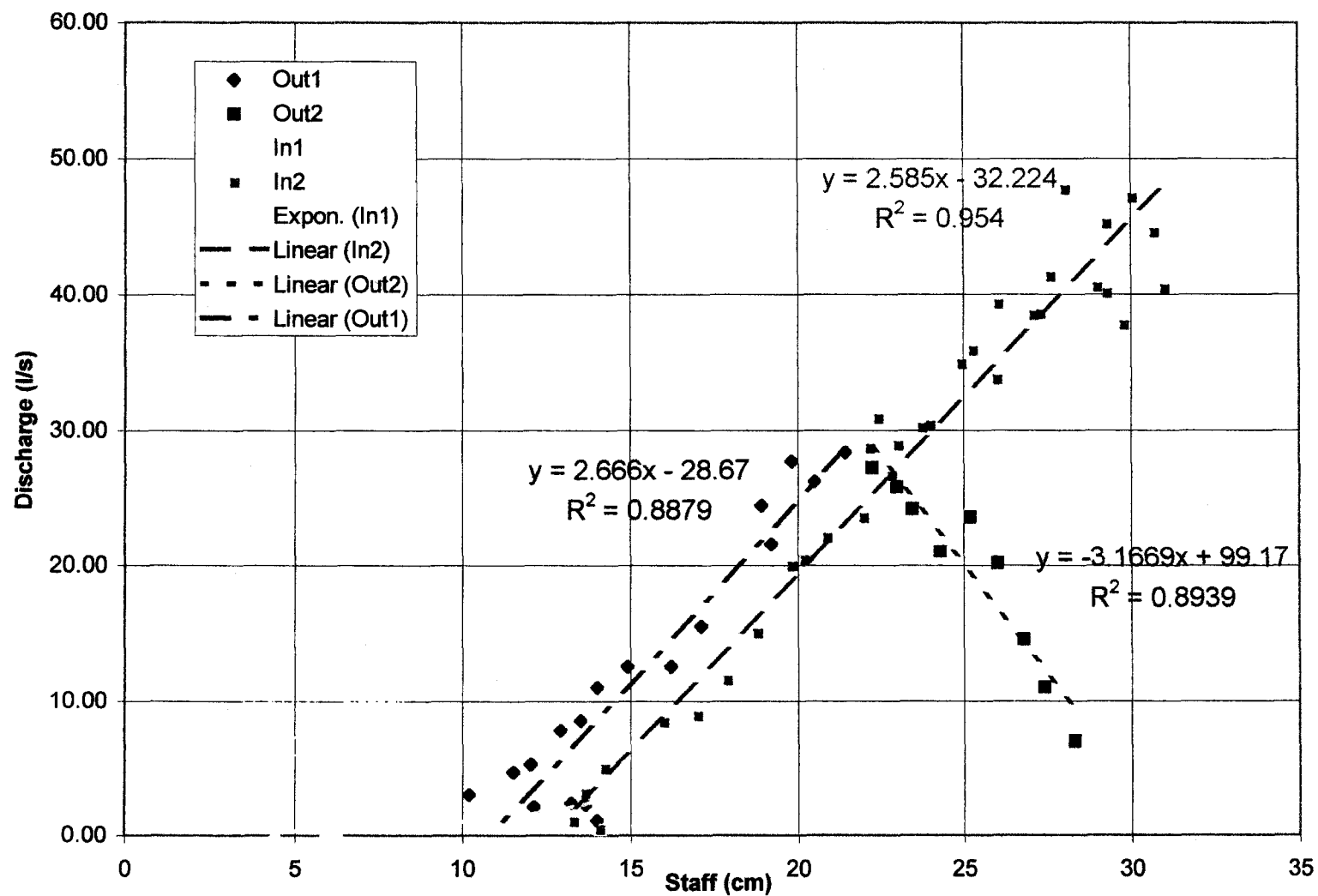


Figure 3. Treatment scrub stage-discharge curve for both rising and falling tides. Incoming and outgoing tidal data was broken into two segments based on the characteristics of the data and four equations were generated.

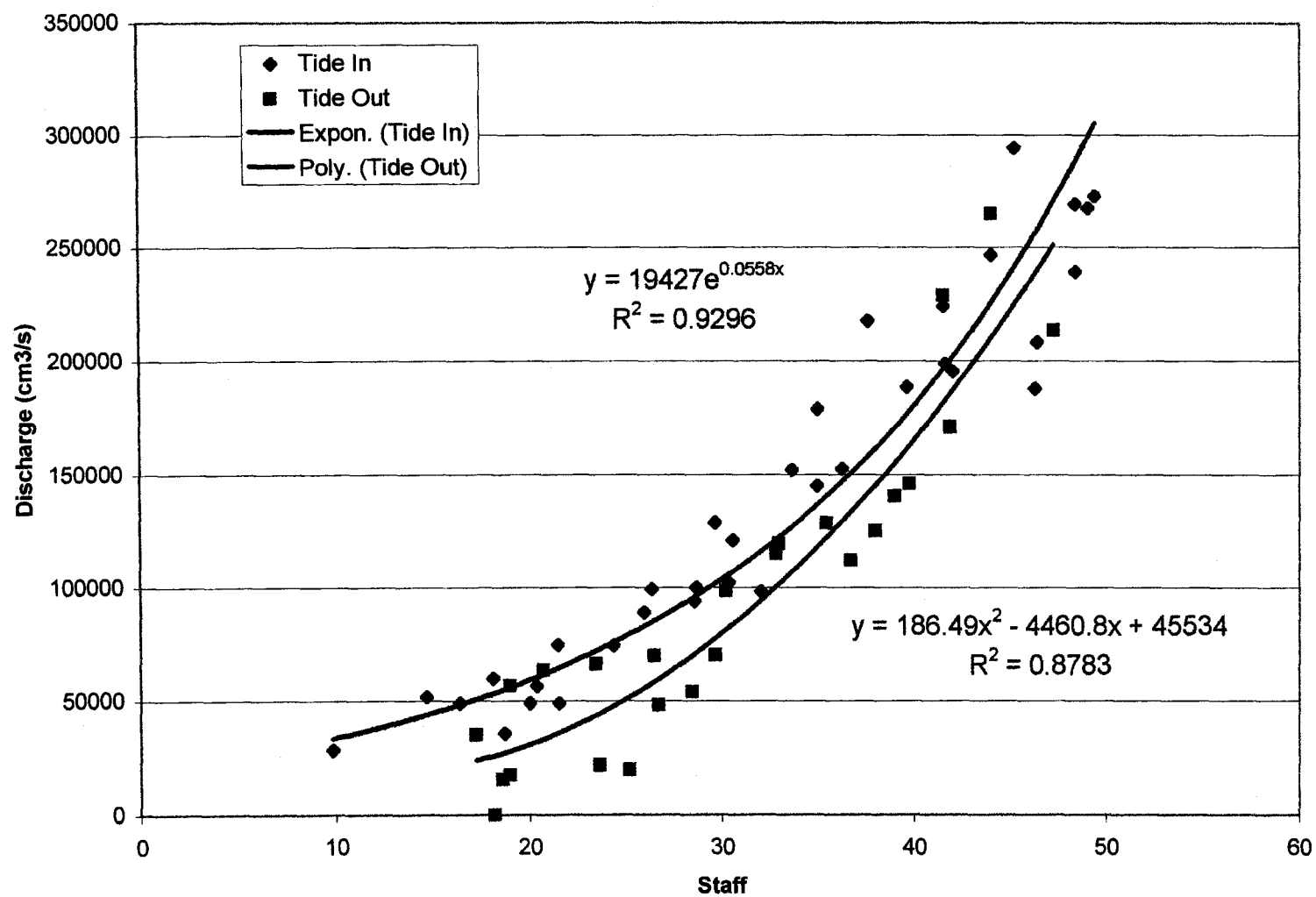


Figure 4. Control fringe stage-discharge curve for both rising and falling tides.

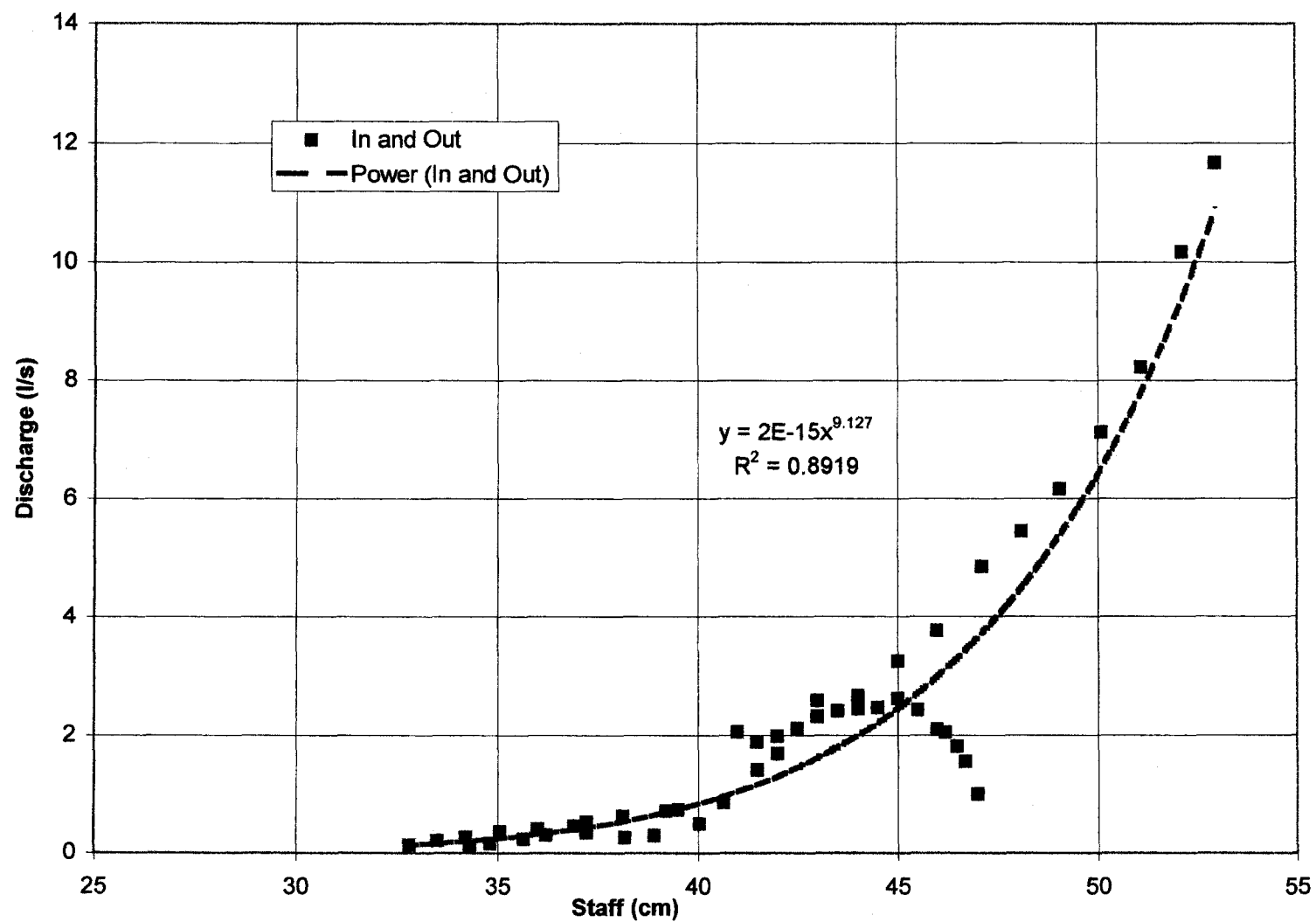


Figure 5. Control scrub stage-discharge curve for both rising and falling tides.

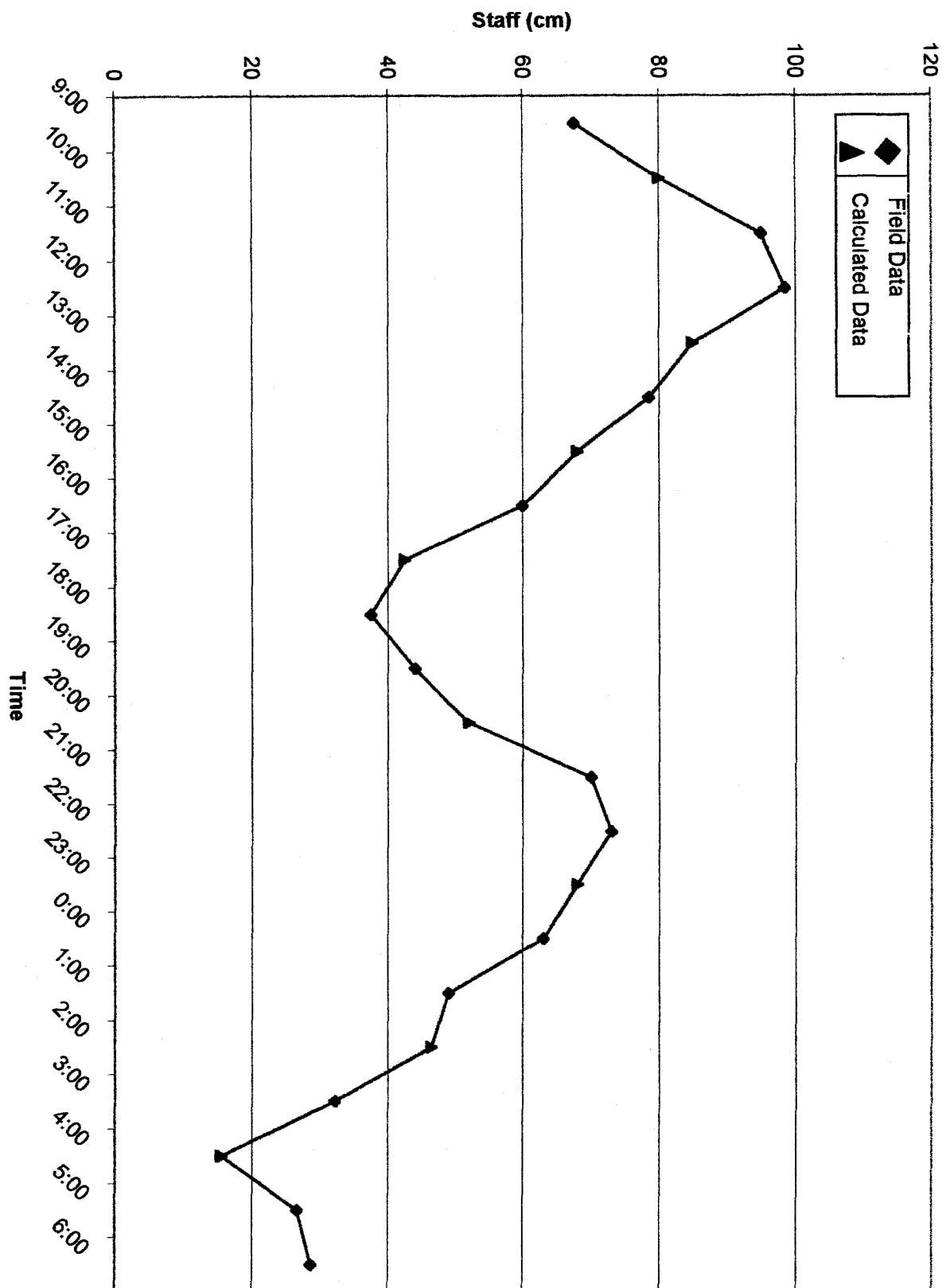


Figure 6. Treatment fringe December stage-time curve.

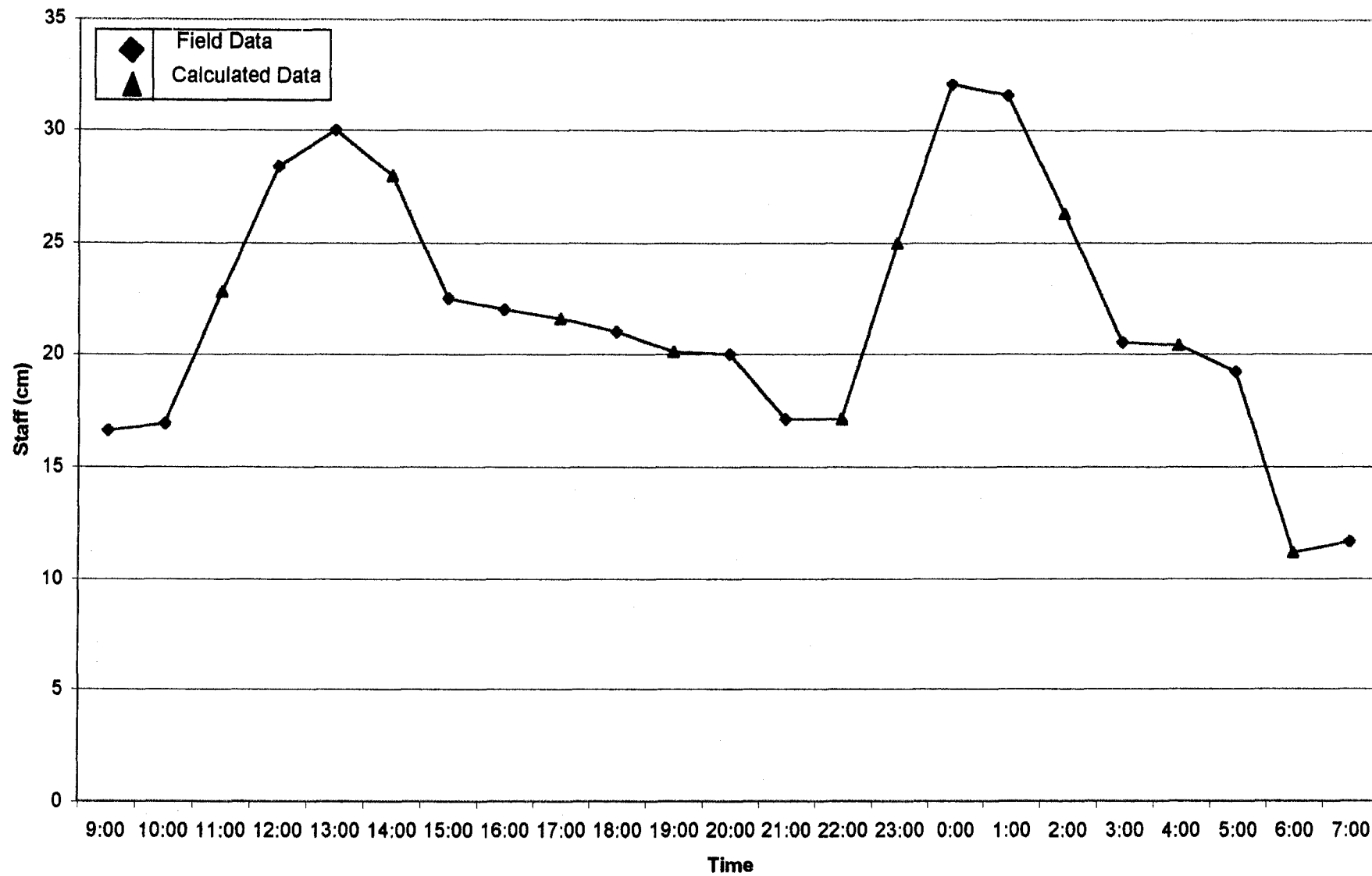


Figure 7. Treatment scrub December stage-time curve.

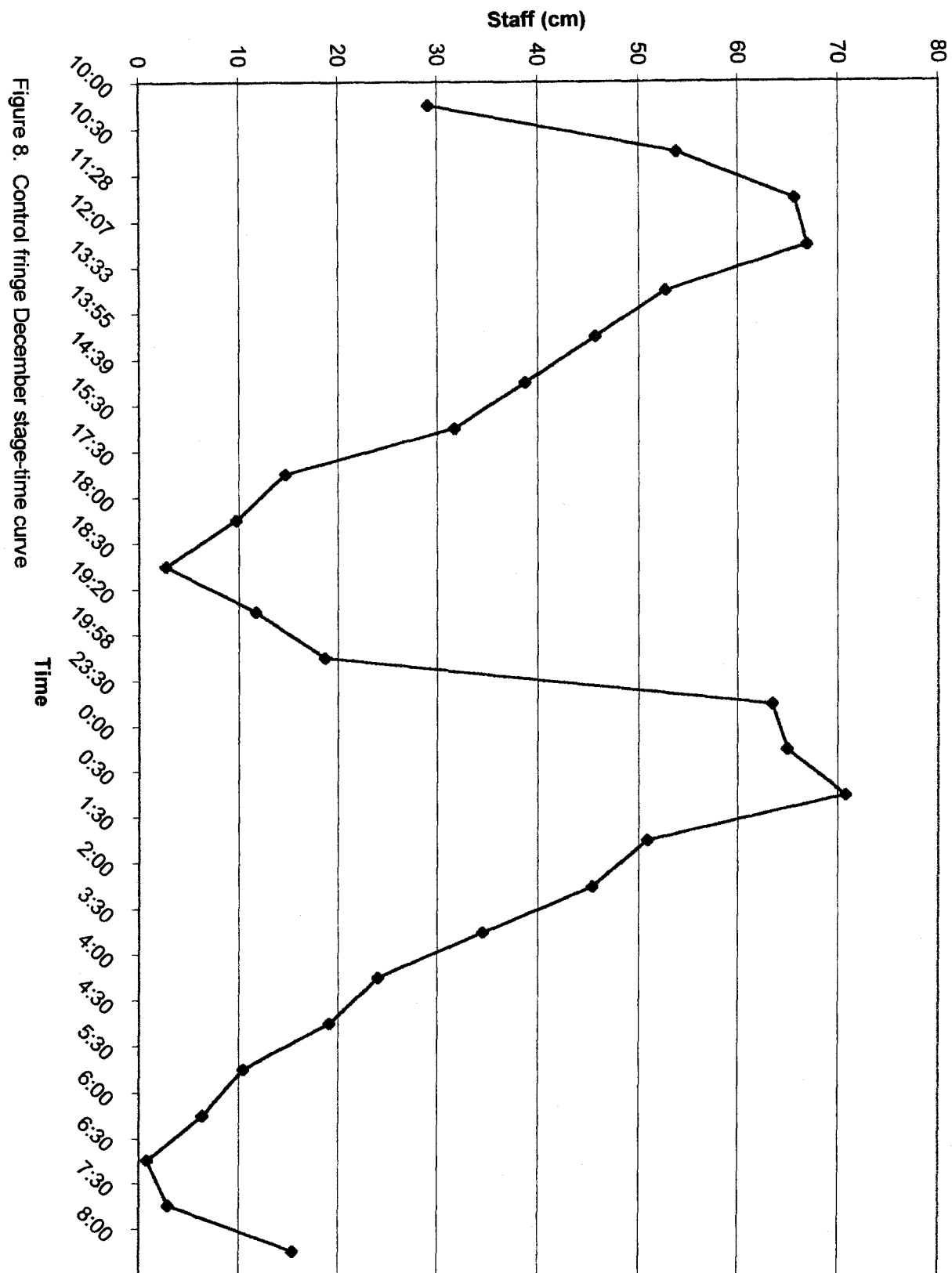


Figure 8. Control fringe December stage-time curve

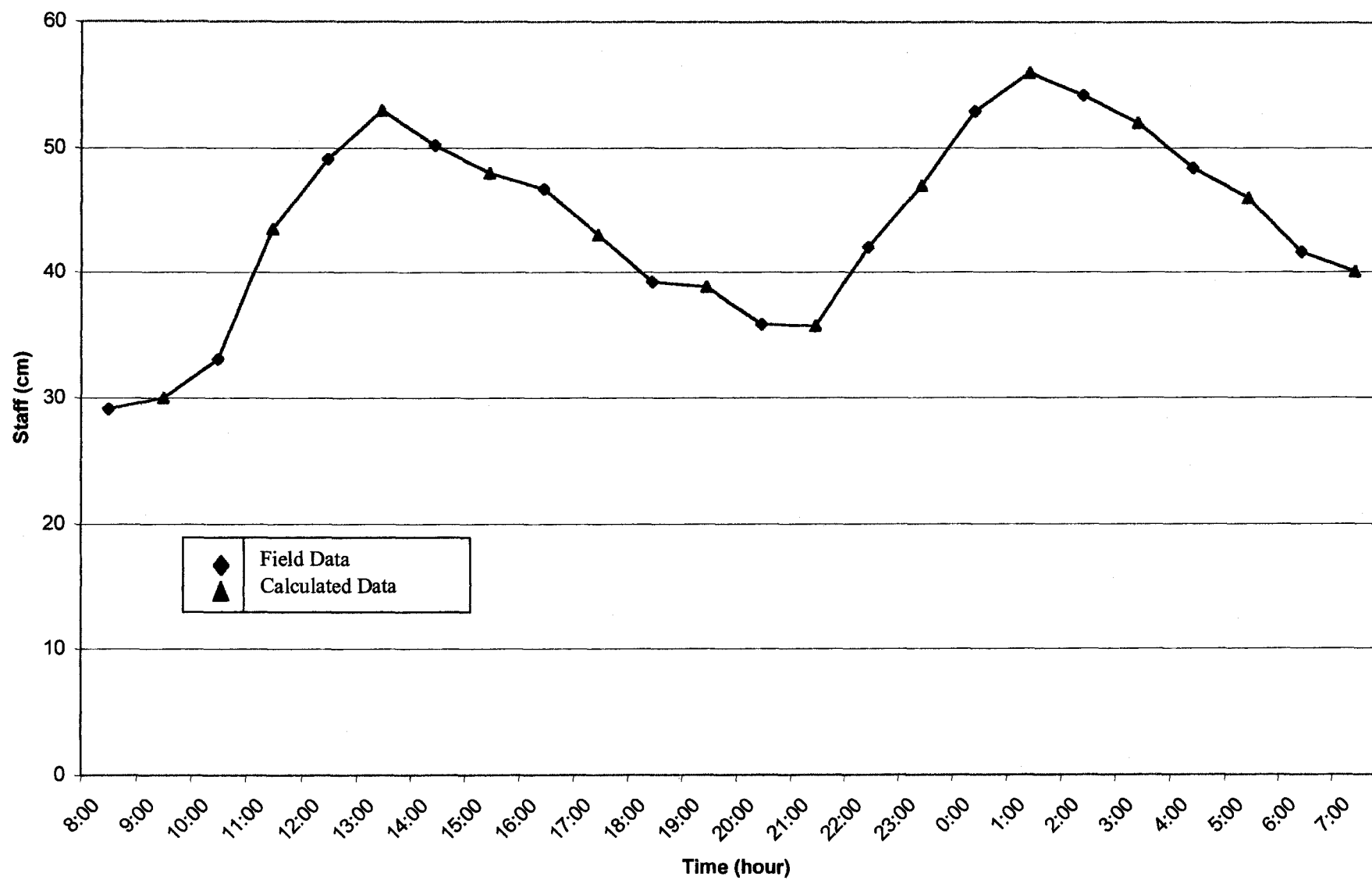


Figure 9. Control scrub December stage-time curve.

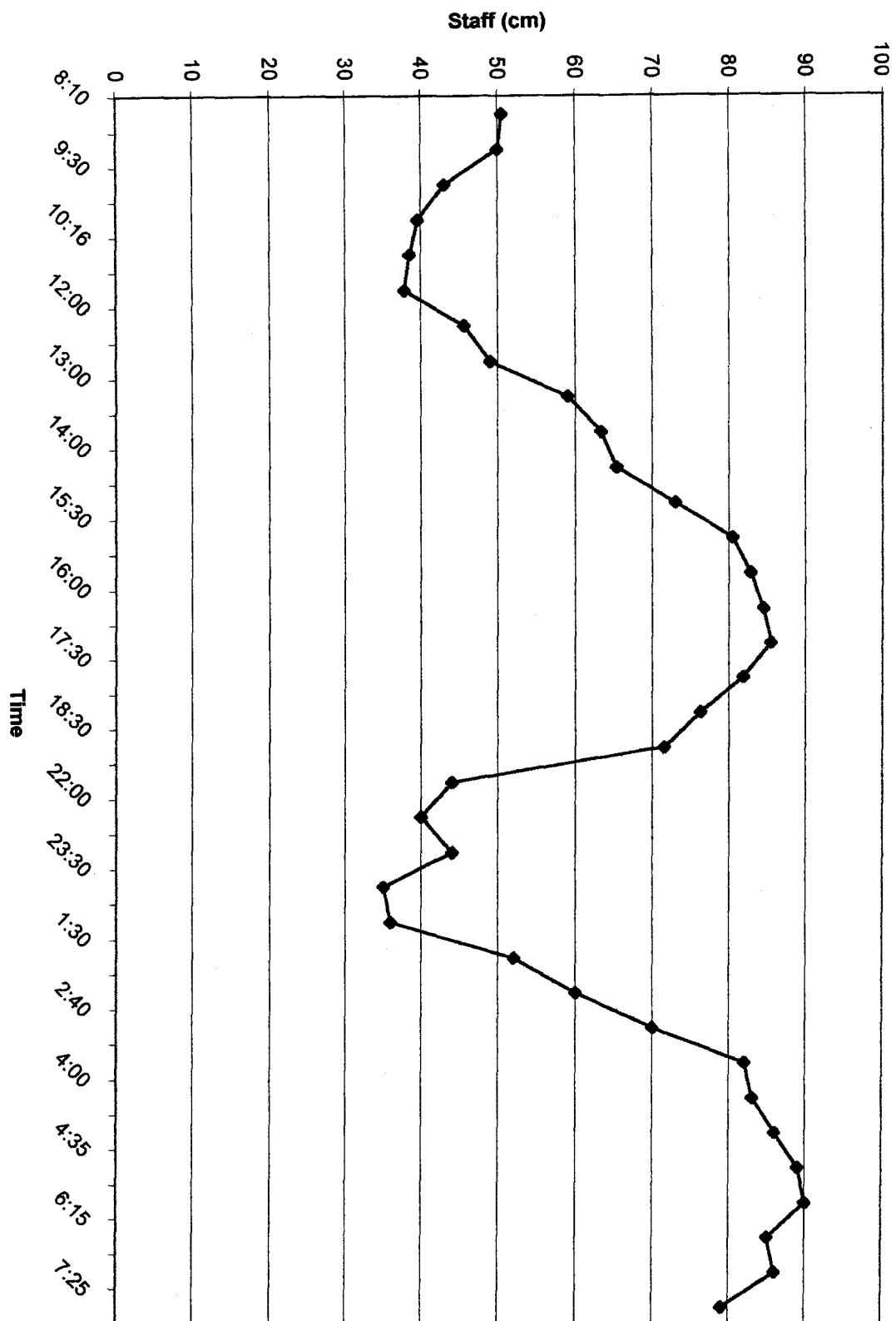


Figure 10. Treatment fringe April stage-time curve

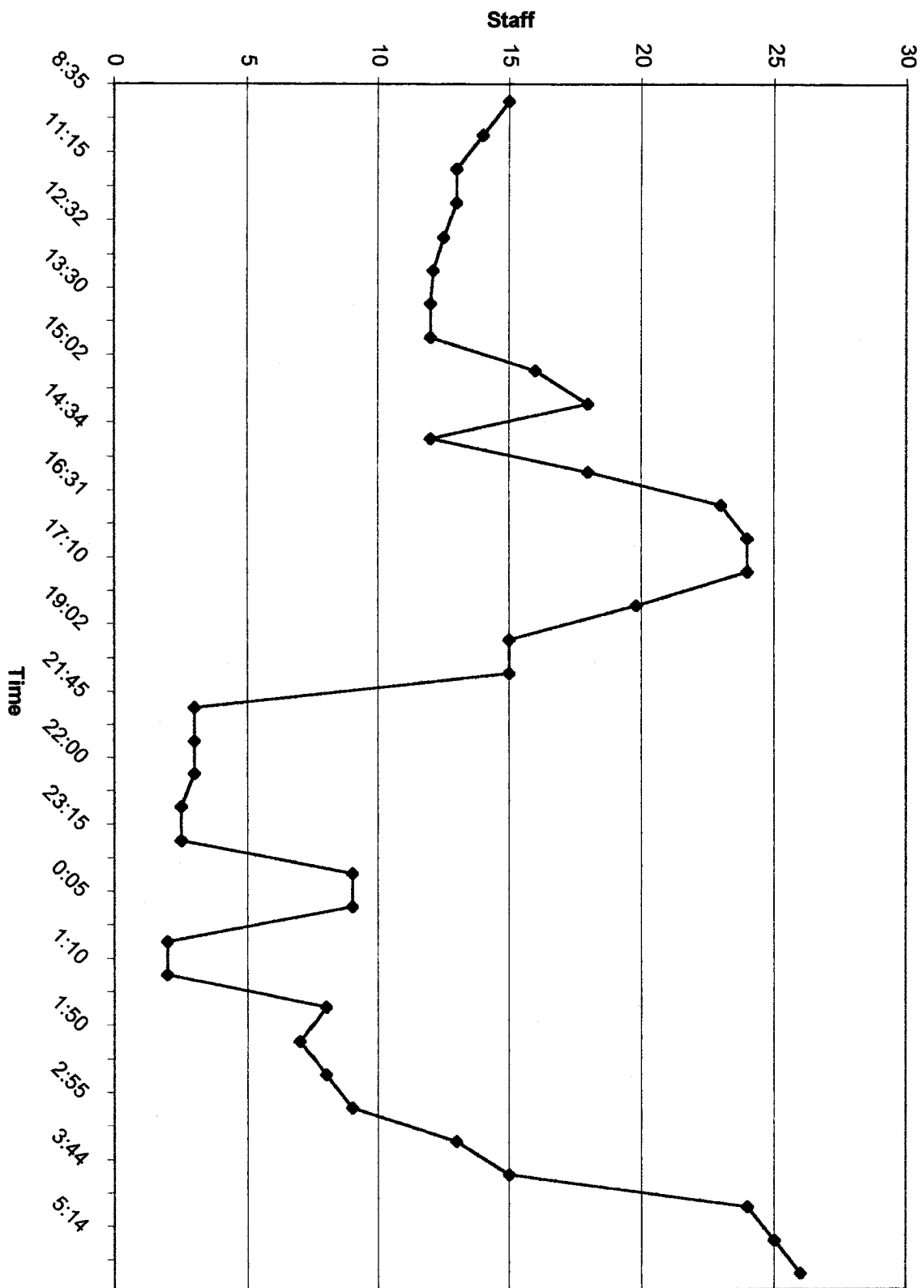


Figure 11. Treatment scrub April stage-time curve.

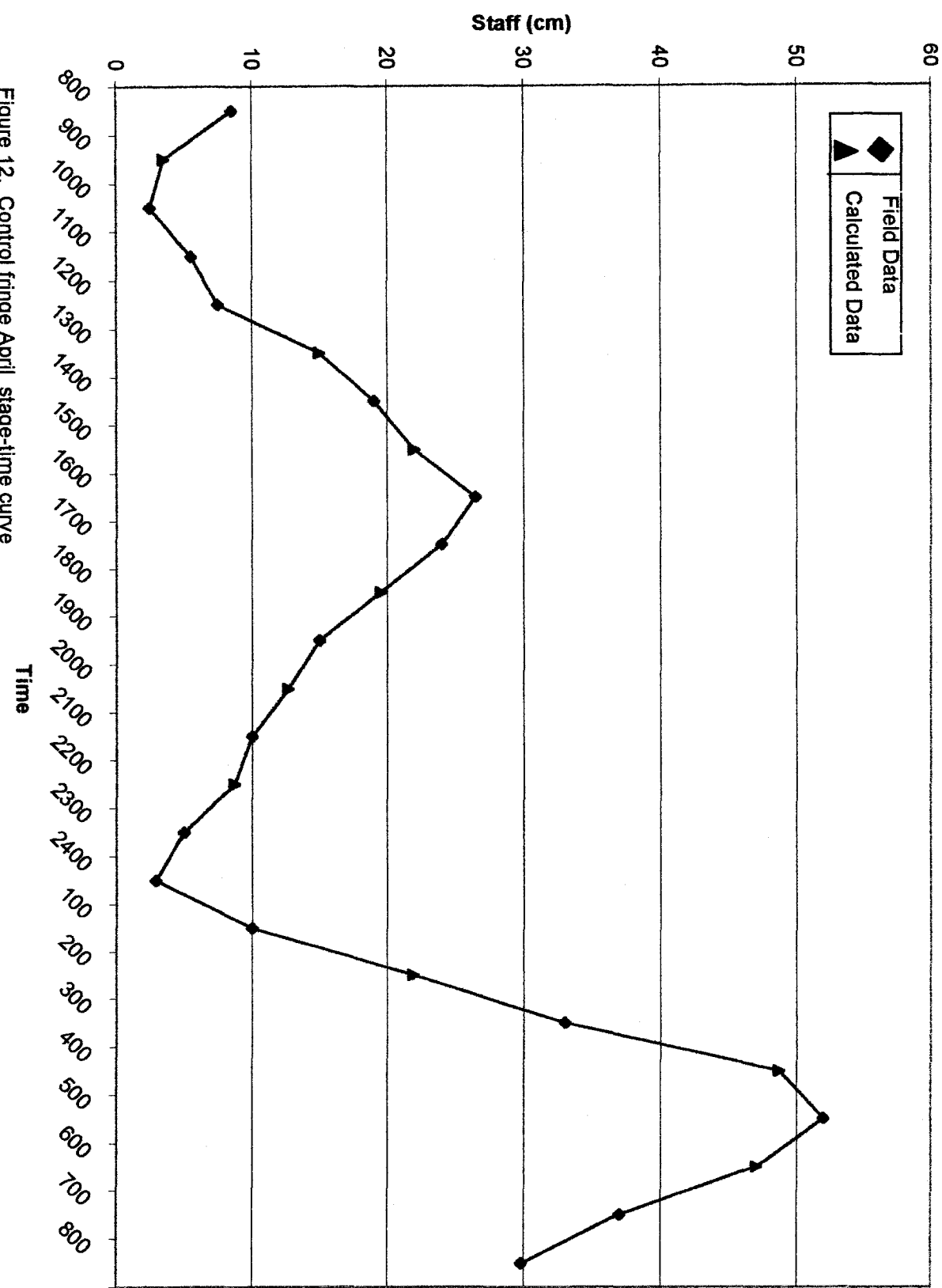


Figure 12. Control fringe April stage-time curve

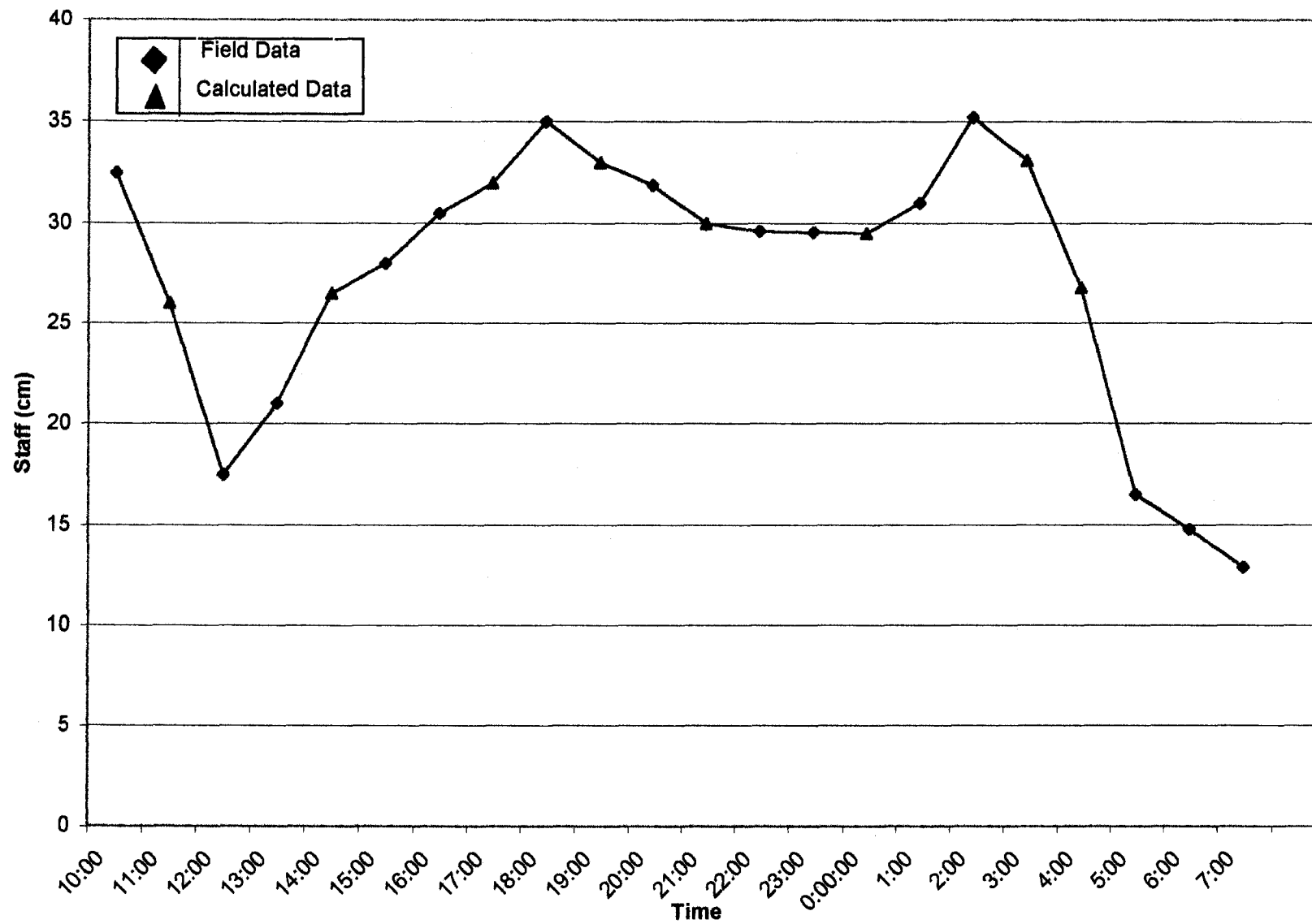


Figure 13. Control scrub April stage-time curve.

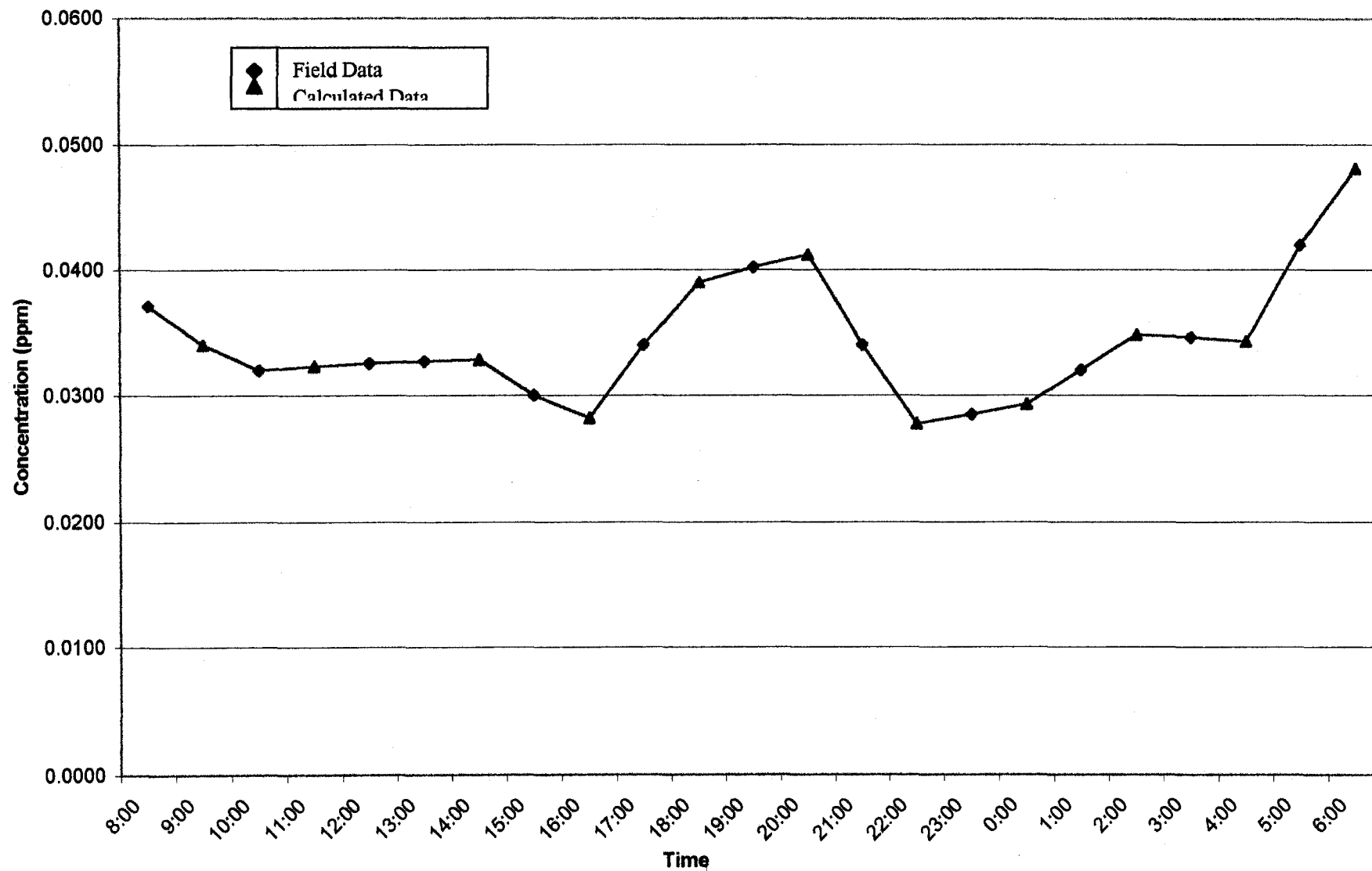


Figure 14. Treatment fringe December instantaneous NH_4 concentration-time plot.

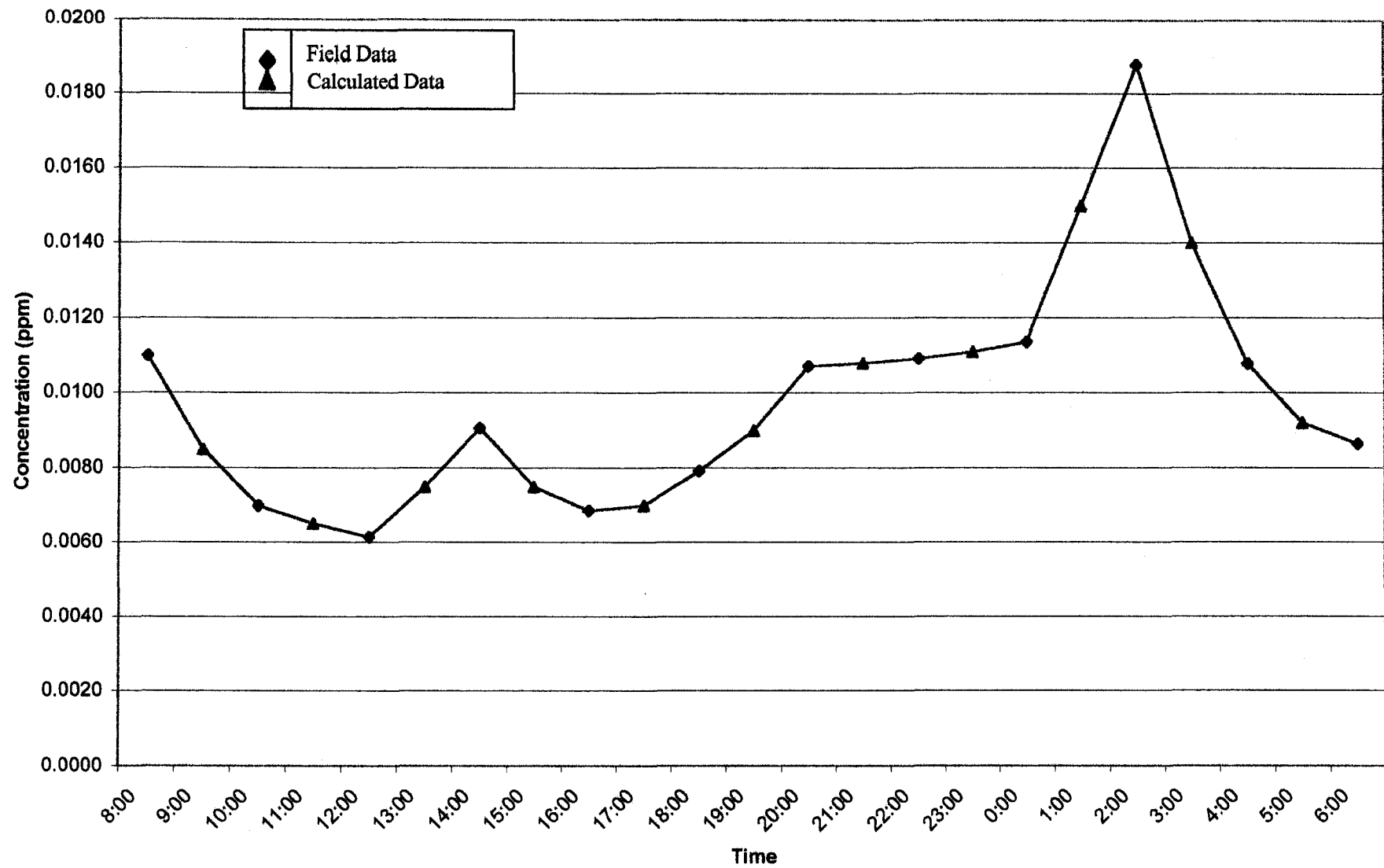


Figure 15. Treatment fringe December instantaneous NO2 + NO3 concentration -time plot.

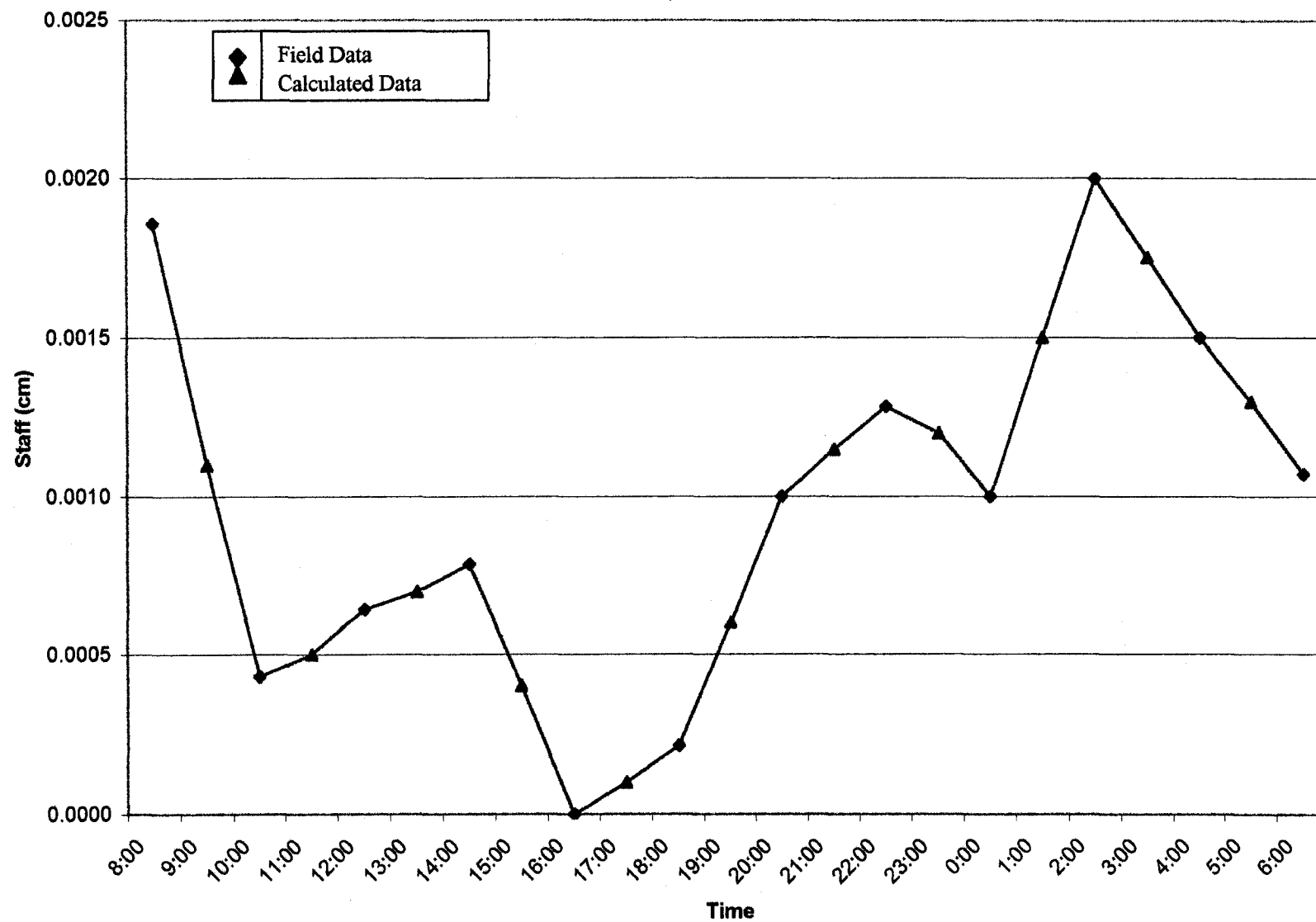


Figure 16. Treatment fringe December instantaneous NO2 concentration-time plot.

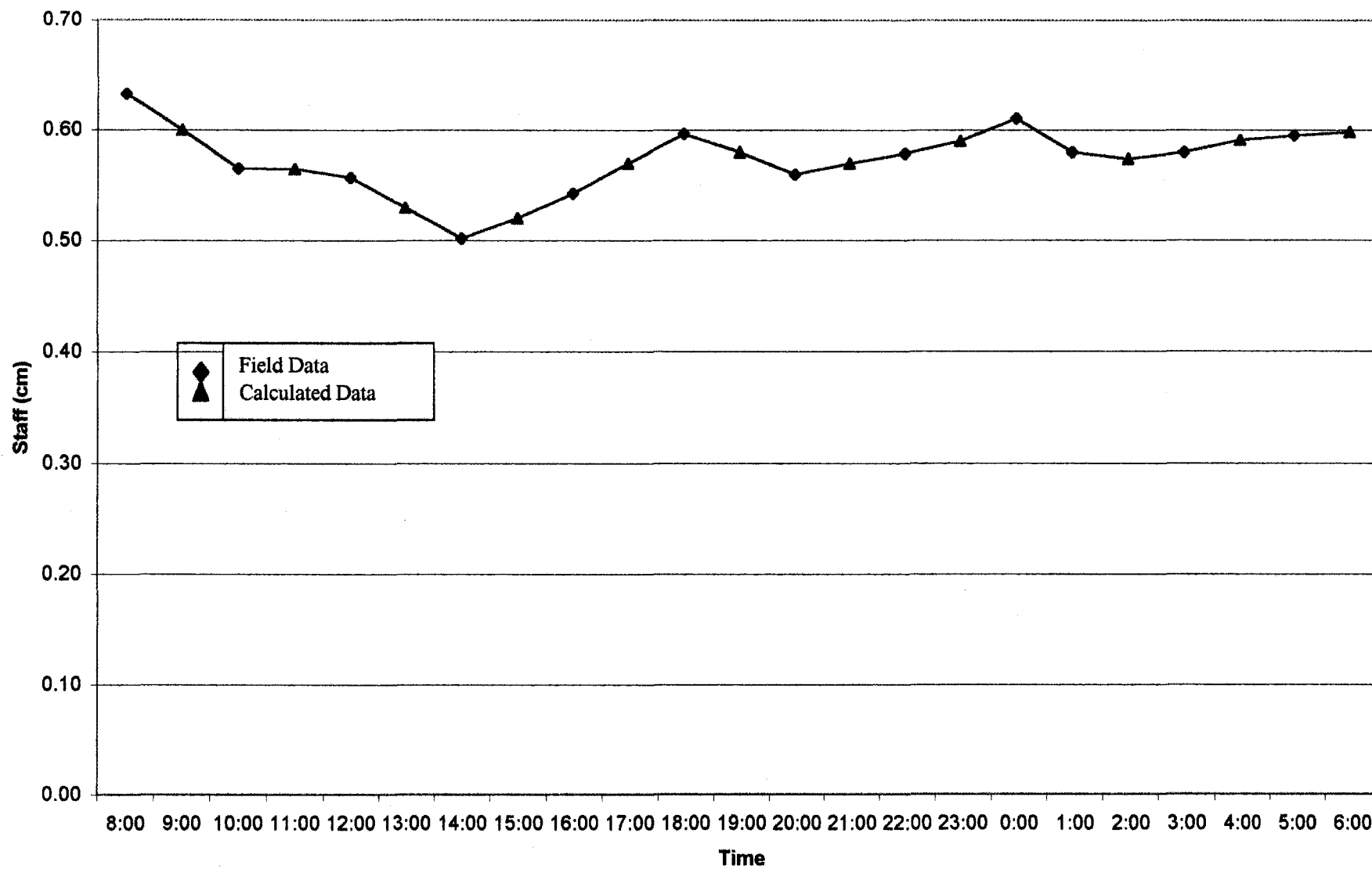


Figure 17. Treatment fringe December instantaneous TN concentration-time plot.

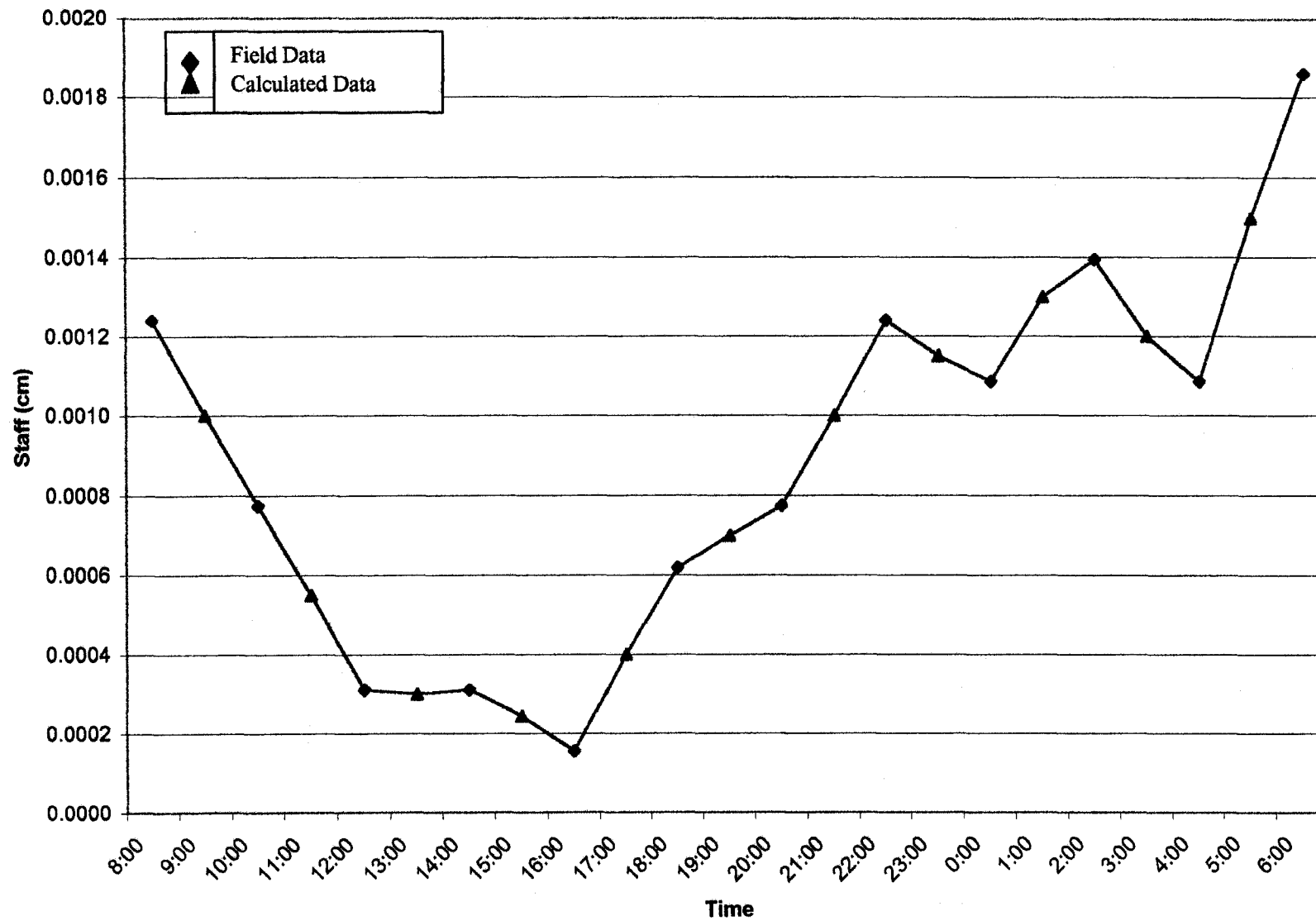


Figure 18. Treatment fringe December instantaneous SRP concentration-time plot.

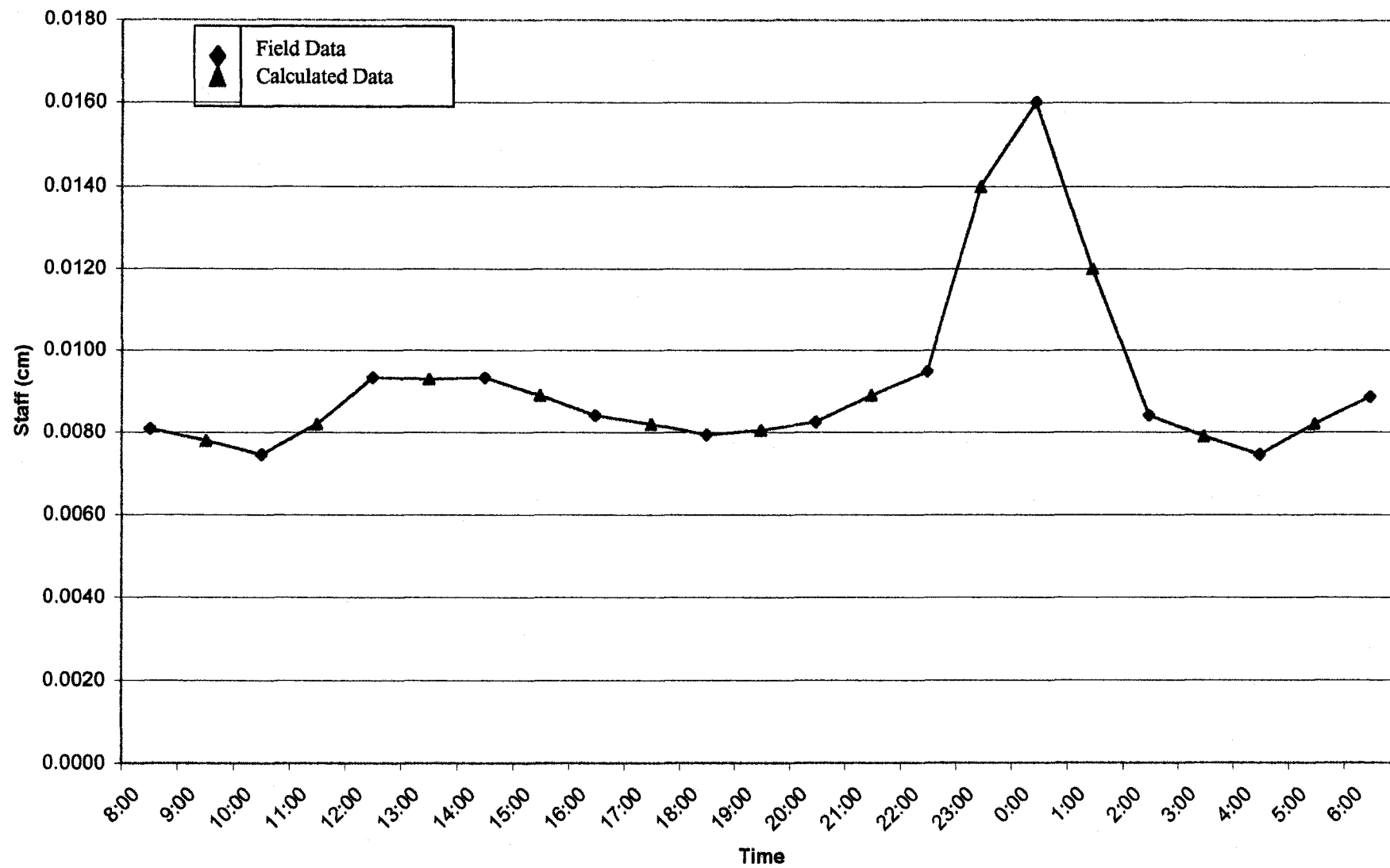


Figure 19. Treatment fringe December instantaneous TP concentration-time plot.

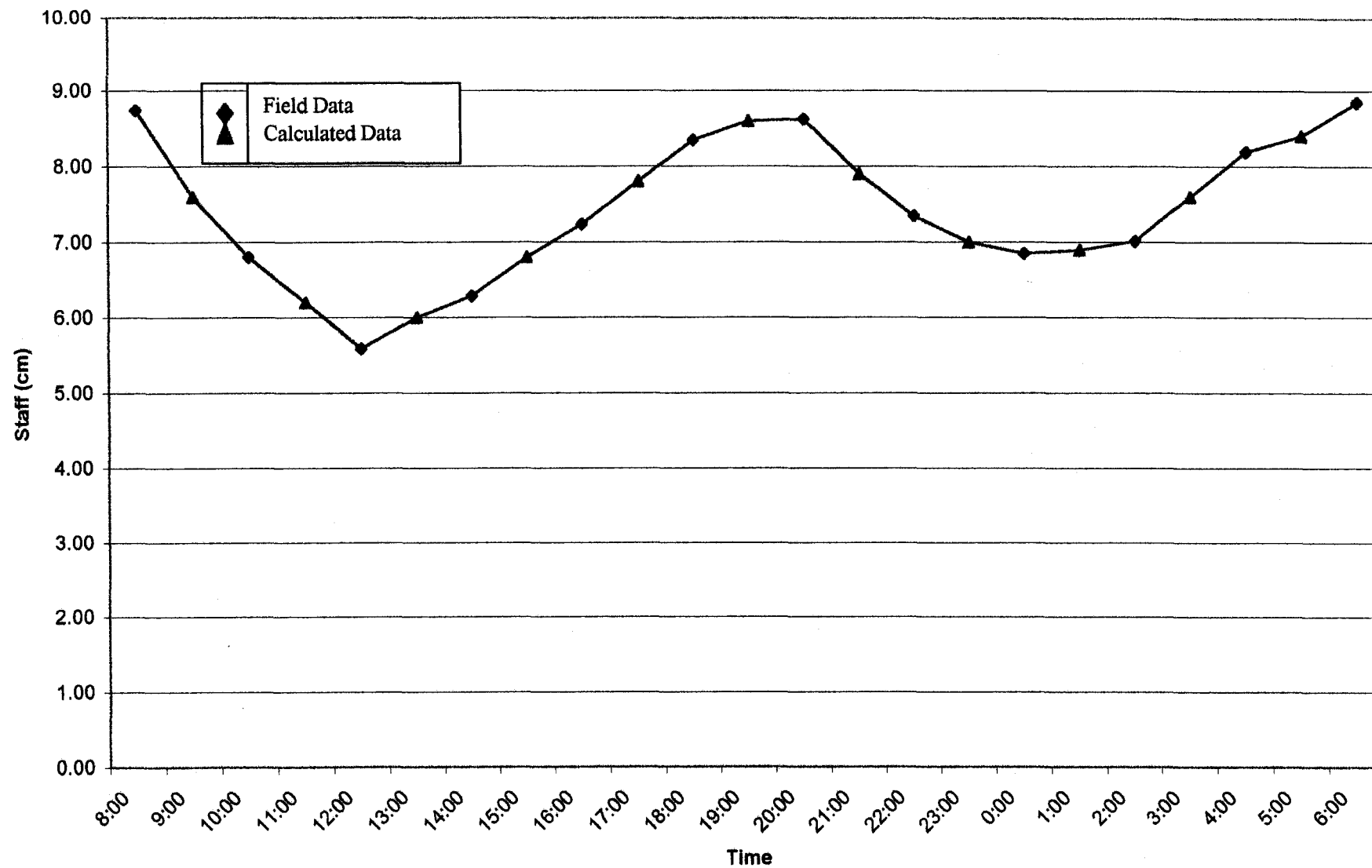


Figure 20. Treatment fringe December instantaneous TOC concentration-time plot.

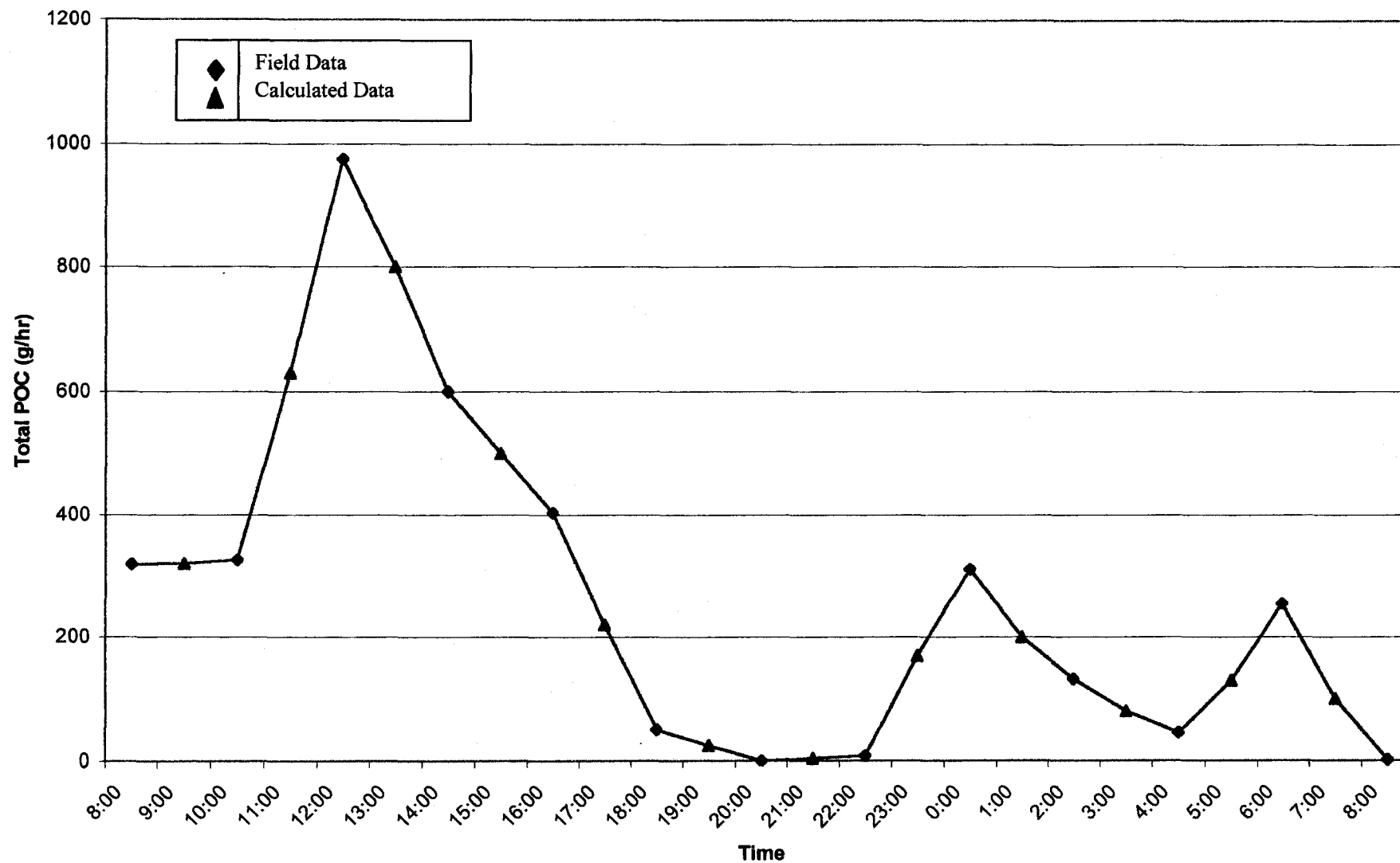


Figure 21. Treatment fringe December hourly total particulate organic carbon (POC) load.

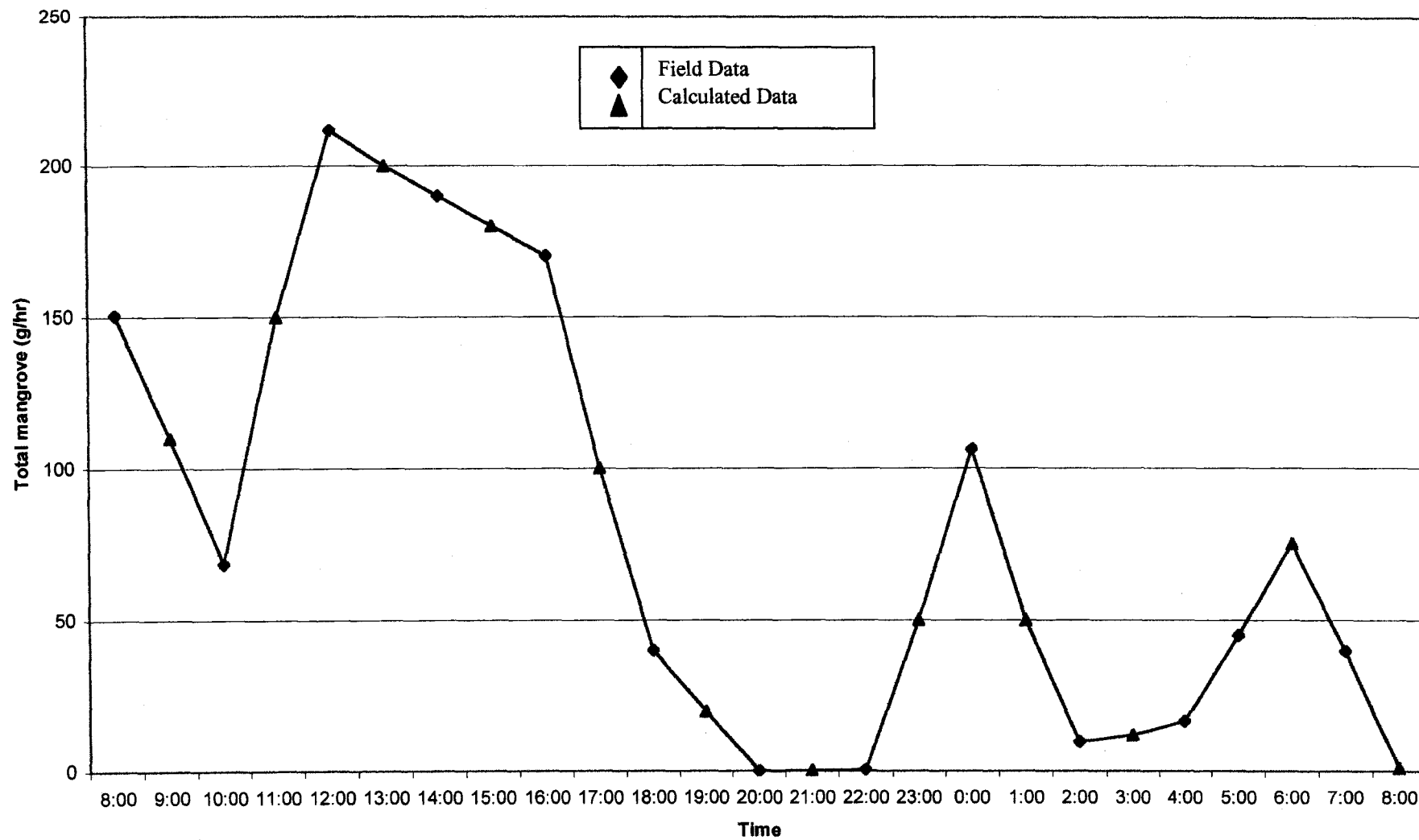


Figure 22. Treatment fringe December hourly total mangrove particulate organic carbon load.

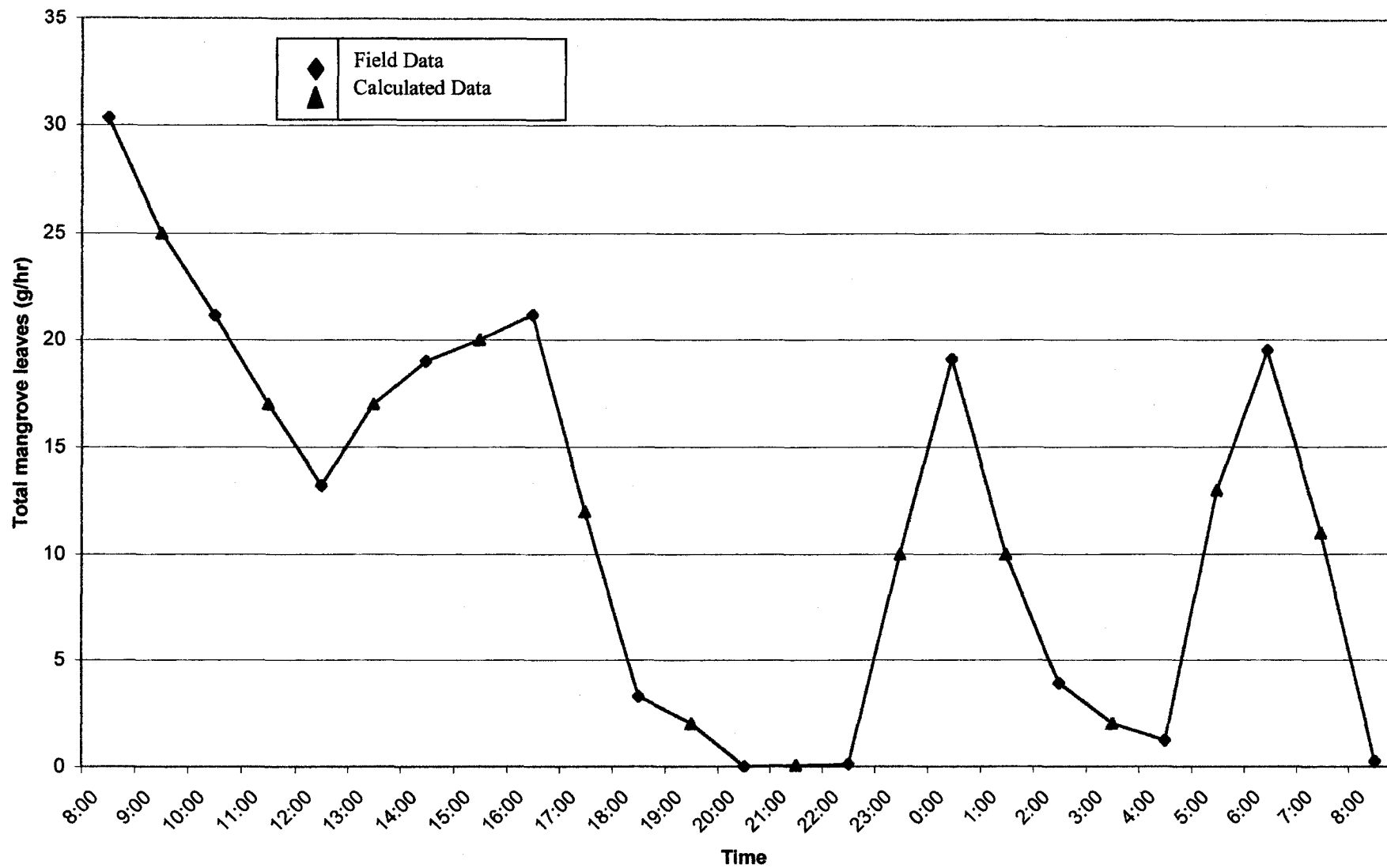


Figure 23. Treatment fringe December hourly mangrove leaf particulate organic carbon load.

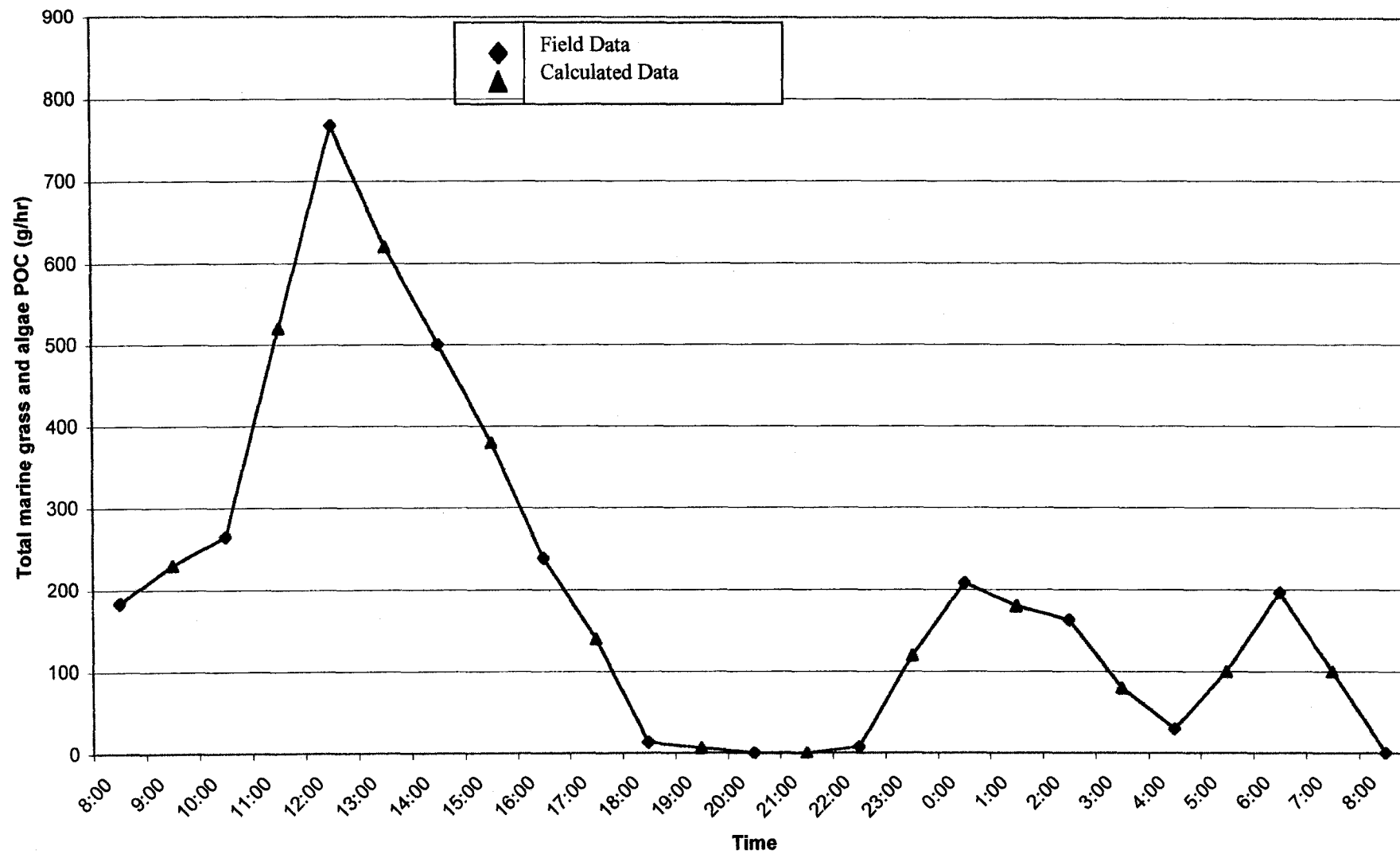


Figure 24. Treatment fringe December hourly total marine grass and algae particulate organic carbon load.

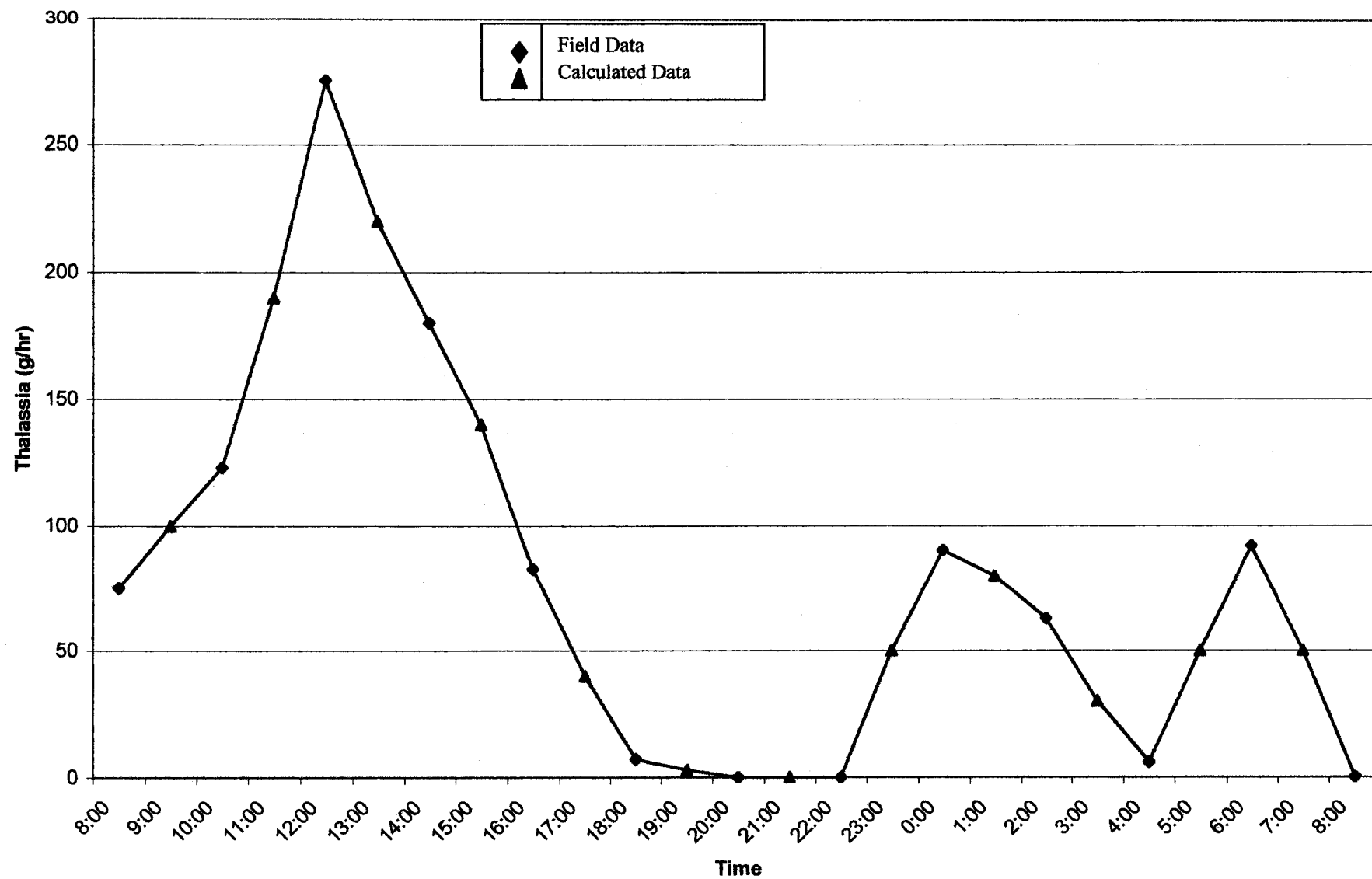


Figure 25. Treatment fringe December hourly *Thalassia* particulate organic carbon load.

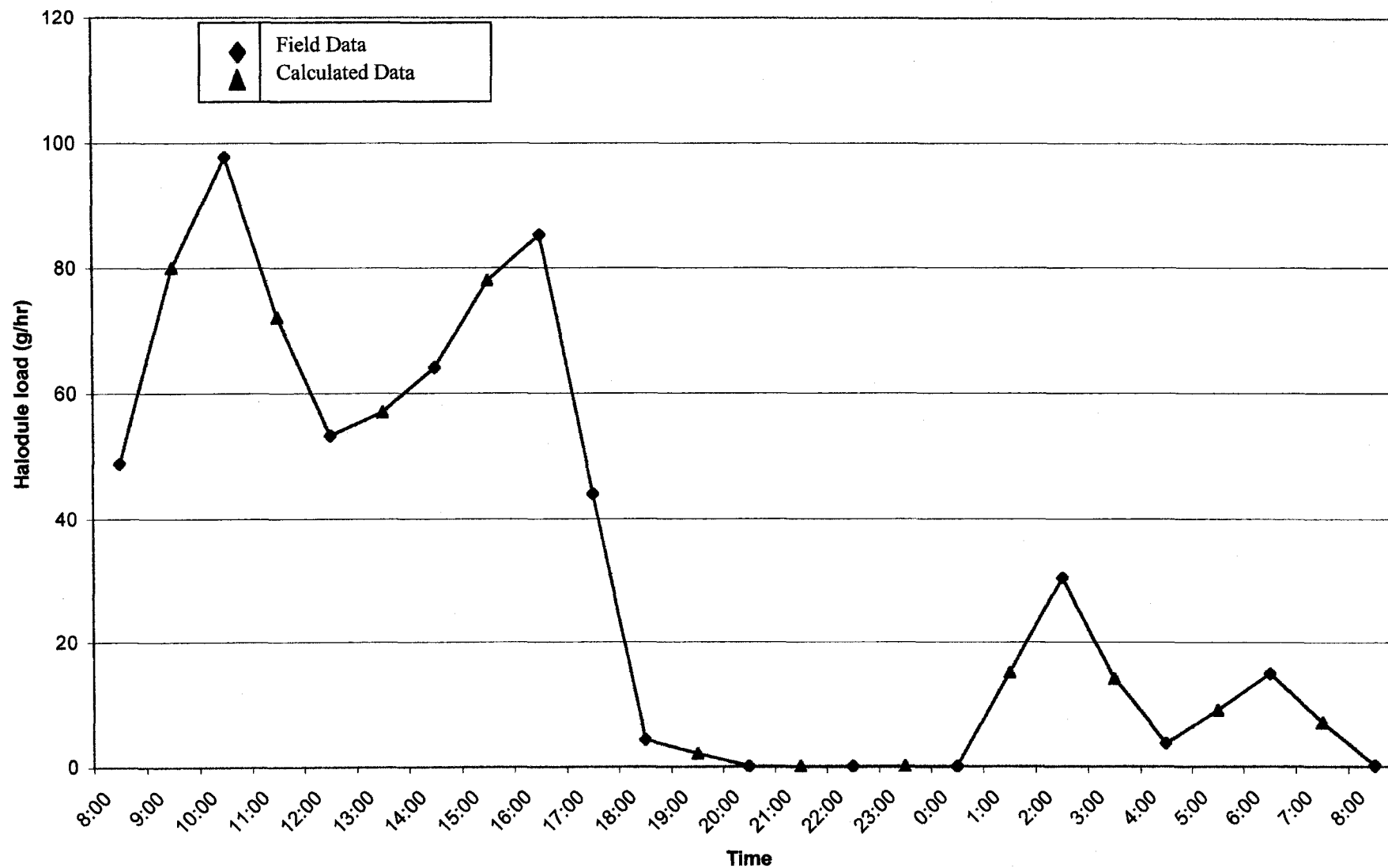


Figure 26. Treatment fringe December hourly Halodule particulated organic carbon load.

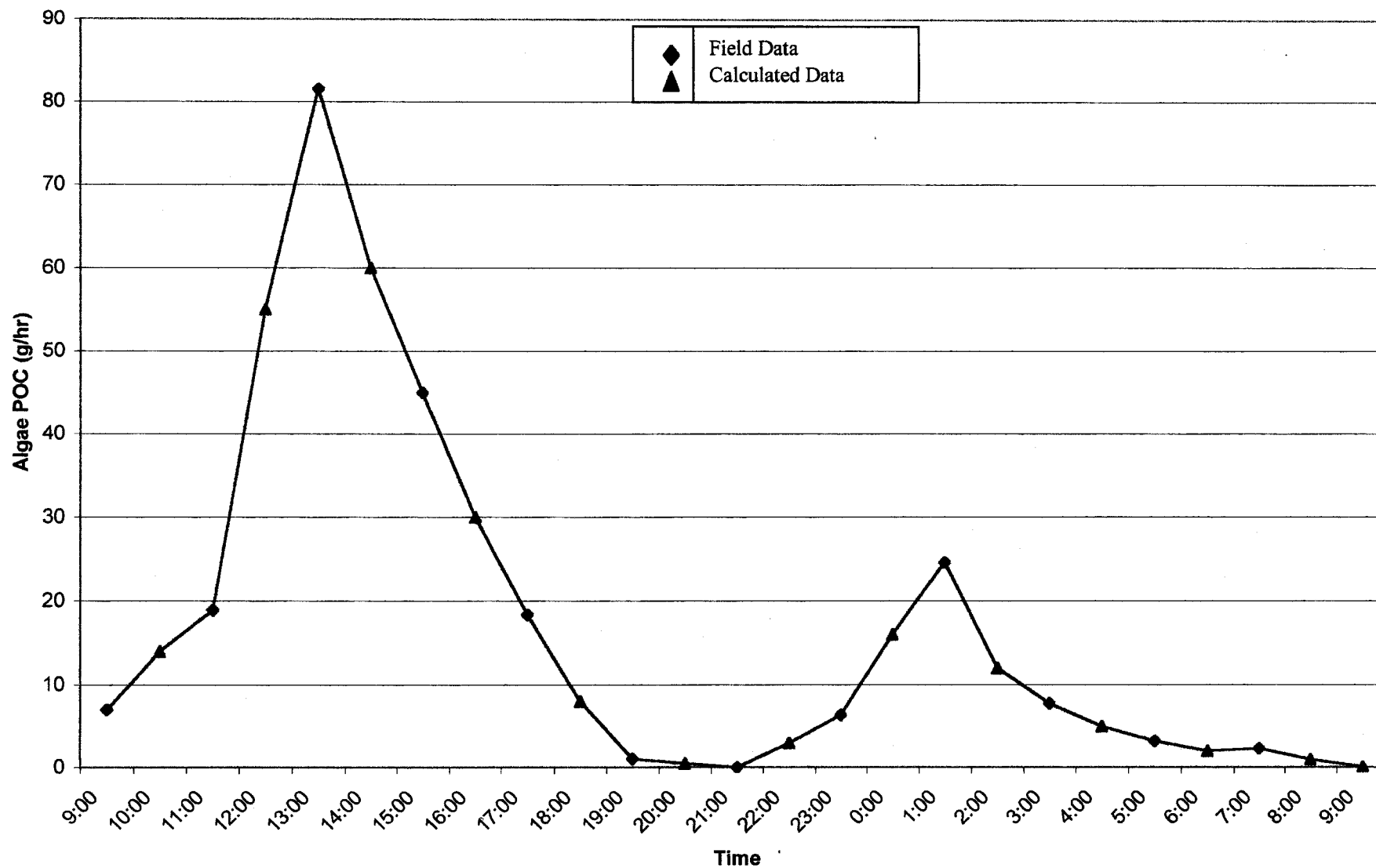


Figure 27. Treatment fringe December hourly algae particulate organic carbon load.

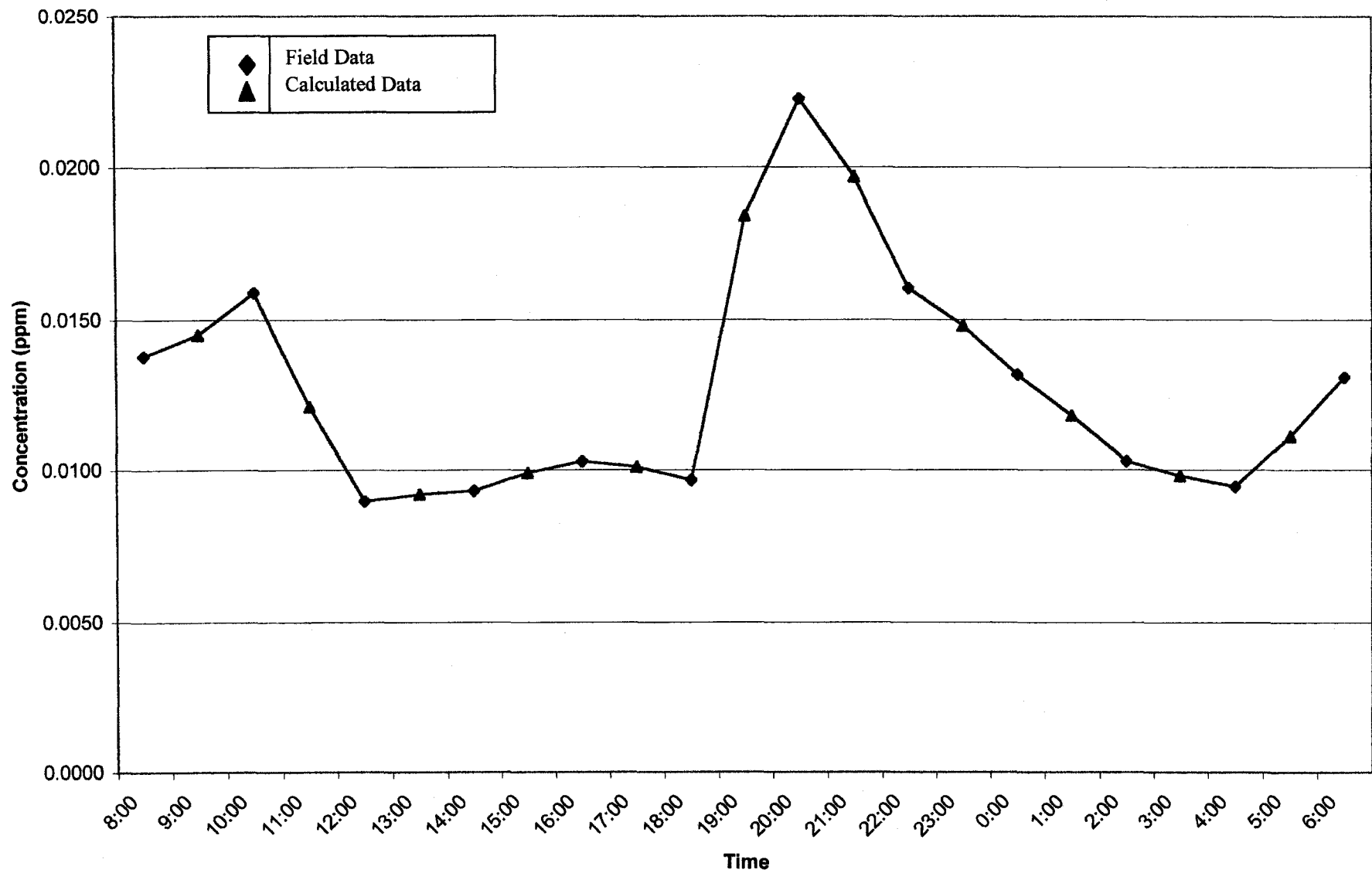


Figure 28. Treatment scrub December instantaneous NH_3 concentration-time plot.

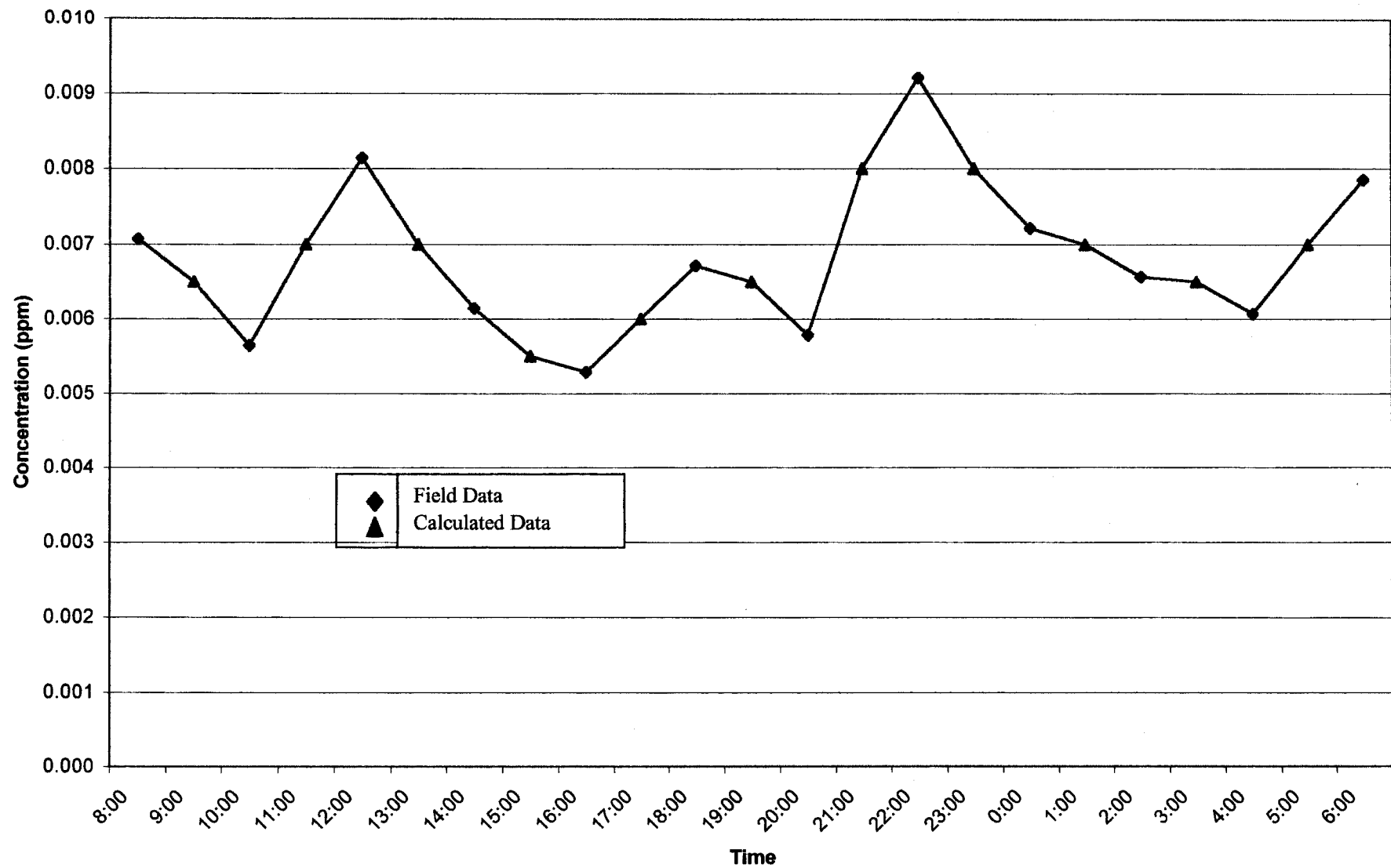


Figure 29. Treatment scrub December instantaneous NO2 + NO3 concentration-time plot.

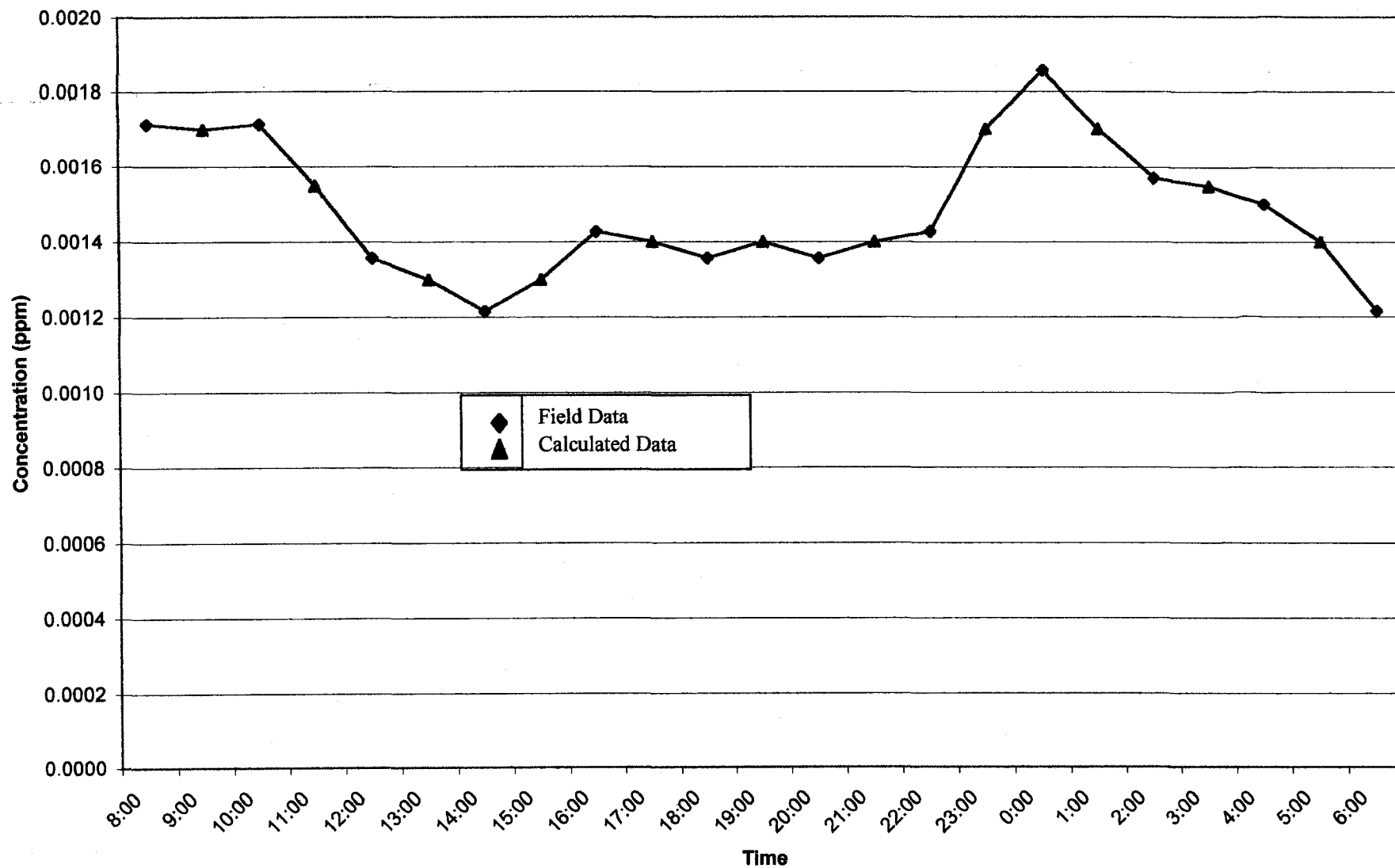


Figure 30. Treatment scrub December instantaneous NO2 concentration-time plot.

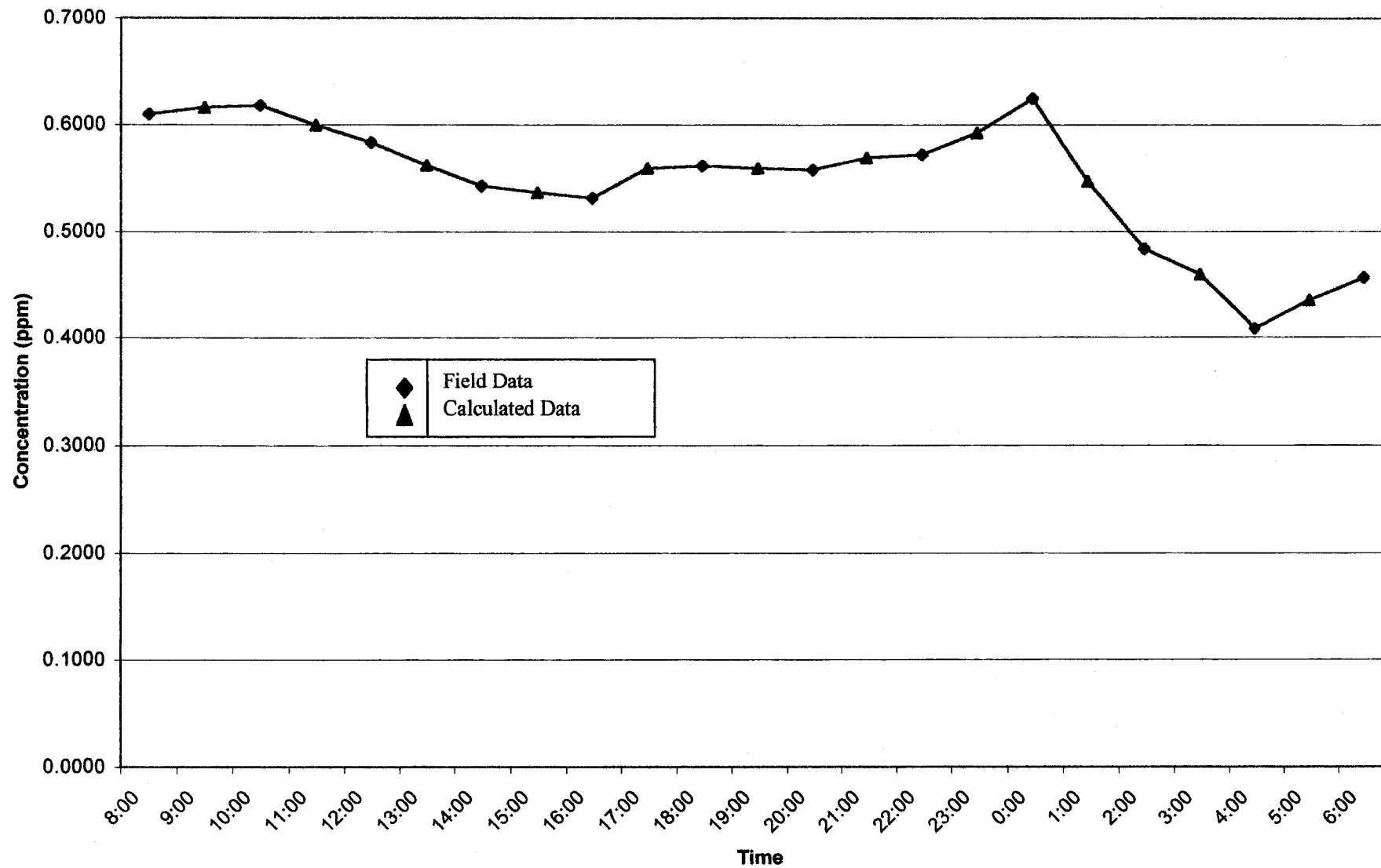


Figure 31. Treatment scrub December instantaneous TN concentration-time plot.

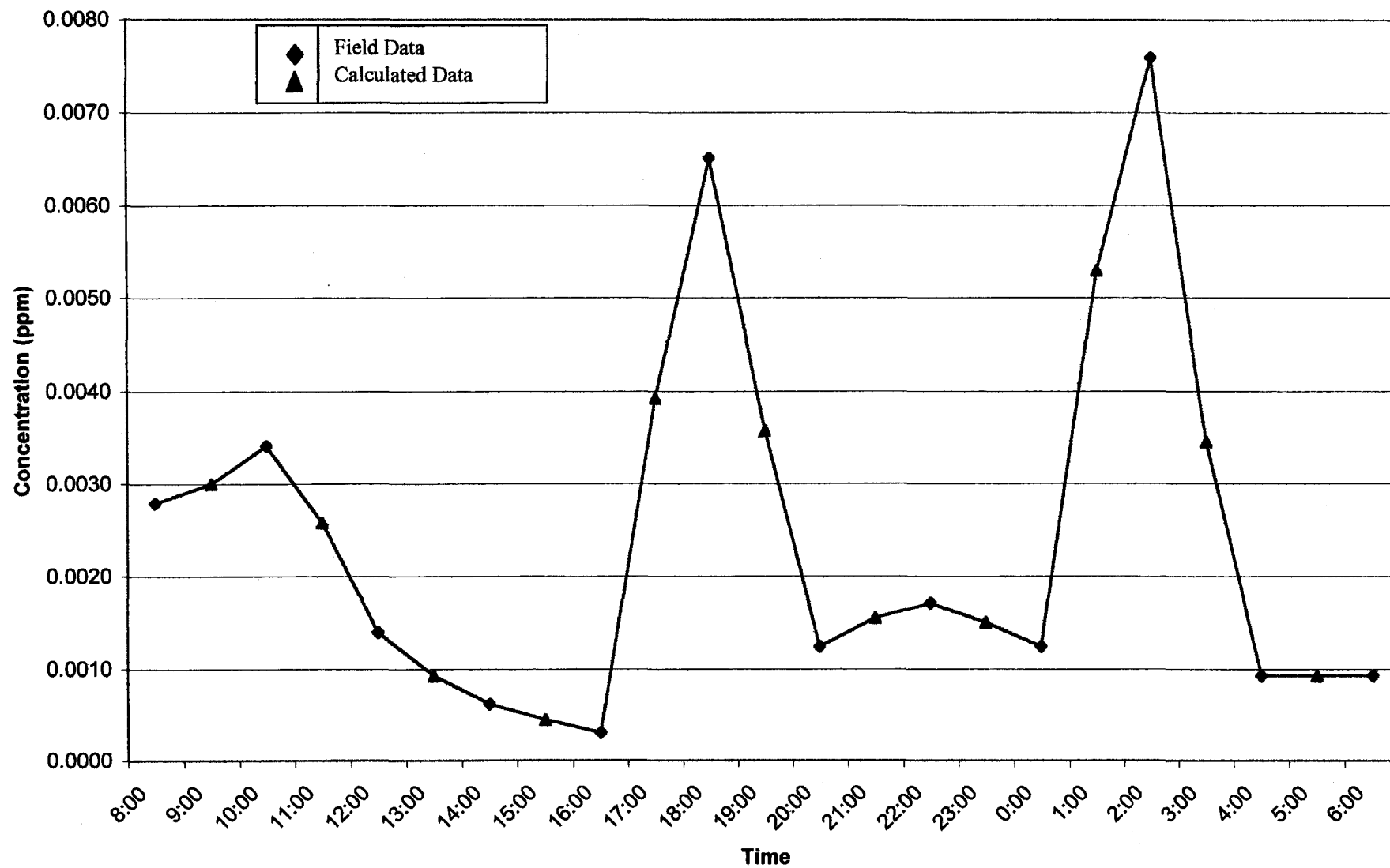


Figure 32. Treatment scrub December instantaneous SRP concentration-time plot

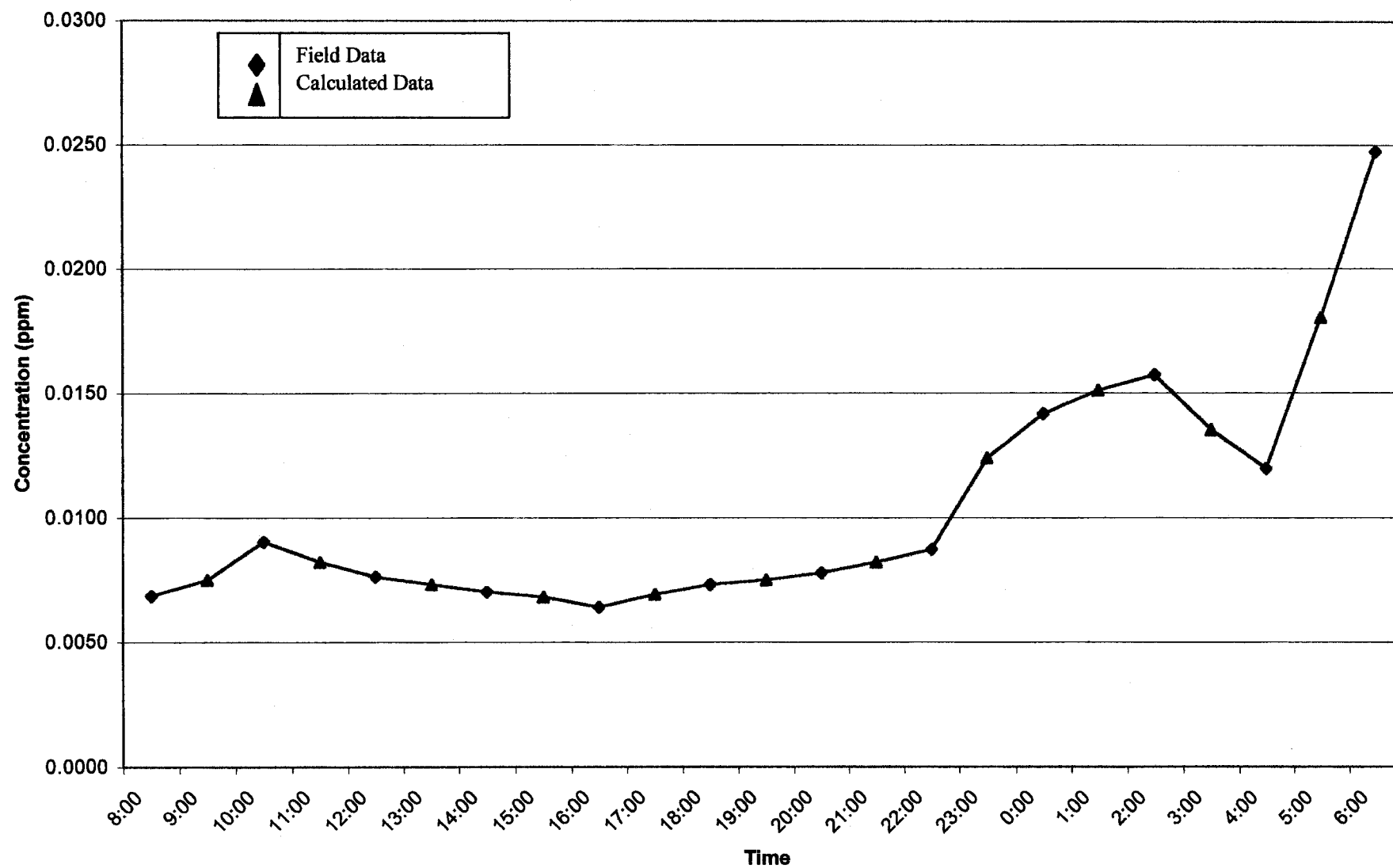


Figure 33. Treatment scrub December instantaneous TP concentration-time plot.

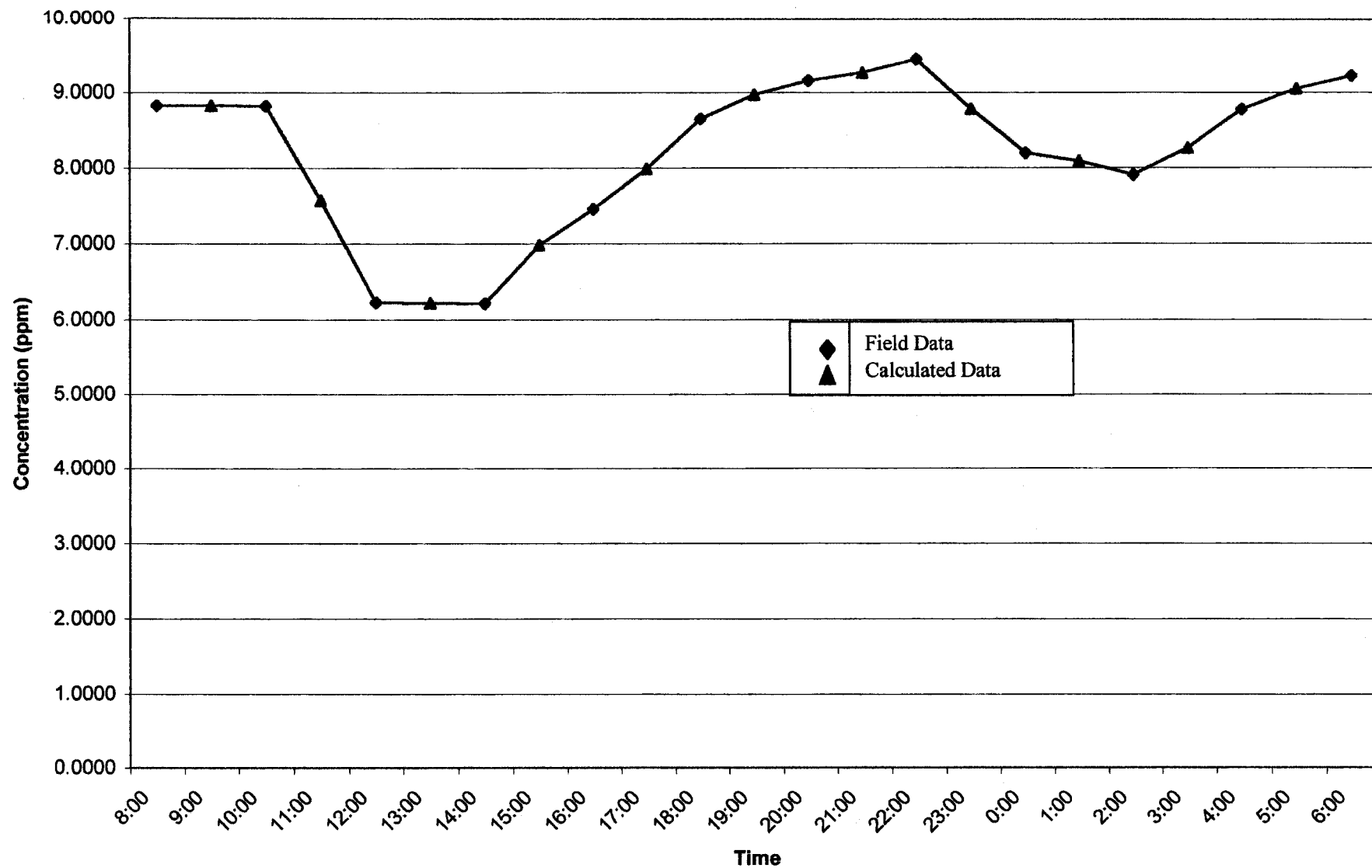


Figure 34. Treatment scrub December instantaneous TOC concentration-time plot.

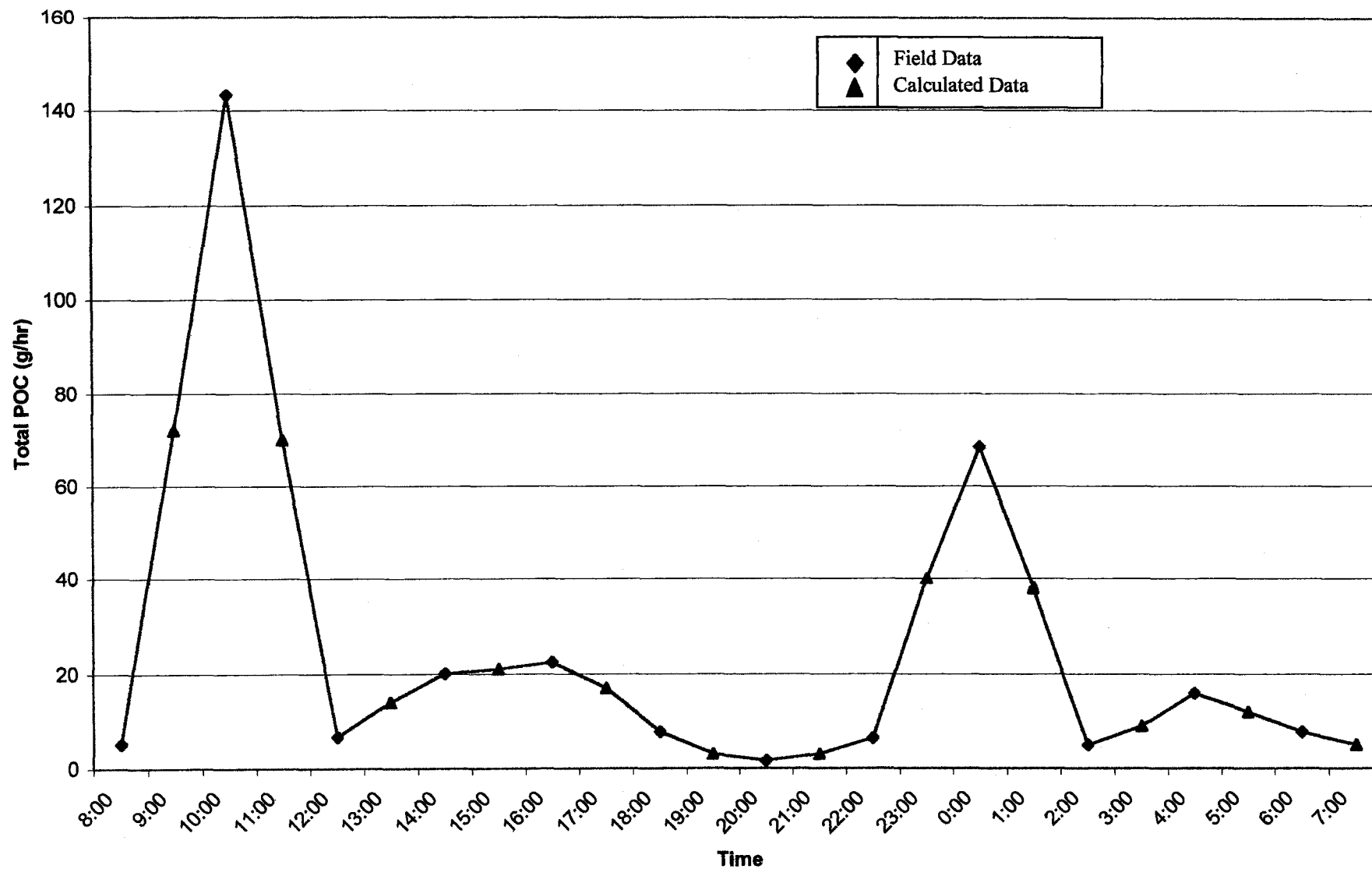


Figure 35. Treatment scrub December hourly total particulate organic carbon (POC) load.

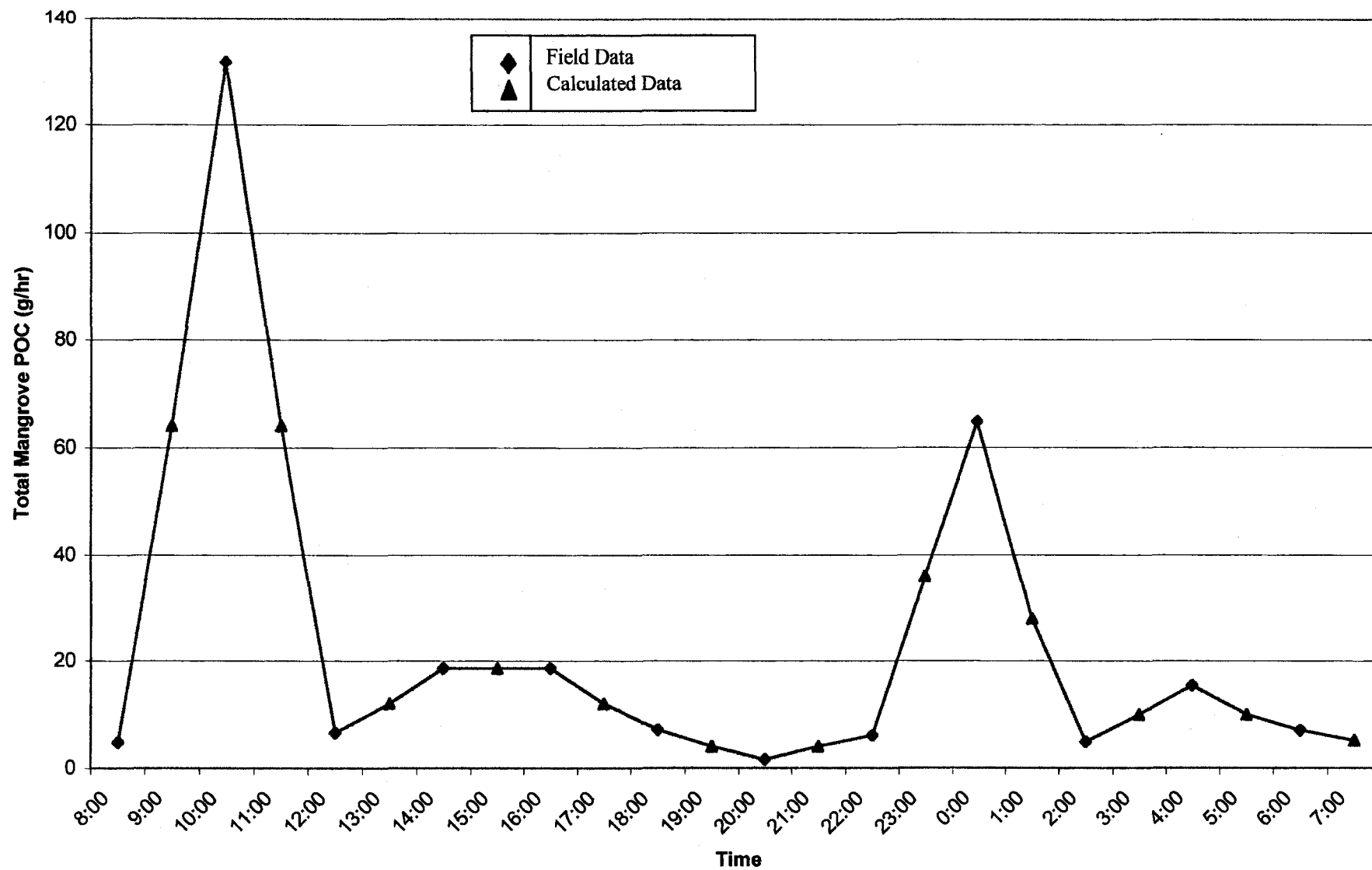


Figure 36. Treatment scrub December hourly total mangrove particulate organic carbon load.

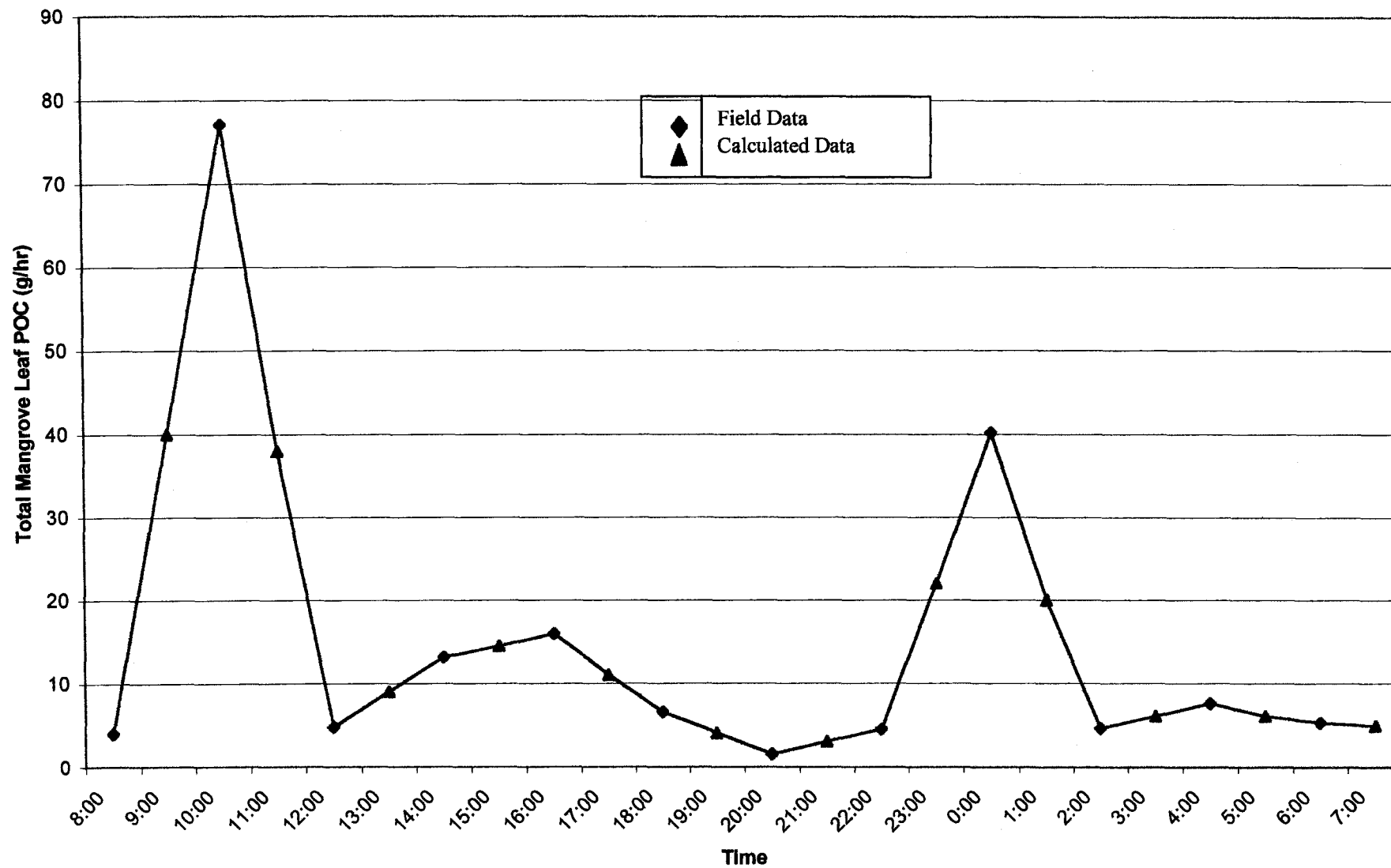


Figure 37. Treatment scrub December hourly mangrove leaf particulate organic carbon load.

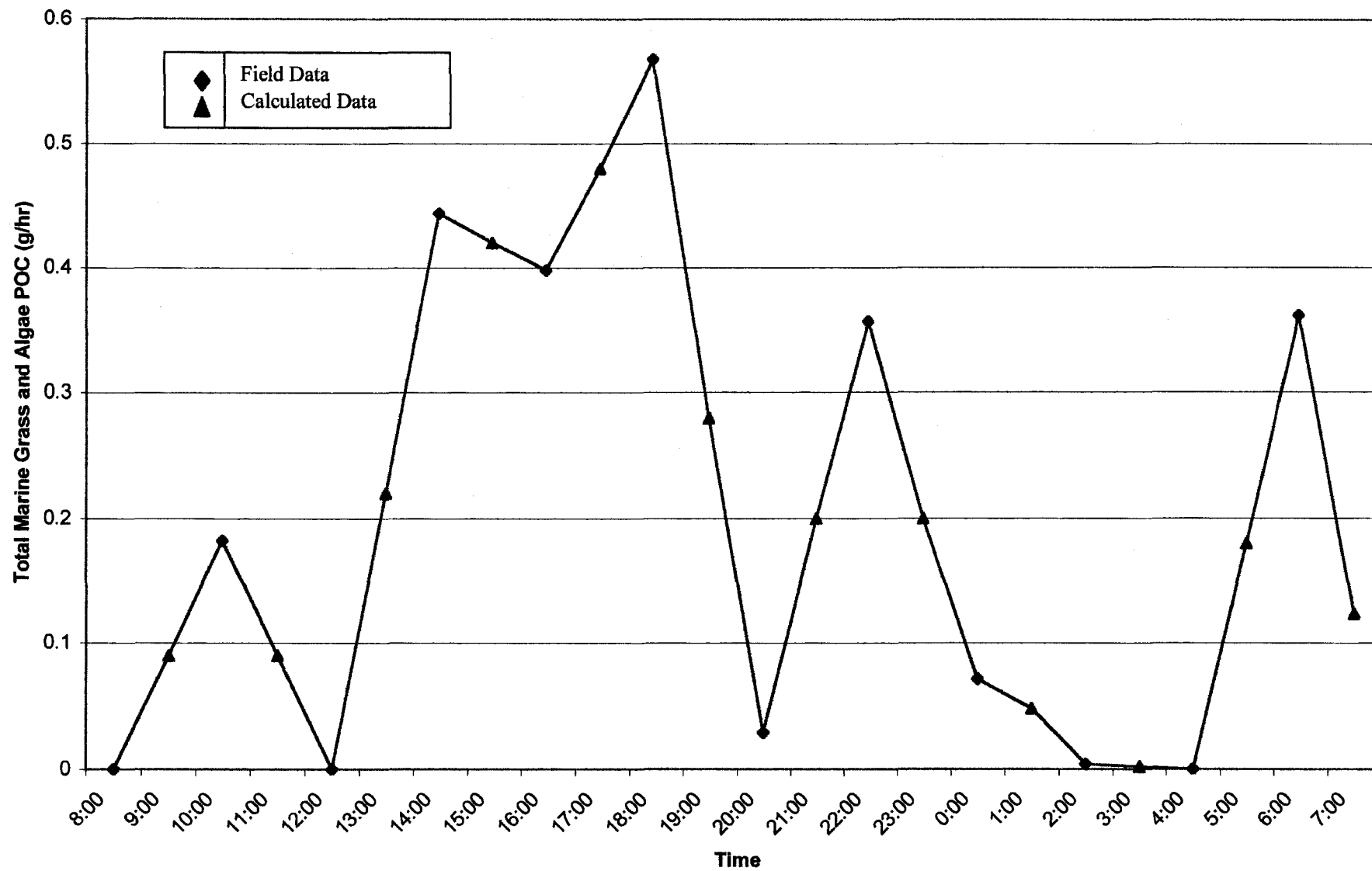


Figure 38. Treatment scrub December hourly total marine grass and algae particulate organic carbon load.

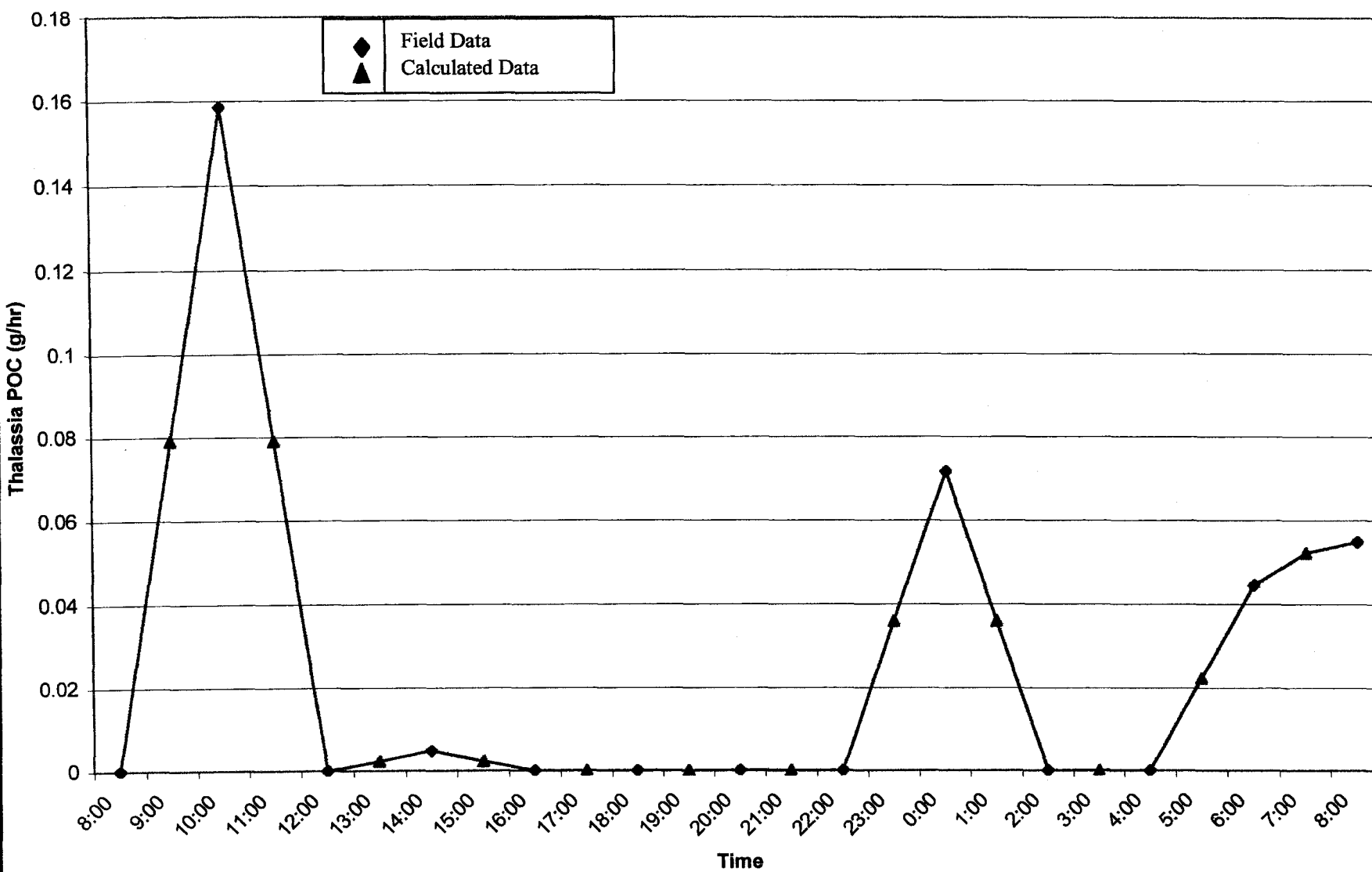


Figure 39. Treatment scrub December hourly Thalassia particulate organic carbon load.

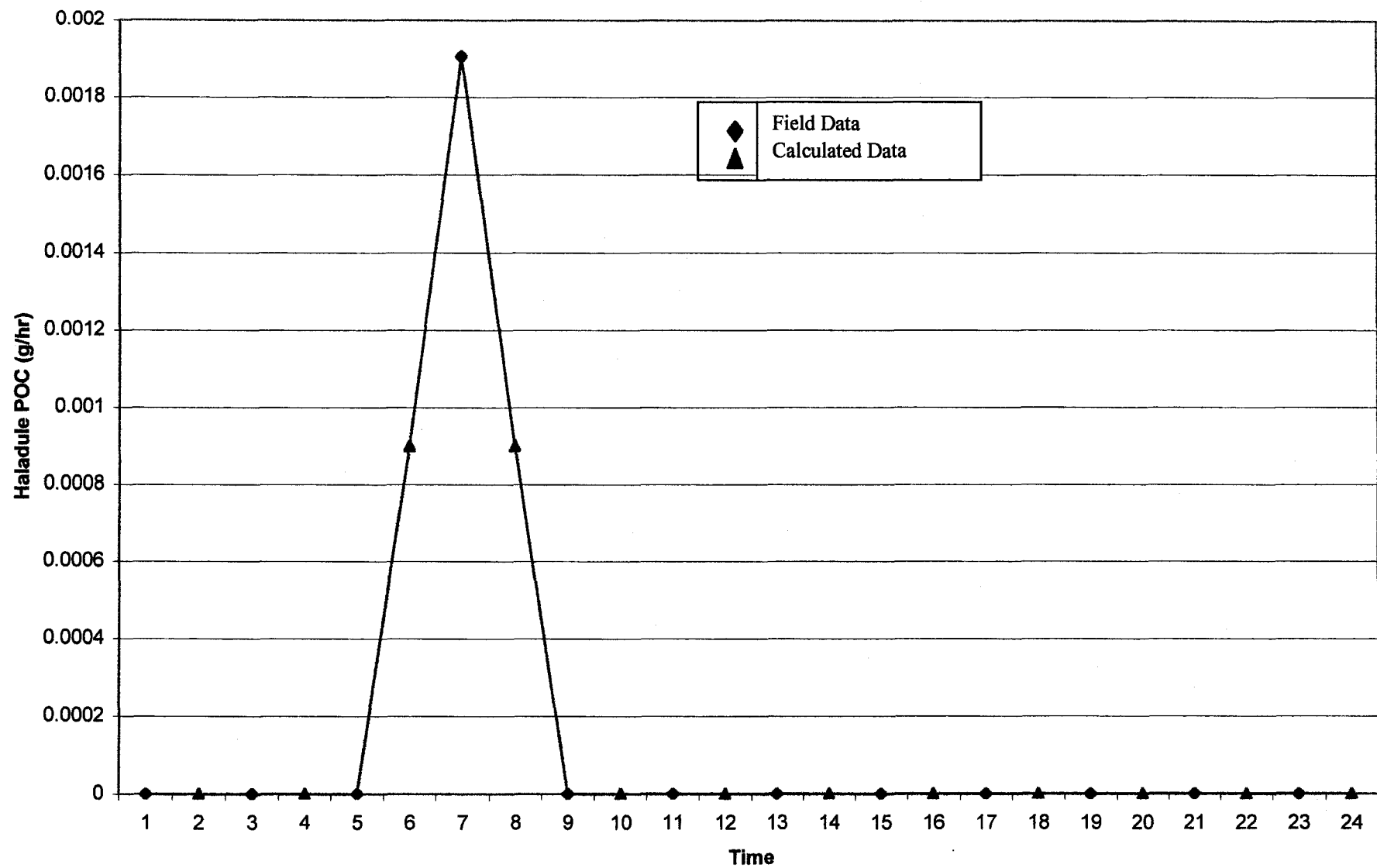


Figure 40. Treatment scrub December hourly Haladule particulate organic carbon load.

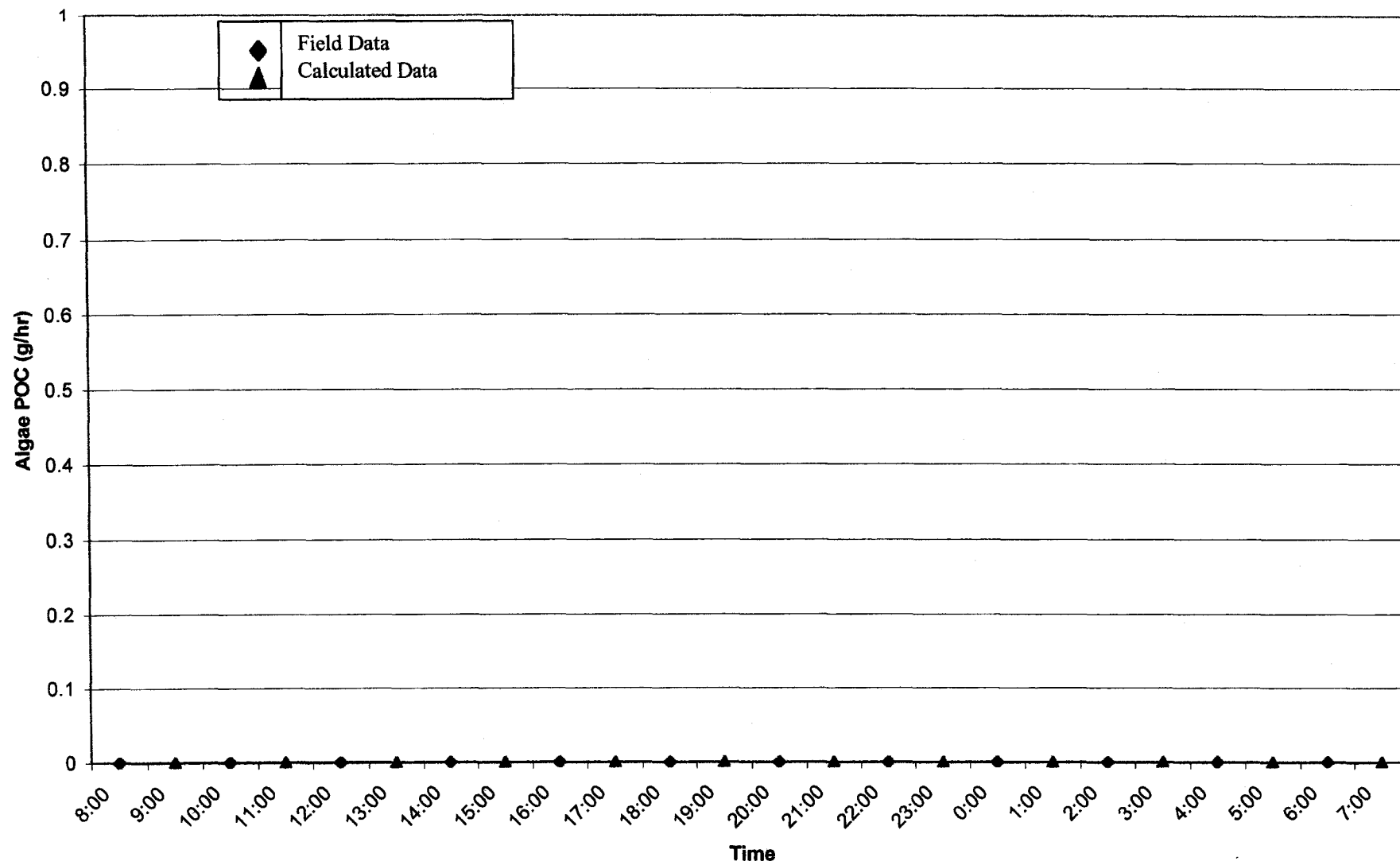


Figure 41. Treatment scrub December hourly algae particulate organic carbon load.

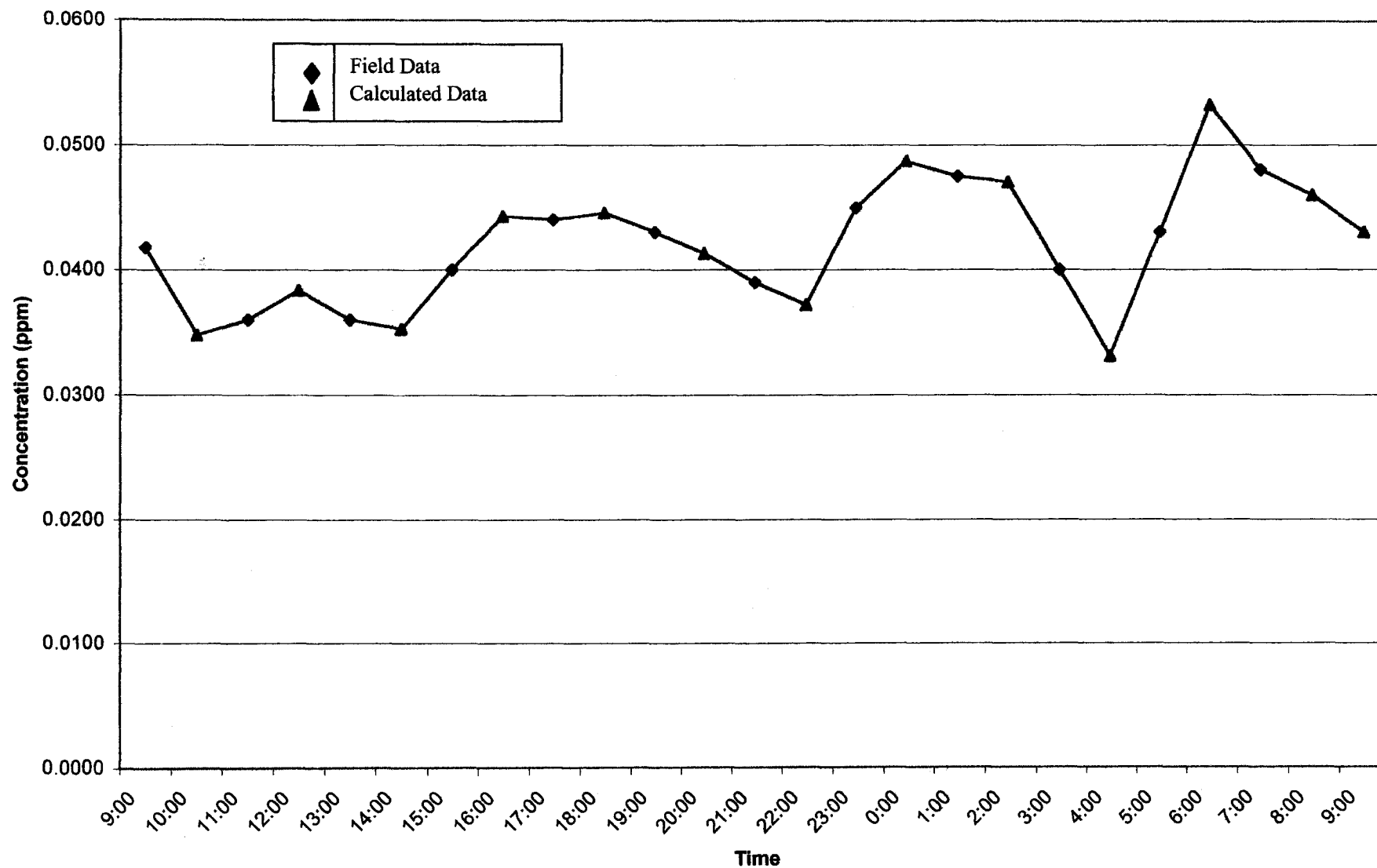


Figure 42. Control fringe December instantaneous NH4 concentration-time plot.

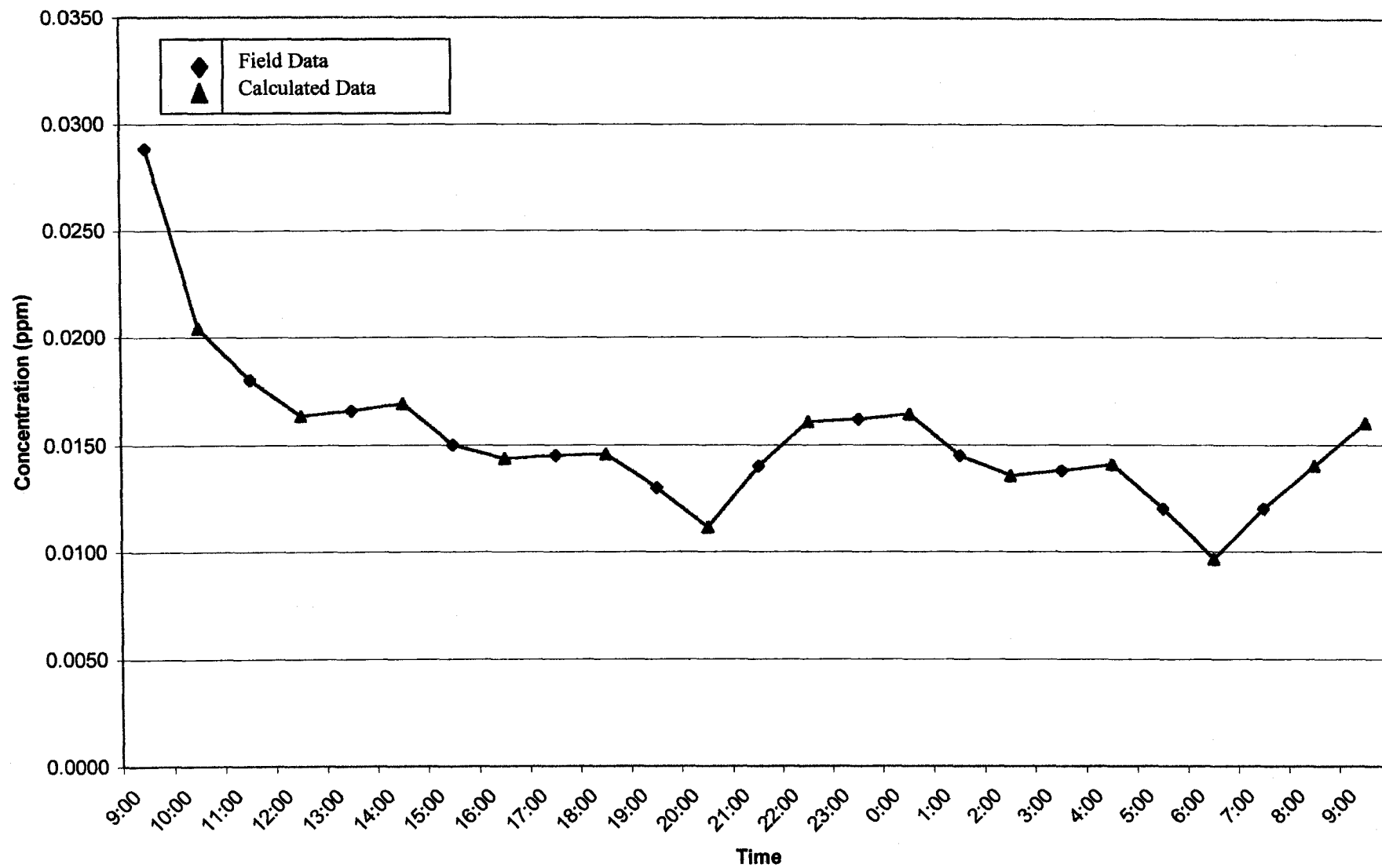


Figure 43. Control fringe December instantaneous NO2 + NO3 concentration-time plot.

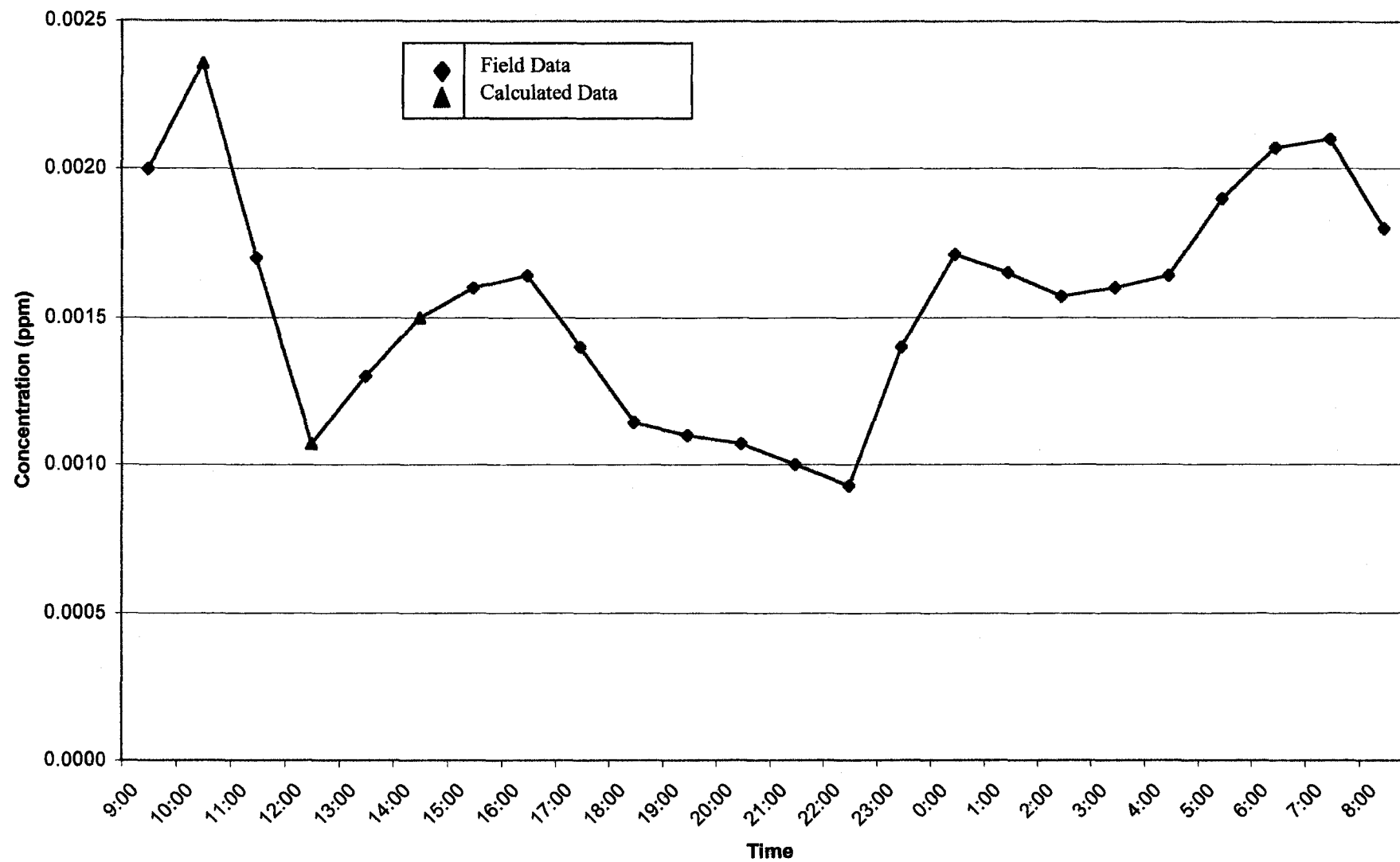


Figure 44. Control fringe December instantaneous NO₂ concentration-time plot.

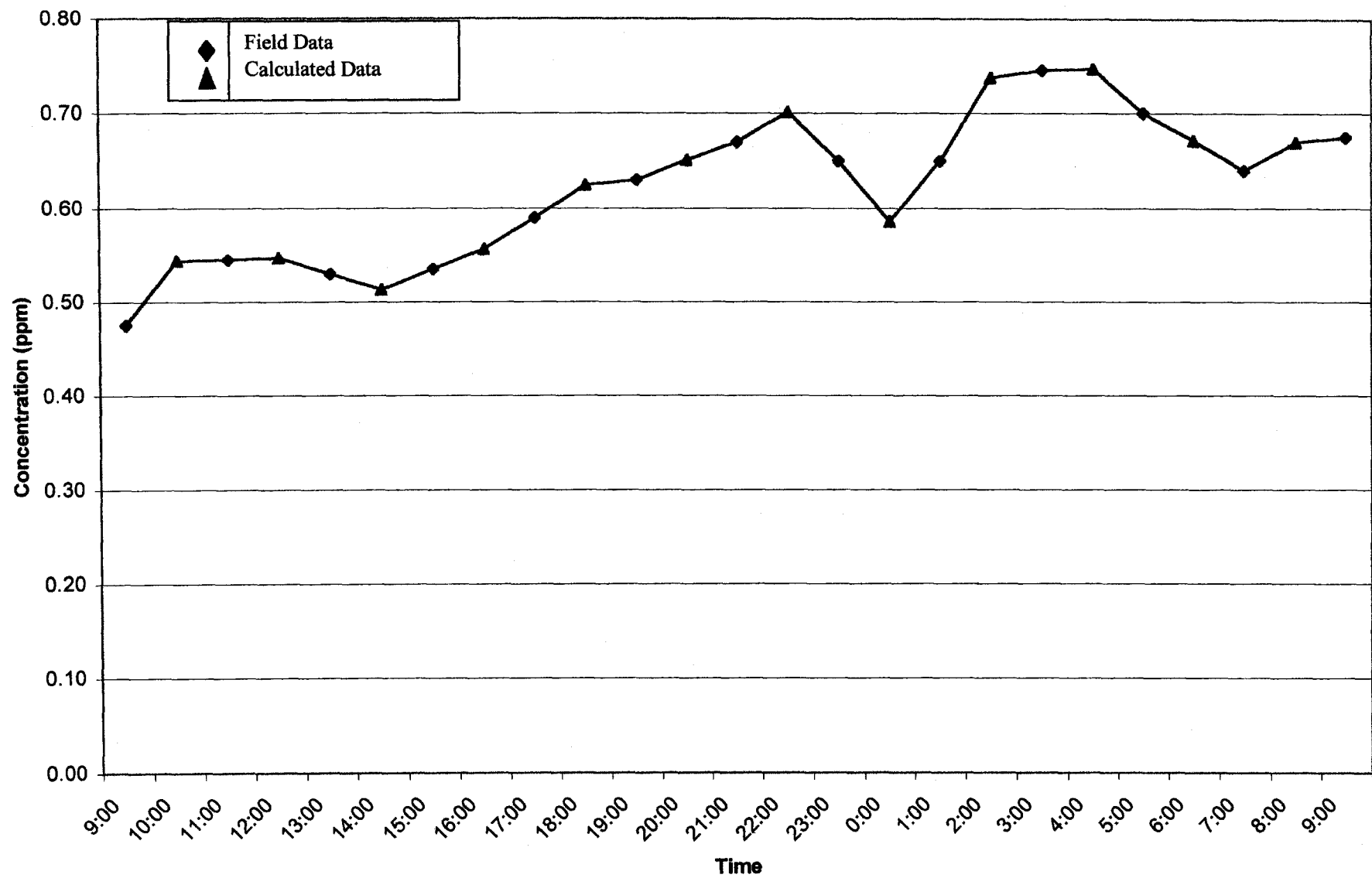


Figure 45. Control fringe December instantaneous TN concentration-time plot.

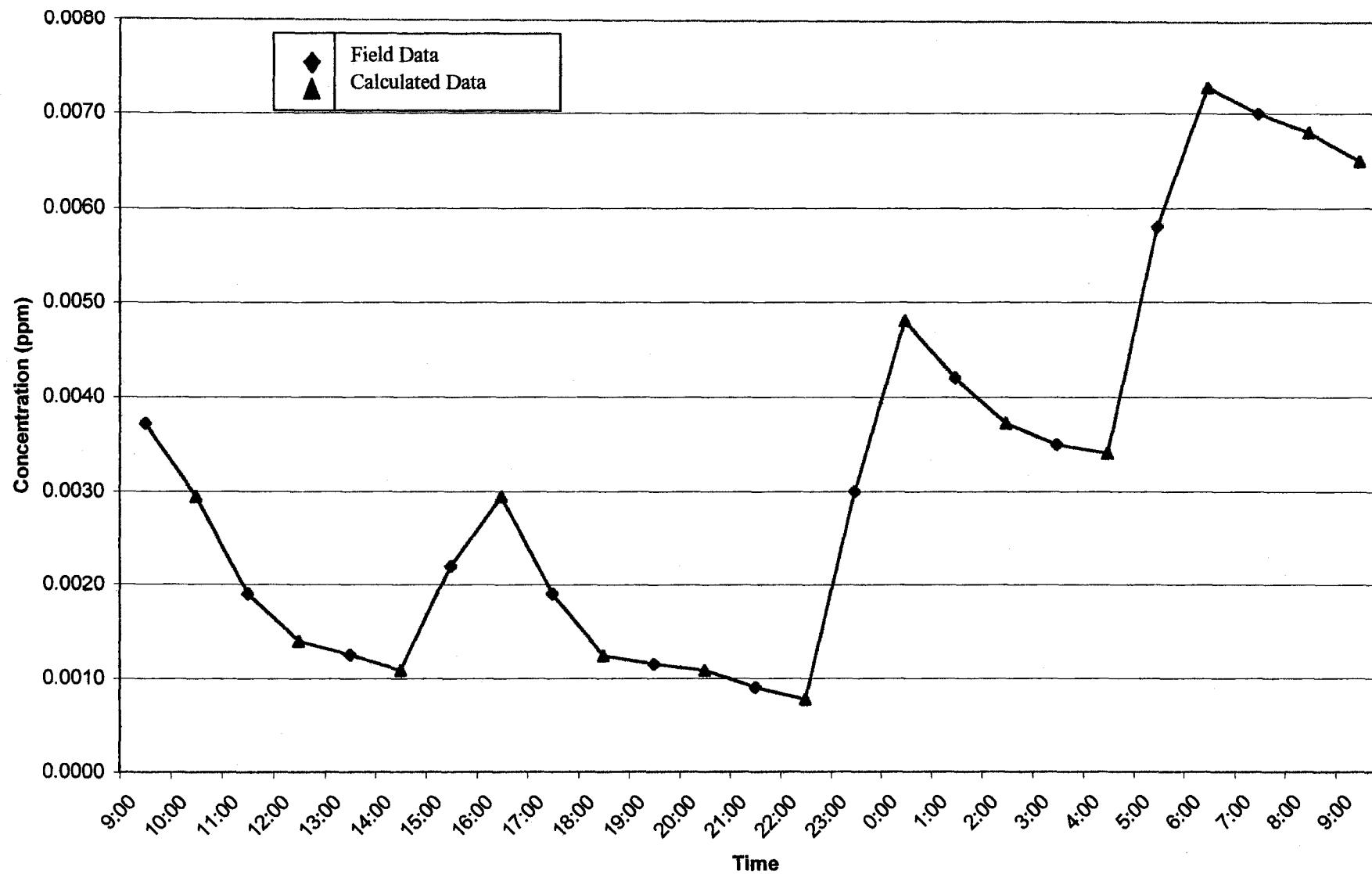


Figure 46. Control fringe December instantaneous SRP concentration-time plot.

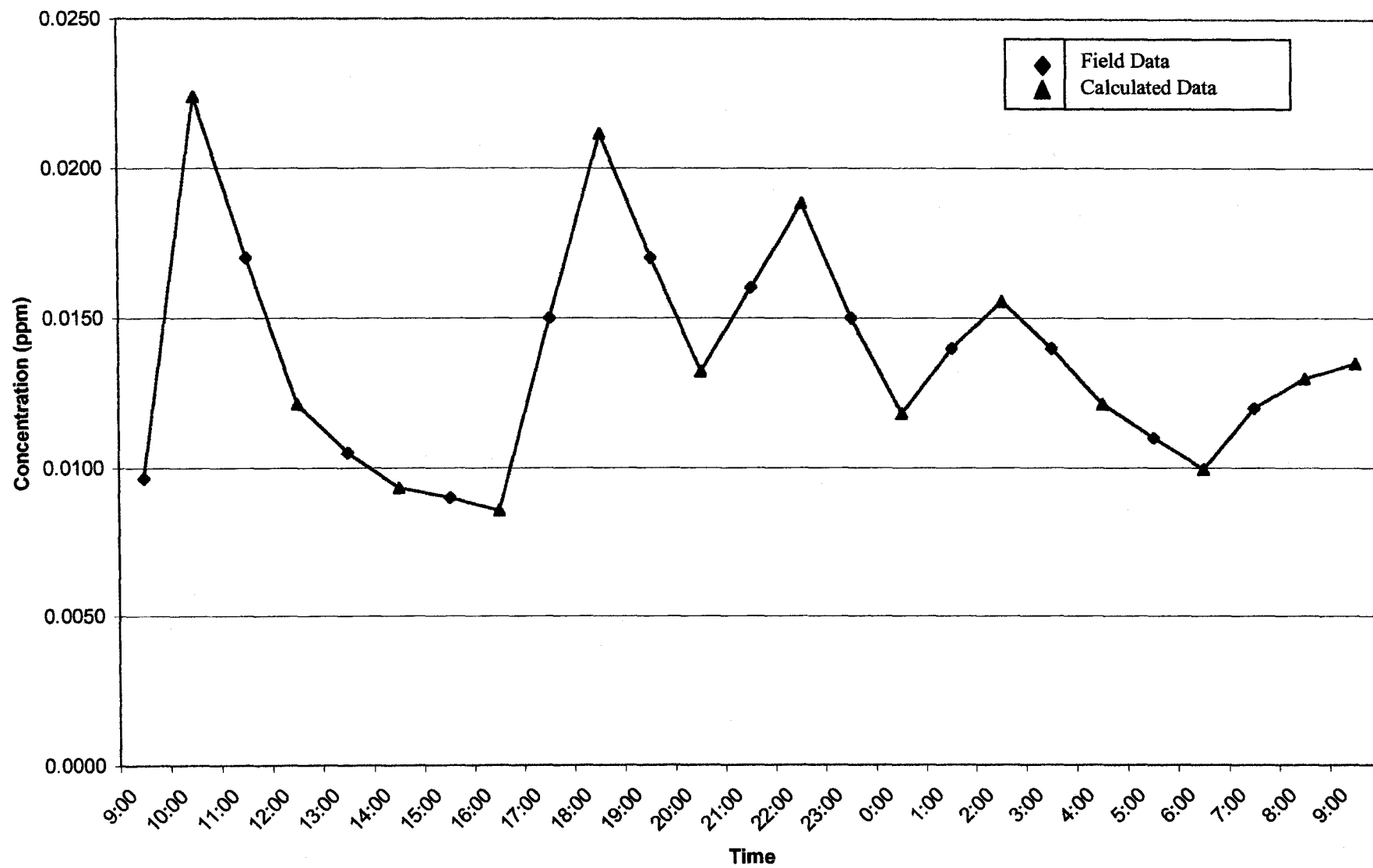


Figure 47. Control fringe December instantaneous TP concentration-time plot.

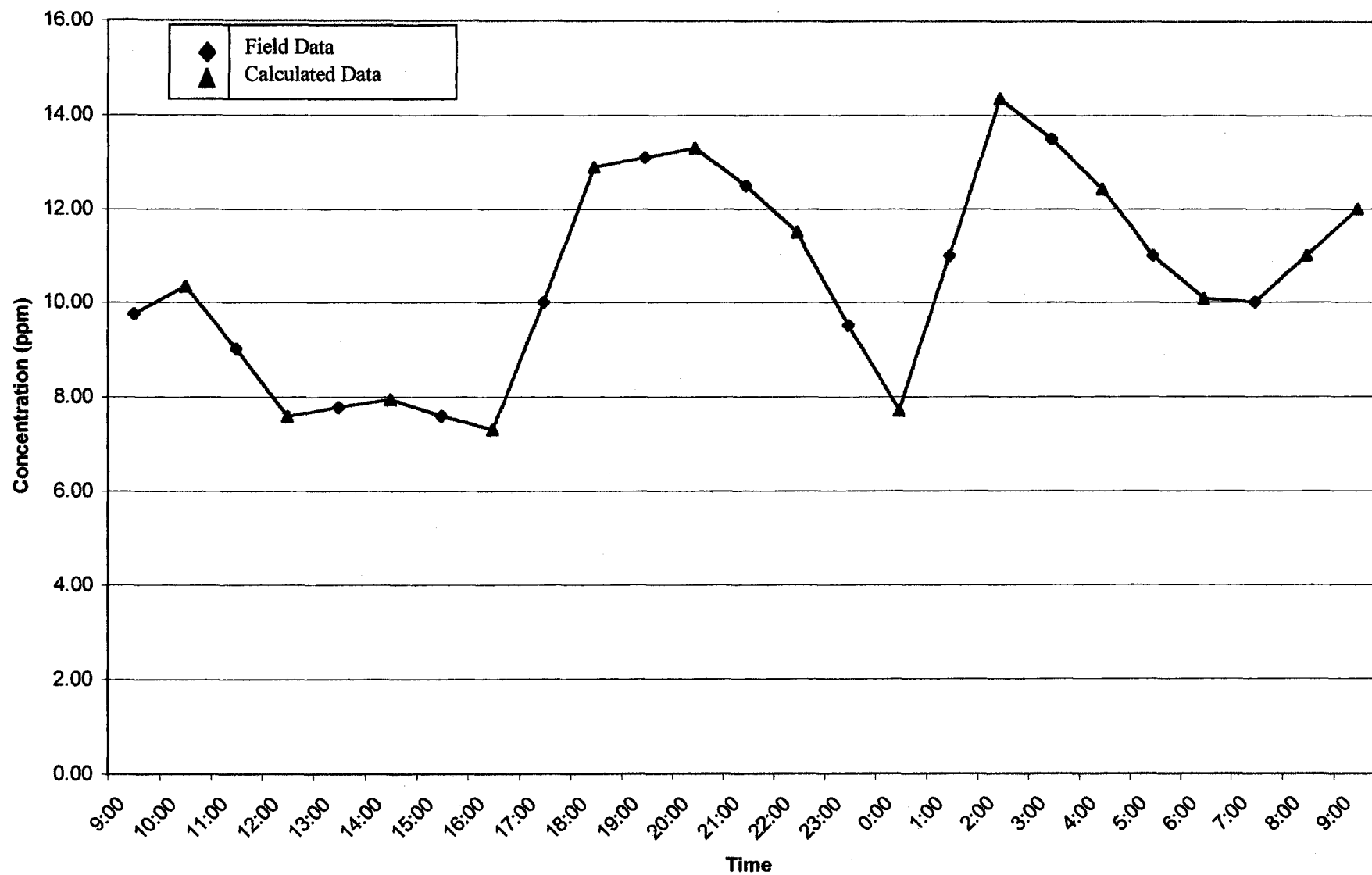


Figure 48. Control fringe December instantaneous TOC concentration-time plot.

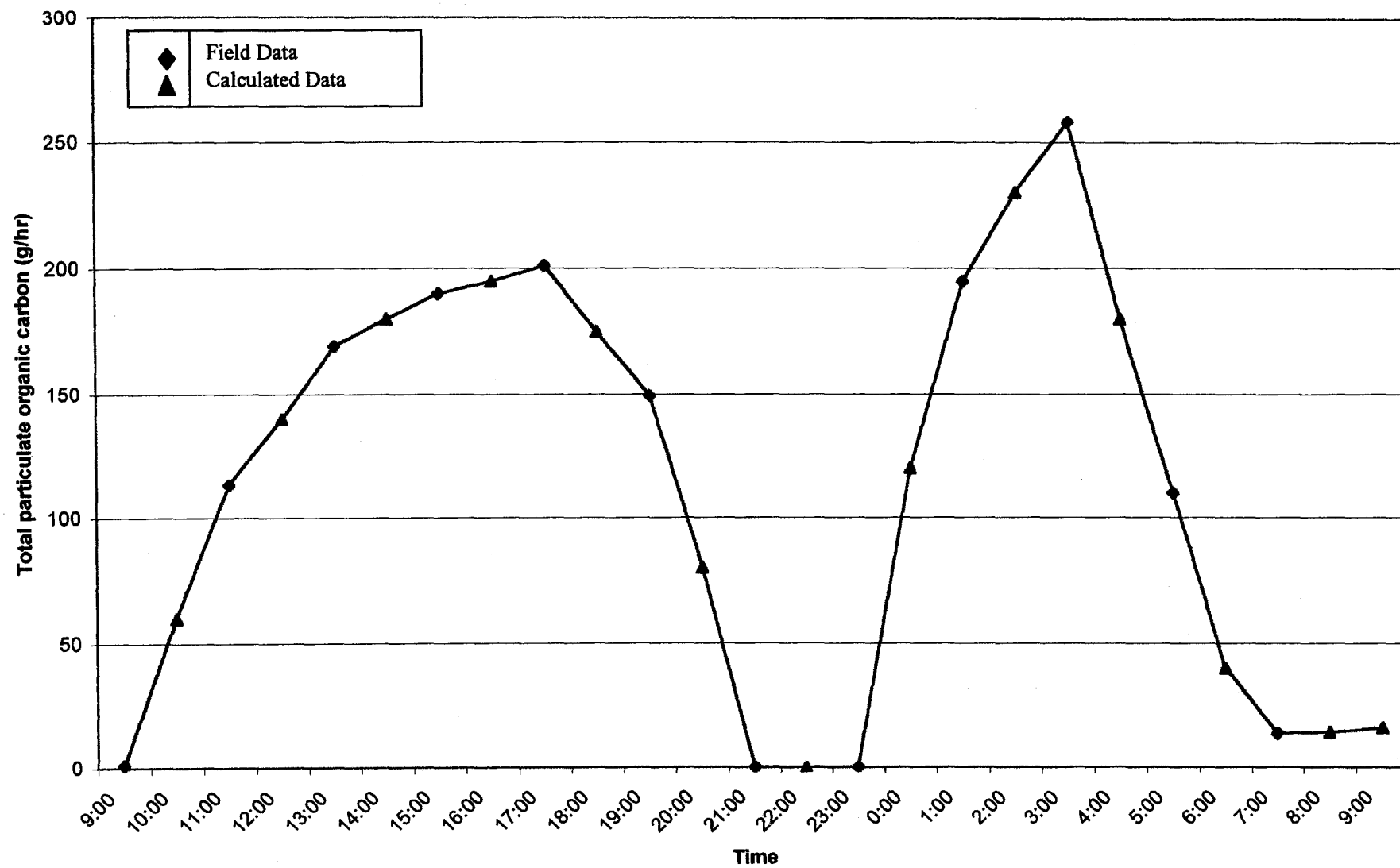


Figure 49. Control fringe December hourly total particulate organic carbon (POC) load.

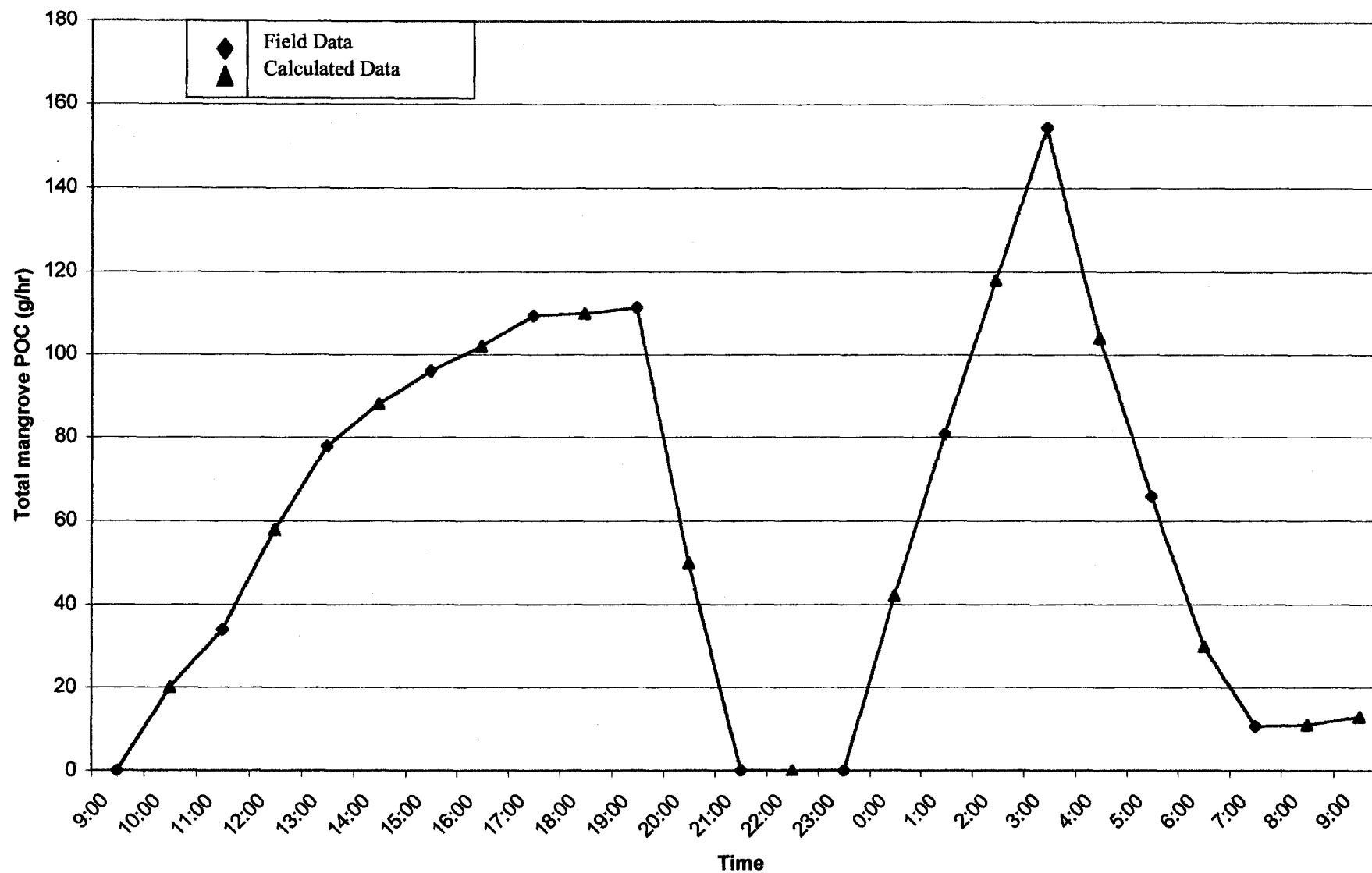


Figure 50. Control fringe December hourly total mangrove particulate organic carbon load.

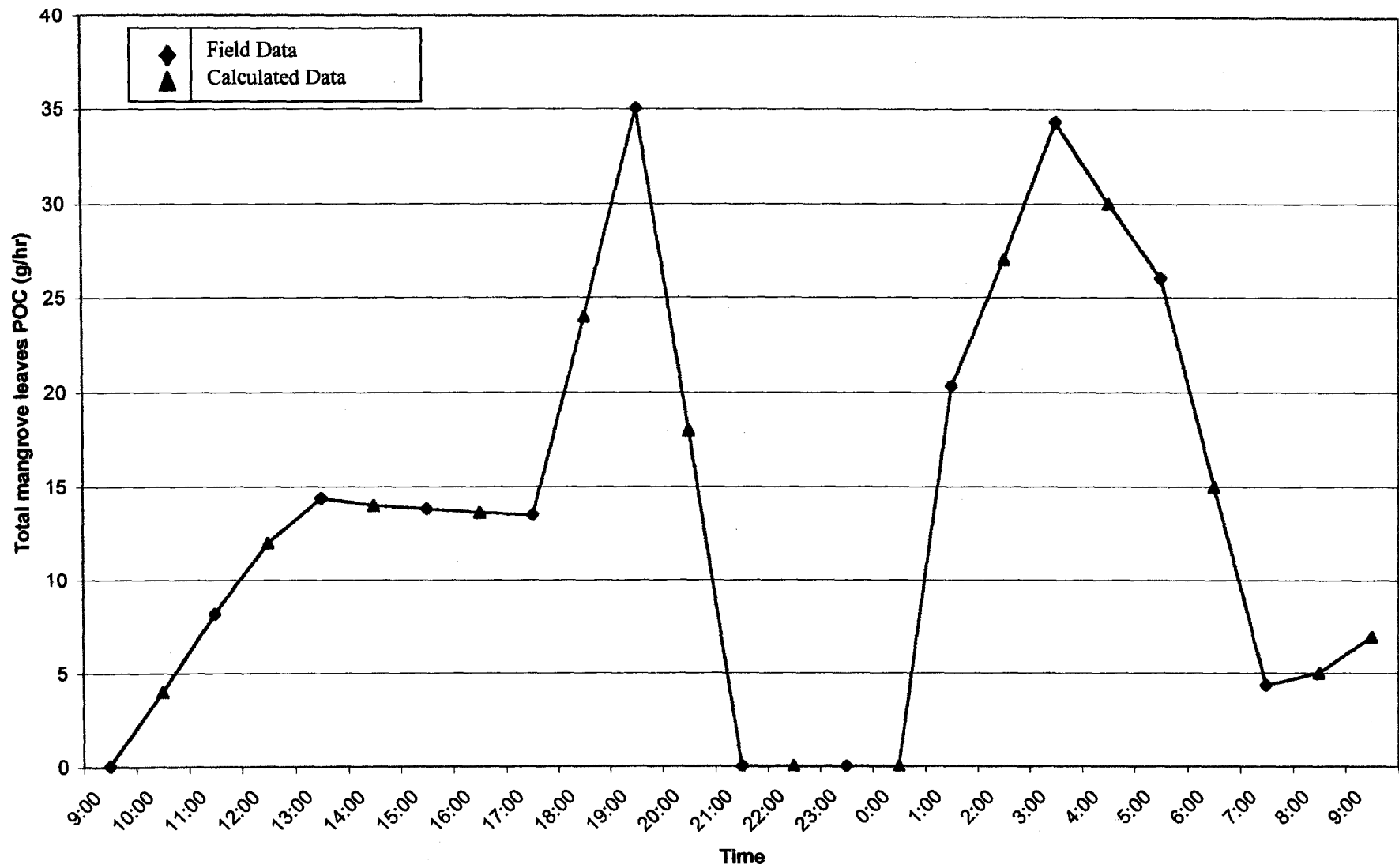


Figure 51. Control fringe December hourly mangrove leaf particulate organic carbon load.

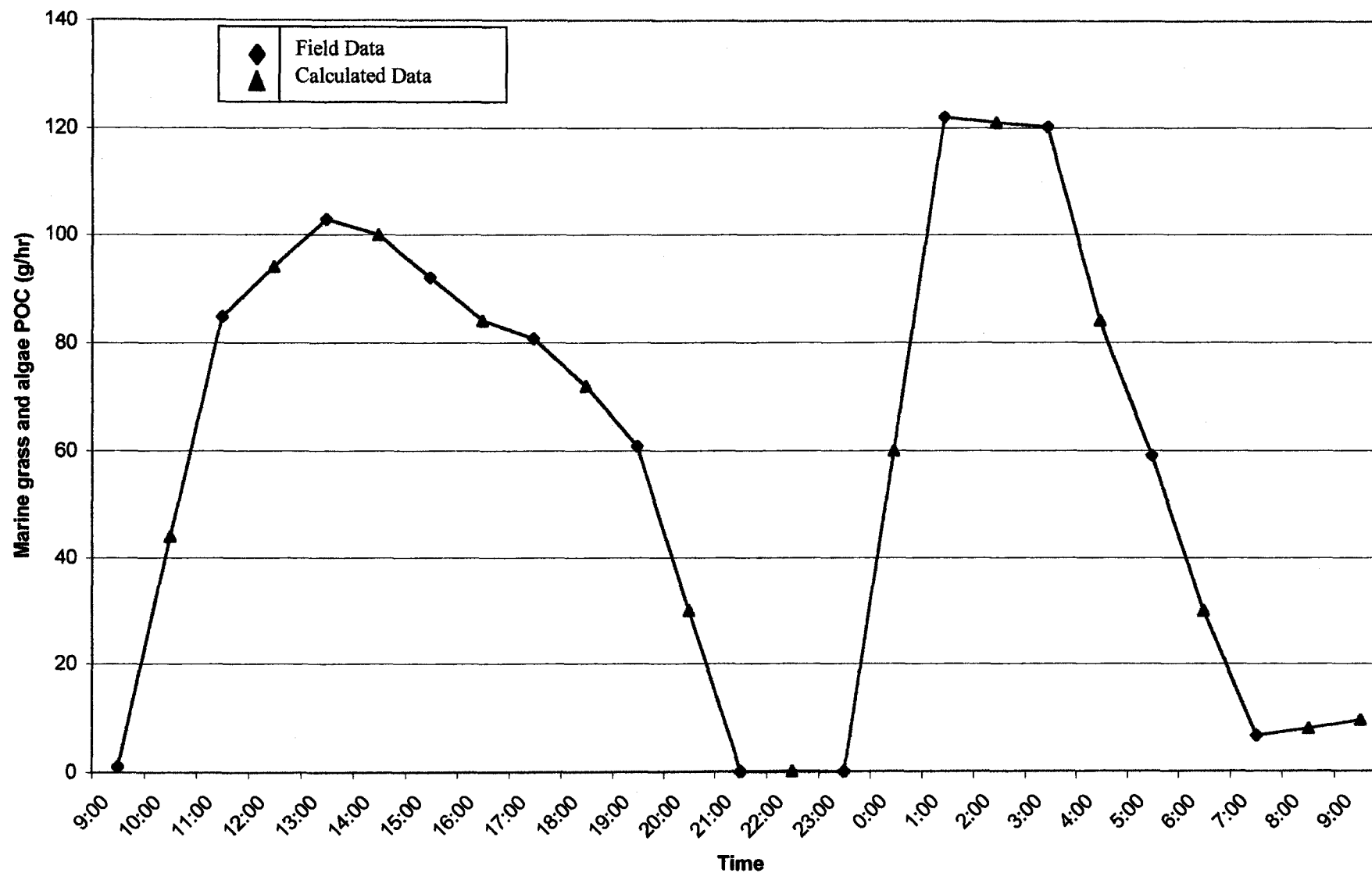


Figure 52. Control fringe December hourly total marine grass and algae particulate organic carbon load.

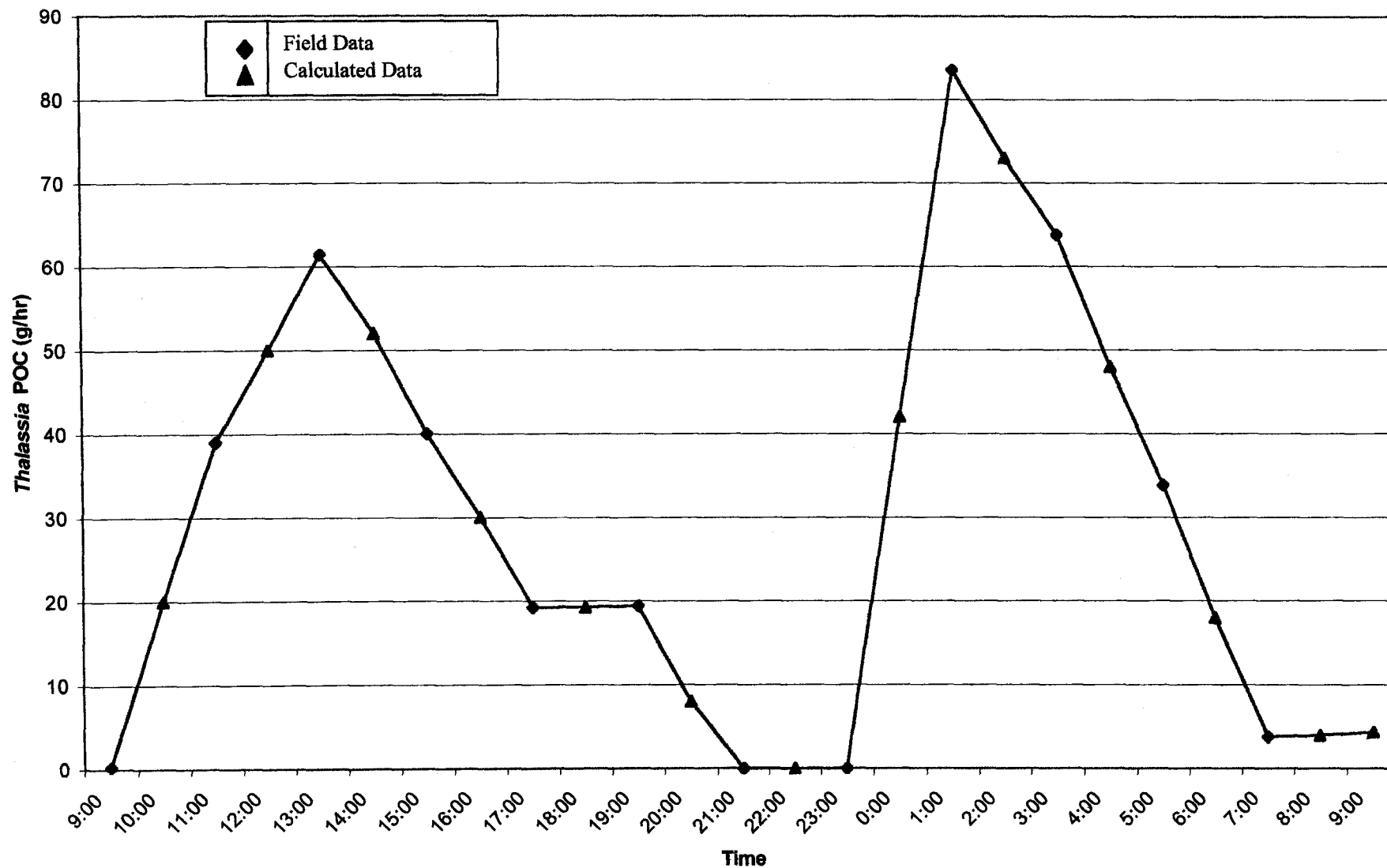


Figure 53. Control fringe December hourly *Thalassia* particulate organic carbon load.

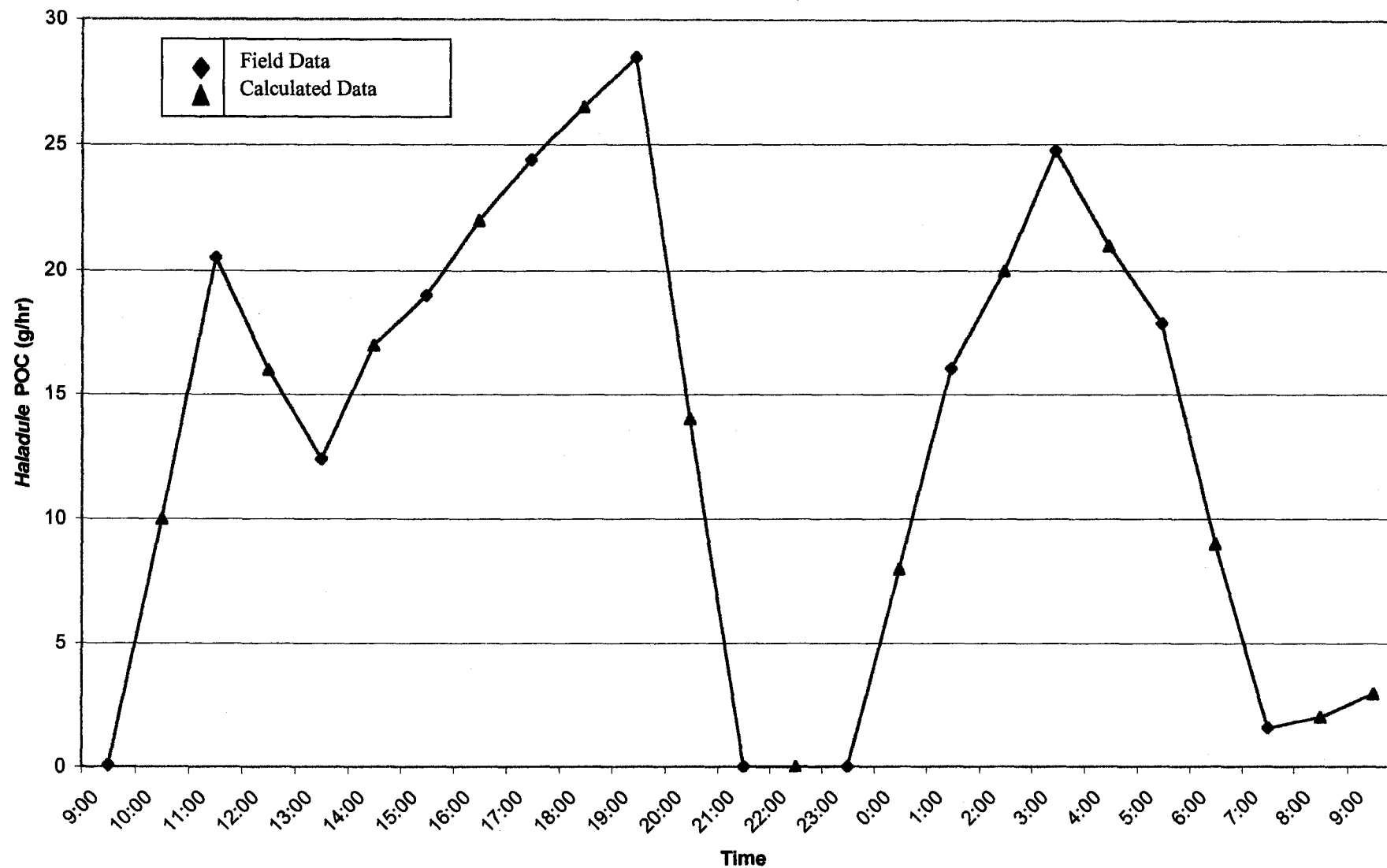


Figure 54. Control fringe December hourly *Halodule* particulate organic carbon load.

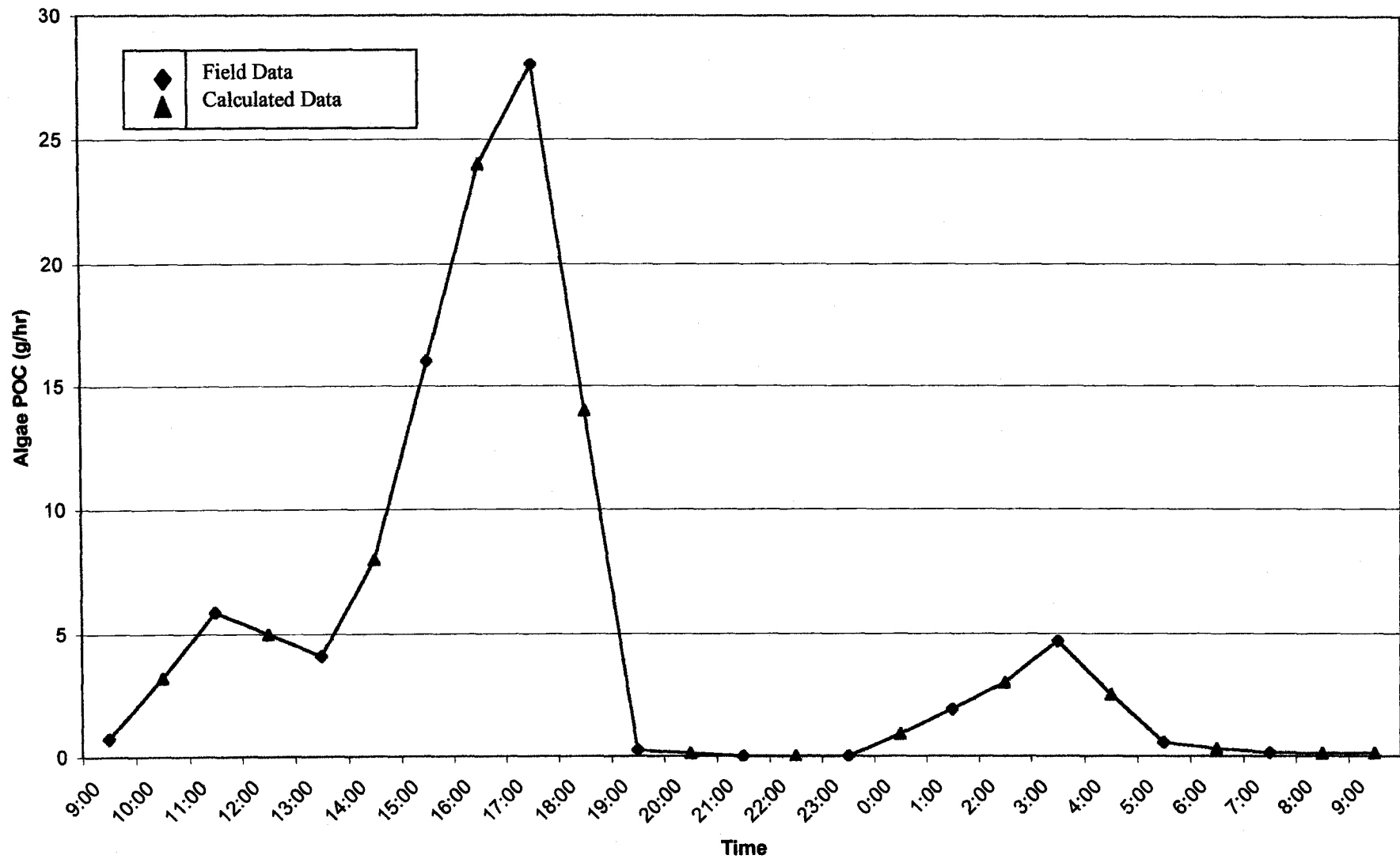


Figure 55. Control fringe December hourly algae particulate organic carbon load.

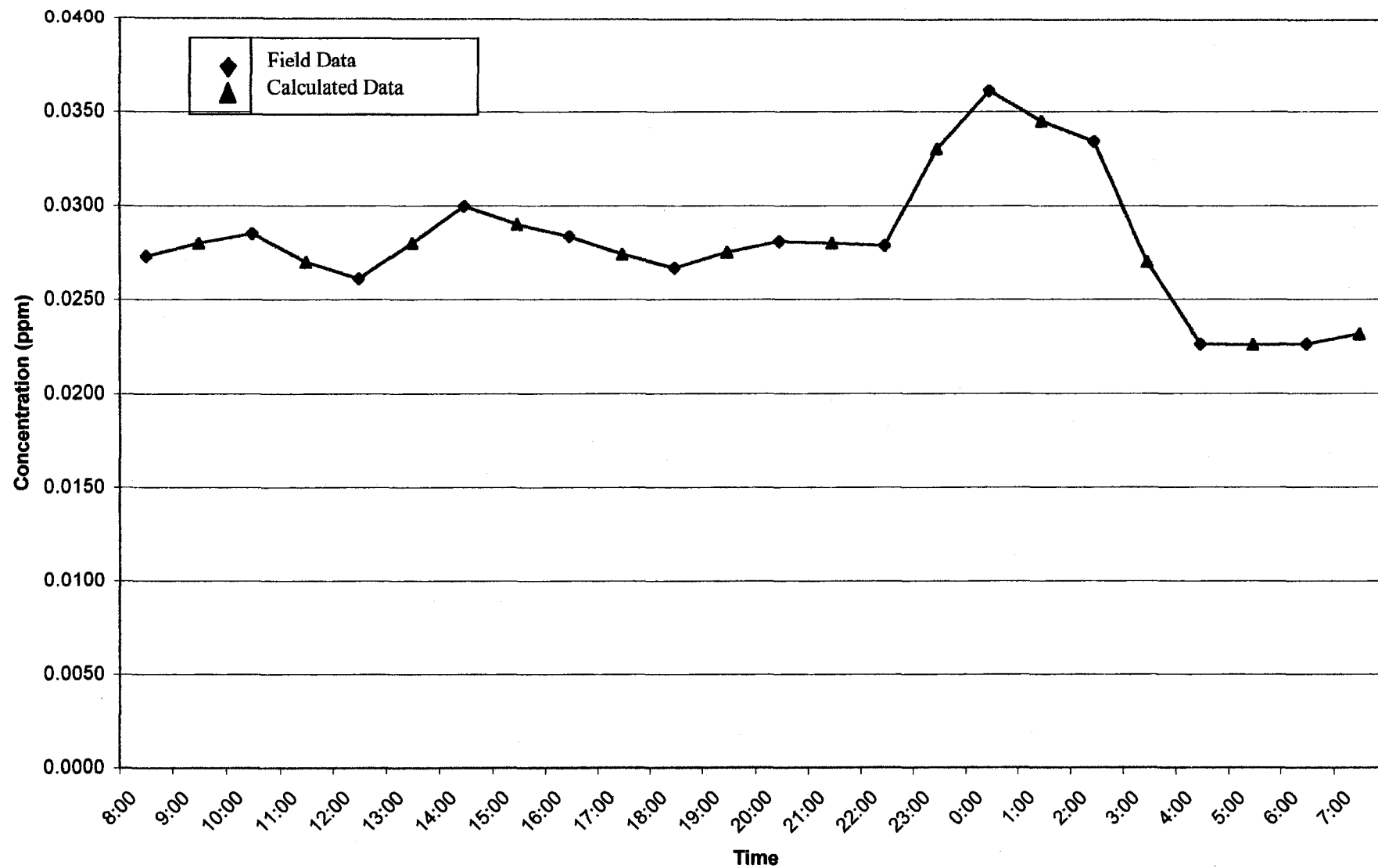


Figure 56. Control scrub December instantaneous NH_4 concentration-time plot

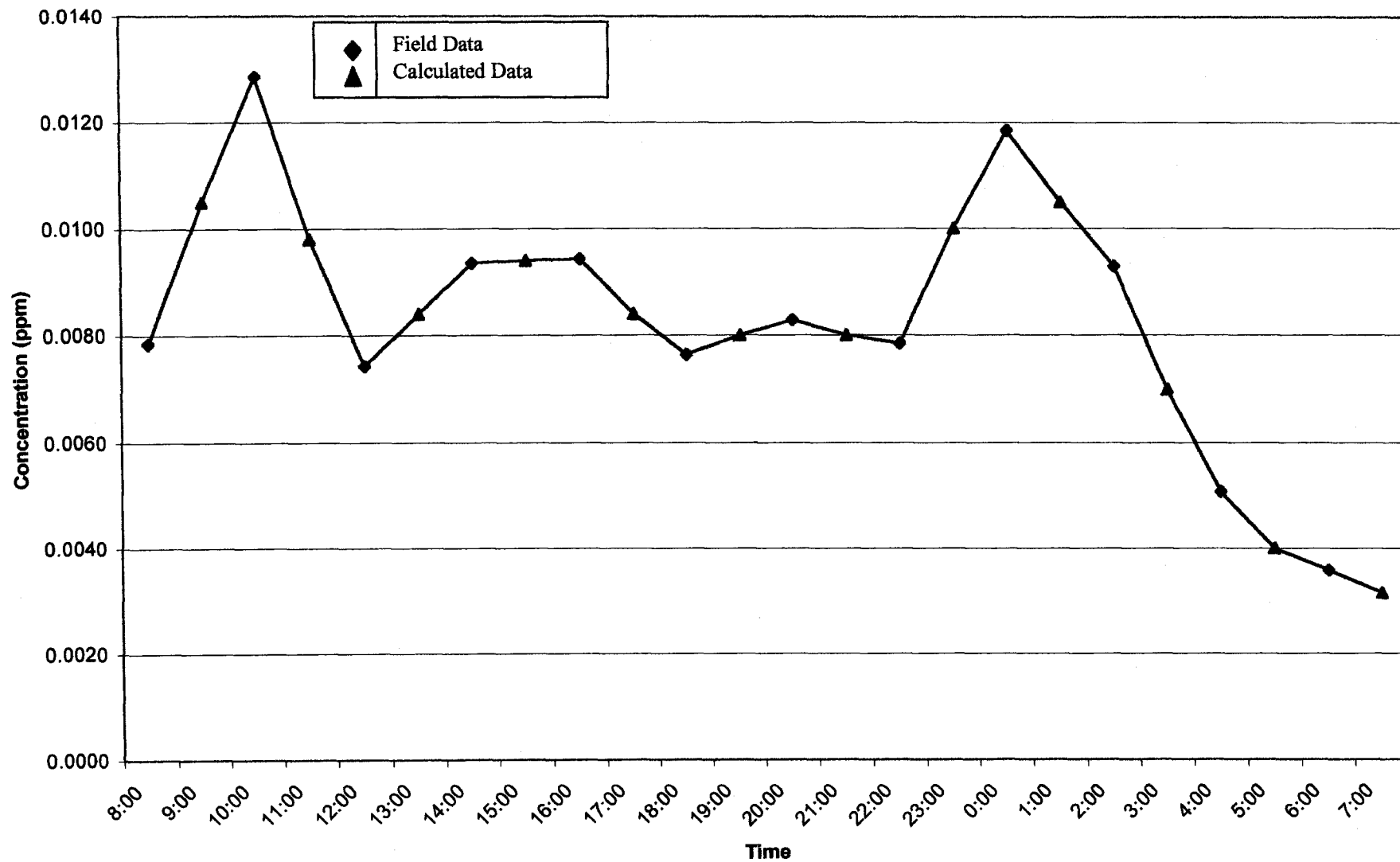


Figure 57. Control scrub December instantaneous NO₂ + NO₃ concentration-time plot.

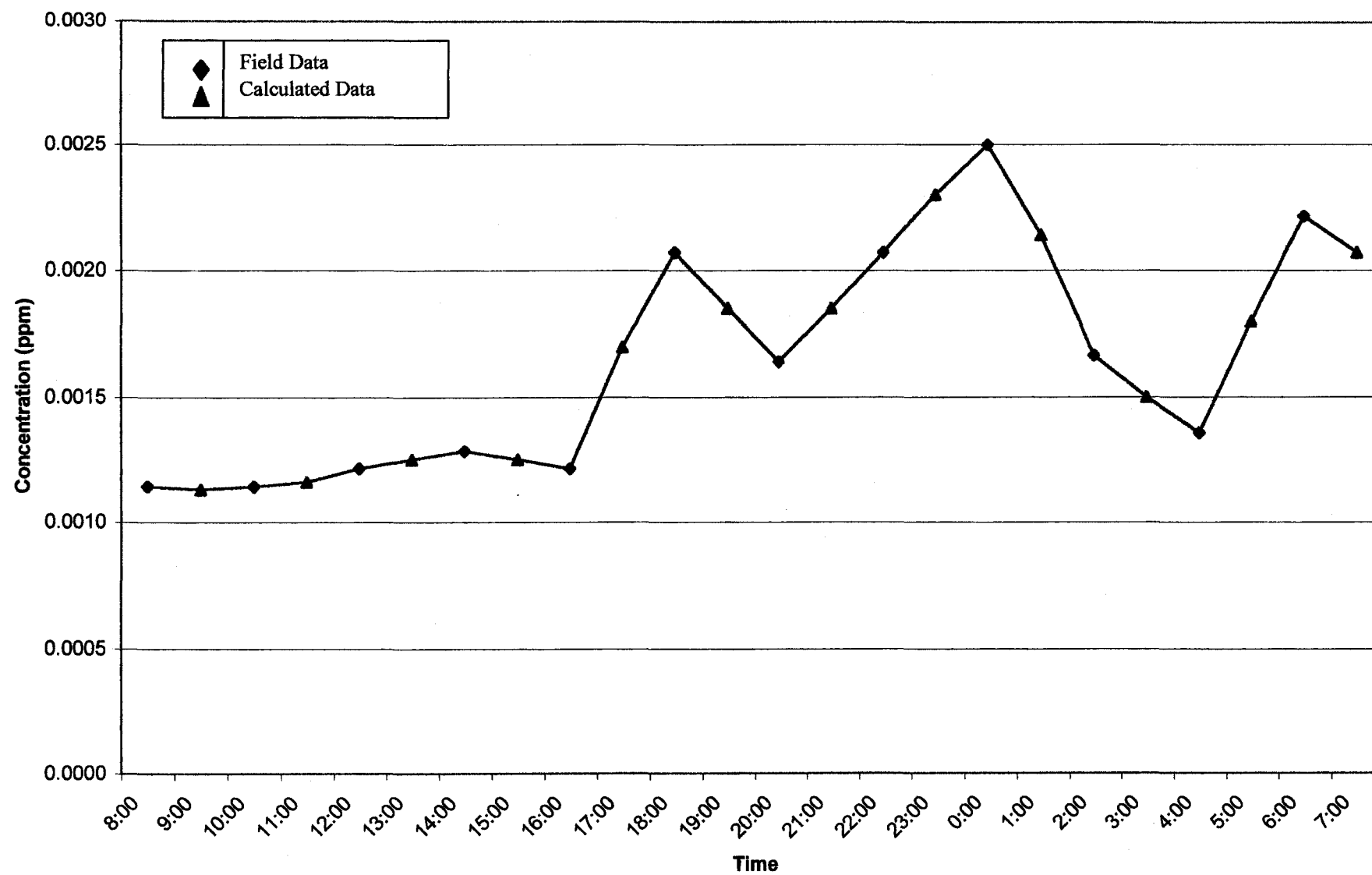


Figure 58. Control scrub December instantaneous NO2 concentration-time plot.

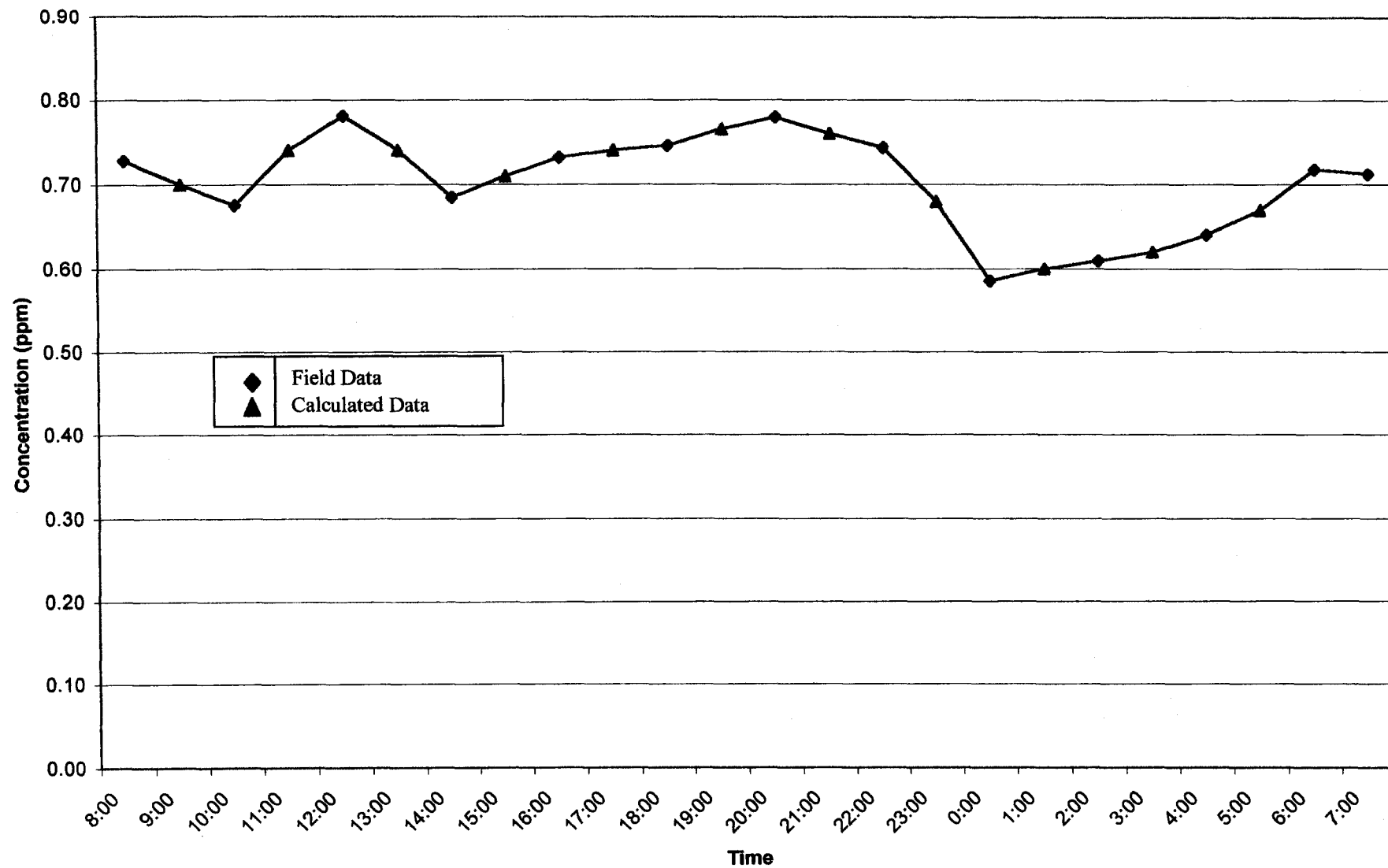


Figure 59. Control scrub December instantaneous TN concentration-time plot.

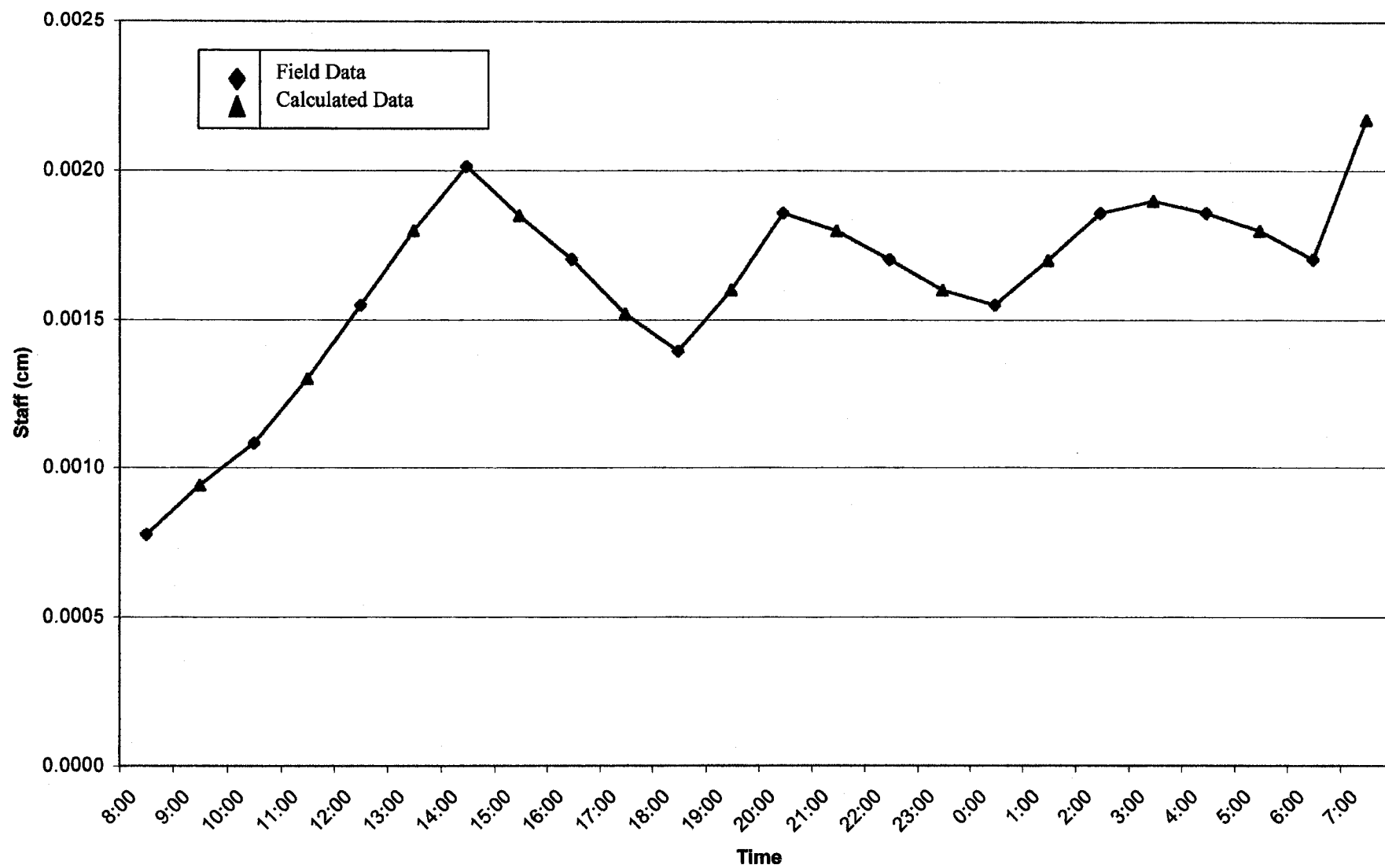


Figure 60. Control scrub December instantaneous SRP concentration-time plot.

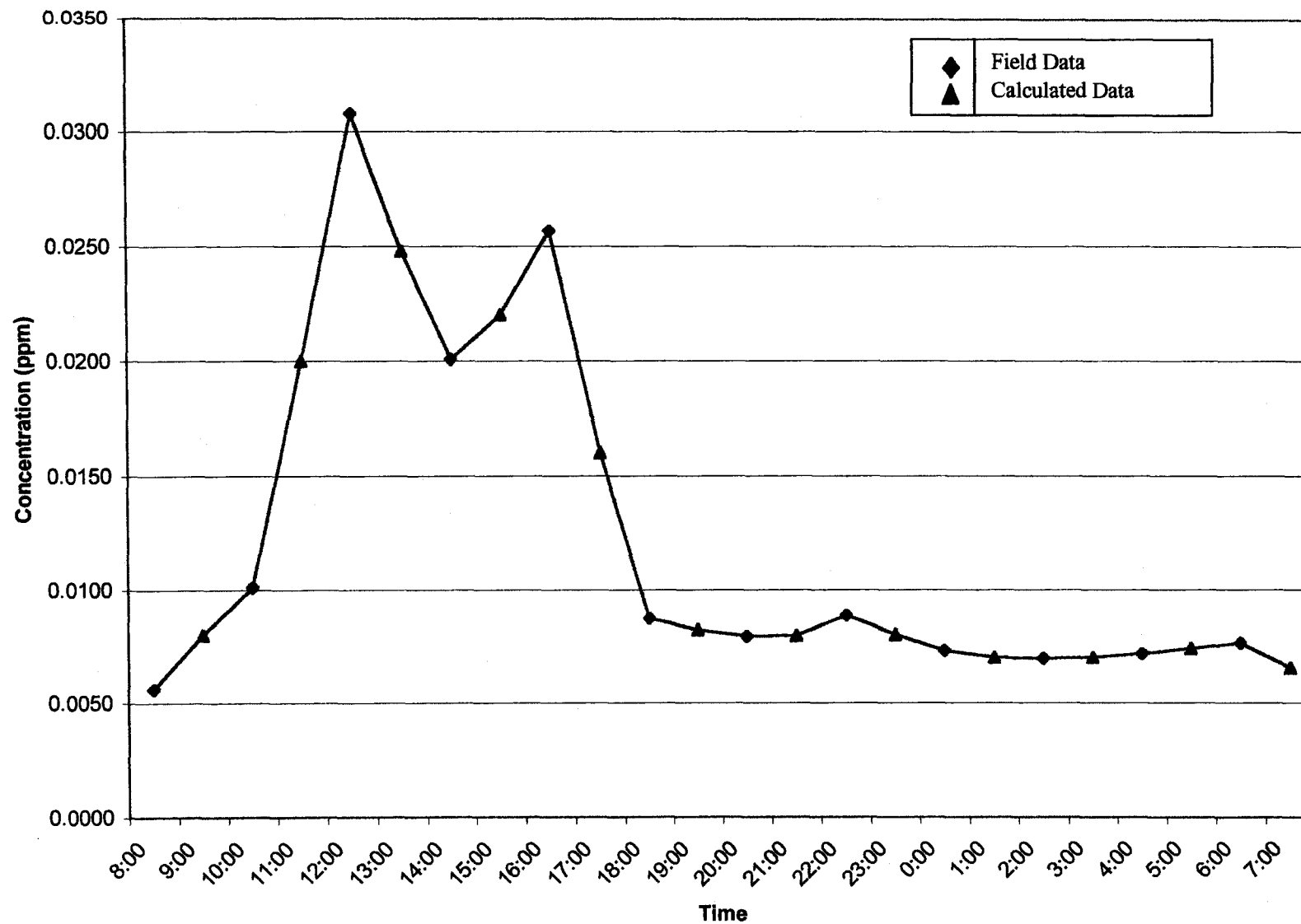


Figure 61. Control scrub December instantaneous TP concentration-time plot.

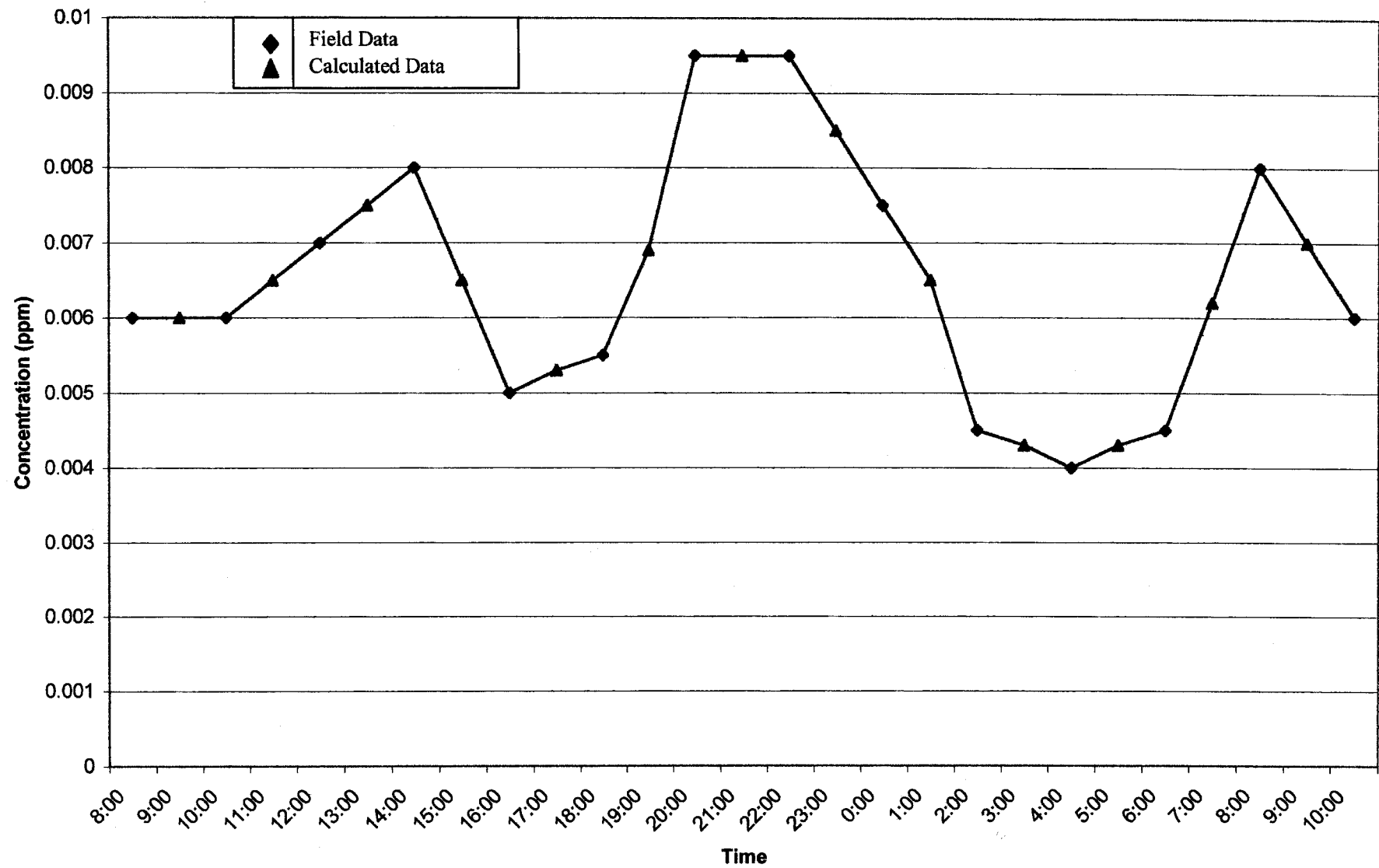


Figure 99. Control fringe April instantaneous NO₂ + NO₃ concentration-time plot.

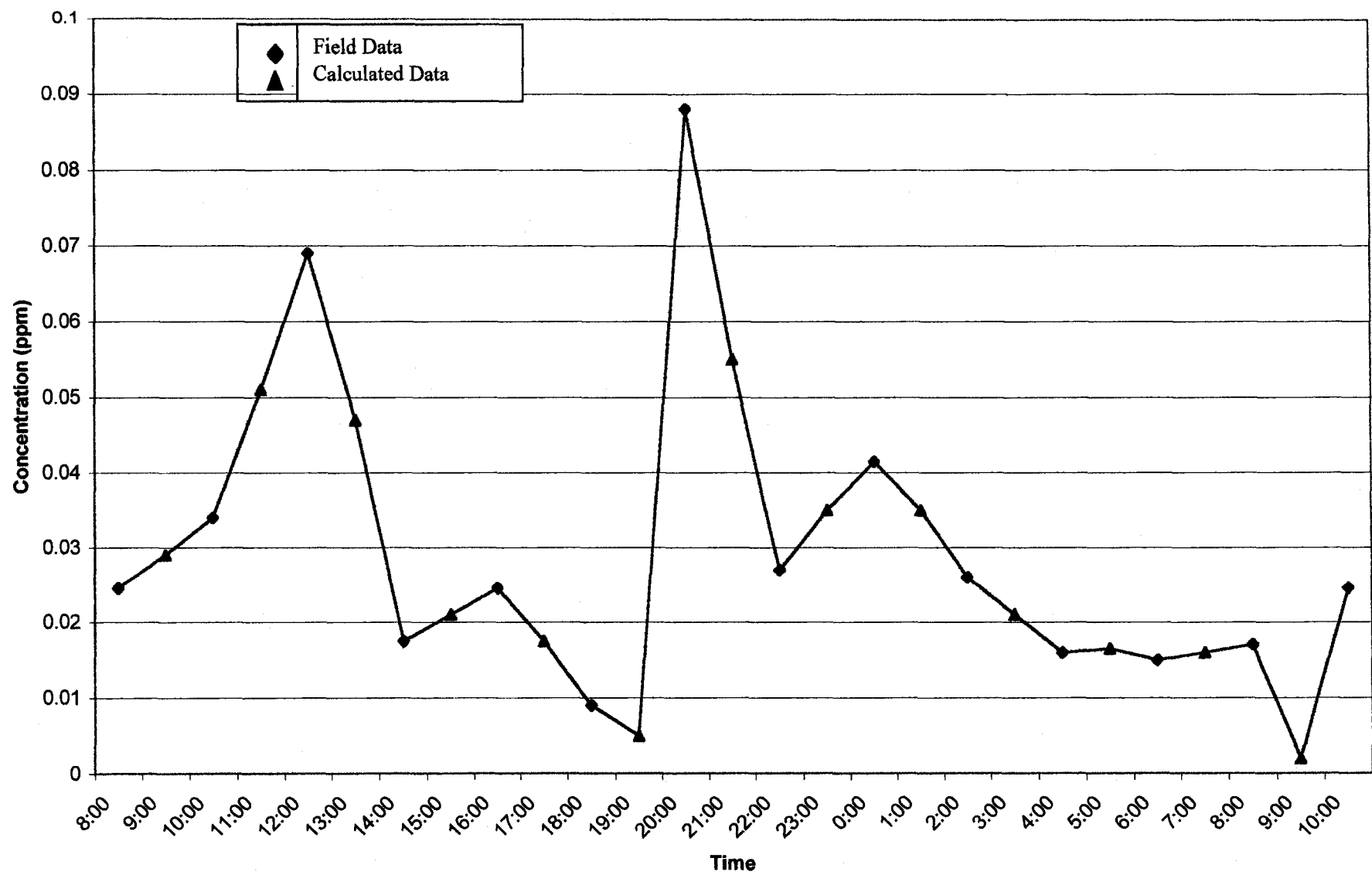


Figure 98. Control fringe April instantaneous NH4 concentration-time plot.

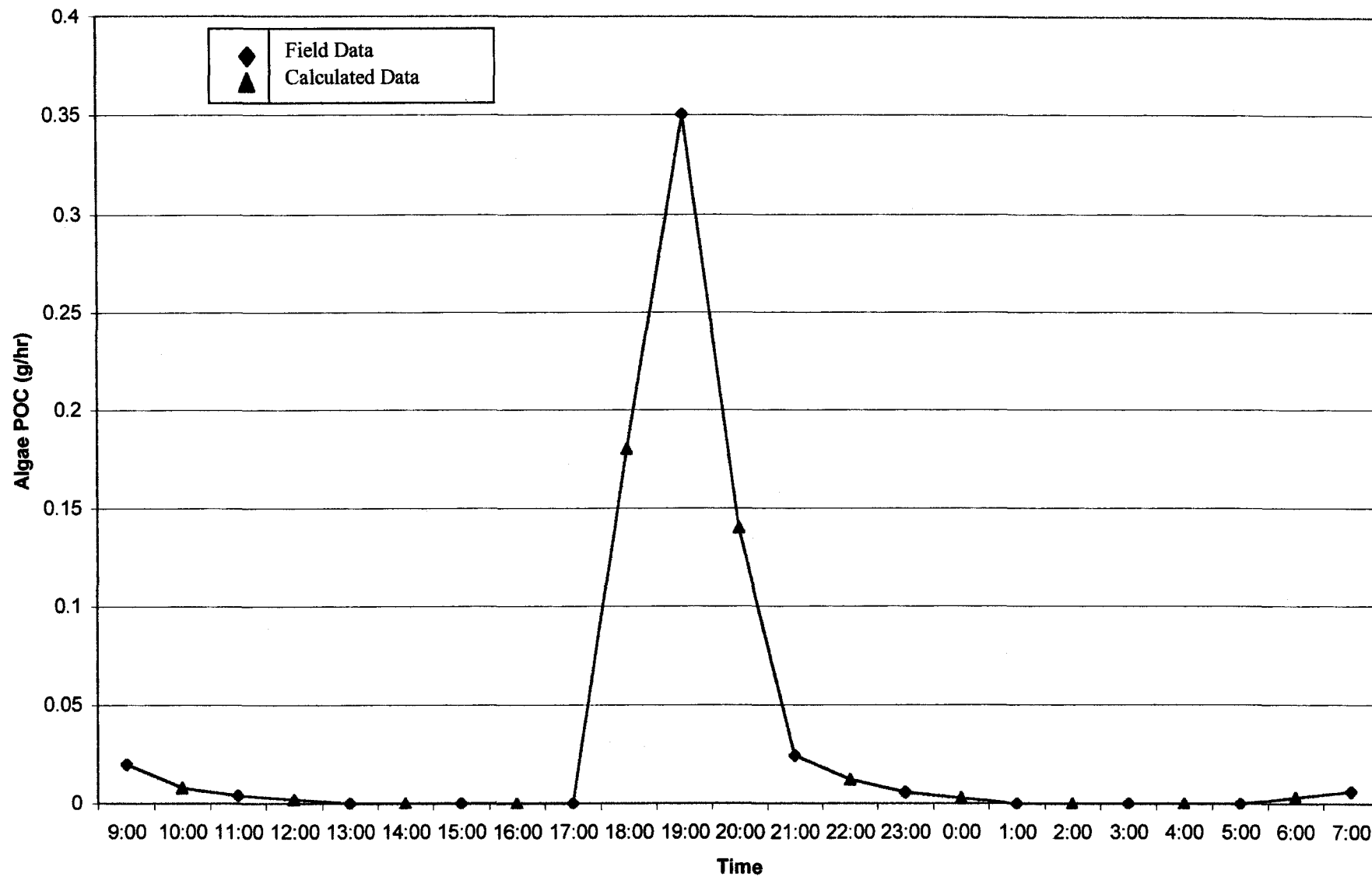


Figure 97. Treatment scrub April hourly algae particulate organic carbon load.

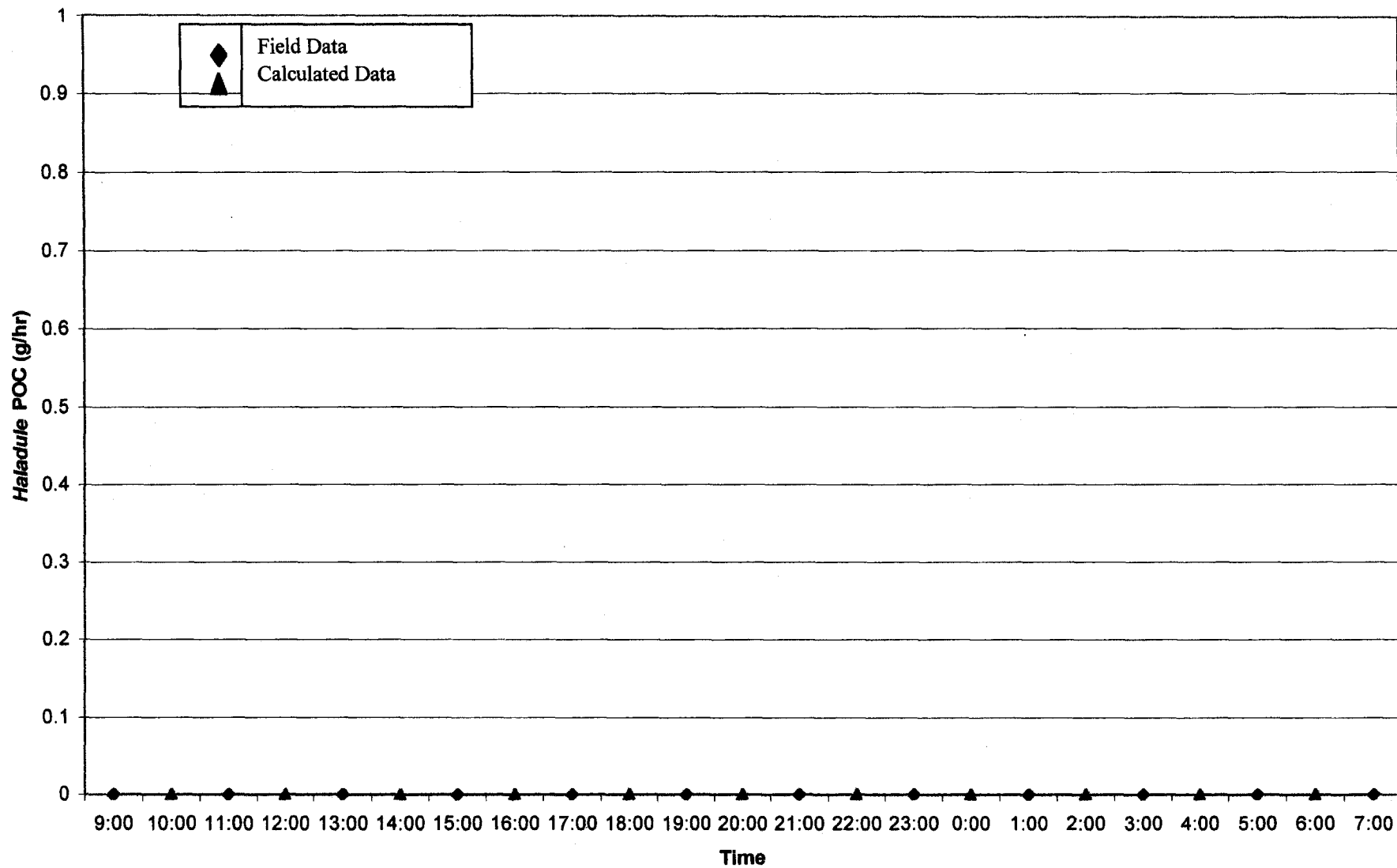


Figure 96. Treatment scrub April hourly *Haladule* particulate organic carbon load.

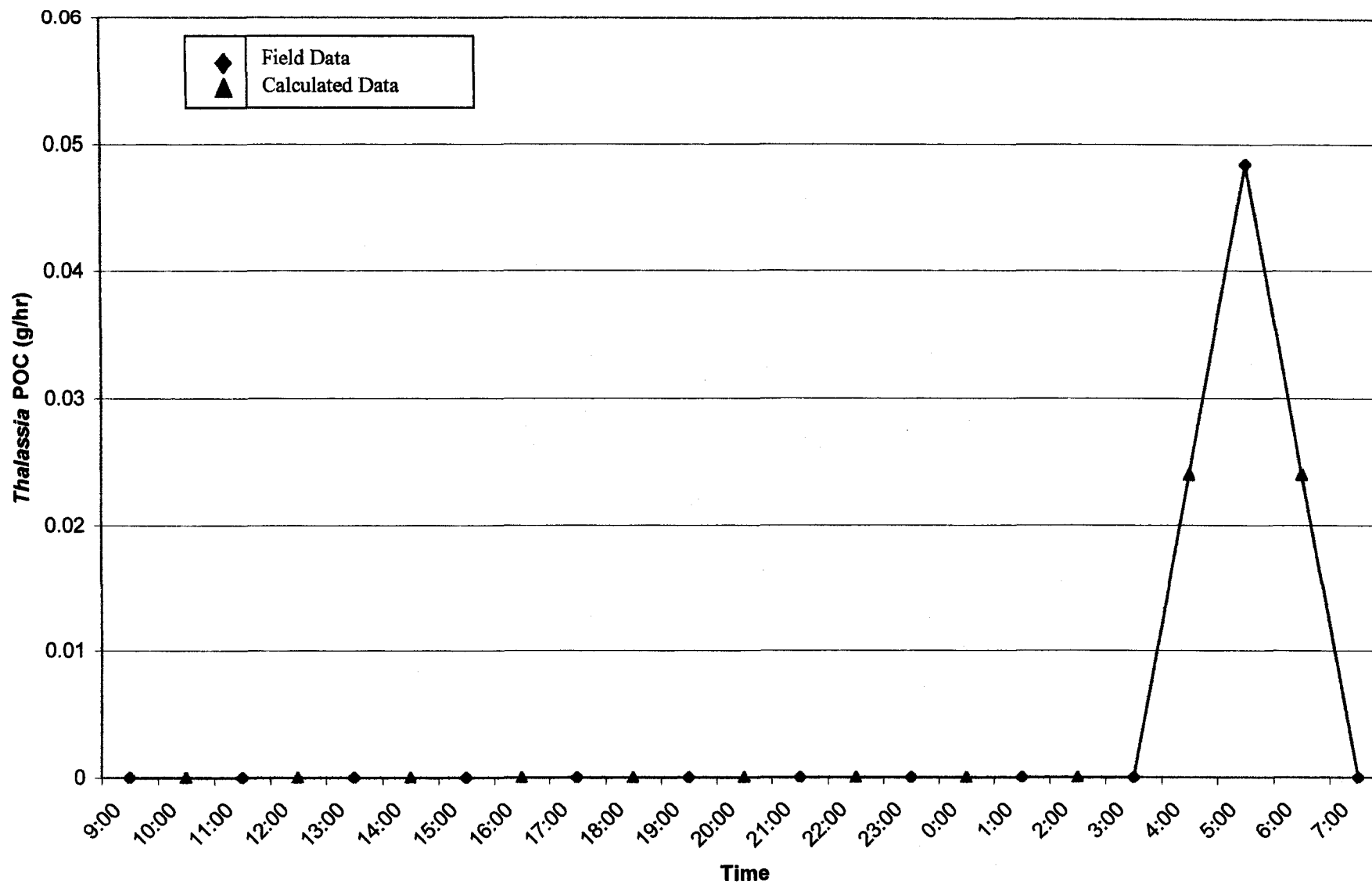


Figure 95. Treatment scrub April hourly *Thalassia* particulate organic carbon load.

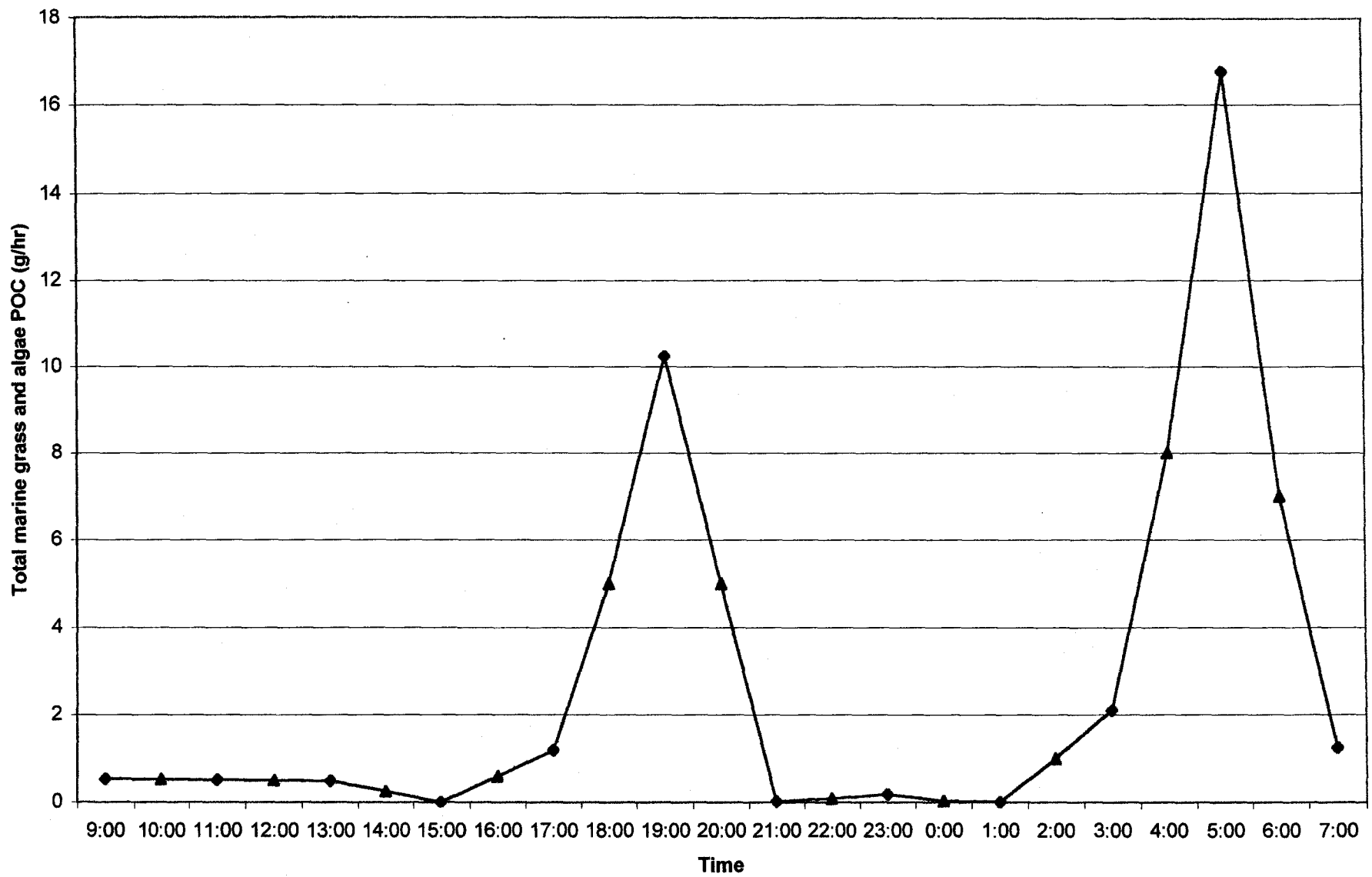


Figure 94. Treatment scrub April hourly total marine grass and algae particulate organic carbon load.

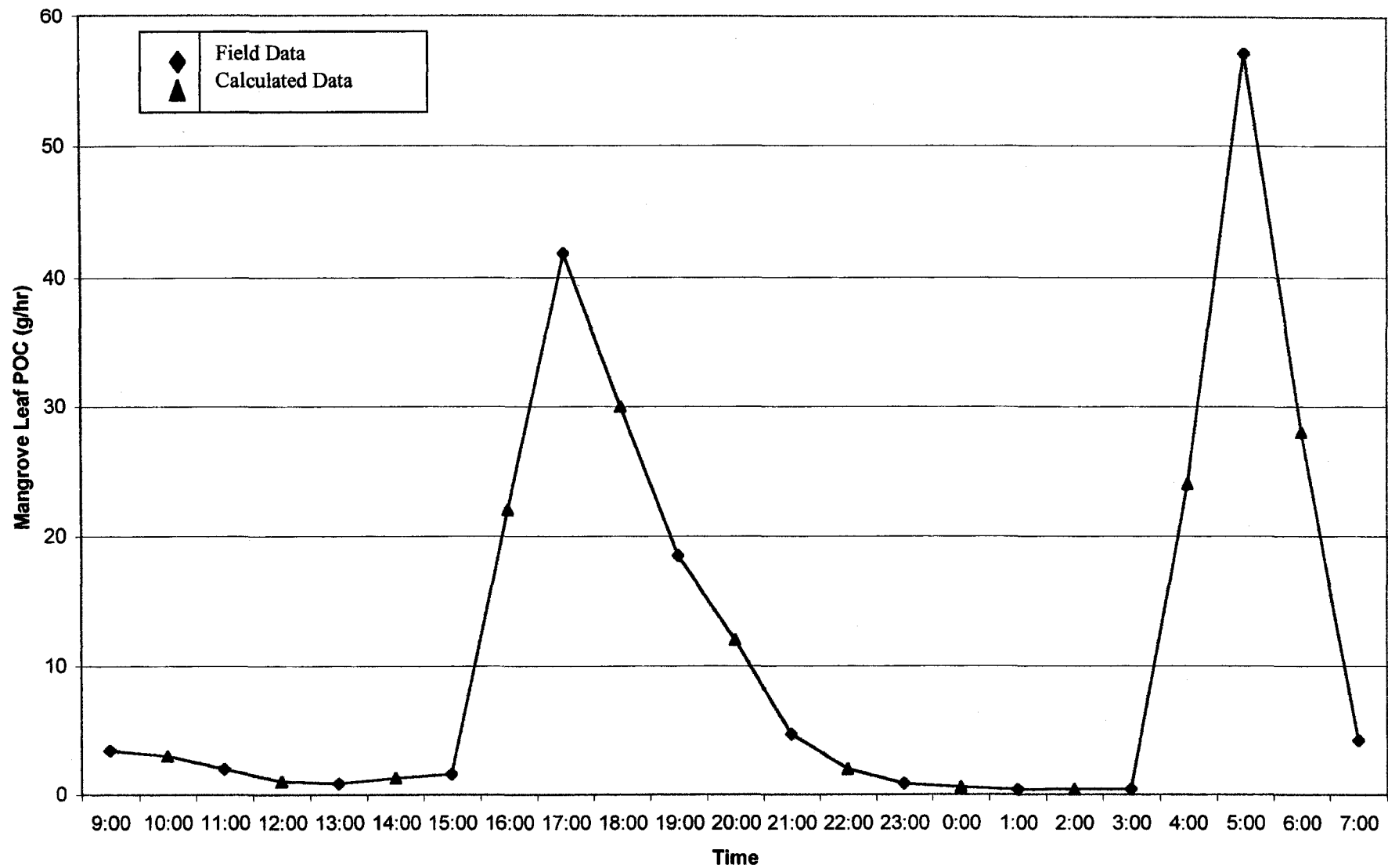


Figure 93. Treatment scrub April hourly mangrove leaf particulate organic carbon load.

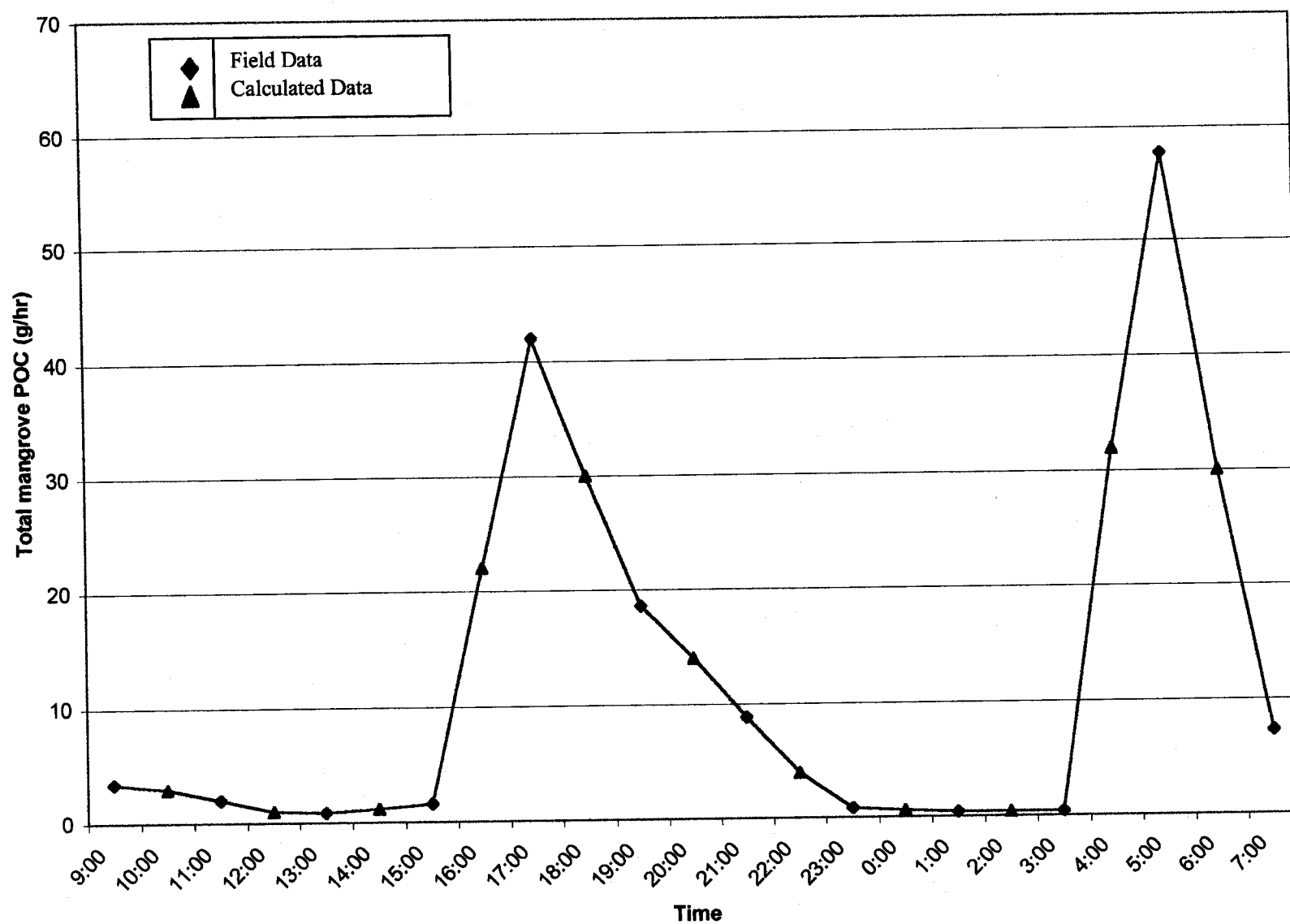


Figure 92. Treatment scrub April hourly total mangrove particulate organic carbon load.

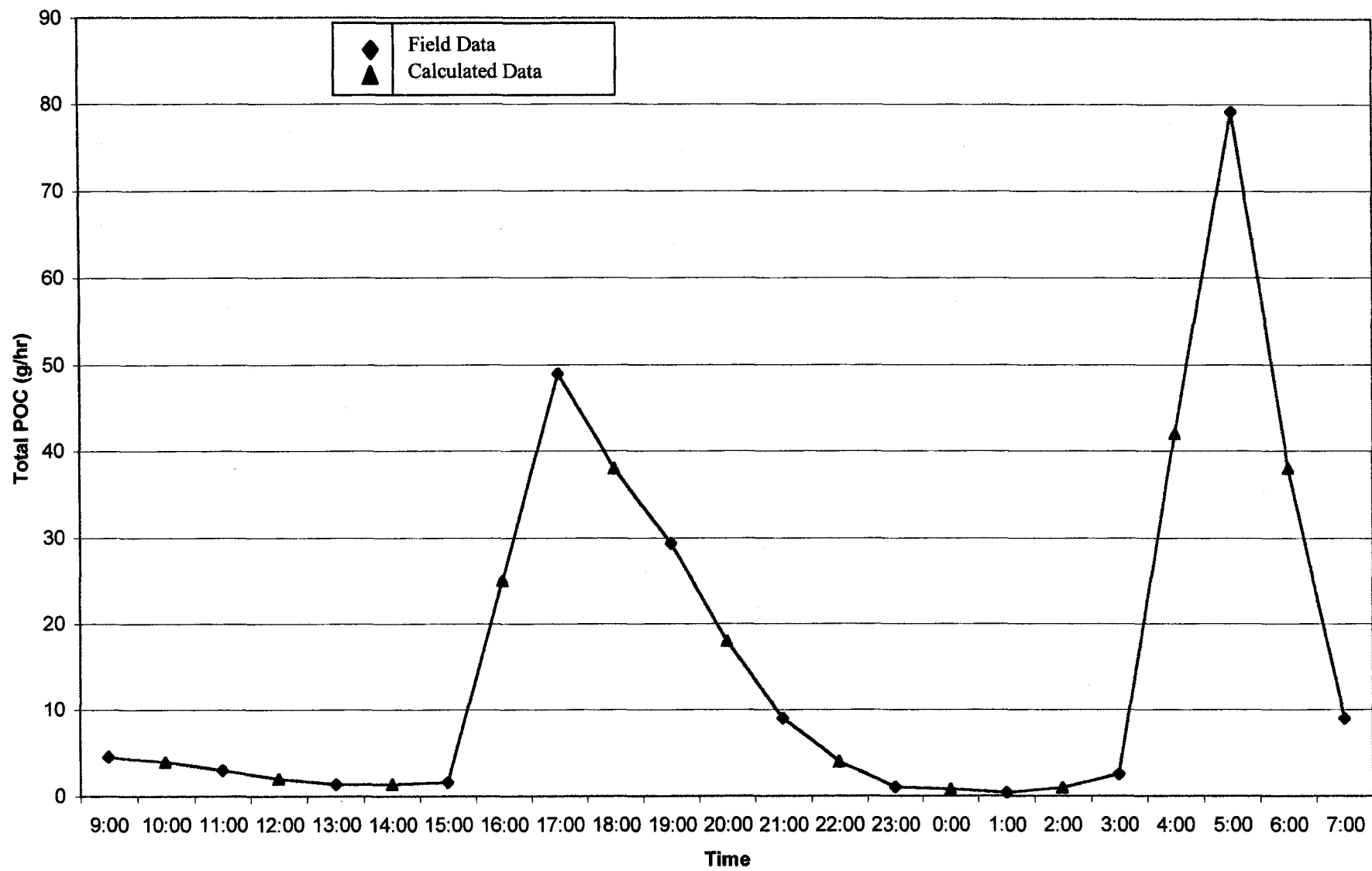


Figure 91. Treatment scrub April hourly total particulate organic carbon (POC) load.

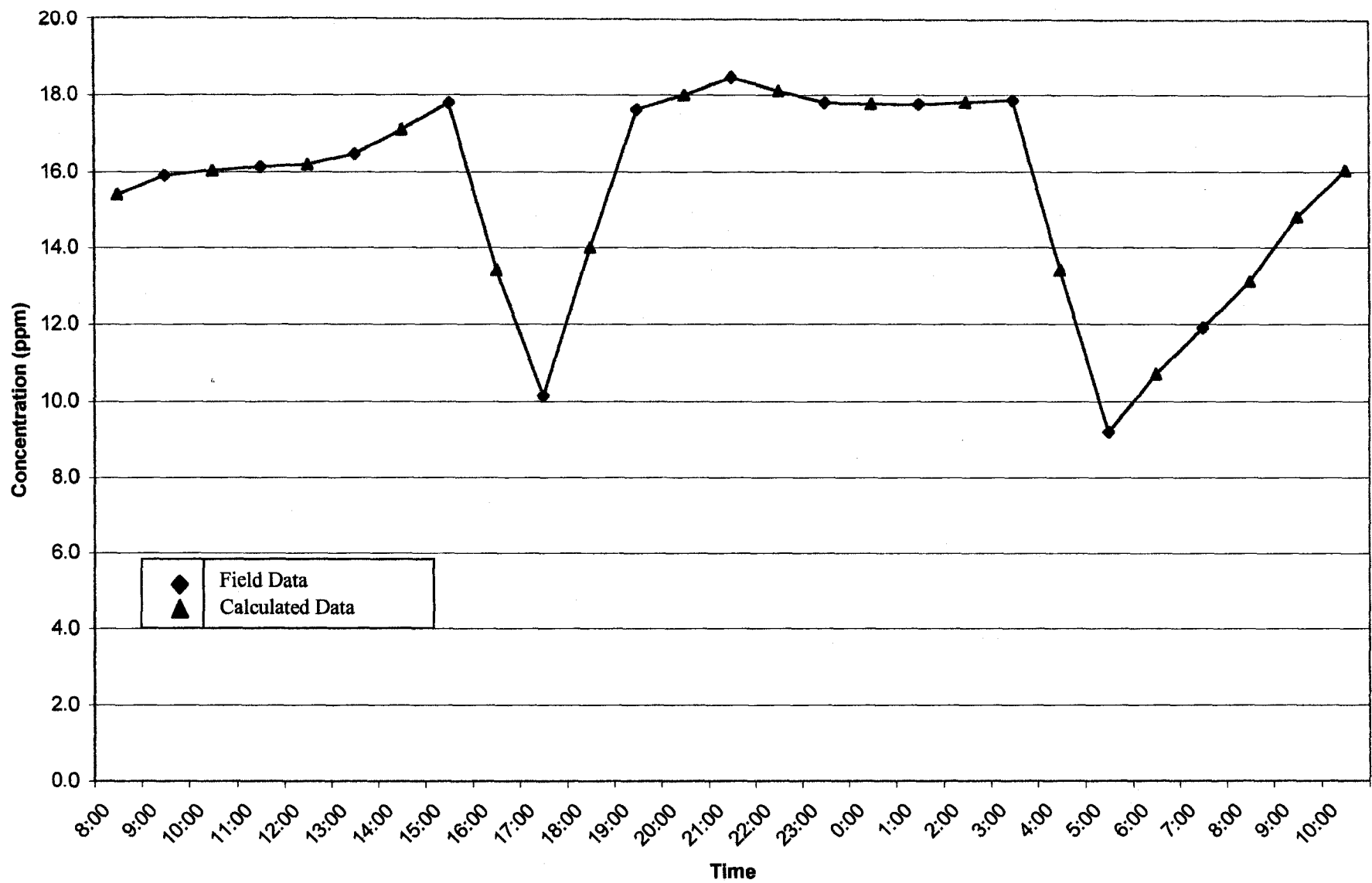


Figure 90. Treatment scrub April instantaneous TOC concentration-time plot.

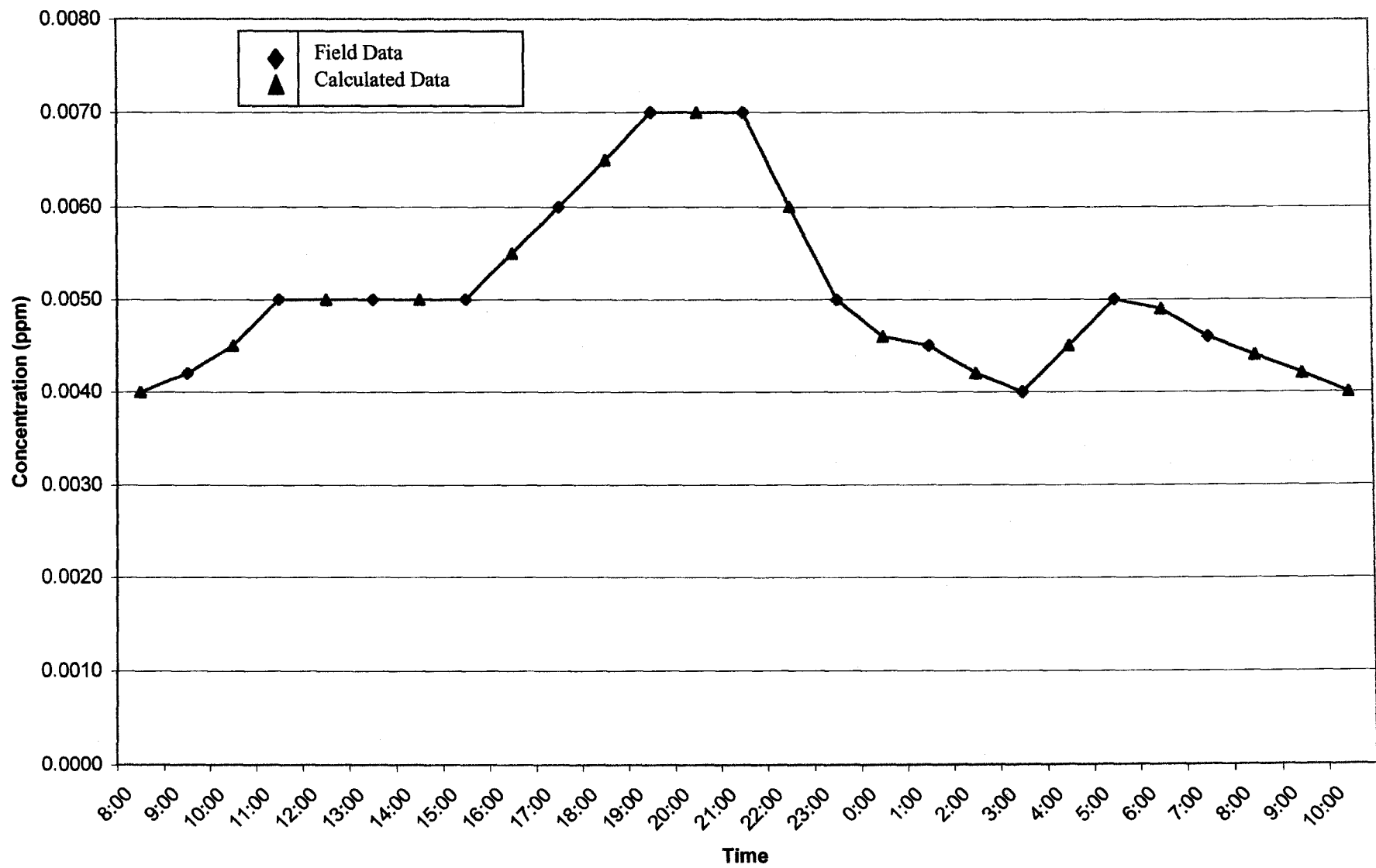


Figure 89. Treatment scrub April instantaneous TP concentration-time plot.

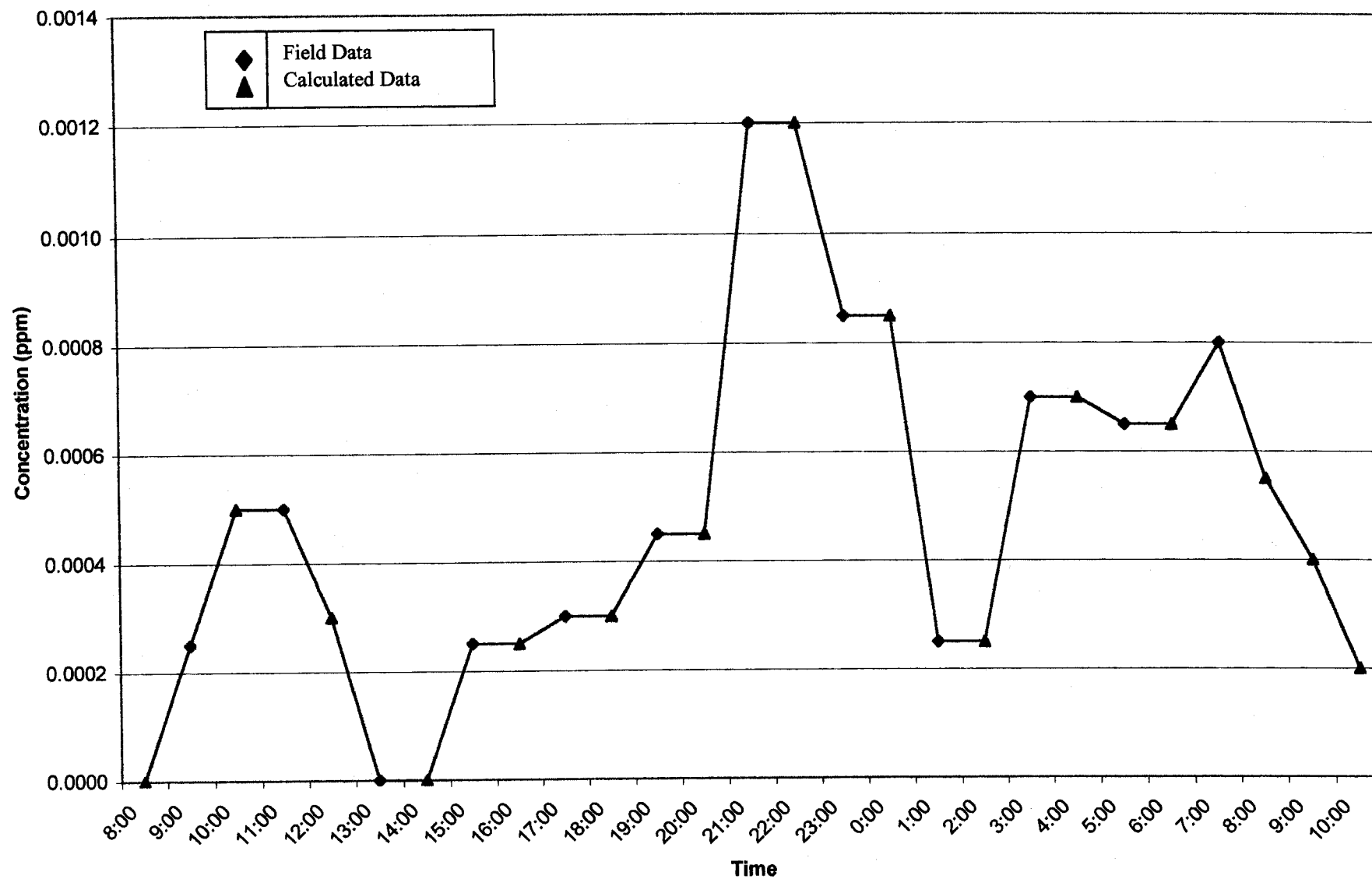


Figure 88. Treatment scrub April instantaneous SRP concentration-time plot.

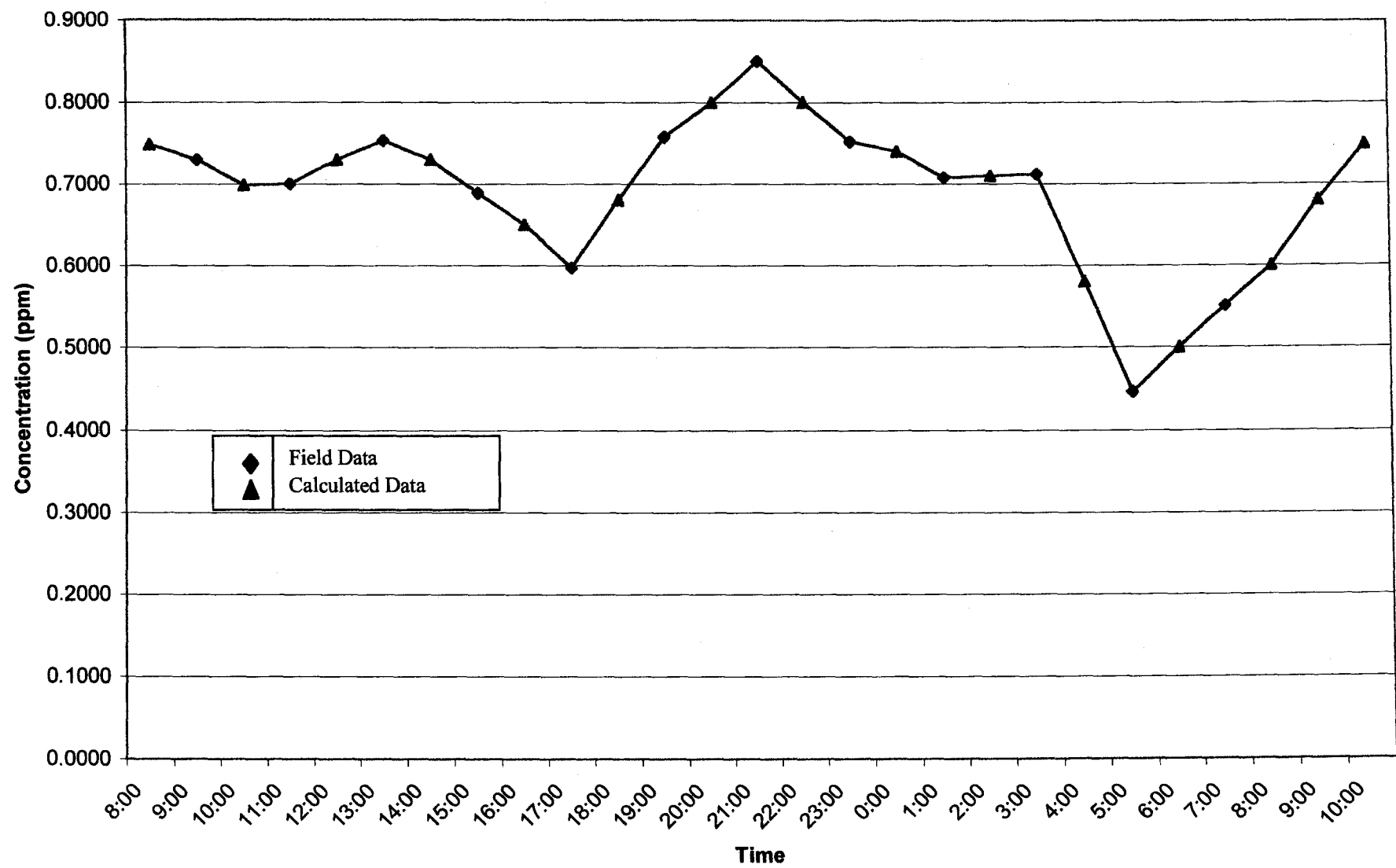


Figure 87. Treatment scrub April instantaneous TN concentration-time plot.

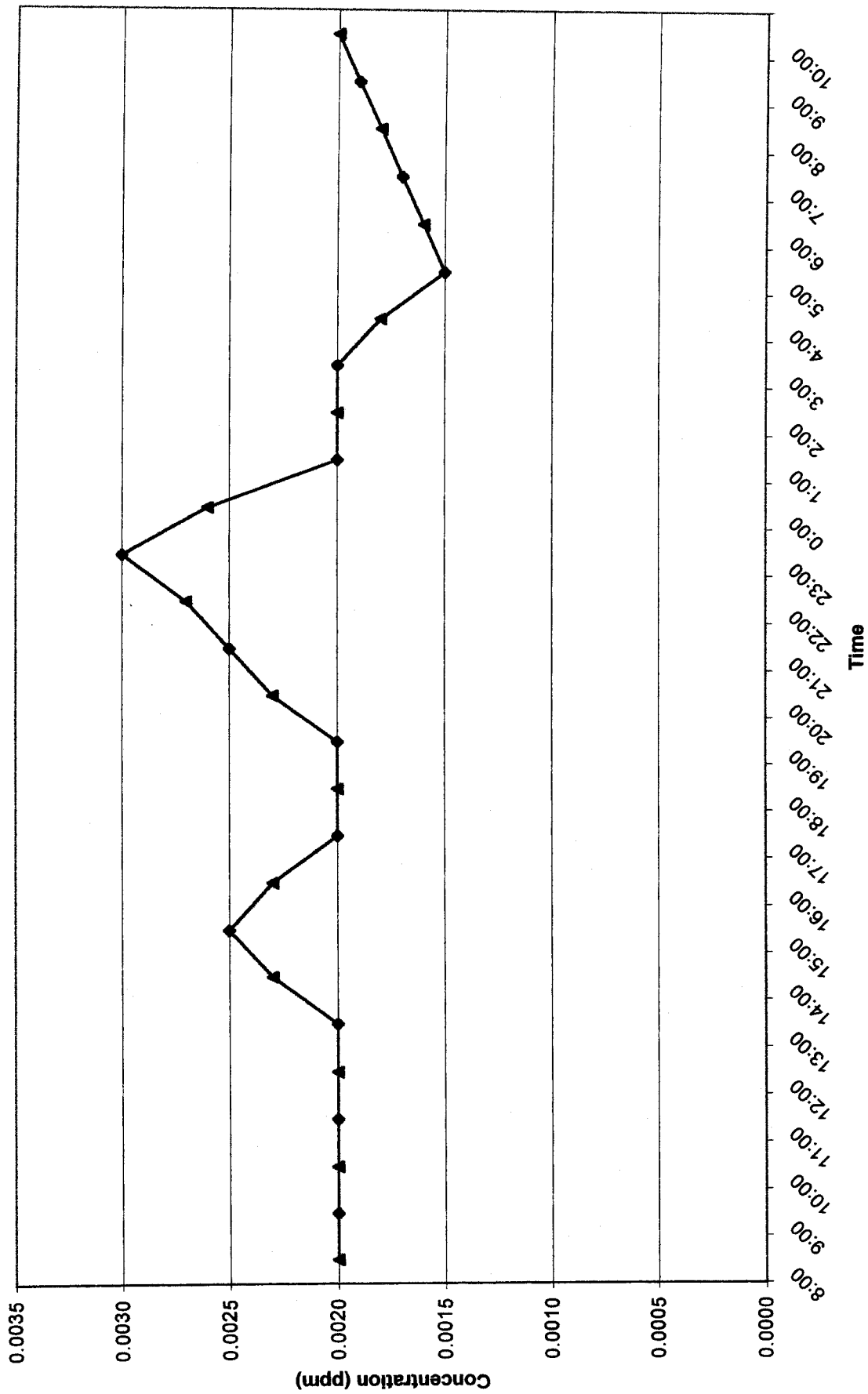


Figure 86. Treatment Scrub April instantaneous NO₂ concentration-time plot.

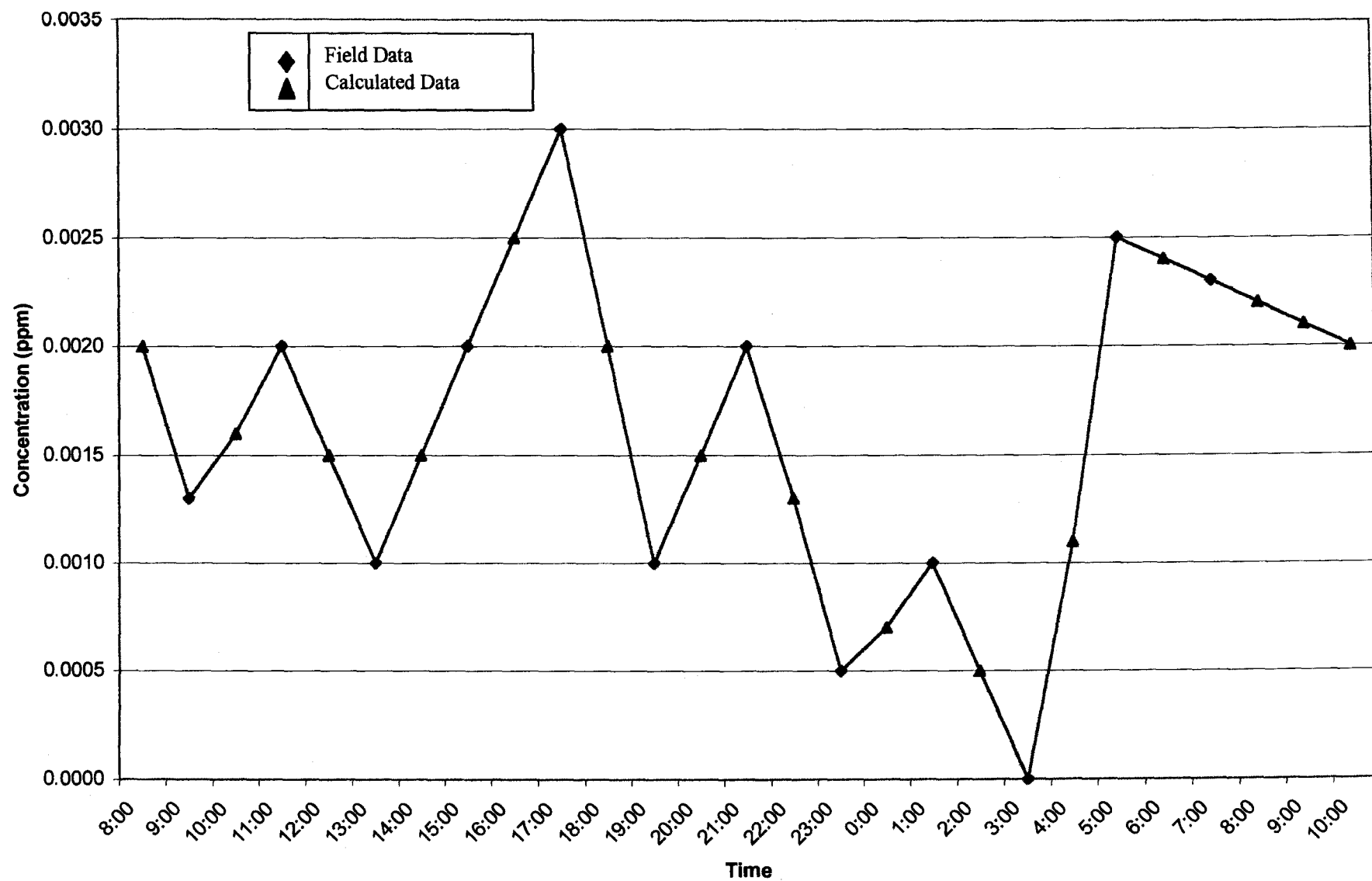


Figure 85. Treatment scrub April instantaneous NO2 + NO3 concentration-time plot.

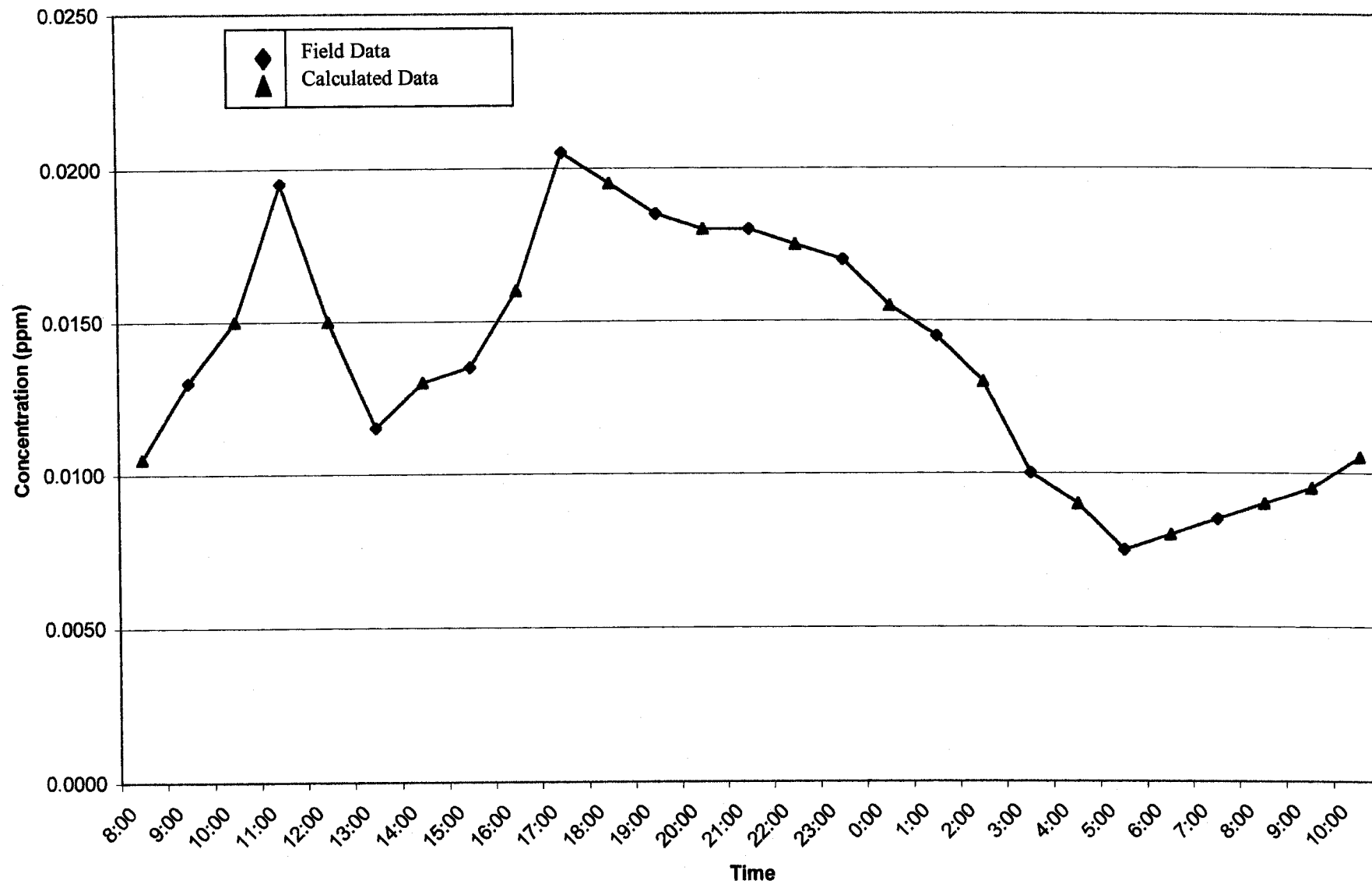


Figure 84. Treatment scrub April instantaneous NH_4 concentration-time plot.

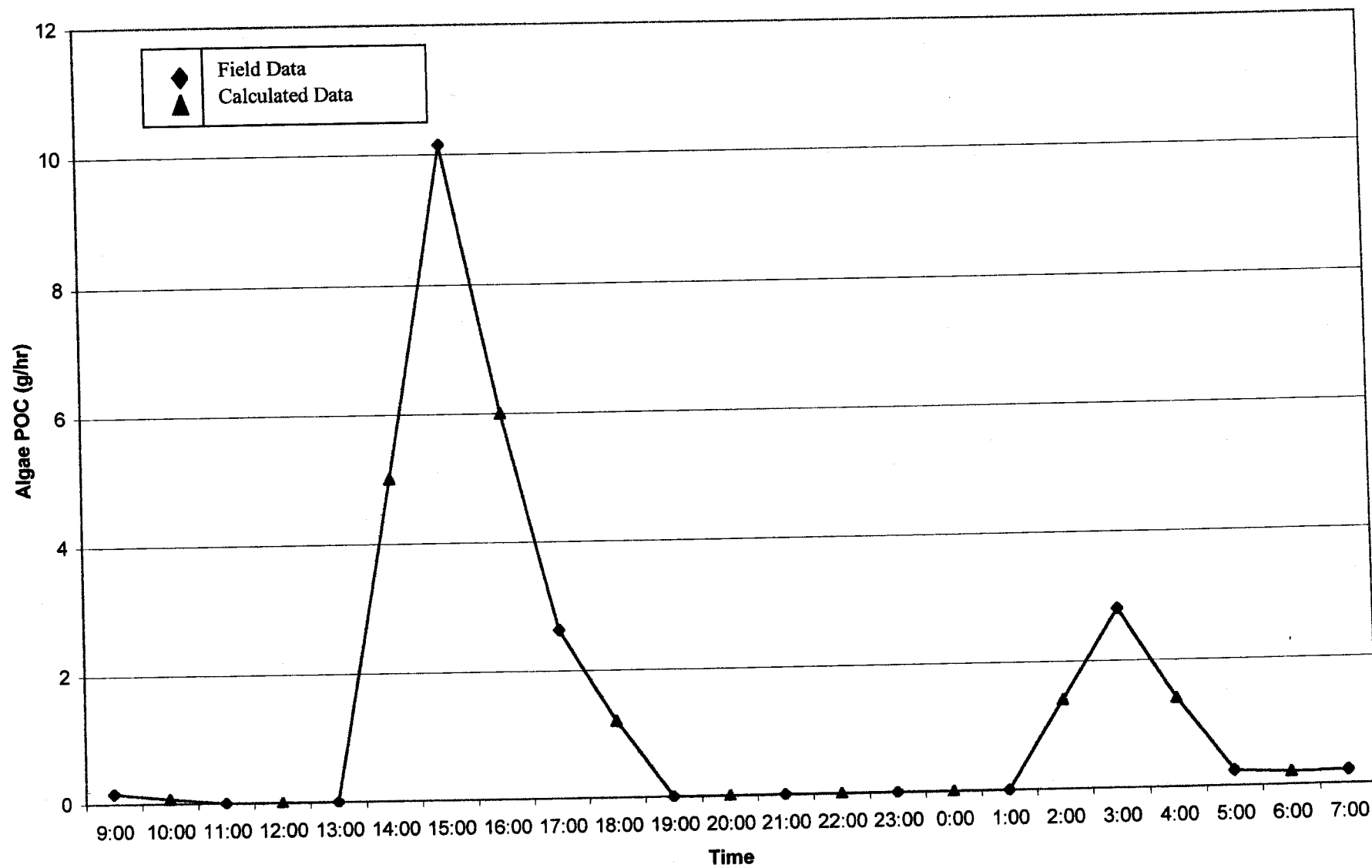


Figure 83. Treatment fringe April hourly algae particulate organic carbon load.

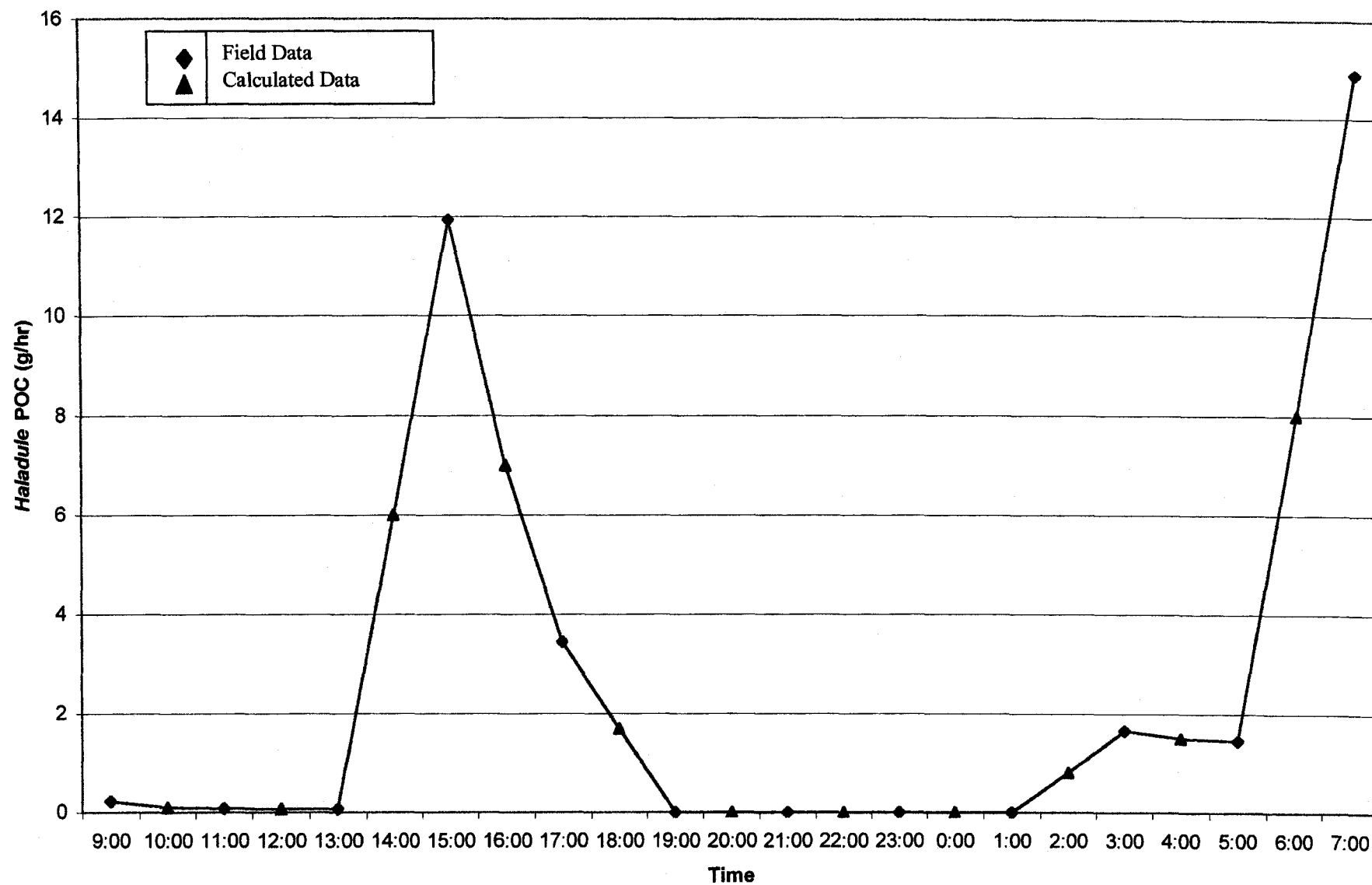


Figure 82. Treatment fringe April hourly *Haladule* particulate organic carbon load.

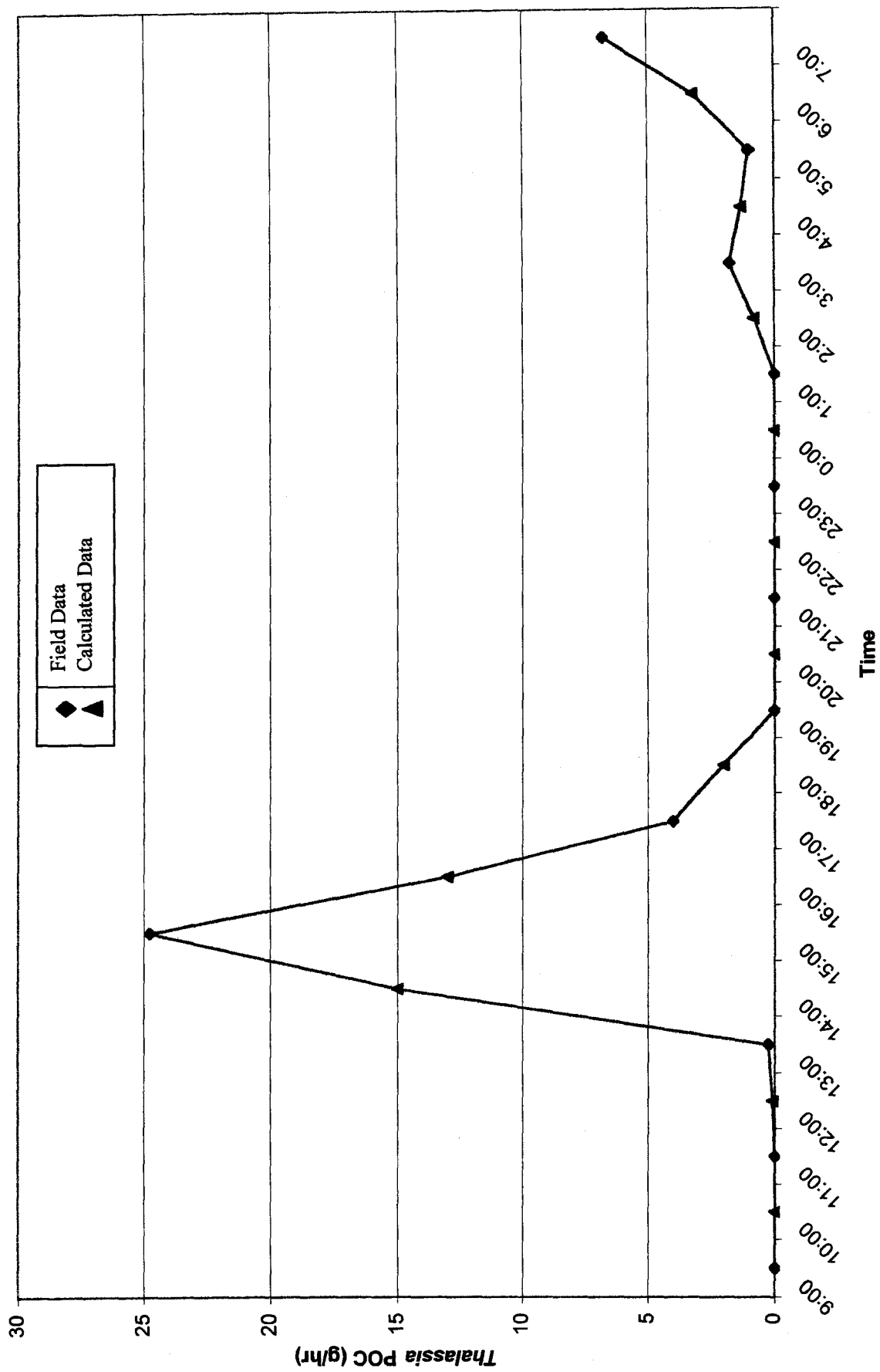


Figure 81. Treatment fringe April hourly *Thalassia* particulate organic carbon load.

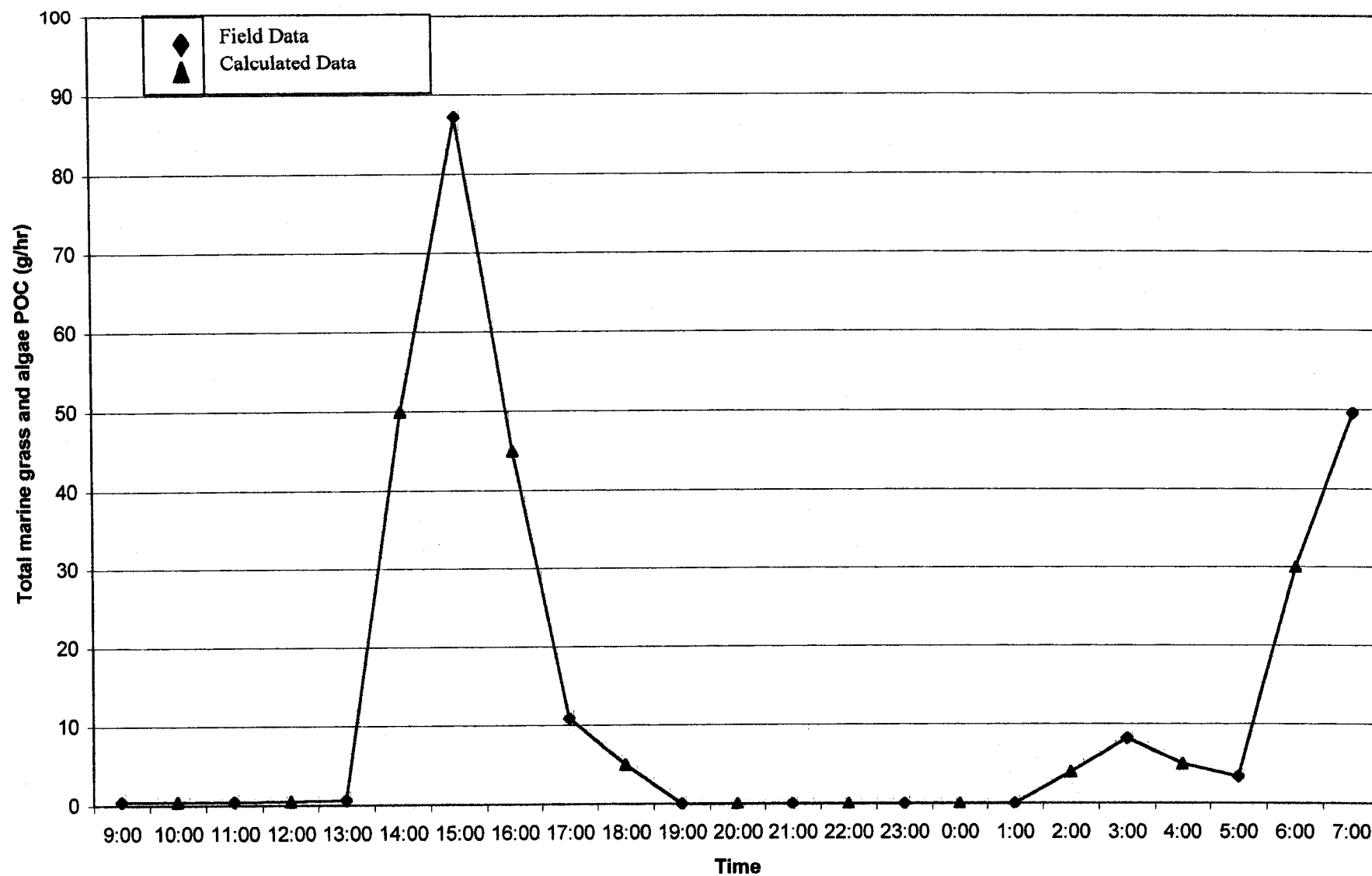


Figure 80. Treatment fringe April hourly total marine grass and algae particulate organic carbon load.

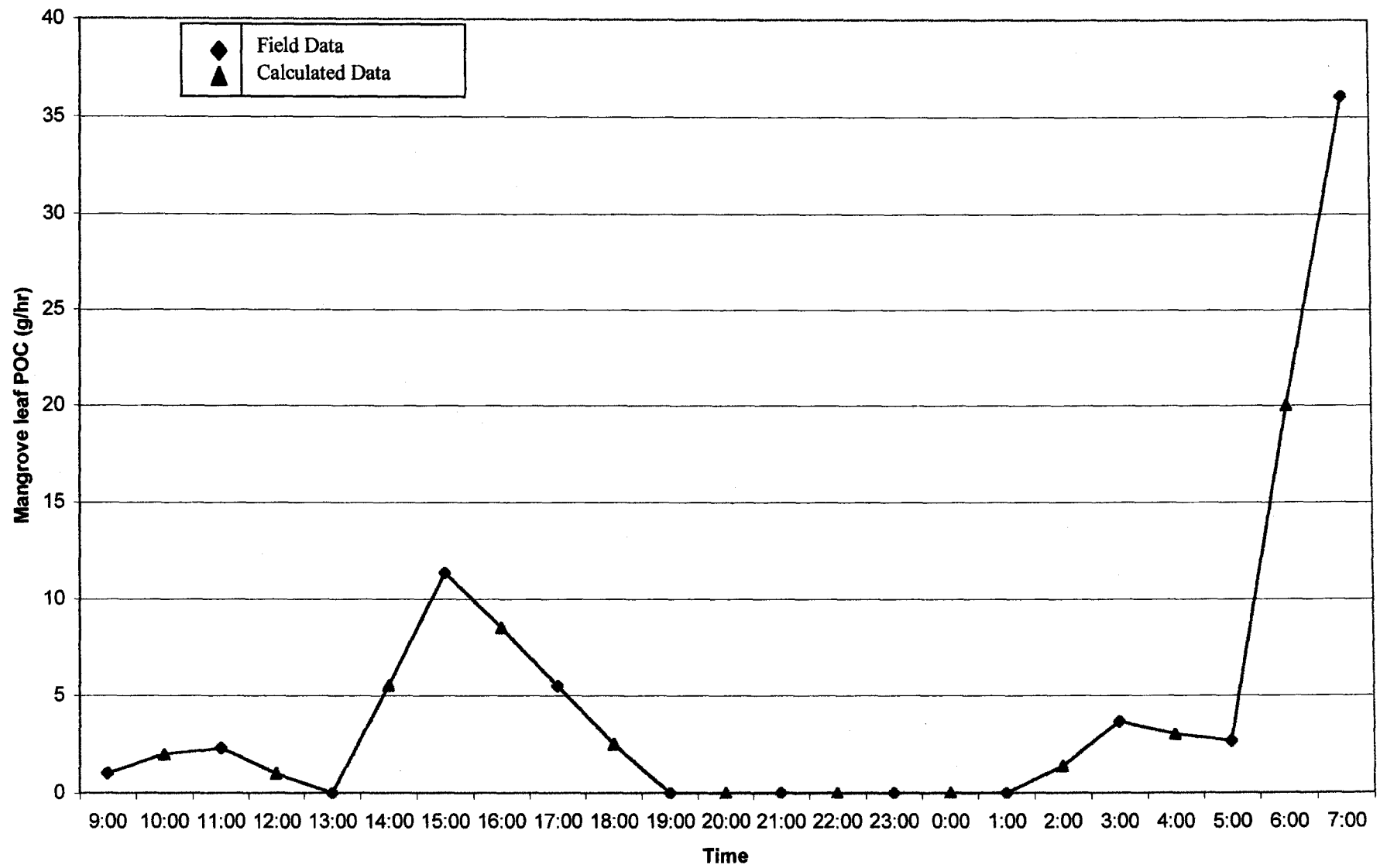


Figure 79. Treatment fringe April hourly mangrove leaf particulate organic carbon load.

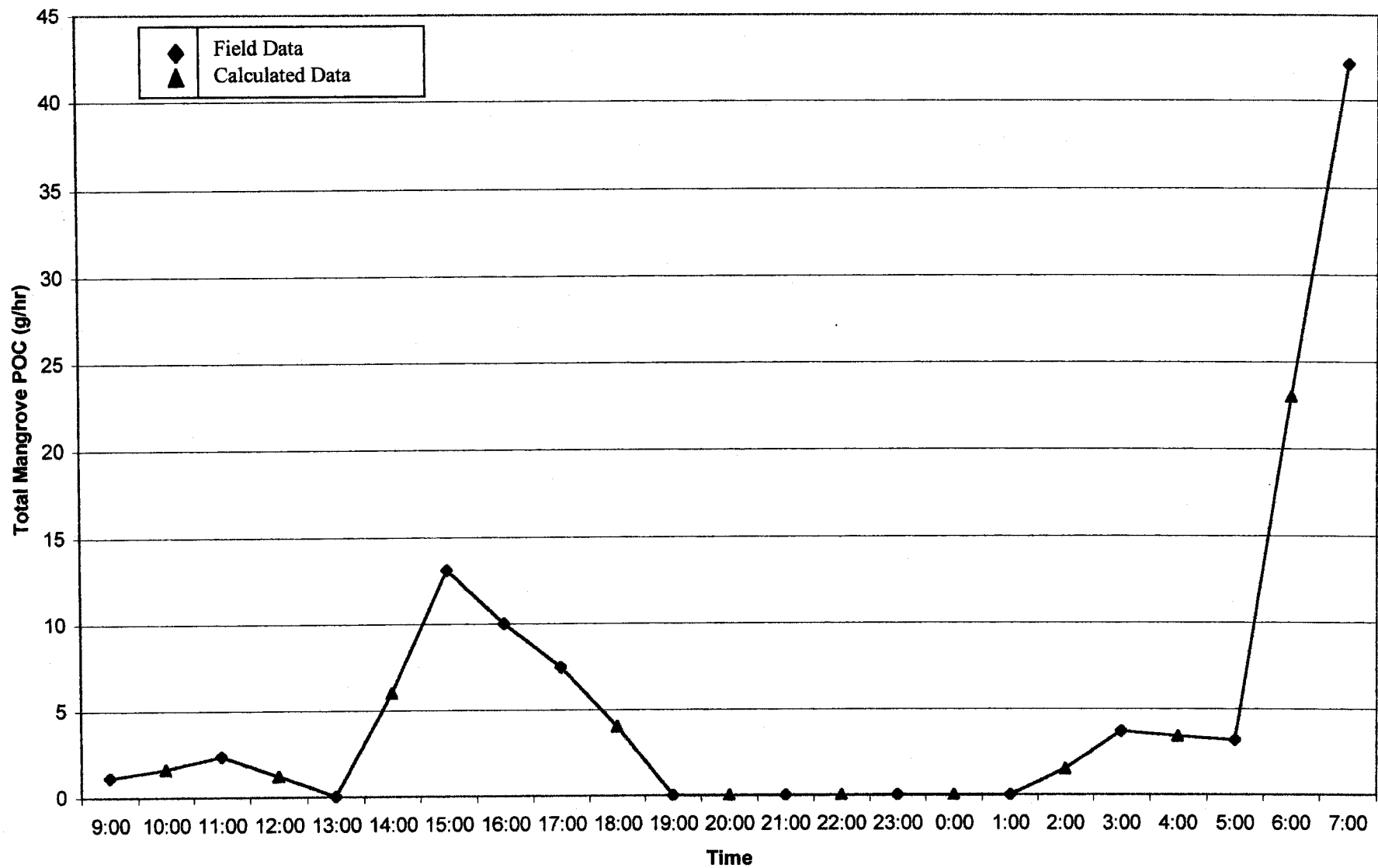


Figure 78. Treatment fringe April hourly mangrove particulate organic carbon load.

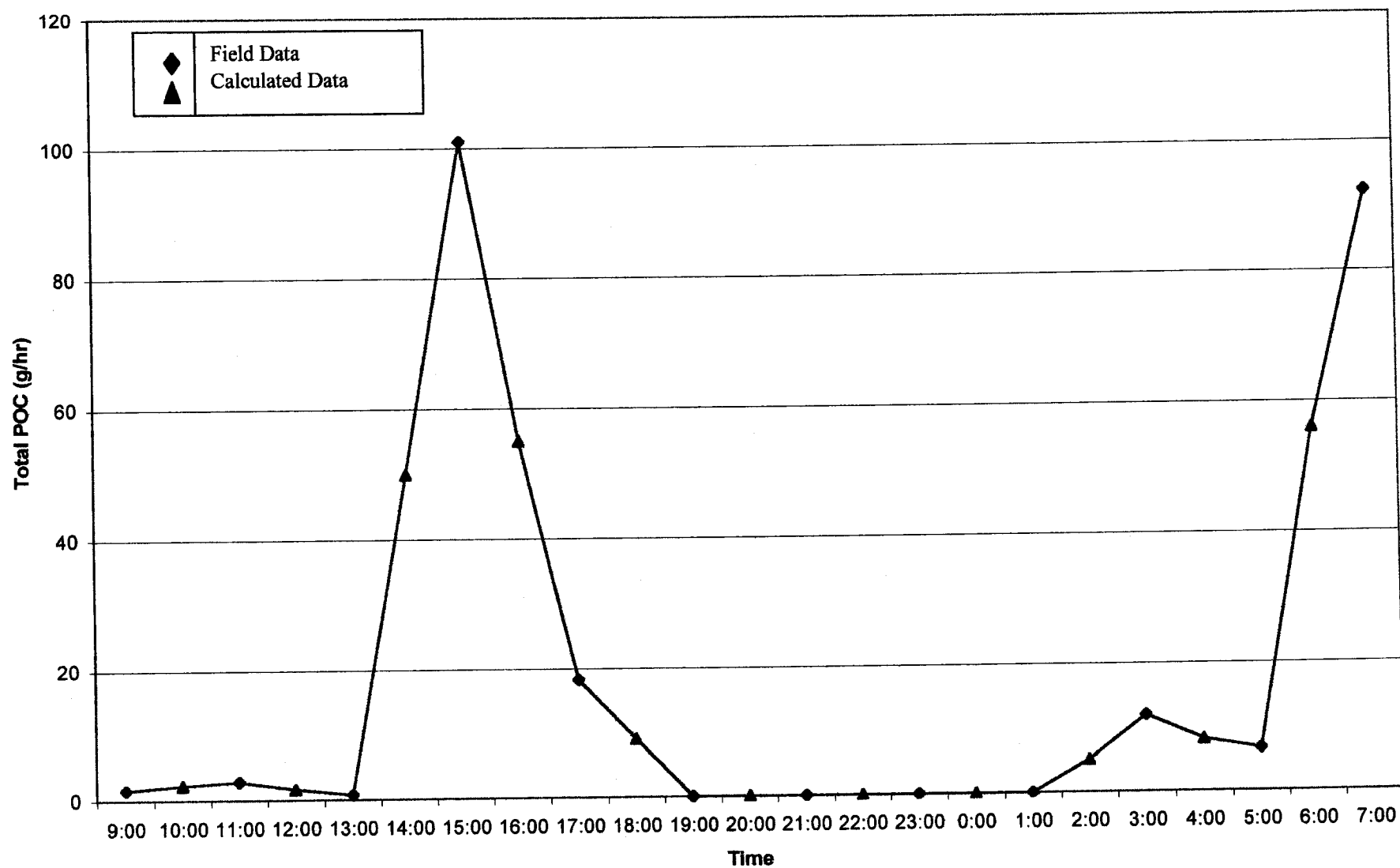


Figure 77. Treatment fringe April hourly total particulate organic carbon (POC) load.

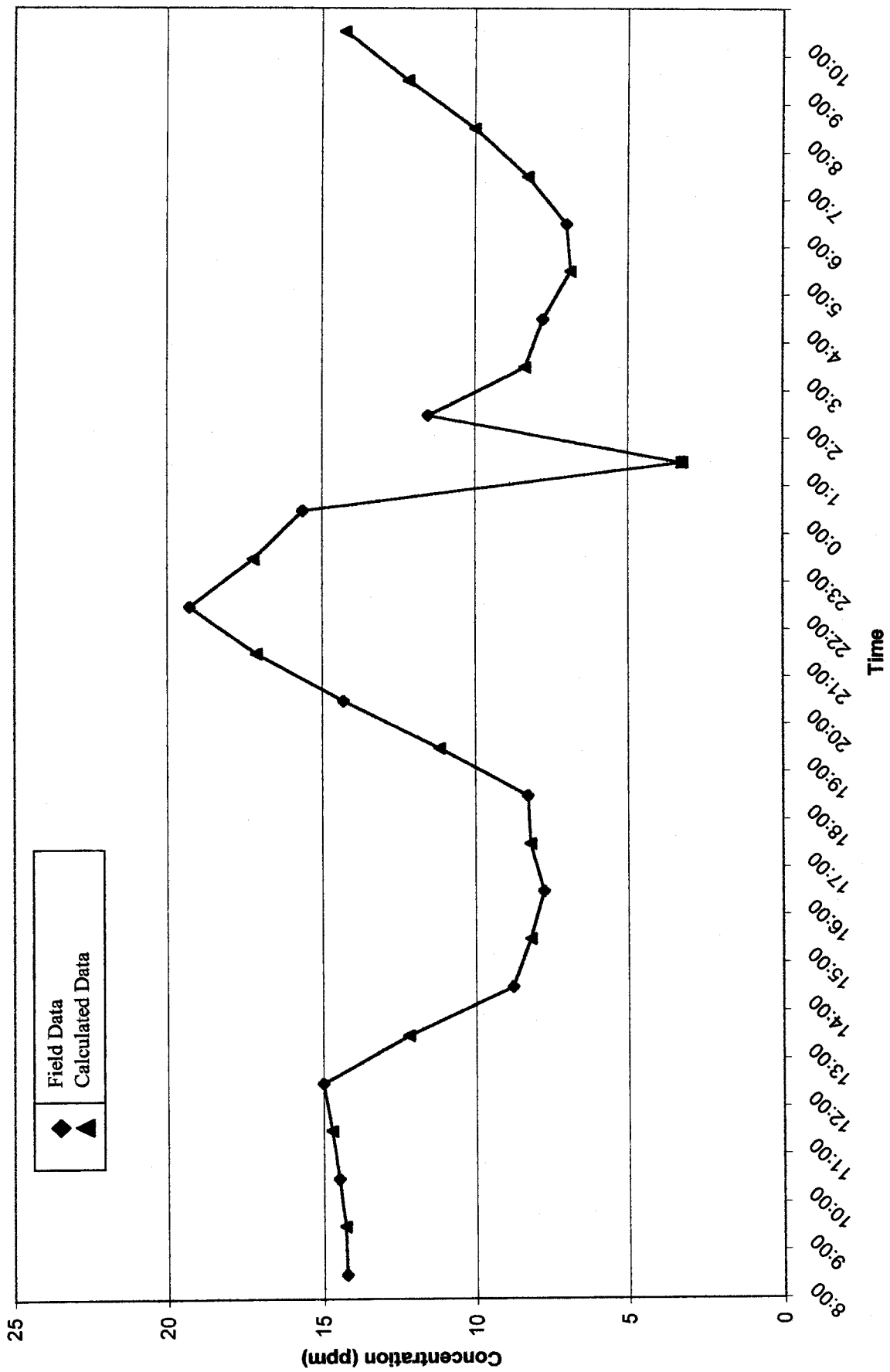


Figure 76. Treatment fringe April instantaneous TOC concentration-time plot.

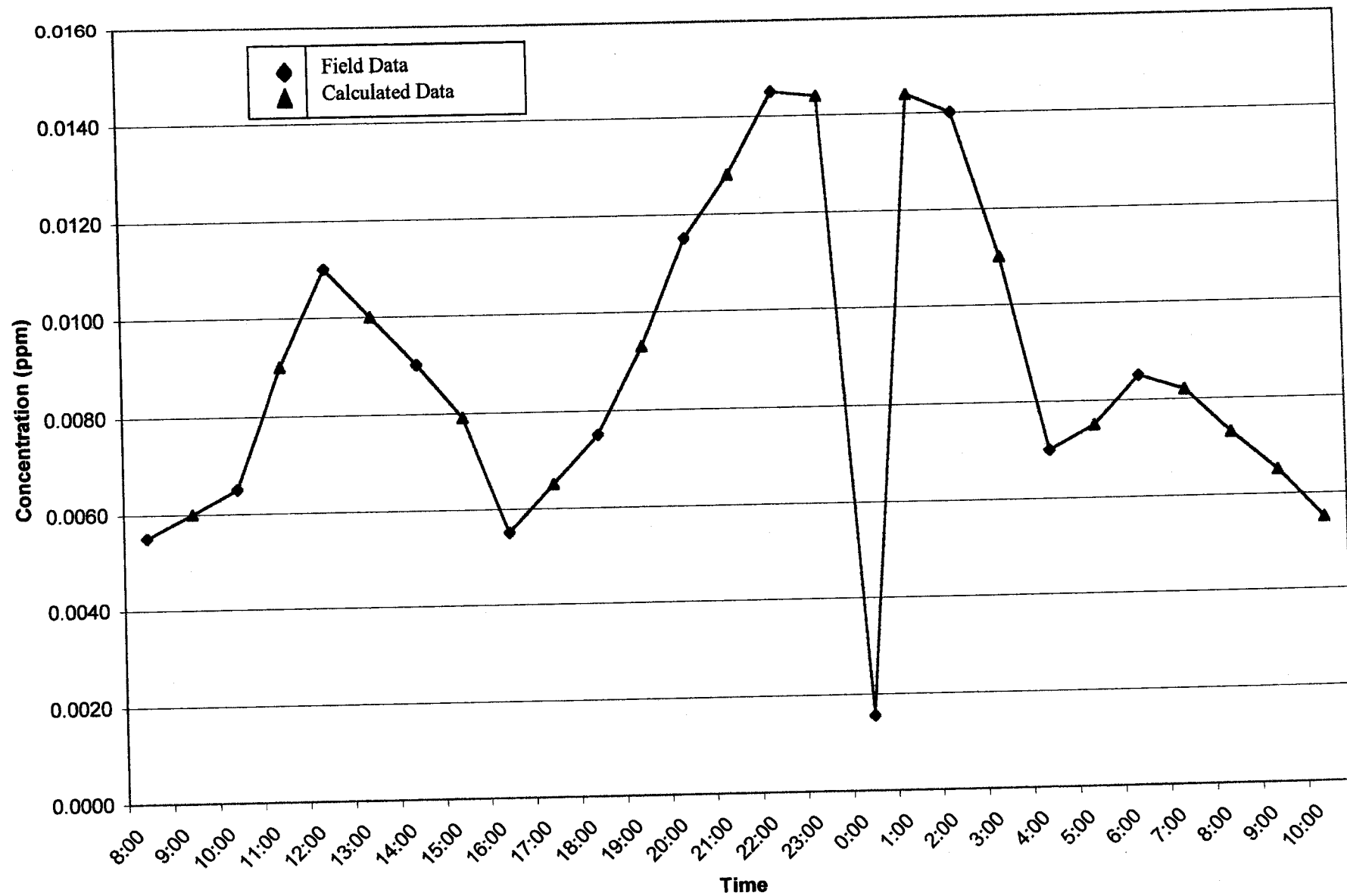


Figure 75. Treatment fringe April instantaneous TP concentration-time plot.

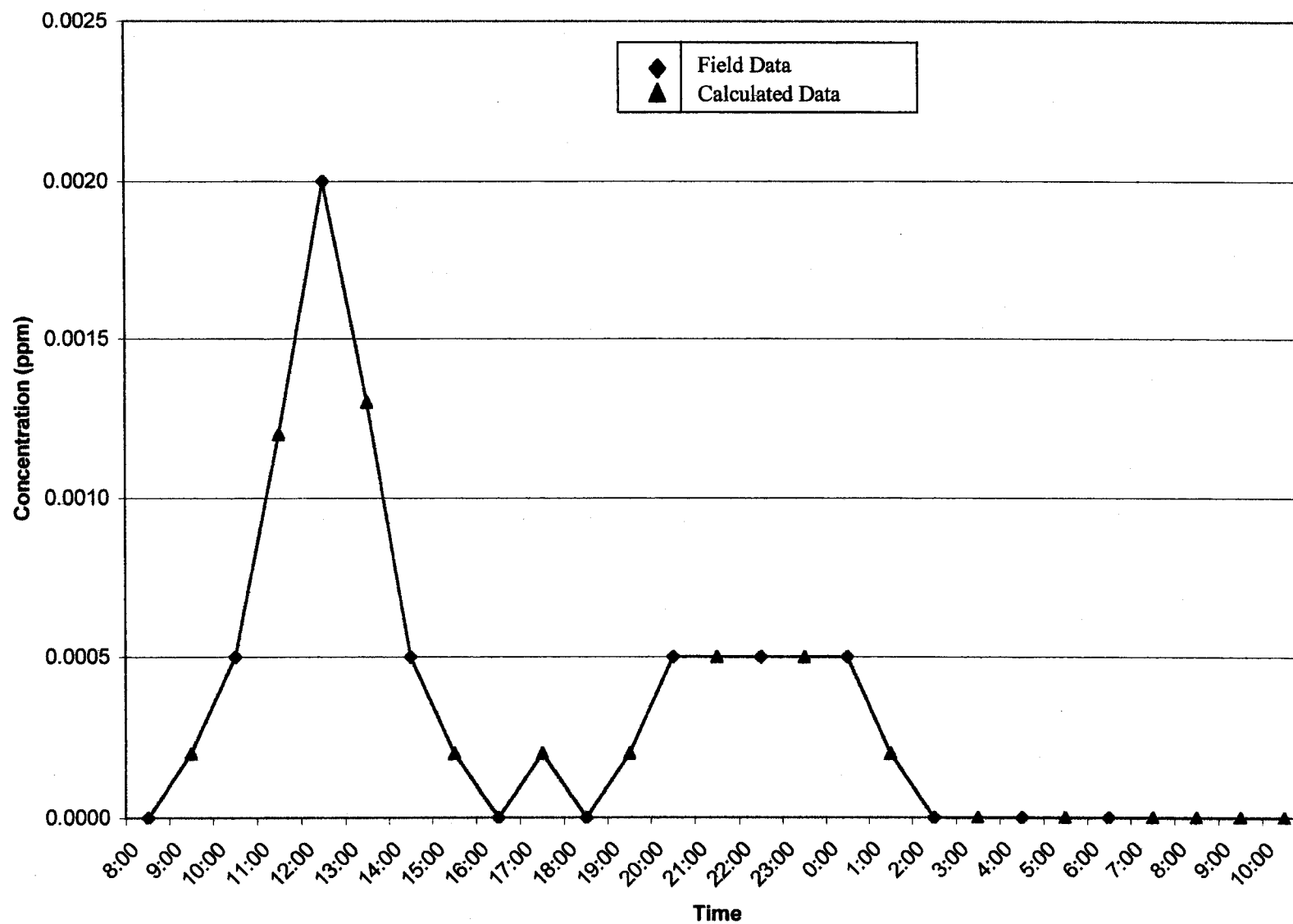


Figure 74 . Treatment fringe April instantaneous SRP concentration-time plot.

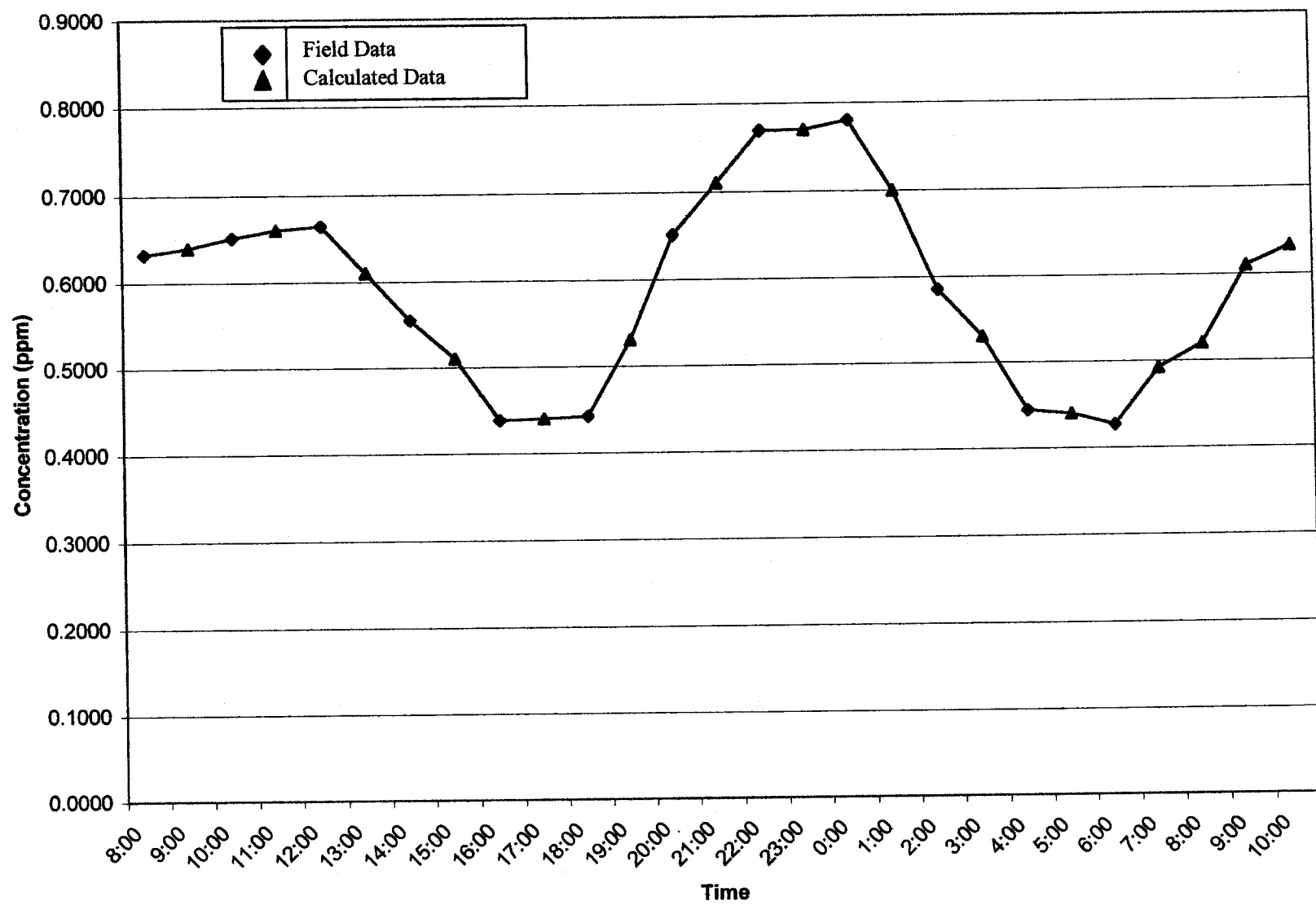


Figure 73. Treatment fringe April instantaneous TN concentration-time plot.

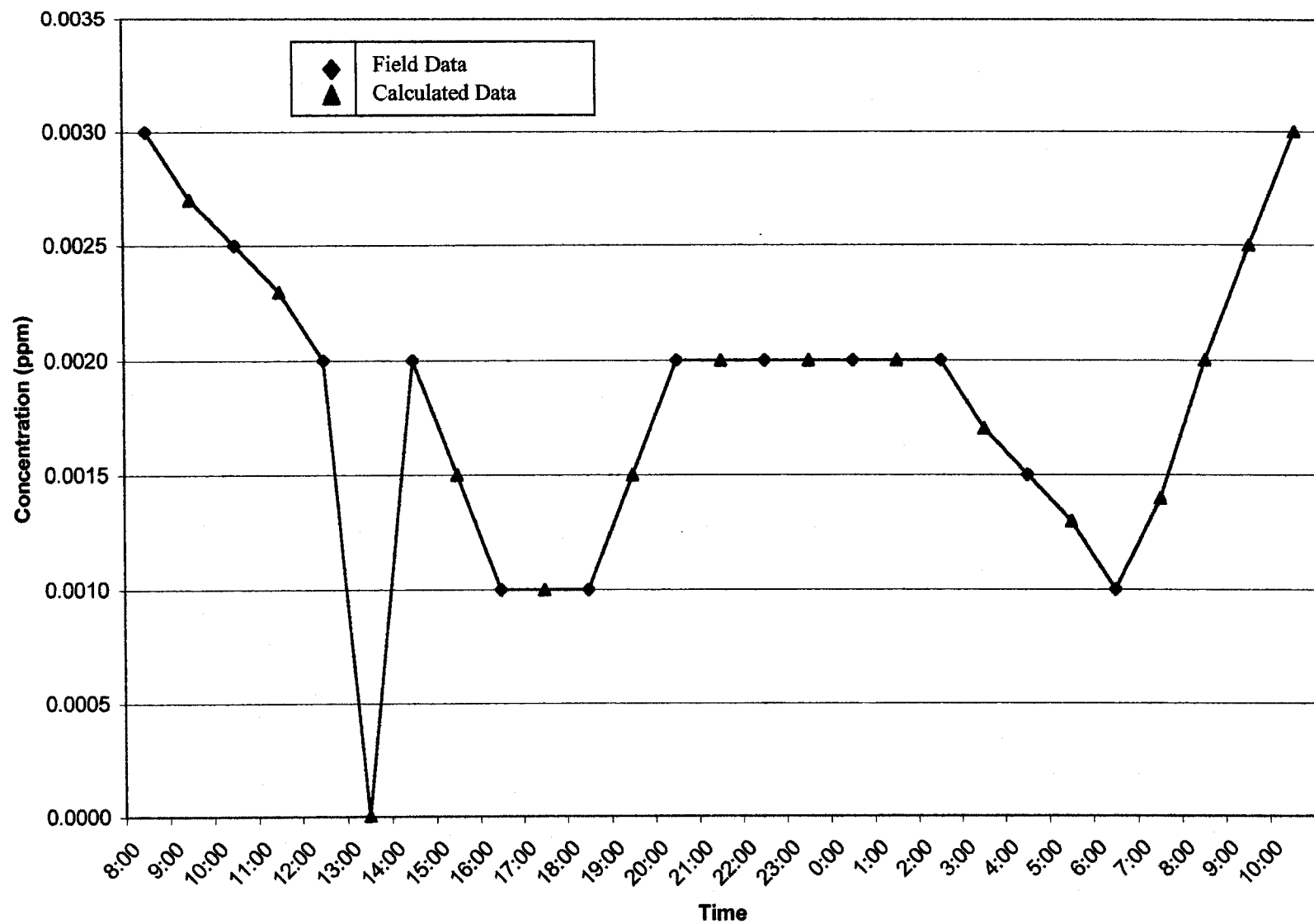


Figure 72. Treatment fringe April instantaneous NO2 concentration-time plot.

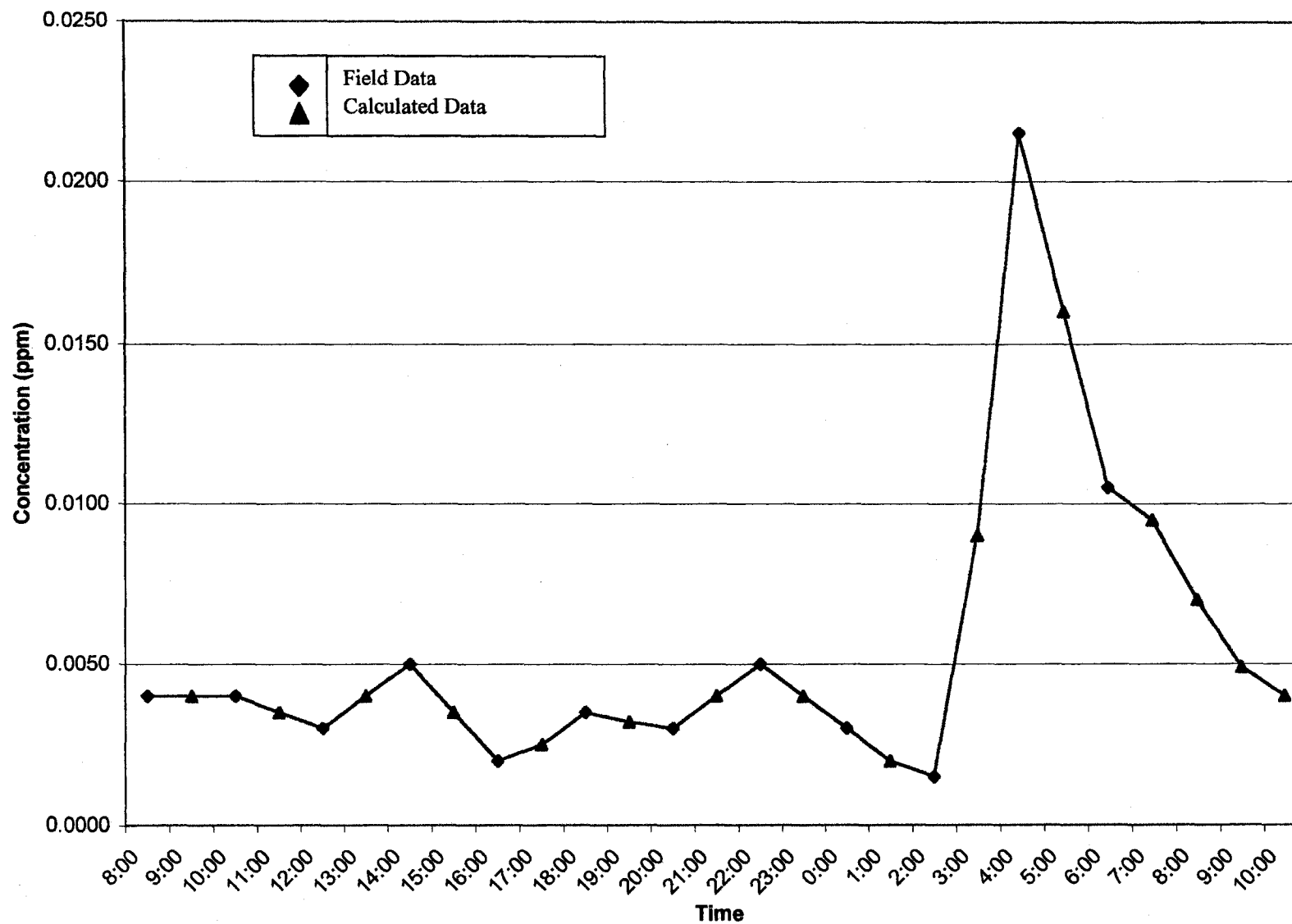


Figure 71. Treatment fringe April instantaneous NO₂ + NO₃ concentration-time plot.

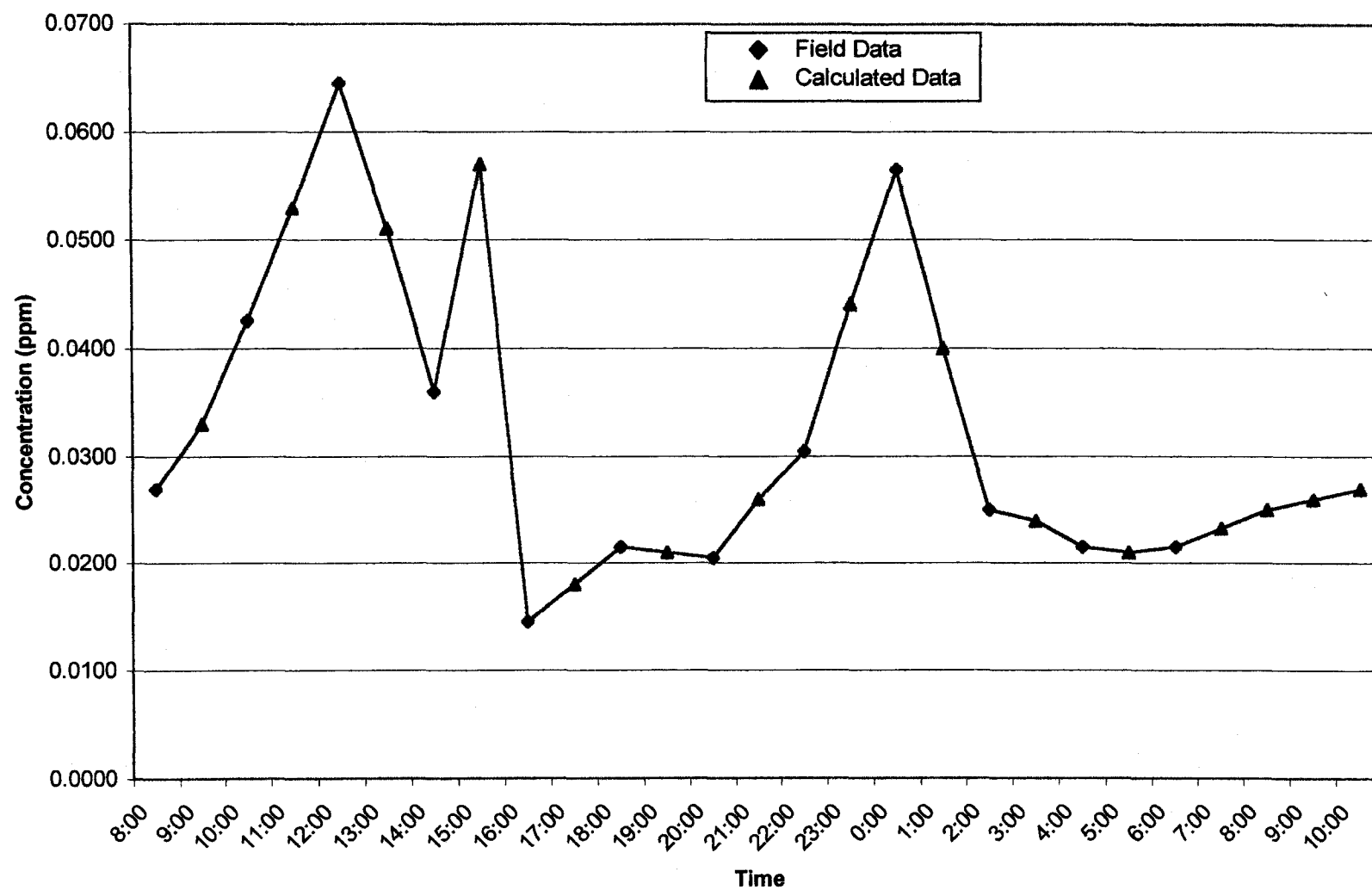


Figure 70. Treatment fringe April instantaneous NH_4 concentration-time plot.

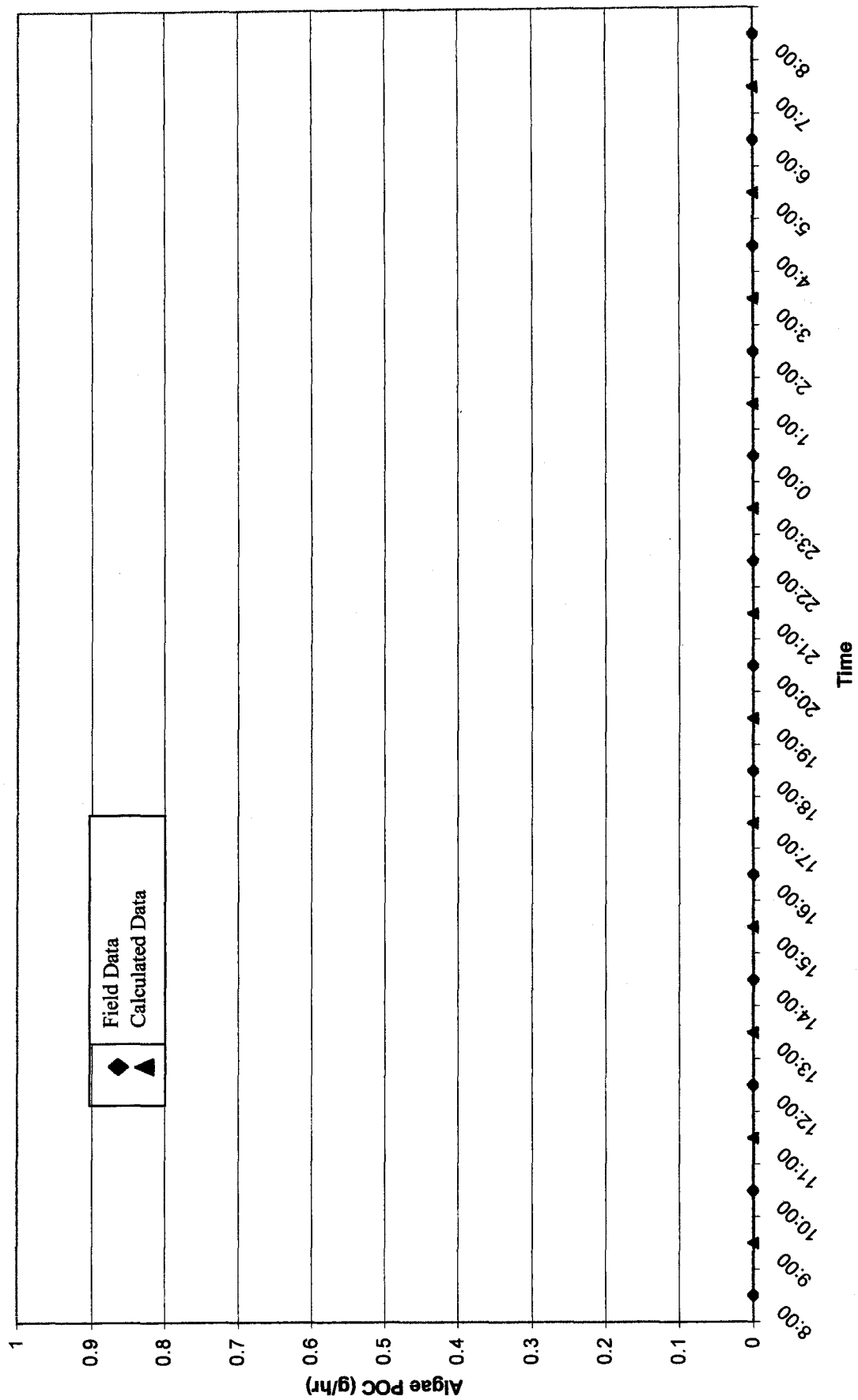


Figure 69. Control scrub December hourly algae particulate organic carbon load.

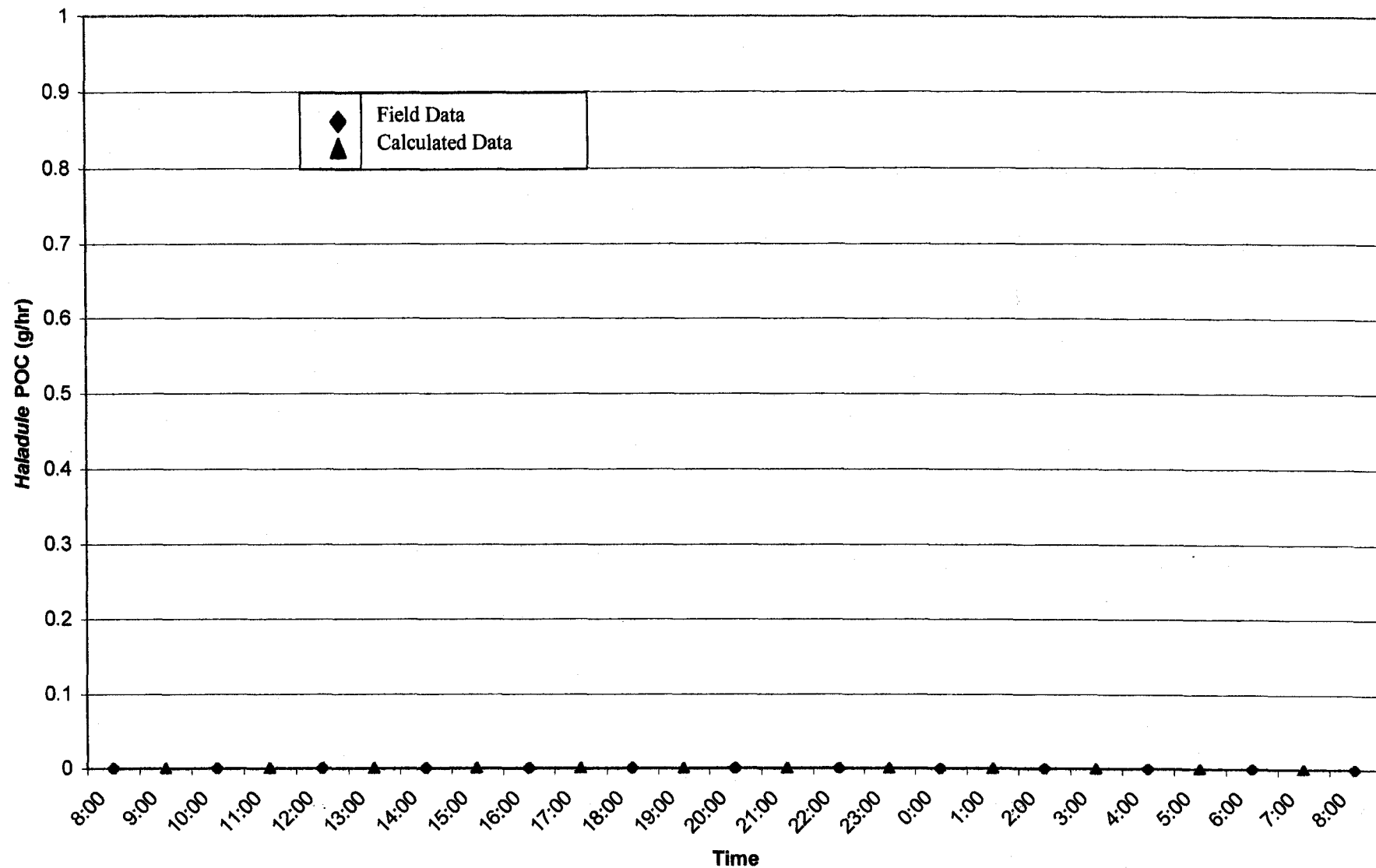


Figure 68. Control scrub December hourly *Halodule* particulate organic carbon load.

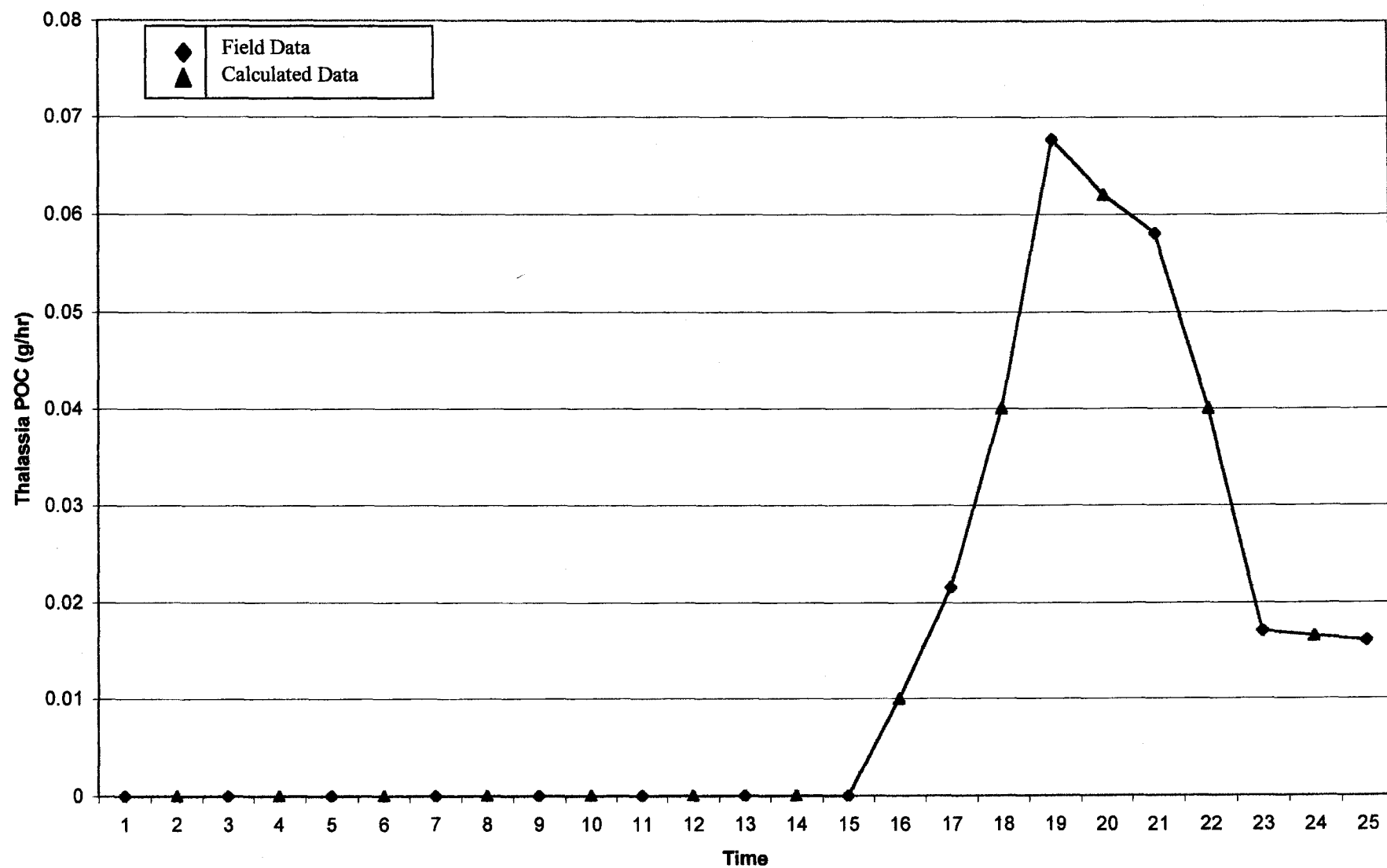


Figure 67. Control scrub December hourly *Thalassia* particulate organic carbon load.

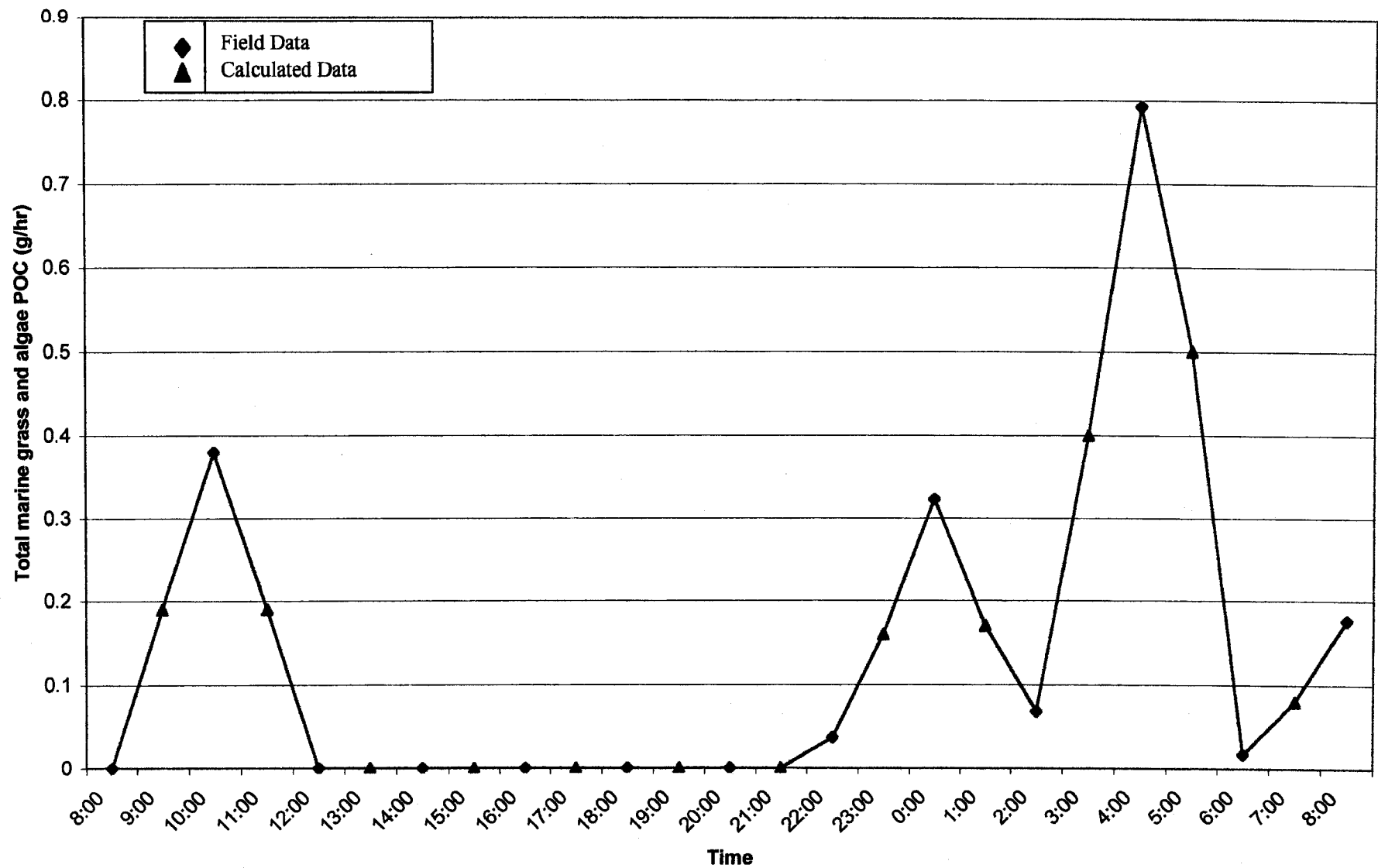


Figure 66. Control scrub December hourly total marine grass and algae particulate organic carbon load.

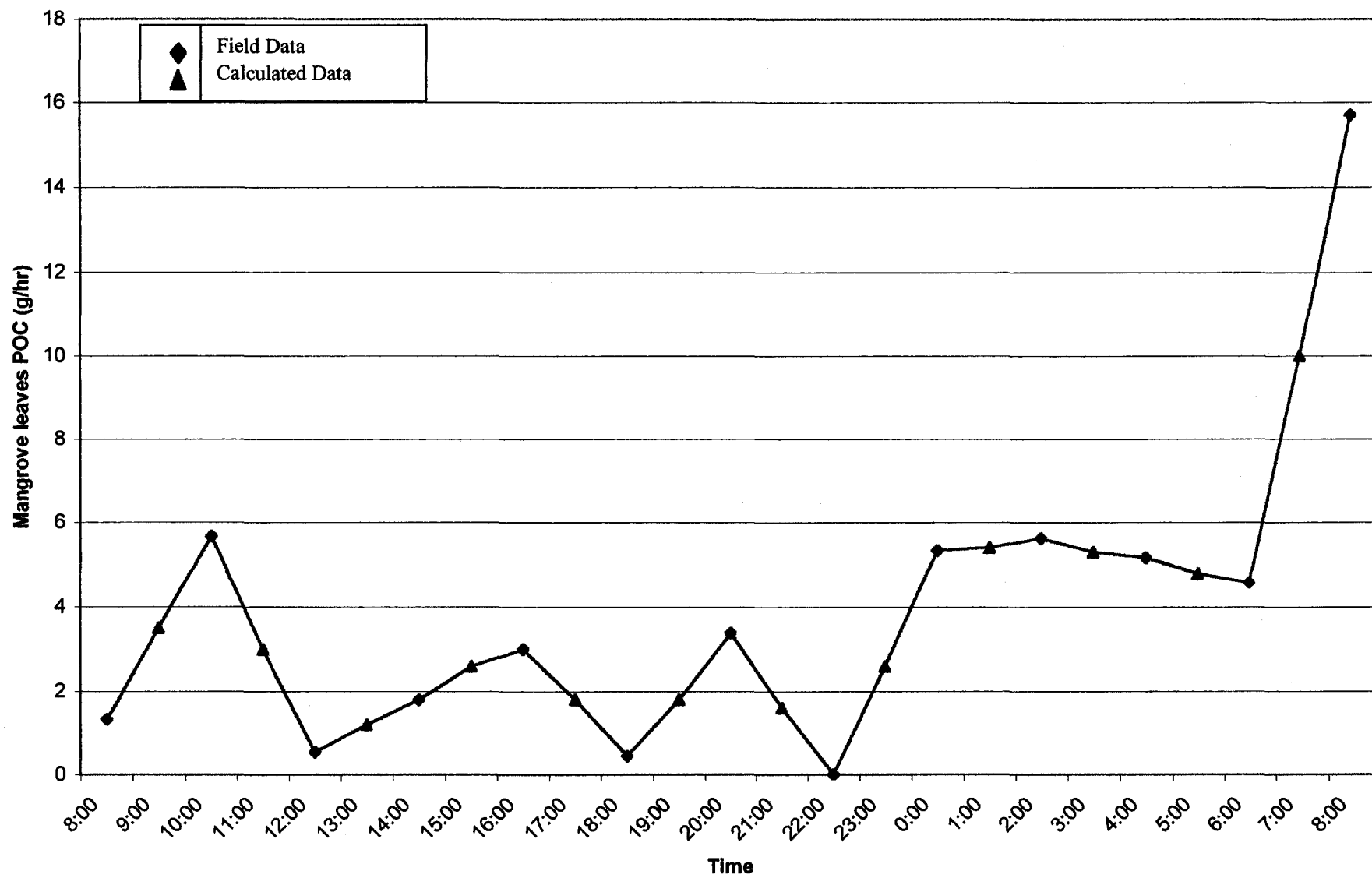


Figure 65. Control scrub December hourly mangrove leaf particulate organic carbon load.

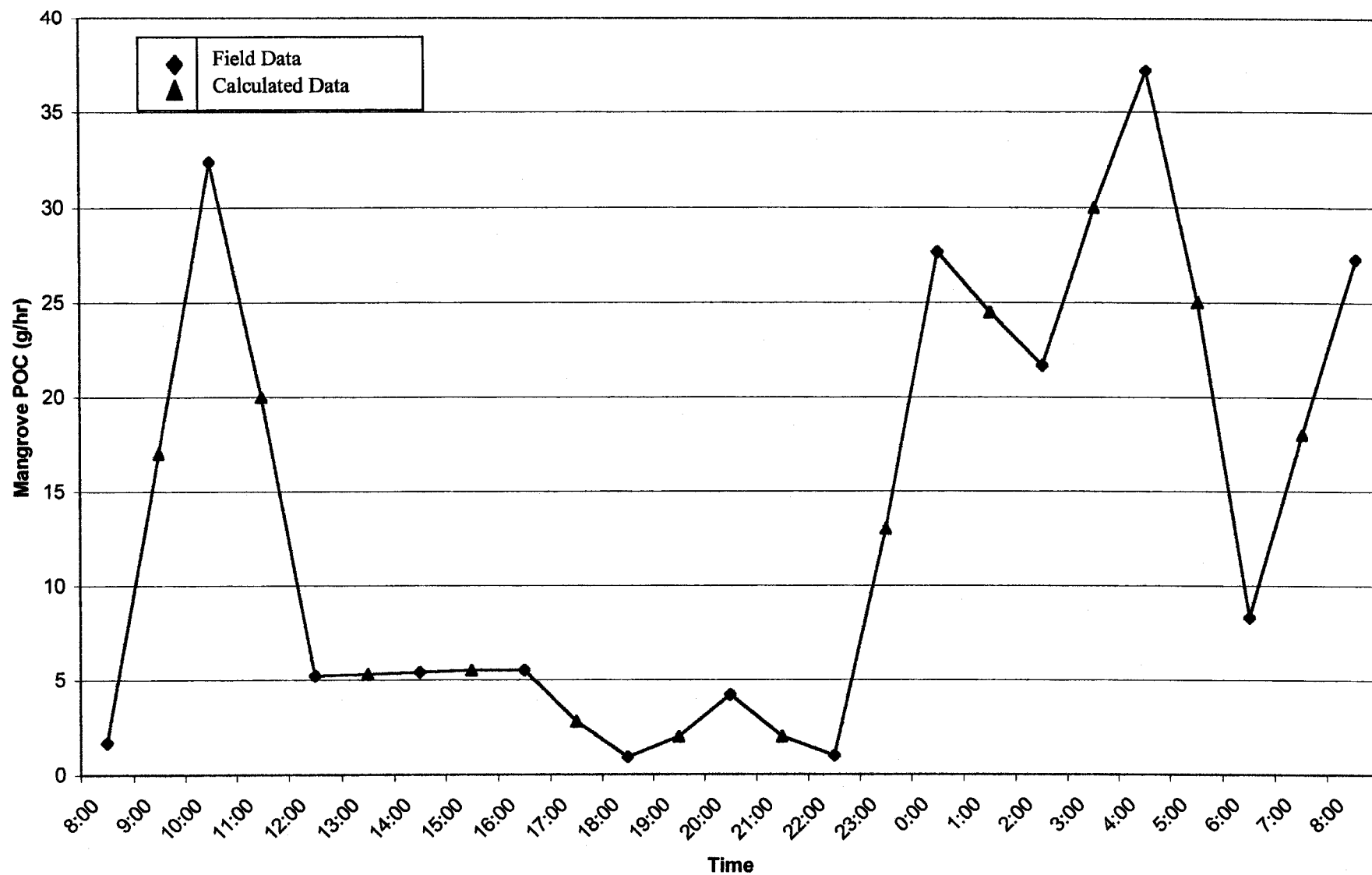


Figure 64. Control scrub December hourly total mangrove particulate organic carbon load.

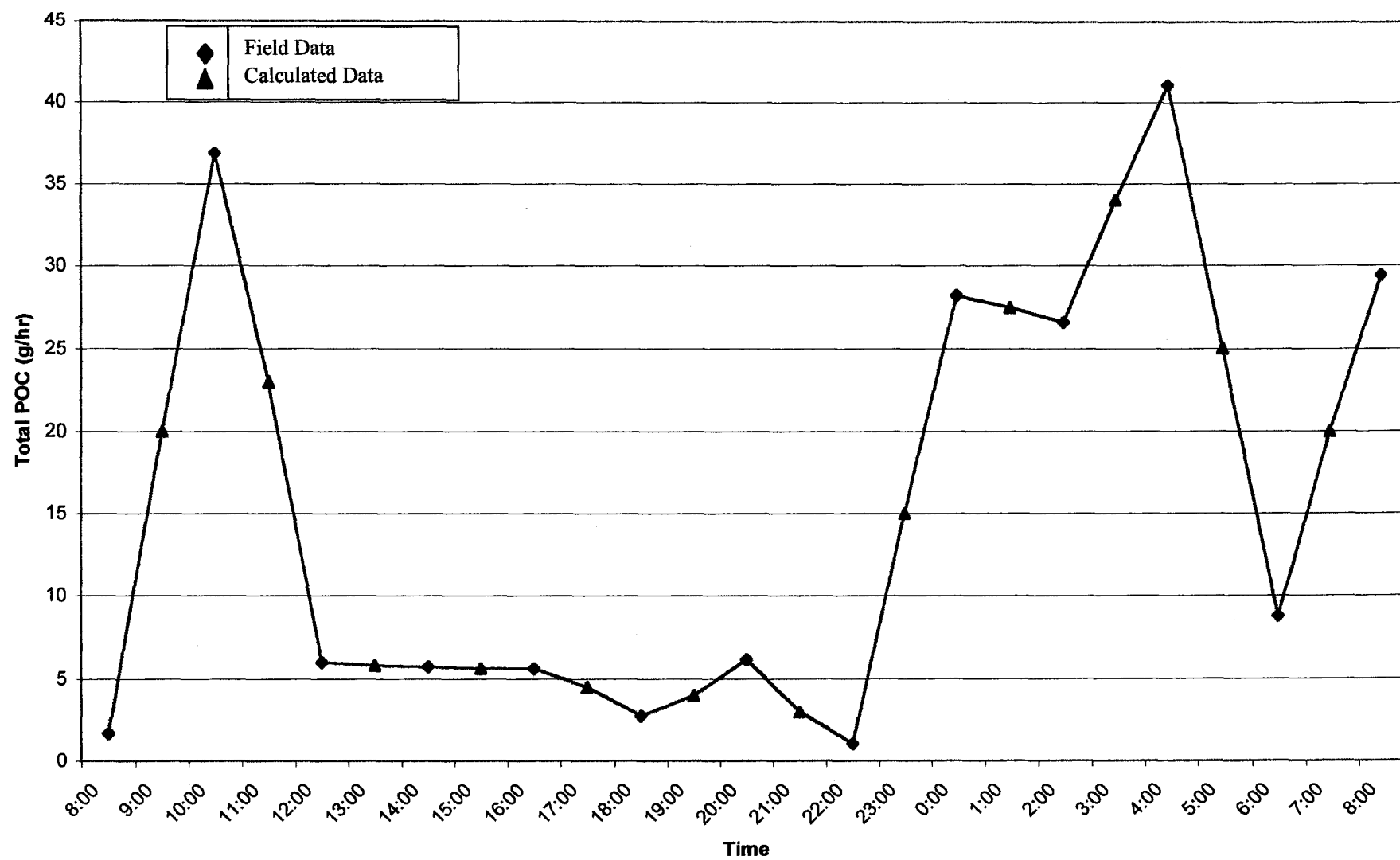


Figure 63. Control scrub December hourly total particulate organic carbon load.

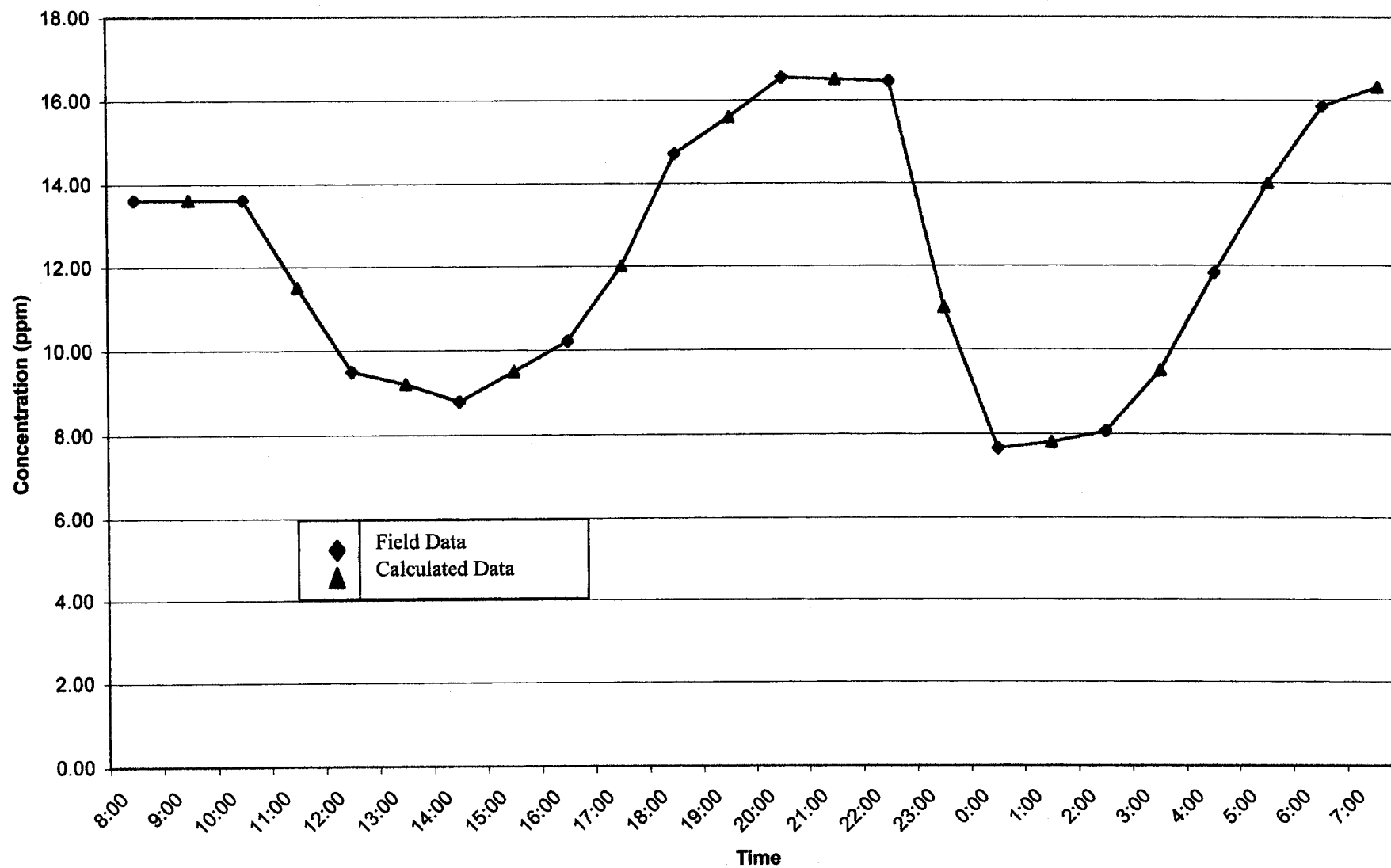


Figure 62. Control scrub December instantaneous TOC concentration-time plot.

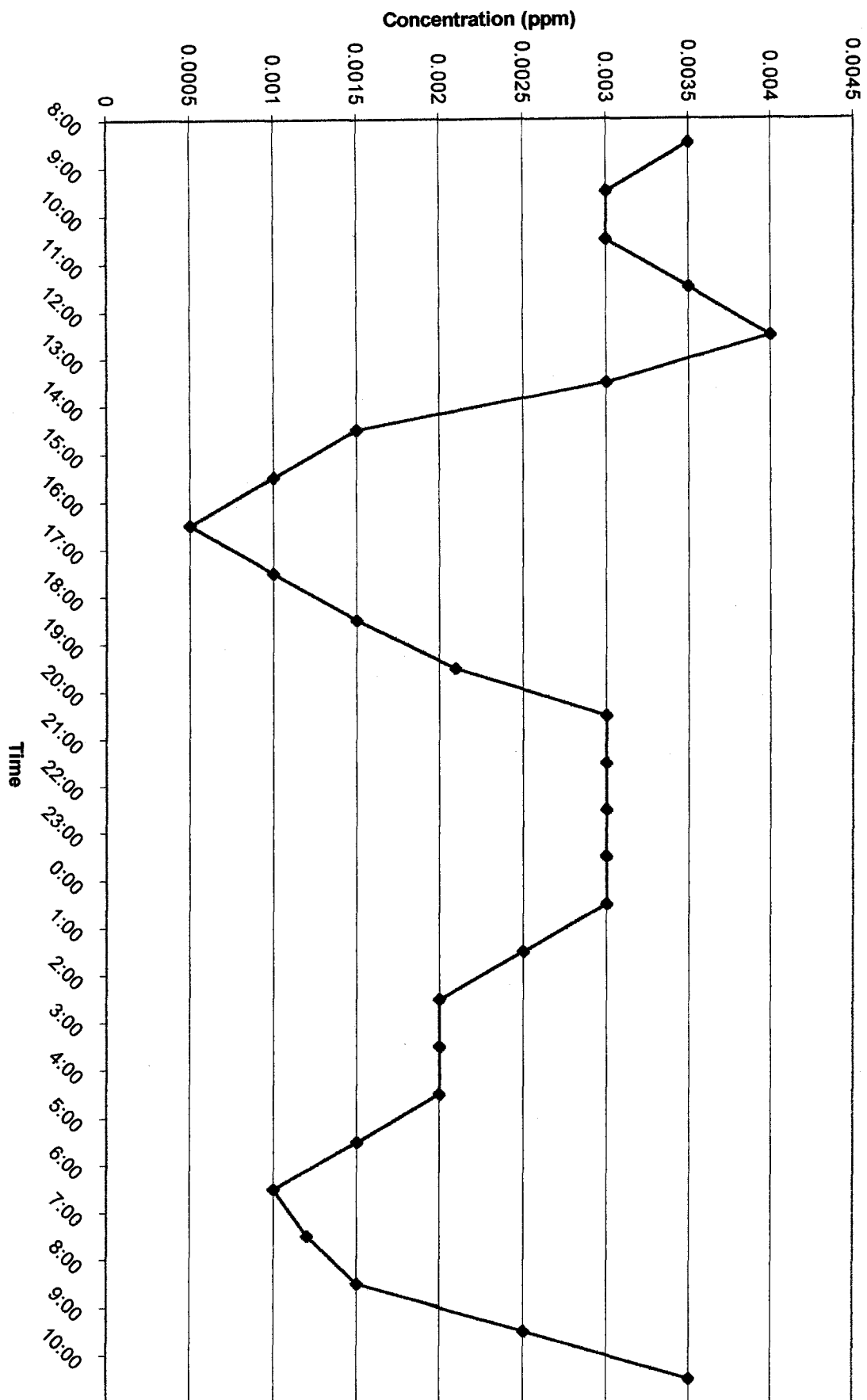


Figure 100. Control fringe April instantaneous NO₂ concentration-time plot.

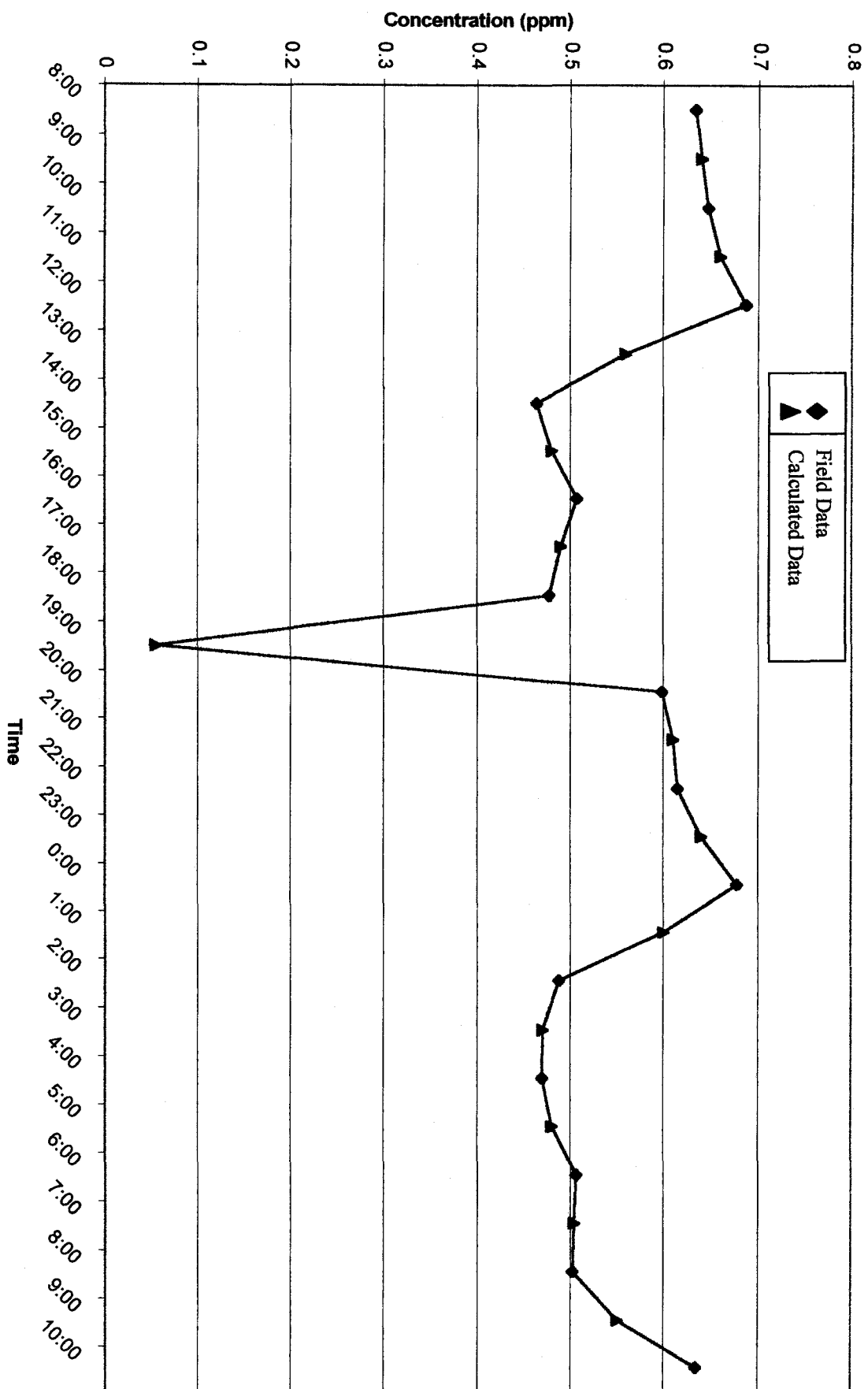


Figure 101. Control fringe April instantaneous TN concentration-time plot.

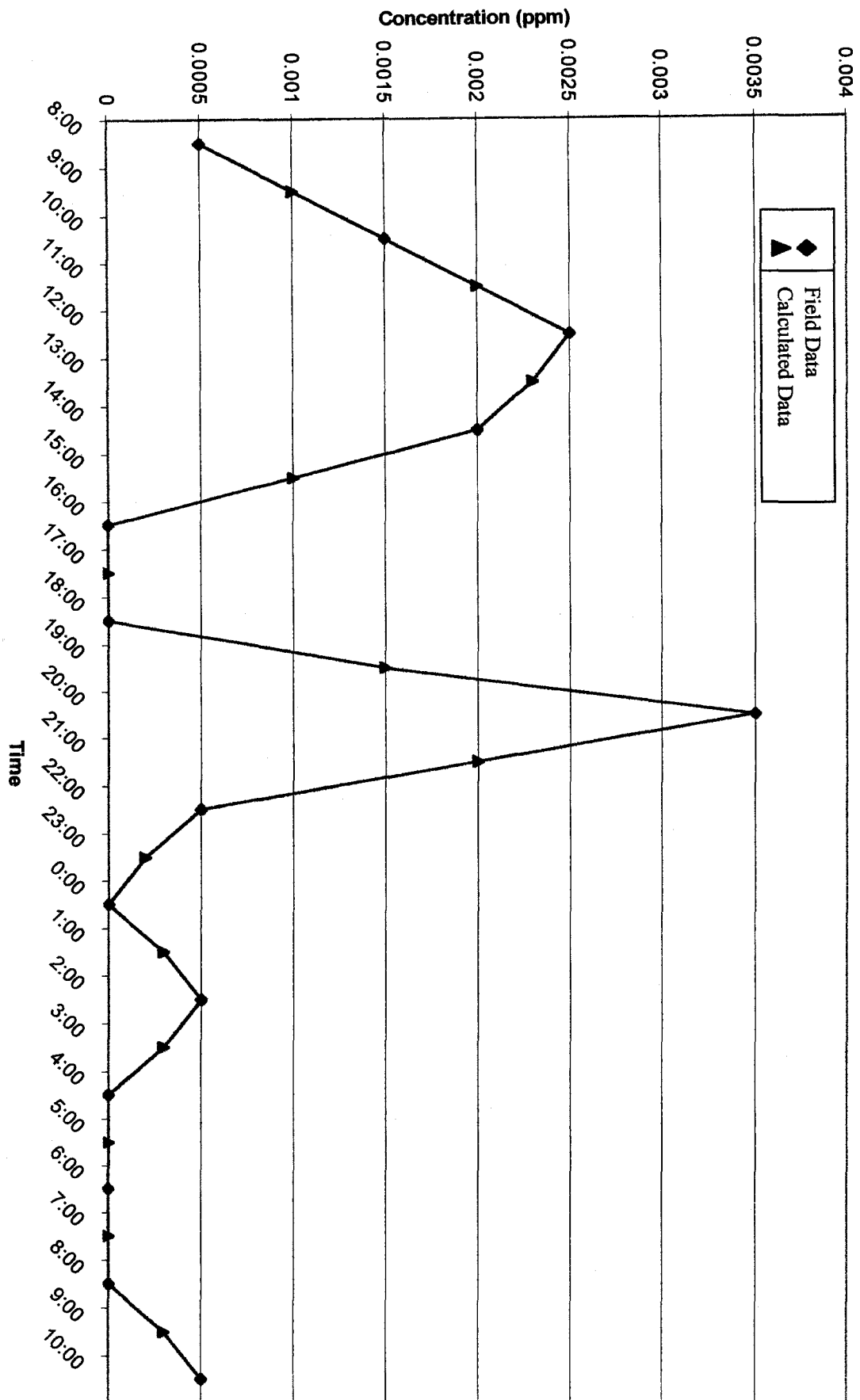


Figure 102. Control fringe April instantaneous SRP concentration-time plot.

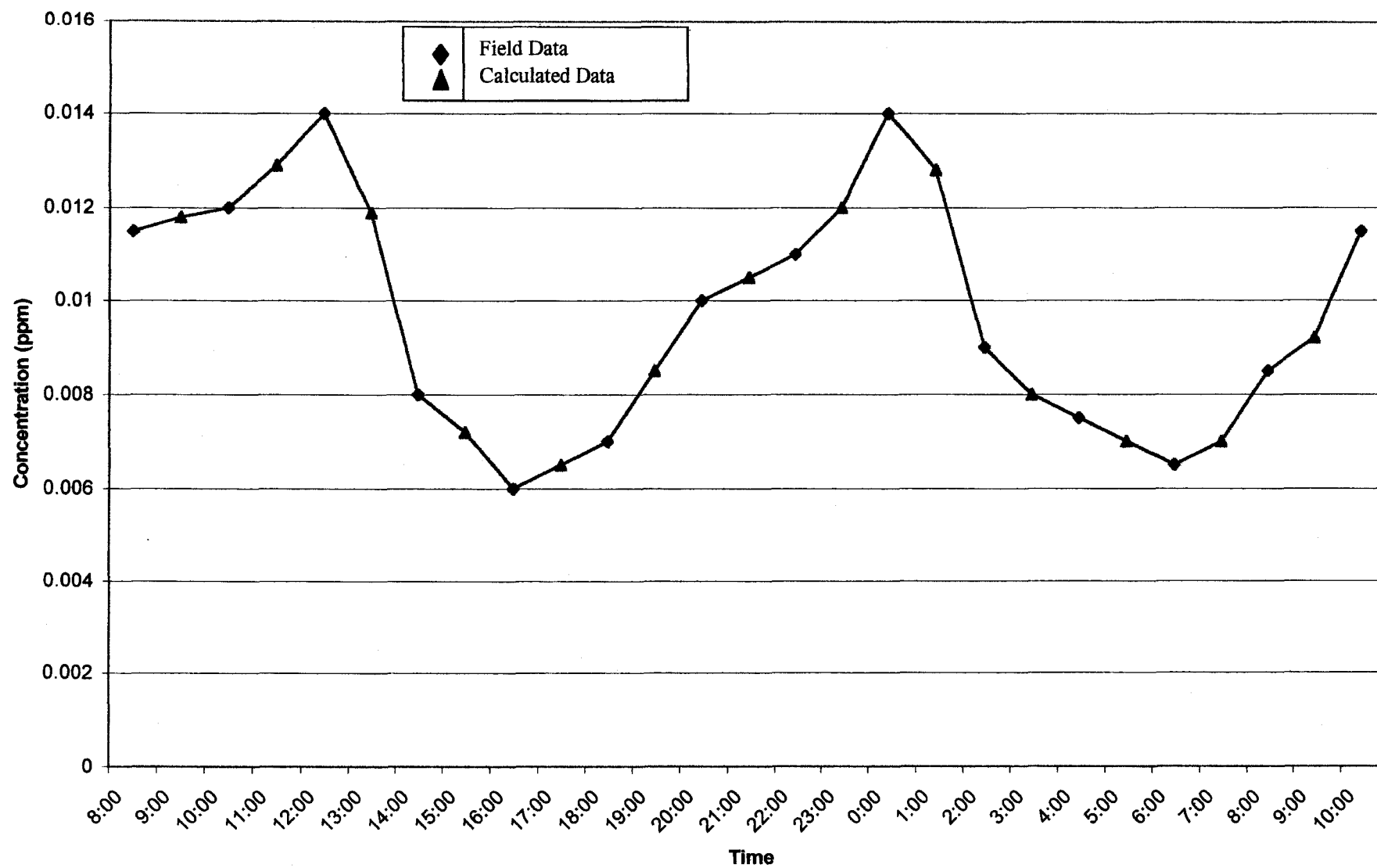


Figure 103. Control fringe April instantaneous TP concentration-time plot.

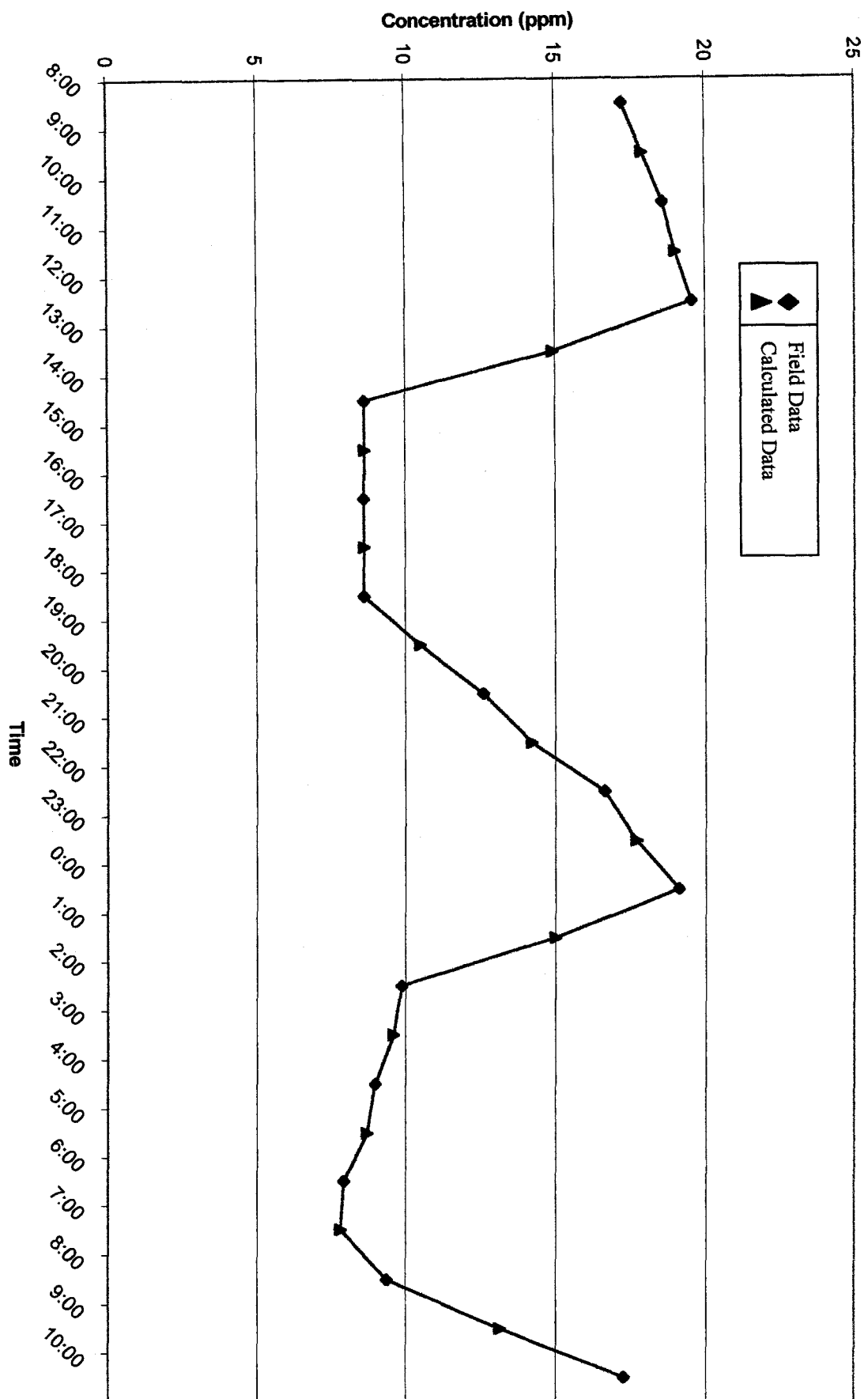


Figure 104. Control fringe April instantaneous TOC concentration-time plot

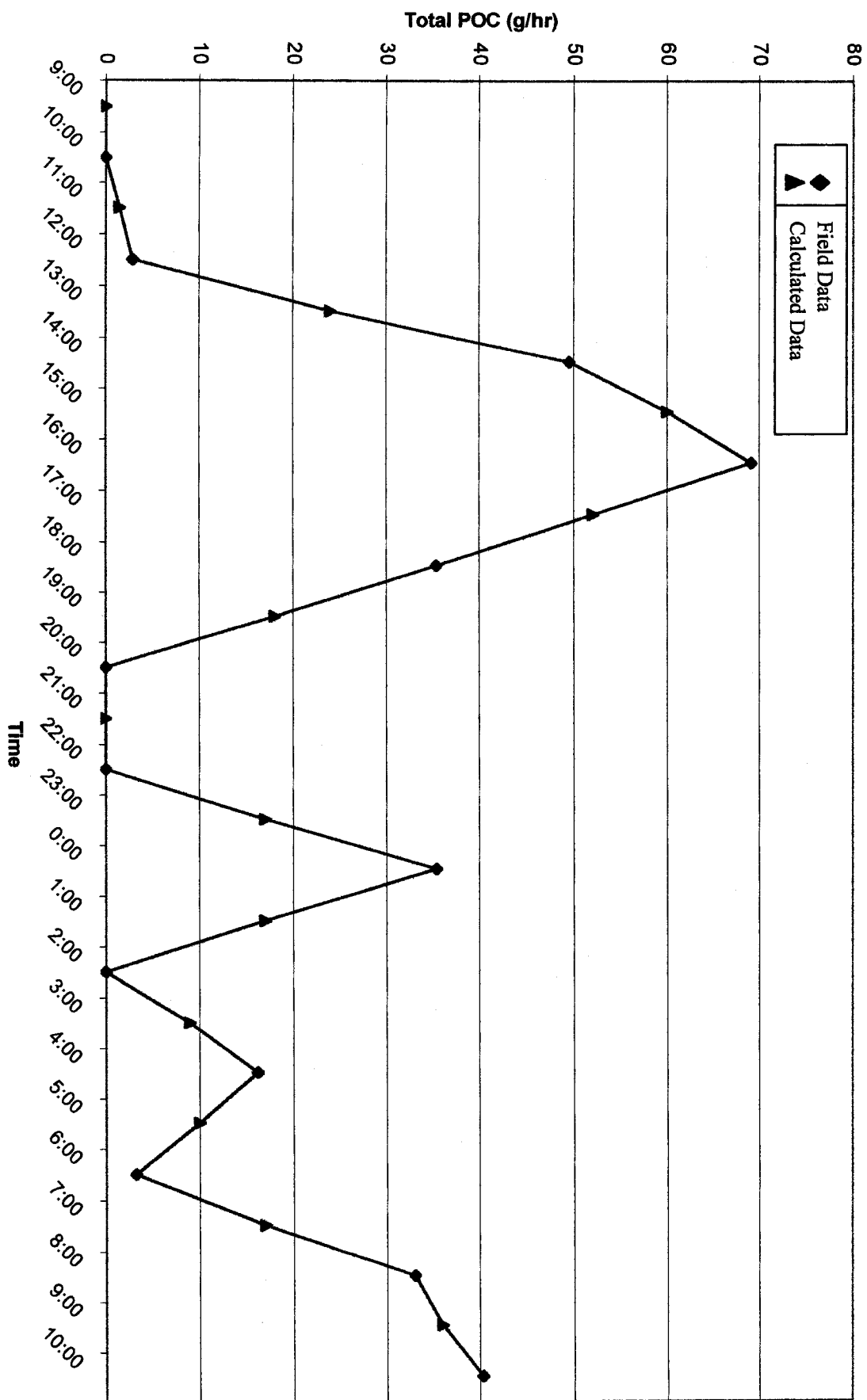


Figure 105. Control fringe April hourly total particulate organic carbon load.

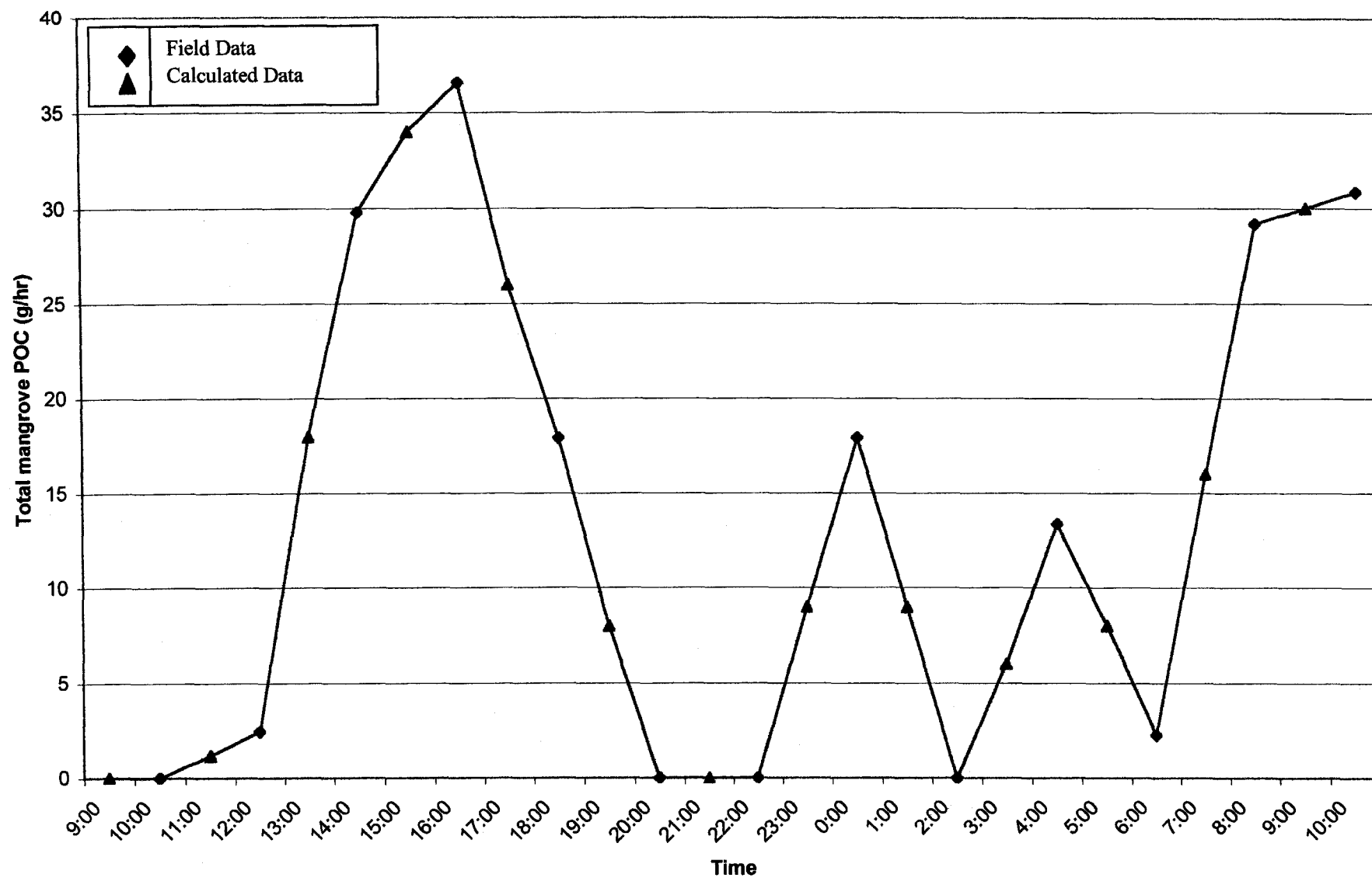


Figure 106. Control fringe April hourly total mangrove particulate organic carbon.

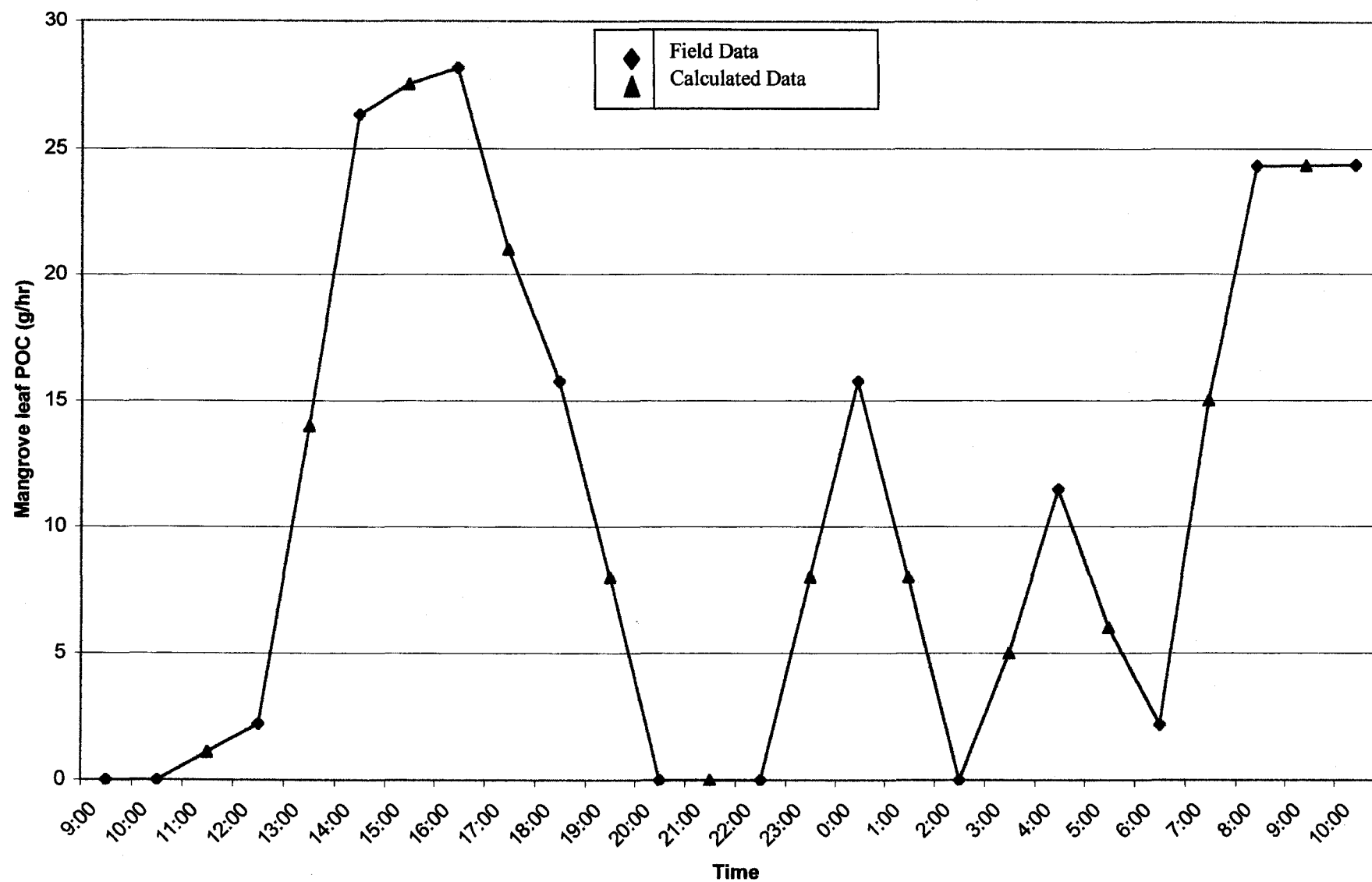


Figure 107. Control fringe April hourly mangrove leaf particulate organic carbon load.

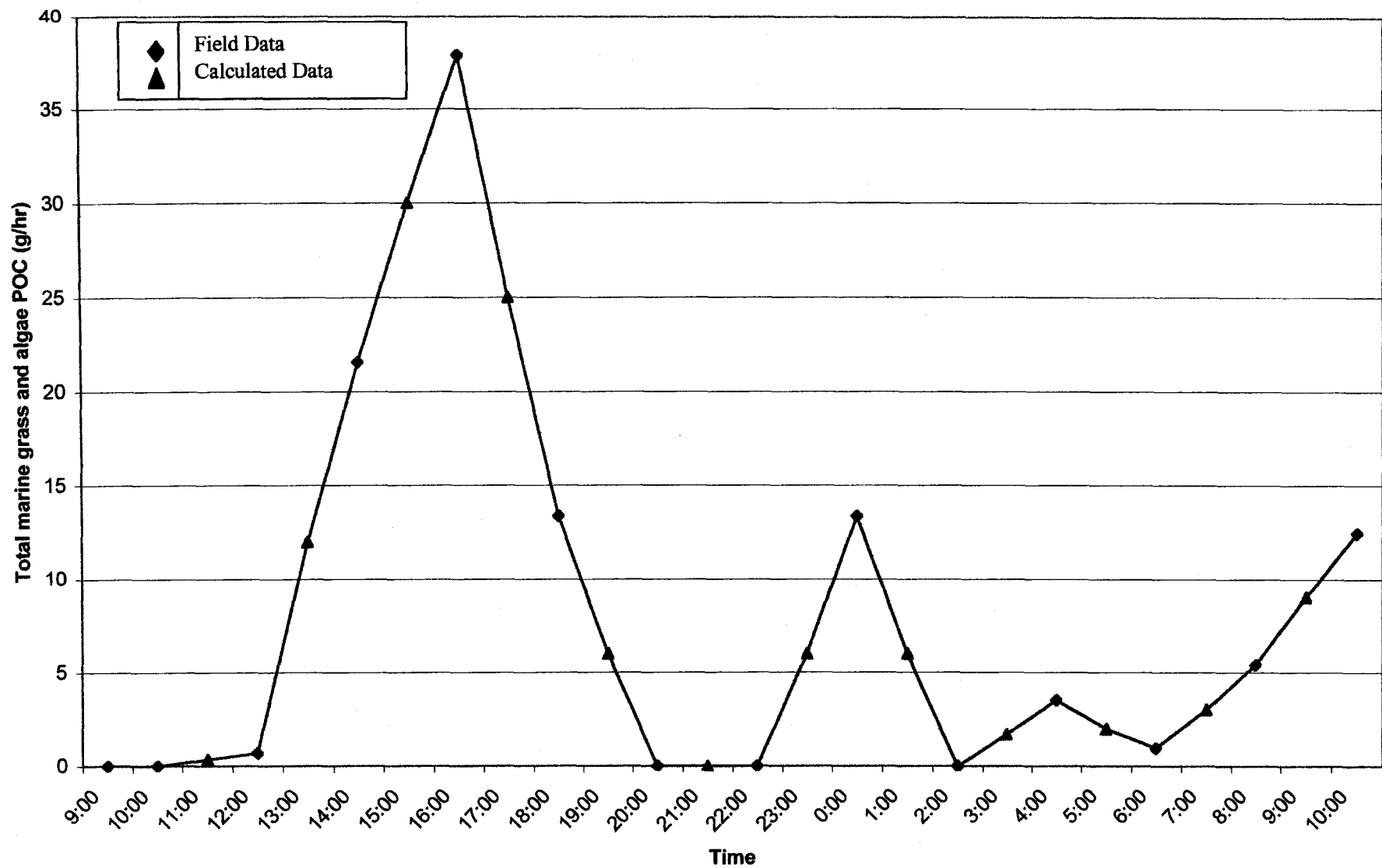


Figure 108. Control fringe April hourly total marine grass and algae particulate organic carbon load.

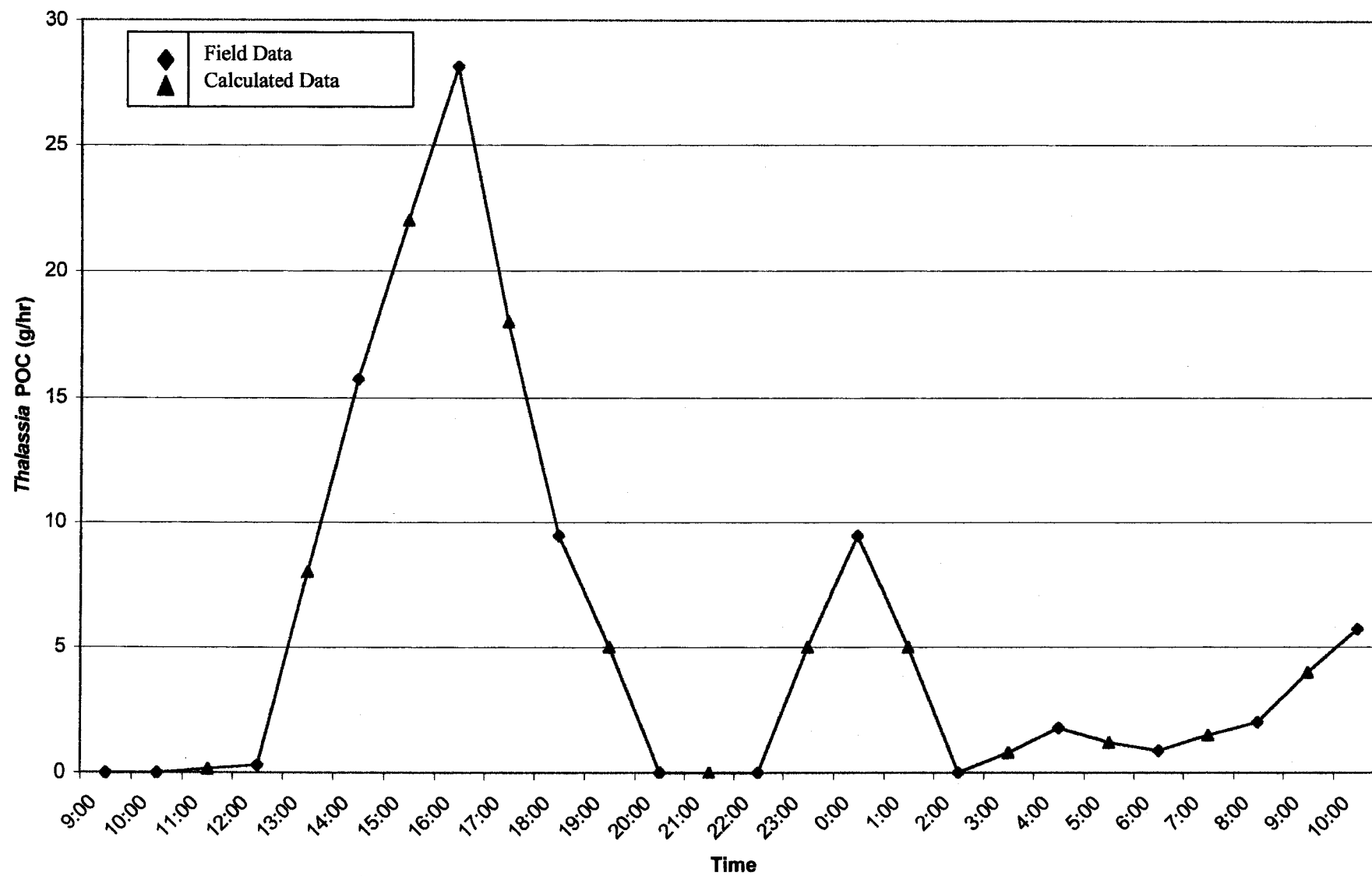


Figure 109. Control fringe April hourly *Thalassia* particulate organic carbon load.

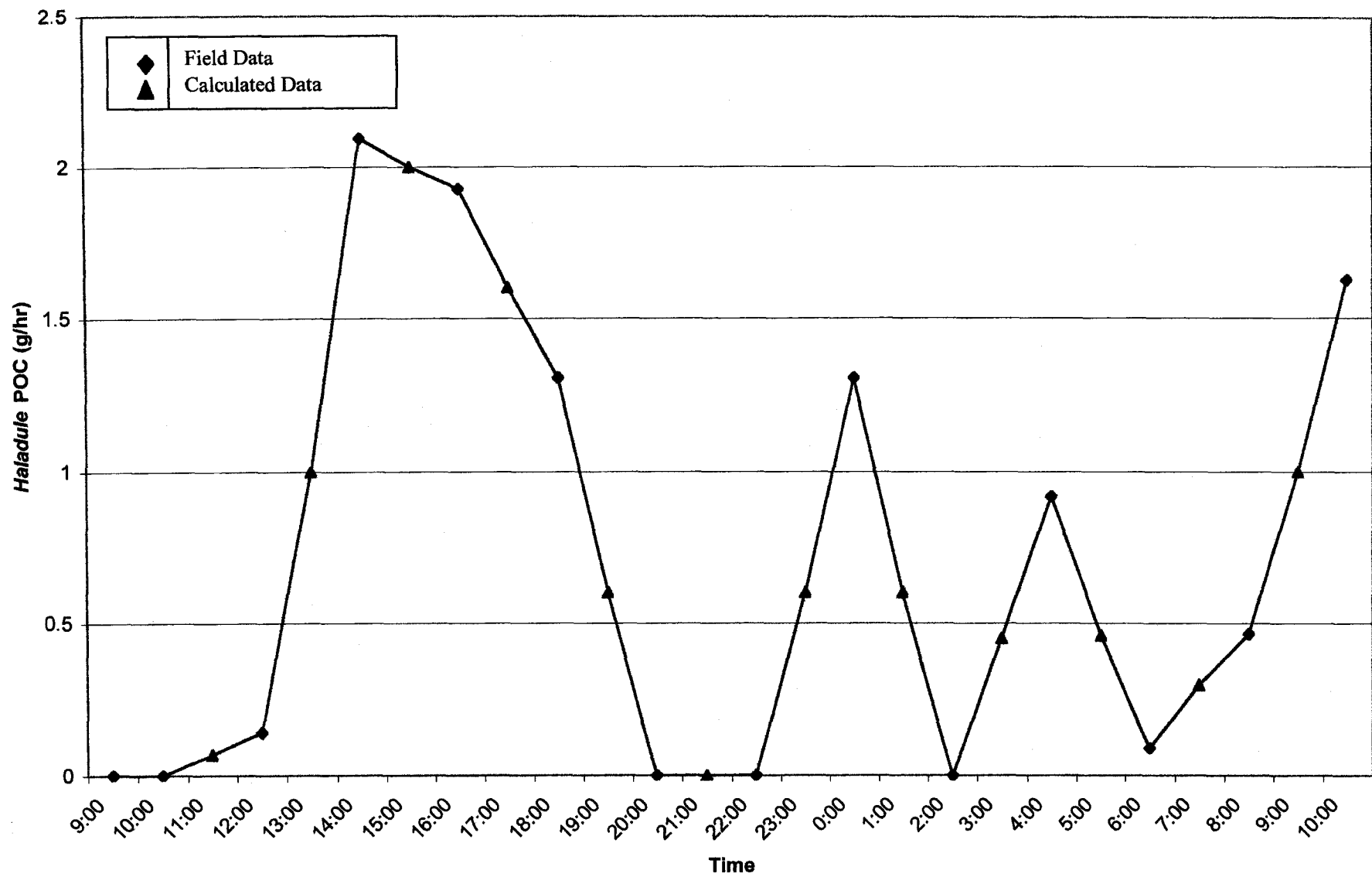


Figure 110. Control fringe April hourly *Haladule* particulate organic carbon load.

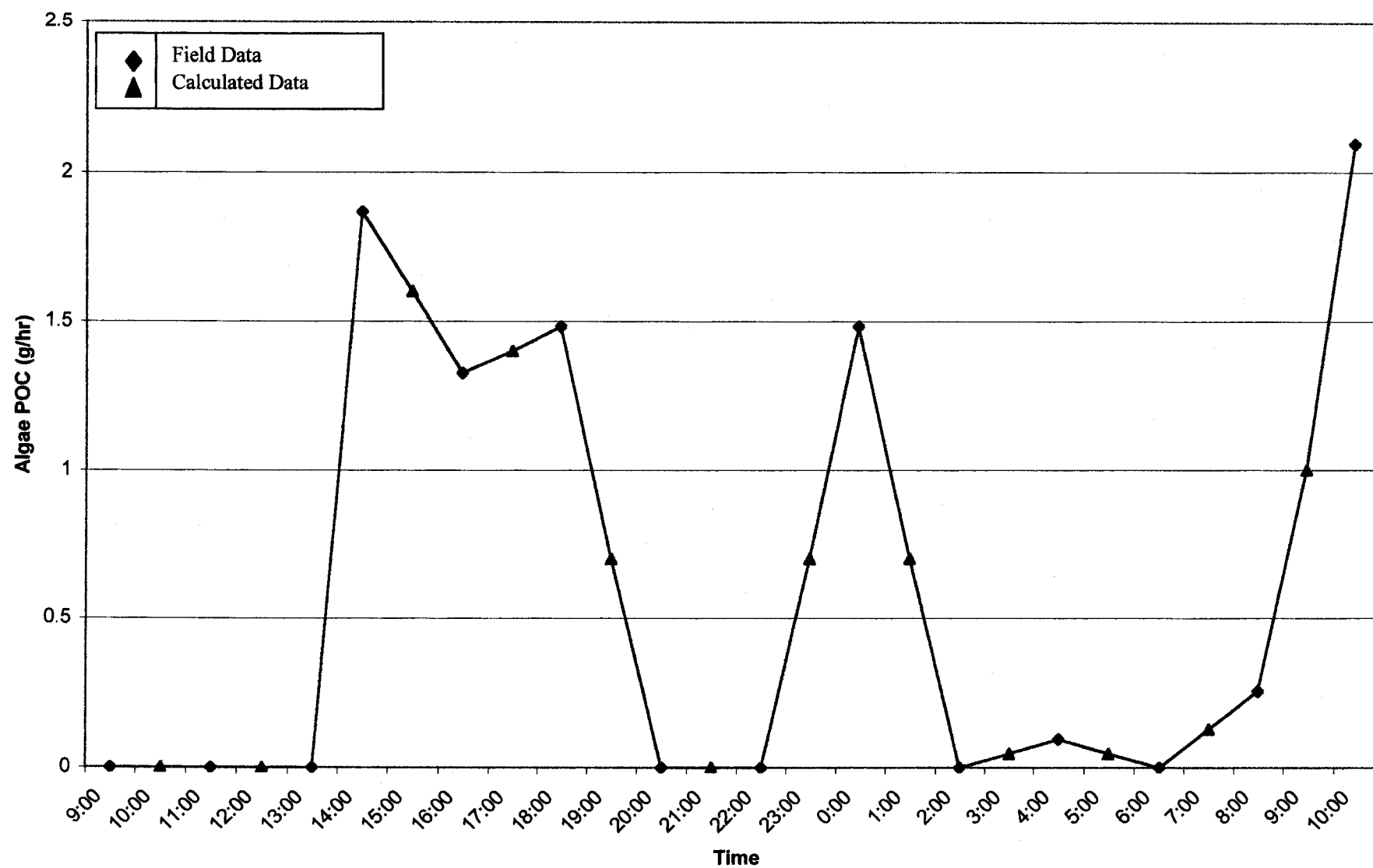


Figure 111. Control fringe April hourly algae particulate organic carbon load.

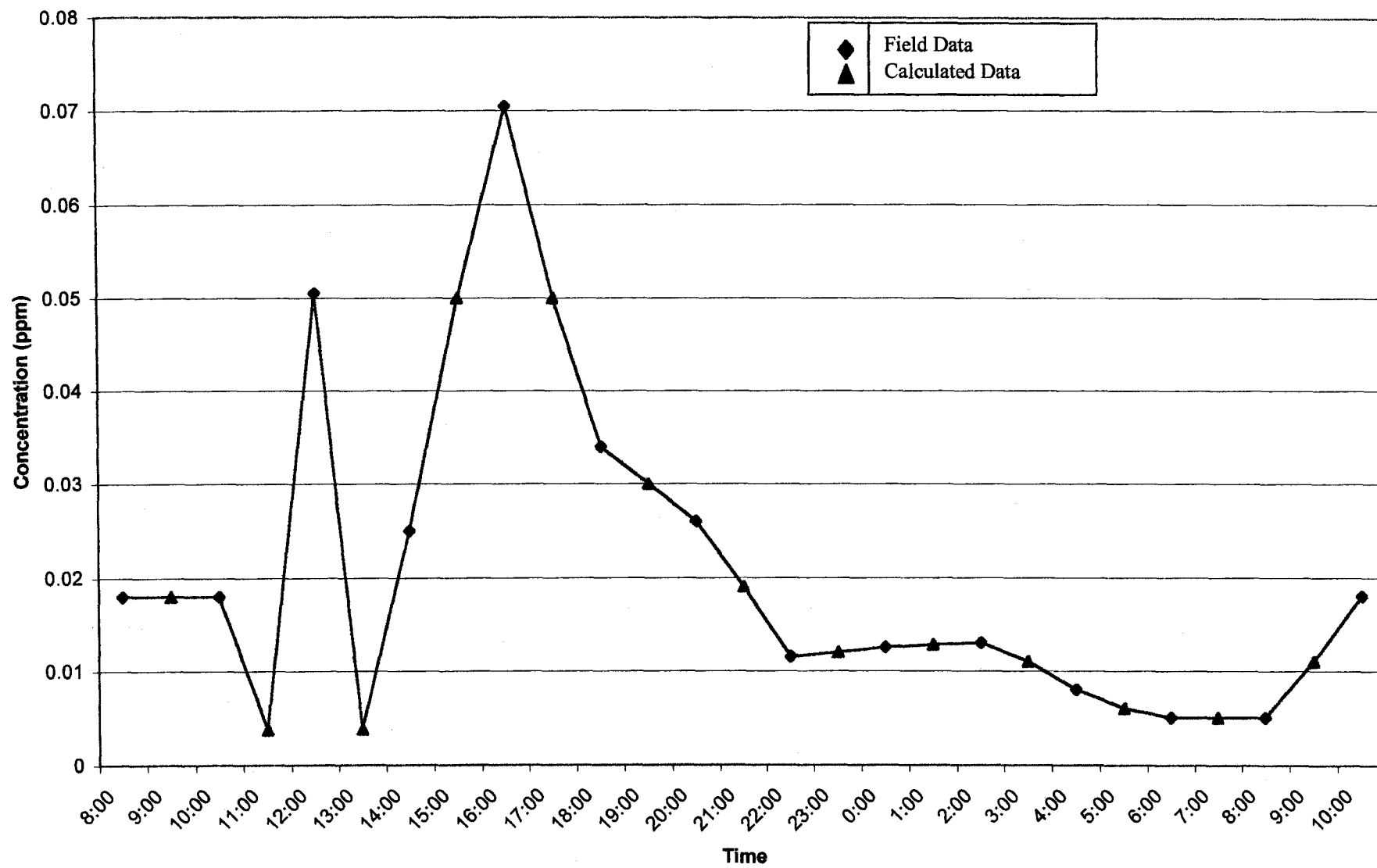


Figure 112. Control scrub April instantaneous NH_4 concentration-time plot.

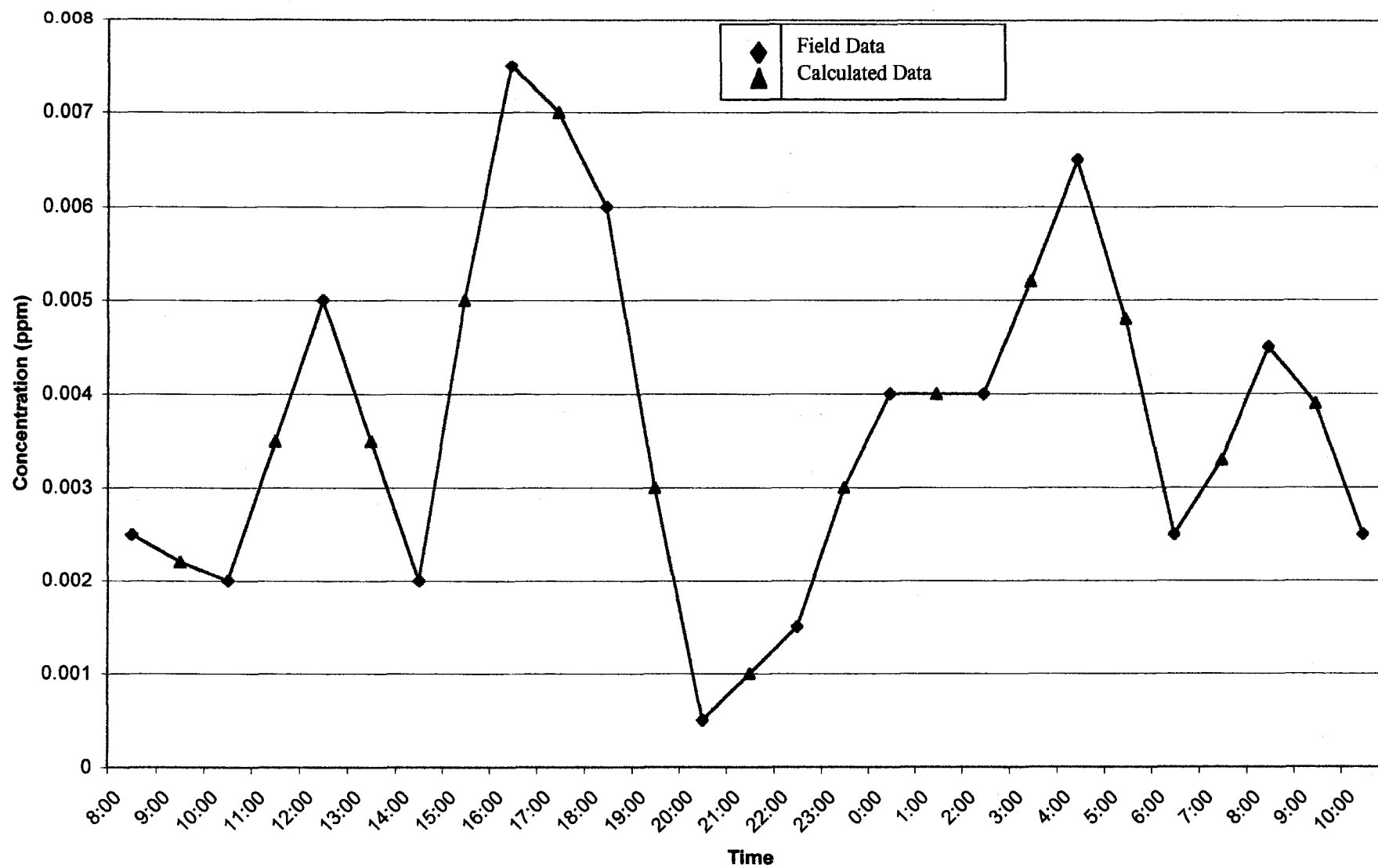


Figure 113. Control scrub April instantaneous NO₂ +NO₃ concentration-time plot.

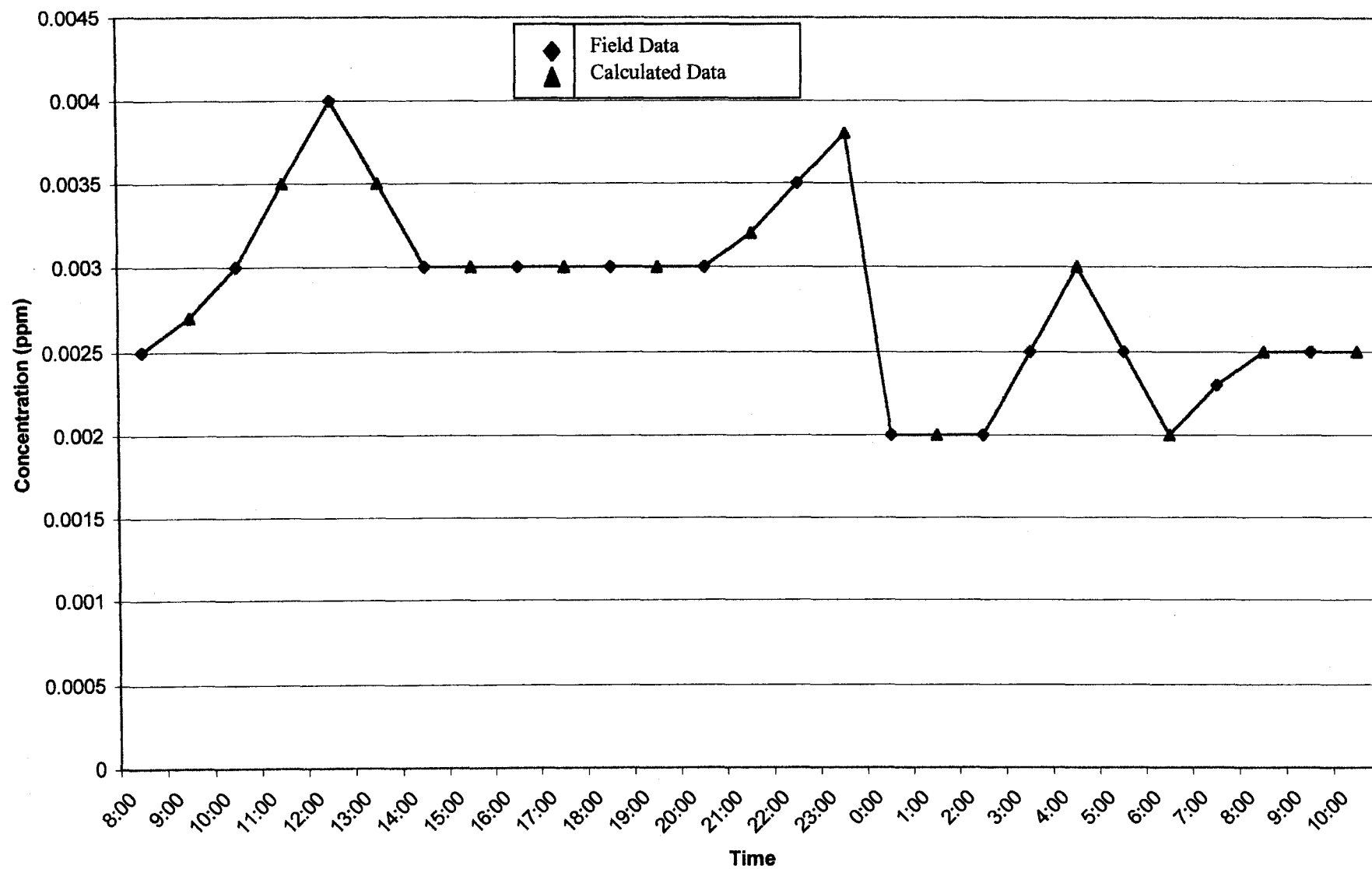


Figure 114. Control scrub April instantaneous NO2 concentration-time plot.

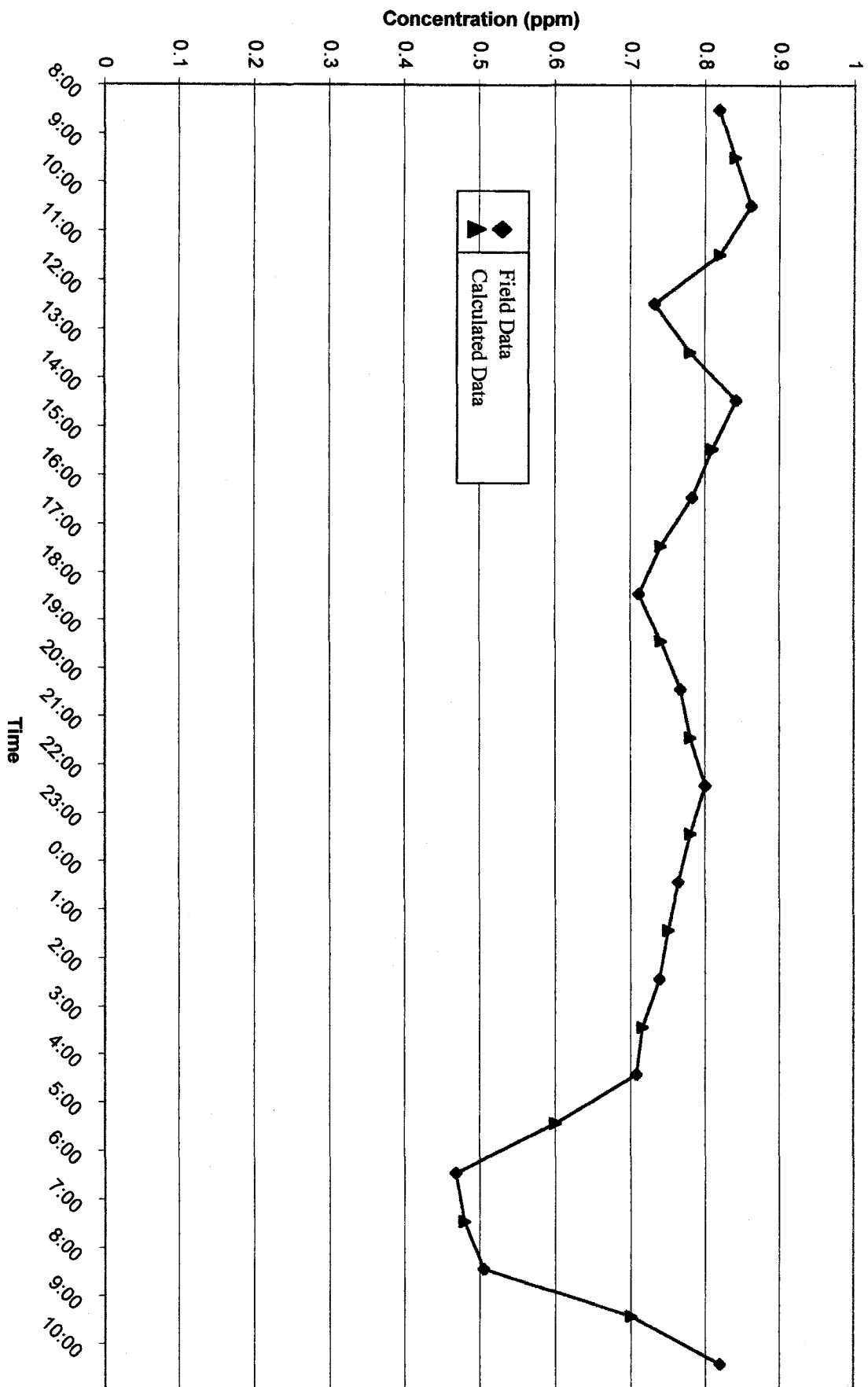


Figure 115. Control scrub April instantaneous TN concentration-time plot.

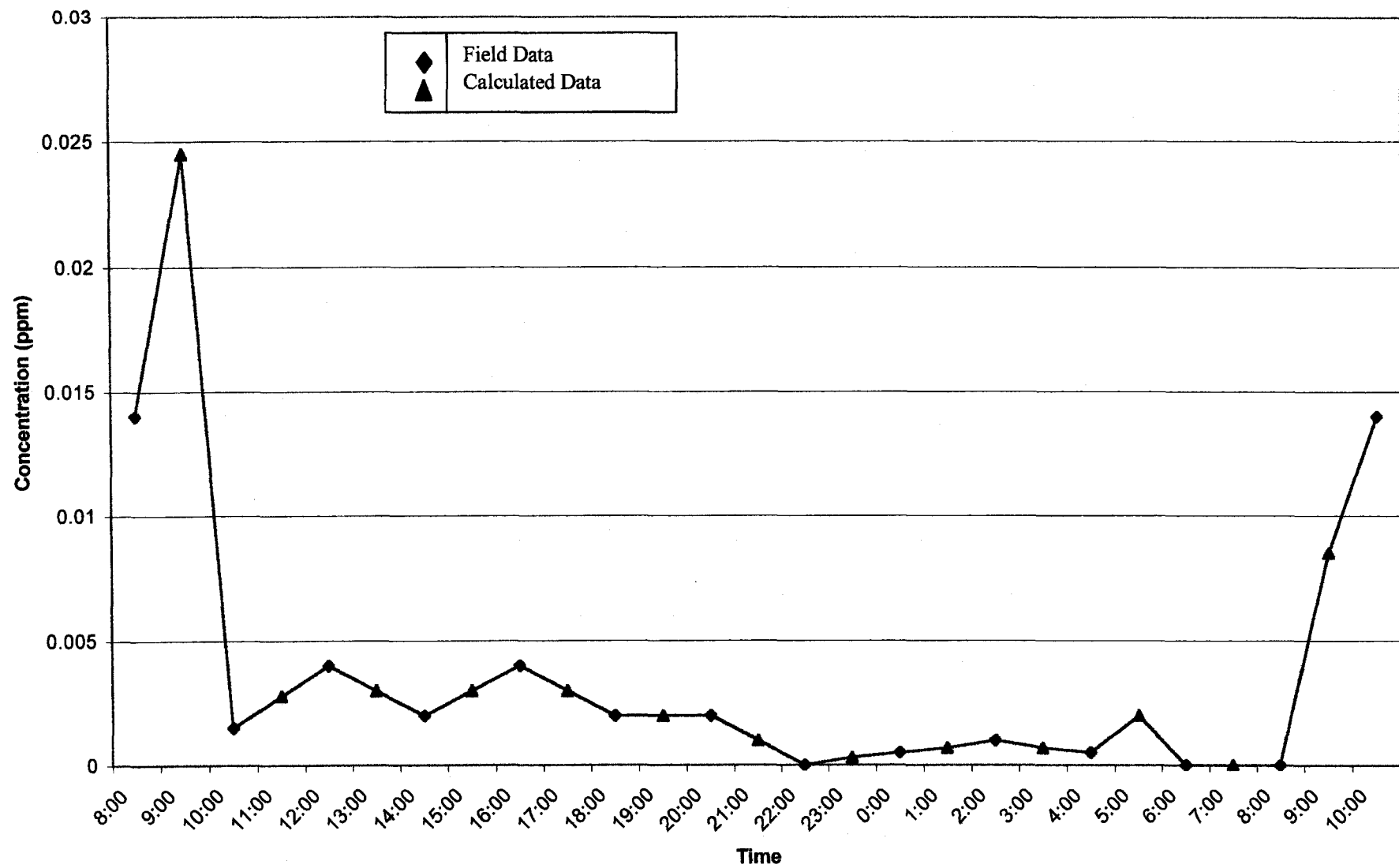


Figure 116. Control scrub April instantaneous SRP concentration-time plot.

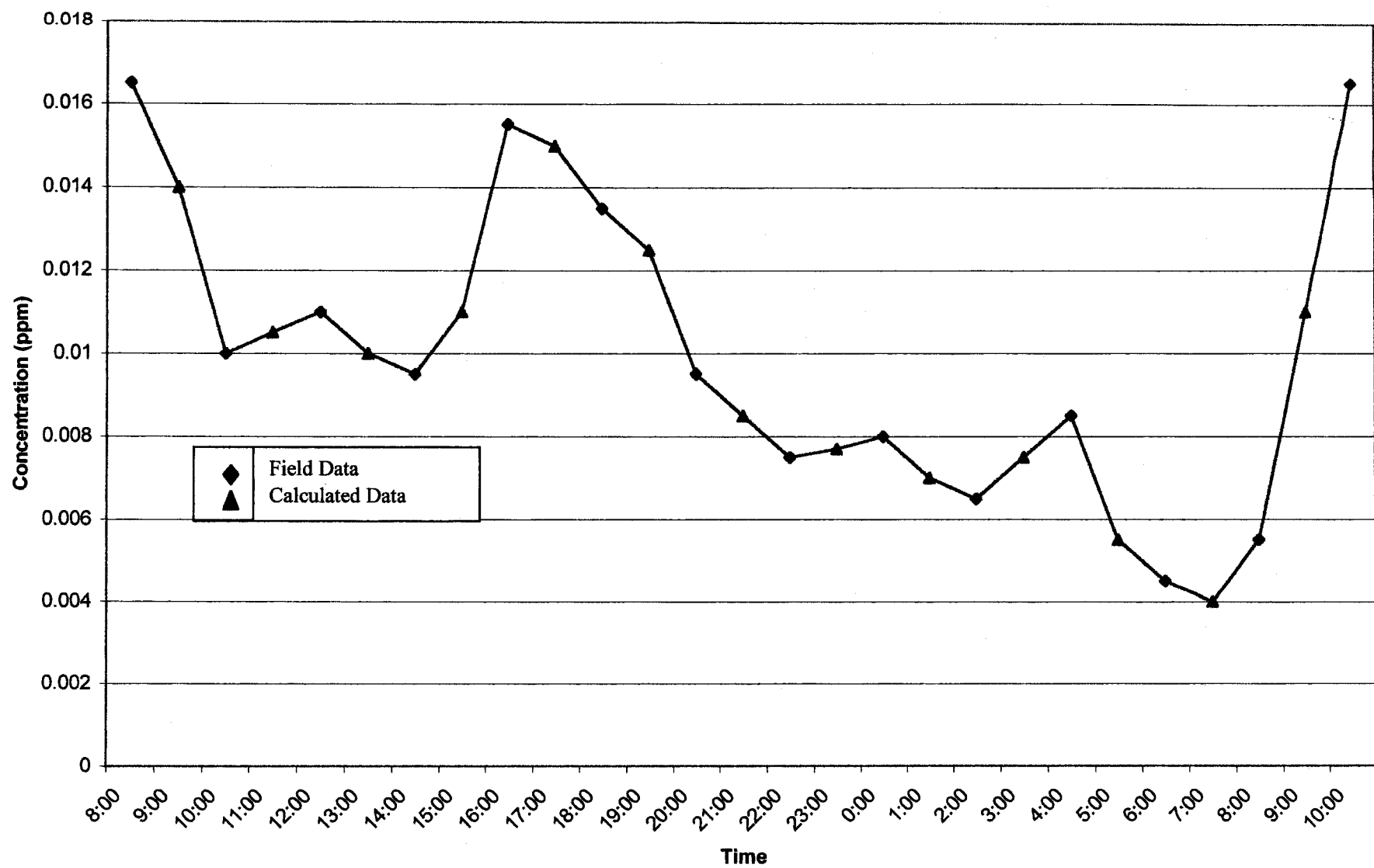


Figure 117. Control scrub April hourly instantaneous TP concentration-time plot.

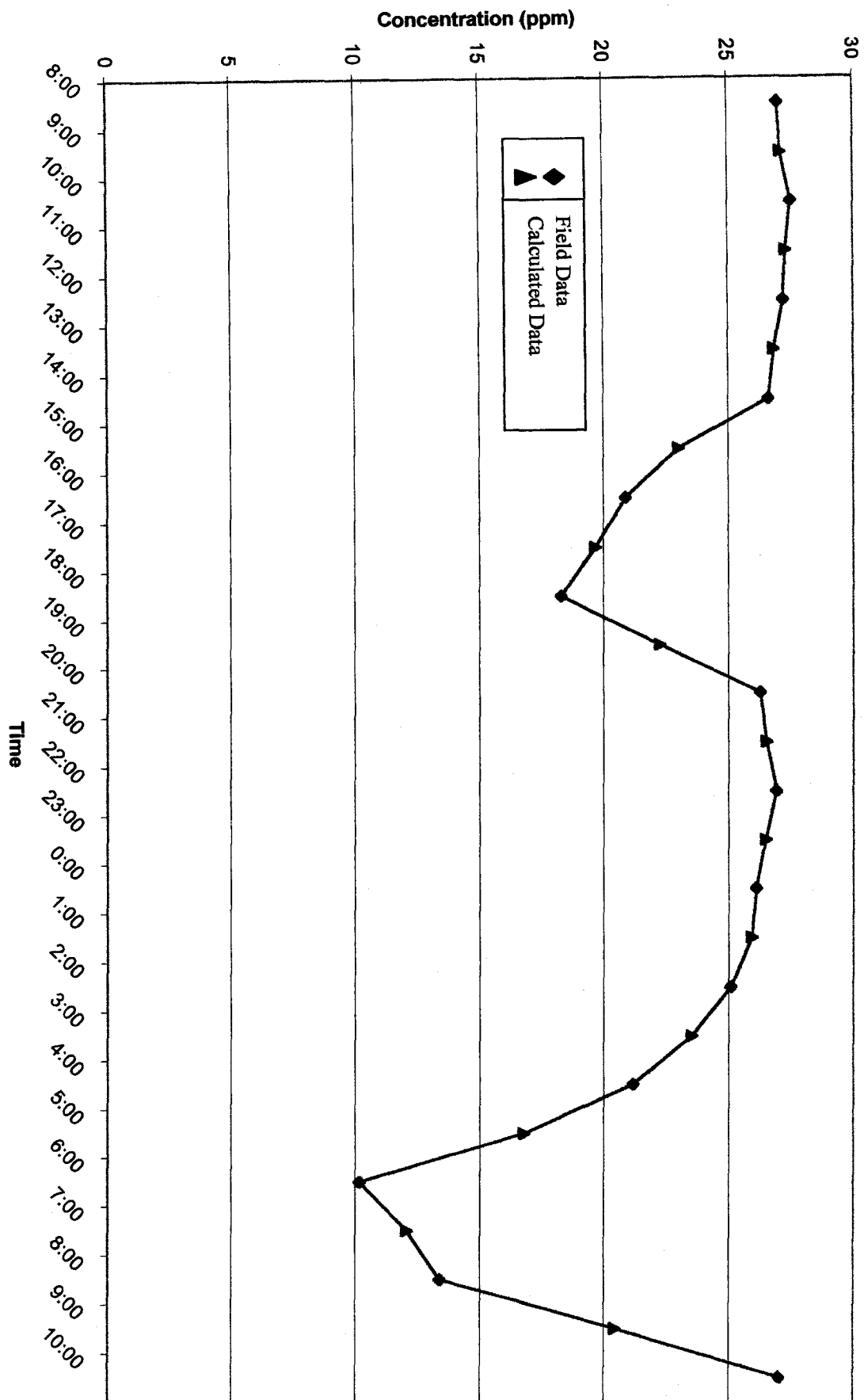


Figure 118. Control scrub April instantaneous TOC concentration-time plot.

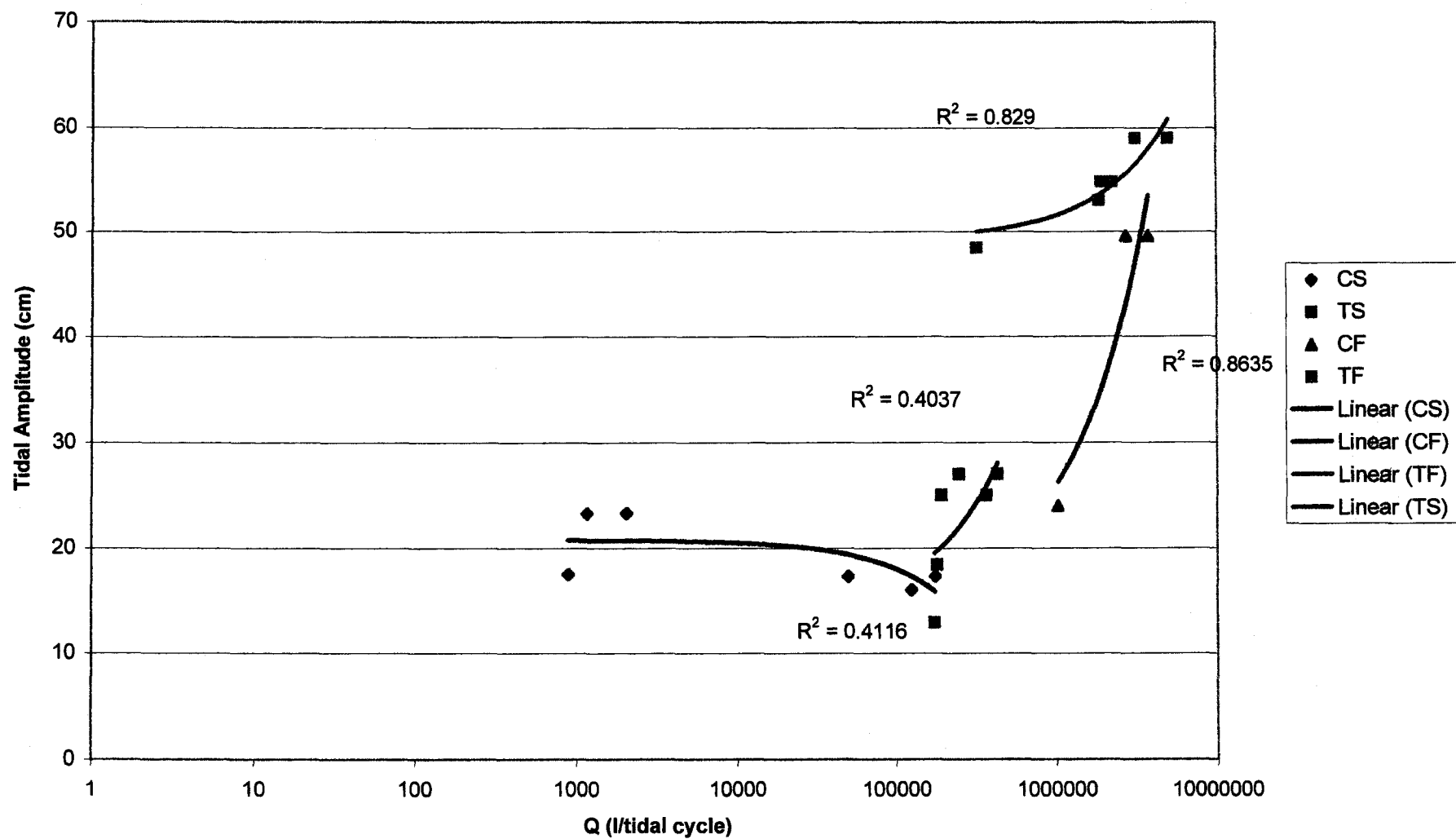


Figure 119. Relationship between tidal amplitude and tidal creek discharge at the four sampling stations.

Table 1. December 1996 Treatment Fringe load and flux data .

Time	Staff	Tide	Discharge (l/hr)	N+N ppm	N+N load (g/hour)	NO2 ppm	NO2 load (g/hour)	NH4 ppm	NH4 load (g/hour)	SRP ppm	SRP load (g/hour)	TN ppm	TN load (g/hour)	TP ppm	TP load (g/hour)	TOC ppm	TOC load (g/hour)
8:00	60	out	1054800	0.0110	11.5982	0.0019	1.9581	0.0371	39.1331	0.0012	1.3075	0.63	667.82	0.0081	8.5319	8.74	9222.8051
9:00	65	out	1316160	0.0085	11.1874	0.0011	1.4478	0.0340	44.7494	0.0010	1.3162	0.60	789.70	0.0078	10.2660	7.60	10002.816
10:00	78	in	-1184868	0.0070	-8.2908	0.0004	-0.5076	0.0320	-37.9039	0.0008	-0.9180	0.57	-670.02	0.0075	-8.8467	6.80	-8058.2992
11:00	95	in	-7109460	0.0065	-46.2115	0.0005	-3.5547	0.0323	-229.6356	0.0006	-3.9102	0.57	-4016.84	0.0082	-58.2976	6.20	-44078.652
12:00	99	in	-10837656	0.0061	-66.5475	0.0006	-6.9643	0.0326	-352.7657	0.0003	-3.3586	0.56	-6038.19	0.0093	-101.1478	5.58	-60496.808
13:00	92	out	5182164	0.0075	38.8662	0.0007	3.6275	0.0327	169.4568	0.0003	1.5546	0.53	2746.55	0.0093	48.1941	6.00	31092.984
14:00	82	out	2785680	0.0091	25.2600	0.0008	2.1879	0.0328	91.4539	0.0003	0.8633	0.50	1398.73	0.0093	25.9988	6.29	17515.775
15:00	70	out	1640880	0.0075	12.3066	0.0004	0.6564	0.0300	49.2264	0.0002	0.4004	0.52	853.26	0.0089	14.6038	6.80	11157.984
16:00	60	out	1057680	0.0069	7.2498	0.0000	0.0000	0.0282	29.8372	0.0002	0.1639	0.54	573.81	0.0084	8.8842	7.24	7658.1089
17:00	48	out	622080	0.0070	4.3546	0.0001	0.0622	0.0340	21.1507	0.0004	0.2488	0.57	354.59	0.0082	5.1011	7.80	4852.224
18:00	40	out	437040	0.0079	3.4637	0.0002	0.0936	0.0390	17.0402	0.0006	0.2709	0.60	260.73	0.0079	3.4671	8.35	3648.1757
19:00	45	in	-262728	0.0090	-2.3646	0.0006	-0.1576	0.0402	-10.5617	0.0007	-0.1839	0.58	-152.38	0.0081	-2.1150	8.60	-2259.4608
20:00	52	in	-368784	0.0107	-3.9497	0.0010	-0.3686	0.0412	-15.2050	0.0008	-0.2857	0.56	-206.47	0.0082	-3.0403	8.63	-3181.8531
21:00	70	in	-641592	0.0108	-6.9292	0.0012	-0.7378	0.0340	-21.8141	0.0010	-0.6416	0.57	-365.71	0.0089	-5.7102	7.90	-5068.5768
22:00	73	in	-699516	0.0109	-7.6417	0.0013	-0.8990	0.0278	-19.4395	0.0012	-0.8671	0.58	-404.62	0.0095	-6.6374	7.35	-5140.6225
23:00	68	out	1502280	0.0111	16.6753	0.0012	1.8027	0.0285	42.8150	0.0012	1.7276	0.59	886.35	0.0140	21.0319	7.00	10515.96
0:00	54	out	810360	0.0114	9.1997	0.0010	0.8100	0.0293	23.7679	0.0011	0.8790	0.61	494.61	0.0160	12.9833	6.85	5552.2409
1:00	49	out	649800	0.0150	9.7470	0.0015	0.9747	0.0320	20.7936	0.0013	0.8447	0.58	376.88	0.0120	7.7976	6.90	4483.62
2:00	42	out	477360	0.0188	8.9640	0.0020	0.9543	0.0348	16.6074	0.0014	0.6657	0.57	273.95	0.0084	4.0097	7.01	3347.2499
3:00	32	out	307080	0.0140	4.2991	0.0018	0.5374	0.0346	10.6250	0.0012	0.3685	0.58	178.11	0.0079	2.4259	7.60	2333.808
4:00	20	out	0	0.0108	0.0000	0.0015	0.0000	0.0343	0.0000	0.0011	0.0000	0.59	0.00	0.0075	0.0000	8.19	0
5:00	20	in	108612	0.0092	0.9992	0.0013	0.1412	0.0420	4.5617	0.0015	0.1629	0.60	64.62	0.0082	0.8906	8.40	912.3408
6:00	28	in	-5076	0.0086	-0.0439	0.0011	-0.0054	0.0481	-0.2441	0.0019	-0.0094	0.60	-3.04	0.0089	-0.0450	8.85	-44.912429
Sum of 1st Tidal Cycle			-5035500.0		-6.7634		-0.993137		-158.2576		-2.061176		-3079.895		-43.24519		-17482.886
Sum of 2nd Tidal Cycle			1877796.0		28.9554		3.0518371		51.906053		2.66066		1142.297		31.59122		11449.794
Day			-3157704.0		22.1920		2.0587005		-106.3515		0.599484		-1937.598		-11.65397		-6033.0924

Table 2. December 1996 Treatment Scrub load and flux data.

Time	Staff	Direction	Discharge (l/hr)	N+N (ppm)	N+N Load (g/hr)	NO2 (ppm)	NO2 Load (g/hr)	NH4 (ppm)	NH4 Load (g/hr)	SRP (ppm)	SRP Load (g/hr)	TN (ppm)	TN Load (g/hr)	TP (ppm)	TP Load (g/hr)	TOC (ppm)	TOC Load (g/hr)
8:00	17.6	in	-46836.0	0.007	-0.331	0.0017	-0.0803	0.0138	-0.6459	0.0028	-0.1306	0.6101	-28.574	0.0068	-0.3206	8.8271	-413.42
9:00	19.8	in	-70200.0	0.007	-0.456	0.0017	-0.1193	0.0145	-1.0179	0.0030	-0.2105	0.6161	-43.250	0.0075	-0.5265	8.8254	-619.54
10:00	26.2	in	-130680.0	0.006	-0.737	0.0017	-0.2239	0.0159	-2.0765	0.0034	-0.4455	0.6181	-80.769	0.0090	-1.1790	8.8238	-1153.09
11:00	27.2	in	-135360.0	0.007	-0.948	0.0016	-0.2098	0.0121	-1.6379	0.0026	-0.3484	0.5998	-81.189	0.0082	-1.1100	7.5689	-1024.53
12:00	28.9	in	-153720.0	0.008	-1.251	0.0014	-0.2085	0.0090	-1.3773	0.0014	-0.2144	0.5835	-89.703	0.0076	-1.1716	6.2239	-956.74
13:00	30.0	in	0.0	0.007	0.000	0.0013	0.0000	0.0092	0.0000	0.0009	0.0000	0.5624	0.000	0.0073	0.0000	6.2187	0.00
14:00	28.0	out	0.0	0.006	0.000	0.0012	0.0000	0.0093	0.0000	0.0006	0.0000	0.5431	0.000	0.0070	0.0000	6.2140	0.00
15:00	25.5	out	66240.0	0.006	0.364	0.0013	0.0861	0.0099	0.6558	0.0005	0.0298	0.5371	35.578	0.0068	0.4504	6.9785	462.26
16:00	20.8	out	0.0	0.005	0.000	0.0014	0.0000	0.0103	0.0000	0.0003	0.0000	0.5317	0.000	0.0064	0.0000	7.4550	0.00
17:00	20.5	out	0.0	0.006	0.000	0.0014	0.0000	0.0101	0.0000	0.0039	0.0000	0.5594	0.000	0.0069	0.0000	7.9847	0.00
18:00	20.3	out	88560.0	0.007	0.594	0.0014	0.1201	0.0097	0.8555	0.0065	0.5763	0.5621	49.781	0.0073	0.6474	8.6451	765.61
19:00	19.3	out	78480.0	0.007	0.510	0.0014	0.1099	0.0184	1.4464	0.0036	0.2802	0.5597	43.925	0.0075	0.5886	8.9761	704.44
20:00	18.2	out	69516.0	0.006	0.402	0.0014	0.0943	0.0223	1.5474	0.0012	0.0862	0.5581	38.794	0.0078	0.5407	9.1641	637.05
21:00	17.1	out	59760.0	0.008	0.478	0.0014	0.0837	0.0197	1.1773	0.0015	0.0925	0.5694	34.027	0.0082	0.4900	9.2678	553.84
22:00	20.1	in	-70200.0	0.009	-0.647	0.0014	-0.1002	0.0160	-1.1253	0.0017	-0.1197	0.5721	-40.164	0.0087	-0.6115	9.4479	-663.24
23:00	25.2	in	-116640.0	0.008	-0.933	0.0017	-0.1983	0.0148	-1.7263	0.0015	-0.1750	0.5924	-69.098	0.0124	-1.4463	8.7845	-1024.62
0:00	33.2	in	-191160.0	0.007	-1.379	0.0019	-0.3549	0.0132	-2.5157	0.0012	-0.2370	0.6246	-119.394	0.0142	-2.7059	8.1905	-1565.69
1:00	28.2	out	0.0	0.007	0.000	0.0017	0.0000	0.0118	0.0000	0.0053	0.0000	0.5471	0.000	0.0151	0.0000	8.0845	0.00
2:00	26.3	out	0.0	0.007	0.000	0.0016	0.0000	0.0103	0.0000	0.0076	0.0000	0.4835	0.000	0.0157	0.0000	7.9070	0.00
3:00	23.2	out	0.0	0.007	0.000	0.0016	0.0000	0.0098	0.0000	0.0035	0.0000	0.4596	0.000	0.0135	0.0000	8.2564	0.00
4:00	20.4	out	93240.0	0.006	0.566	0.0015	0.1398	0.0095	0.8811	0.0009	0.0867	0.4080	38.043	0.0120	1.1168	8.7762	818.30
5:00	19.8	out	88560.0	0.007	0.620	0.0014	0.1240	0.0111	0.9830	0.0009	0.0824	0.4350	38.524	0.0180	1.5941	9.0578	802.16
6:00	11.2	out	2340.0	0.008	0.018	0.0012	0.0028	0.0131	0.0306	0.0009	0.0022	0.4561	1.067	0.0247	0.0579	9.2328	21.60
7:00	8.2	out	1800.0	0.007	0.013	0.0013	0.0023	0.0121	0.0218	0.0009	0.0016	0.0445	0.080	0.0195	0.0351	9.0123	16.22
1st Cycle			-174240.0		-1.4		-0.3		-1.1		-0.3		-121.4		-1.6		-1044.1
2nd Cycle			-192060.0		-1.7		-0.4		-3.5		-0.4		-150.9		-2.0		-1595.3
Day			-366300.0		-3.1		-0.7		-4.5		-0.6		-272.3		-3.6		-2639.4

Table 3. December 1996 Control Fringe lad and flux data.

Time	Staff	Direction	Discharge l/hour	N + N ppm	N+N Load g/hour	NO2 ppm	NO2 Load g/hour	NH4 ppm	NH4 Load g/hour	SRP ppm	SRP Load g/hour	TN ppm	TN Load g/hour	TP ppm	TP Load g/hour	TOC ppm	TOC Load g/hour
9:00	15.0	in	-161532.0	0.0288	-4.6595	0.0020	-0.323	0.0418	-6.7504	0.0037	-0.6007	0.48	-76.75	0.0096	-1.5578	9.75	-1575.64
10:00	29.6	in	-362736.0	0.0204	-7.4072	0.0024	-0.855	0.0348	-12.6196	0.0029	-1.0679	0.54	-197.32	0.0224	-8.1250	10.34	-3751.46
11:00	53.8	in	-1384236.0	0.0180	-24.9162	0.0017	-2.353	0.0360	-49.8325	0.0019	-2.6300	0.55	-754.41	0.0170	-23.5320	9.00	-12458.12
12:00	67.0	in	-2940084.0	0.0164	-48.0721	0.0011	-3.149	0.0384	-112.7816	0.0014	-4.1001	0.55	-1608.42	0.0121	-35.6717	7.58	-22294.86
13:00	62.0	out	0.0	0.0166	0.0000	0.0013	0.000	0.0360	0.0000	0.0013	0.0000	0.53	0.00	0.0105	0.0000	7.78	0.00
14:00	45.7	out	823140.0	0.0169	13.9290	0.0015	1.234	0.0353	29.0404	0.0011	0.8928	0.51	422.36	0.0093	7.6824	7.94	6538.32
15:00	34.8	out	408960.0	0.0150	6.1344	0.0016	0.654	0.0400	16.3584	0.0022	0.8997	0.54	218.79	0.0090	3.6806	7.60	3108.10
16:00	29.5	out	274428.0	0.0144	3.9384	0.0016	0.451	0.0443	12.1599	0.0029	0.8079	0.56	152.76	0.0086	2.3478	7.31	2007.30
17:00	22.2	out	135540.0	0.0145	1.9653	0.0014	0.190	0.0440	5.9638	0.0019	0.2575	0.59	79.97	0.0150	2.0331	10.00	1355.40
18:00	9.7	out	71964.0	0.0146	1.0482	0.0011	0.082	0.0446	3.2089	0.0012	0.0892	0.62	44.95	0.0212	1.5224	12.89	927.76
19:00	5.4	out	95904.0	0.0130	1.2468	0.0011	0.105	0.0430	4.1239	0.0012	0.1103	0.63	60.42	0.0170	1.6304	13.10	1256.34
20:00	18.7	in	-196344.0	0.0111	-2.1870	0.0011	-0.210	0.0413	-8.1090	0.0011	-0.2130	0.65	-127.86	0.0132	-2.5960	13.30	-2611.64
21:00	31.2	in	-405576.0	0.0140	-5.6781	0.0010	-0.406	0.0390	-15.8175	0.0009	-0.3650	0.67	-271.74	0.0160	-6.4892	12.50	-5069.70
22:00	48.7	in	-1047204.0	0.0161	-16.8233	0.0009	-0.972	0.0372	-38.9246	0.0008	-0.8113	0.70	-734.06	0.0188	-19.7100	11.50	-12043.08
23:00	55.9	in	-1591452.0	0.0162	-25.7815	0.0014	-2.228	0.0450	-71.6153	0.0030	-4.7744	0.65	-1034.44	0.0150	-23.8718	9.50	-15118.79
0:00	65.0	in	-2629620.0	0.0164	-43.1836	0.0017	-4.506	0.0487	-128.1151	0.0048	-12.6312	0.59	-1540.58	0.0118	-31.0868	7.71	-20264.14
1:00	60.7	out	0.0	0.0145	0.0000	0.0017	0.000	0.0475	0.0000	0.0042	0.0000	0.65	0.00	0.0140	0.0000	11.00	0.00
2:00	45.4	out	823140.0	0.0136	11.1667	0.0016	1.293	0.0470	38.7205	0.0037	3.0611	0.74	606.91	0.0156	12.8039	14.35	11814.13
3:00	39.6	out	577080.0	0.0138	7.9637	0.0016	0.923	0.0400	23.0832	0.0035	2.0198	0.75	429.92	0.0140	8.0791	13.50	7790.58
4:00	24.0	out	165204.0	0.0141	2.3237	0.0016	0.271	0.0331	5.4699	0.0034	0.5632	0.75	123.39	0.0121	2.0044	12.42	2052.16
5:00	15.2	out	76320.0	0.0120	0.9158	0.0019	0.145	0.0430	3.2818	0.0058	0.4427	0.70	53.42	0.0110	0.8395	11.00	839.52
6:00	6.3	out	87912.0	0.0096	0.8474	0.0021	0.182	0.0533	4.6831	0.0073	0.6402	0.67	59.03	0.0100	0.8752	10.07	885.09
7:00	2.3	out	127260.0	0.0120	1.5271	0.0021	0.267	0.0480	6.1085	0.0070	0.8908	0.64	81.45	0.0120	1.5271	10.00	1272.60
8:00	15.4	in	-166068.0	0.0140	-2.3250	0.0018	-0.299	0.0460	-7.6391	0.0068	-1.1293	0.67	-111.27	0.0130	-2.1589	11.00	-1826.75
9:00	22.4	in	-245448.0	0.0160	-3.9272	0.0018	-0.430	0.043	-10.5543	0.0065	-1.5954	0.675	-165.68	0.0135	-3.3135	12	-2945.38
1st cycle			-3450168.0		-63.0		-4.7		-129.3		-8.1		-1934.6		-55.5		-29659.00
2nd cycle			-4013280.0		-68.9		-5.2		-181.2		-11.2		-2354.5		-57.6		-30453.27
day			-7463448		-131.954		-9.932		-310.557		-19.243		-4289.142		-113.087		-60112.27

Table 4. December 1996 Control Scrub load and flux data.

Time	Staff	Tide	Discharge (l/hr)	N+N ppm	N+N load (g/hour)	NO2 ppm	NO2 load (g/hour)	NH4 ppm	NH4 load (g/hour)	SRP ppm	SRP load (g/hour)	TN ppm	TN load (g/hour)	TP ppm	TP Load (g/hour)	TOC ppm	TOC load (g/hour)
8:00	29.1	in	-194.652	0.0079	-0.0015	0.0011	-0.0002	0.0273	-0.0053	0.0008	-0.0002	0.73	-0.14	0.0056	-0.0011	13.62	-2.65
9:00	30	in	-247.68	0.0105	-0.0026	0.0011	-0.0003	0.0280	-0.0069	0.0009	-0.0002	0.70	-0.17	0.0080	-0.0020	13.62	-3.37
10:00	33.1	in	-510.12	0.0129	-0.0066	0.0011	-0.0006	0.0285	-0.0145	0.0011	-0.0006	0.68	-0.34	0.0101	-0.0052	13.62	-6.95
11:00	43.5	in	-6401.88	0.0098	-0.0627	0.0012	-0.0074	0.0270	-0.1729	0.0013	-0.0083	0.74	-4.74	0.0200	-0.1280	11.50	-73.62
12:00	49.1	in	-24083.64	0.0074	-0.1788	0.0012	-0.0292	0.0261	-0.6288	0.0015	-0.0373	0.78	-18.81	0.0308	-0.7417	9.50	-228.73
13:00	53	in	-63126.72	0.0084	-0.5303	0.0013	-0.0789	0.0280	-1.7675	0.0018	-0.1136	0.74	-46.71	0.0248	-1.5655	9.20	-580.77
14:00	50.2	out	0	0.0094	0.0000	0.0013	0.0000	0.0300	0.0000	0.0020	0.0000	0.69	0.00	0.0201	0.0000	8.78	0.00
15:00	48	out	18927.72	0.0094	0.1779	0.0013	0.0237	0.0290	0.5489	0.0019	0.0350	0.71	13.44	0.0220	0.4164	9.50	179.81
16:00	46.7	out	13187.844	0.0094	0.1243	0.0012	0.0160	0.0284	0.3739	0.0017	0.0225	0.73	9.65	0.0257	0.3385	10.21	134.68
17:00	43	out	5675.4	0.0084	0.0477	0.0017	0.0096	0.0274	0.1555	0.0015	0.0086	0.74	4.20	0.0160	0.0908	12.00	68.10
18:00	39.2	out	2165.256	0.0076	0.0165	0.0021	0.0045	0.0267	0.0577	0.0014	0.0030	0.75	1.61	0.0087	0.0189	14.72	31.86
19:00	38.8	out	2165.256	0.0080	0.0173	0.0019	0.0040	0.0275	0.0595	0.0016	0.0035	0.77	1.66	0.0082	0.0178	15.60	33.78
20:00	35.8	out	1051.092	0.0083	0.0087	0.0016	0.0017	0.0281	0.0295	0.0019	0.0020	0.78	0.82	0.0079	0.0083	16.54	17.39
21:00	35.7	out	931.824	0.0080	0.0075	0.0019	0.0017	0.0280	0.0261	0.0018	0.0017	0.76	0.71	0.0080	0.0074	16.50	15.38
22:00	42	in	-4460.4	0.0079	-0.0350	0.0021	-0.0092	0.0279	-0.1243	0.0017	-0.0076	0.74	-3.32	0.0089	-0.0395	16.45	-73.38
23:00	47	in	-14875.92	0.0100	-0.1488	0.0023	-0.0342	0.0330	-0.4909	0.0016	-0.0238	0.68	-10.12	0.0080	-0.1190	11.00	-163.64
0:00	52.9	in	-63126.72	0.0119	-0.7482	0.0025	-0.1578	0.0361	-2.2801	0.0015	-0.0978	0.59	-36.97	0.0073	-0.4615	7.66	-483.40
1:00	56	in	-130040.28	0.0105	-1.3654	0.0021	-0.2783	0.0345	-4.4864	0.0017	-0.2211	0.60	-78.02	0.0070	-0.9103	7.80	-1014.31
2:00	54.2	out	0	0.0093	0.0000	0.0017	0.0000	0.0334	0.0000	0.0019	0.0000	0.61	0.00	0.0069	0.0000	8.06	0.00
3:00	52	out	49612.644	0.0070	0.3473	0.0015	0.0744	0.0270	1.3395	0.0019	0.0943	0.62	30.76	0.0070	0.3473	9.50	471.32
4:00	48.4	out	18928.044	0.0051	0.0960	0.0014	0.0257	0.0226	0.4280	0.0019	0.0352	0.64	12.13	0.0072	0.1354	11.82	223.74
5:00	46	out	11691.288	0.0040	0.0468	0.0018	0.0210	0.0226	0.2642	0.0018	0.0210	0.67	7.83	0.0074	0.0865	14.00	163.68
6:00	41.6	out	3954.24	0.0036	0.0141	0.0022	0.0088	0.0226	0.0894	0.0017	0.0067	0.72	2.84	0.0076	0.0301	15.85	62.69
7:00	40	out	2755.08	0.0031	0.0087	0.0021	0.0057	0.0232	0.0638	0.0022	0.0060	0.71	1.96	0.0065	0.0180	16.32	44.96
1st Cycle			-50460.3		-0.3826		-0.055398		-1.344833		-0.08397		-38.8341		-1.5455		-415.09
2nd Cycle			-125562.02		-1.7846		-0.343892		-5.196731		-0.18707		-72.8945		-0.91297		-768.35
Day			-176022.32		-2.1673		-0.39929		-6.541564		-0.27104		-111.729		-2.45847		-1183.44

Table 5. April 1997 Treatment Fringe load and flux data.

Time	Staff	Direction	Discharge (l/hr)	NH ₄ ppm	NH ₄ Load (g/hr)	N + N ppm	N+N Load (g/hr)	NO ₂ ppm	NO ₂ Load (g/hr)	SRP ppm	SRP Load (g/hr)	TN ppm	TN Load (g/hr)	TP ppm	TP Load (g/hr)	TOC ppm	TOC Load (g/hr)
8:00	50.5	out	694440	0.027	18.75	0.004	2.78	0.003	2.08	0	0.00	0.6325	439.23	0.0055	3.82	14.245	9892.30
9:00	46	out	569520	0.033	18.79	0.004	2.28	0.0027	1.54	0.0002	0.11	0.64	364.49	0.006	3.42	14.3	8144.14
10:00	39.6	out	427320	0.0425	18.16	0.004	1.71	0.0025	1.07	0.0005	0.21	0.651	278.19	0.0065	2.78	14.495	6194.00
11:00	37.2	out	383040	0.053	20.30	0.0035	1.34	0.0023	0.88	0.0012	0.46	0.66	252.81	0.009	3.45	14.72	5638.35
12:00	45.6	in	-270288	0.0645	-17.43	0.003	-0.81	0.002	-0.54	0.002	-0.54	0.6645	-179.61	0.011	-2.97	14.99	-4051.62
13:00	59	in	-474876	0.051	-24.22	0.004	-1.90	0	0.00	0.0013	-0.62	0.61	-289.67	0.01	-4.75	12.2	-5793.49
14:00	65.3	in	-573408	0.036	-20.64	0.005	-2.87	0.002	-1.15	0.0005	-0.29	0.555	-318.24	0.009	-5.16	8.78	-5034.52
15:00	76	in	-959652	0.057	-54.70	0.0035	-3.36	0.0015	-1.44	0.0002	-0.19	0.51	-489.42	0.0079	-7.58	8.2	-7869.15
16:00	84.5	in	-2350728	0.0145	-34.09	0.002	-4.70	0.001	-2.35	0	0.00	0.438	-1029.62	0.0055	-12.93	7.76	-18241.65
17:00	83	out	2910960	0.018	52.40	0.0025	7.28	0.001	2.91	0.0002	0.58	0.44	1280.82	0.0065	18.92	8.2	23869.87
18:00	76.3	out	2185560	0.0215	46.99	0.0035	7.65	0.001	2.19	0.0005	1.09	0.442	966.02	0.0075	16.39	8.275	18085.51
19:00	54	out	810360	0.021	17.02	0.0032	2.59	0.0015	1.22	0.0005	0.41	0.53	429.49	0.0093	7.54	11.17	9051.72
20:00	46	out	569520	0.0205	11.68	0.003	1.71	0.002	1.14	0.0005	0.28	0.651	370.76	0.0115	6.55	14.32	8155.53
21:00	44	out	521280	0.026	13.55	0.004	2.09	0.002	1.04	0.0005	0.26	0.71	370.11	0.0128	6.67	17.1	8913.89
22:00	40	out	437040	0.0305	13.33	0.005	2.19	0.002	0.87	0.0005	0.22	0.7695	336.30	0.0145	6.34	19.275	8423.95
23:00	38	out	399960	0.044	17.60	0.004	1.60	0.002	0.80	0.0005	0.20	0.77	307.97	0.0144	5.76	17.2	6879.31
0:00	36	out	366480	0.0565	20.71	0.003	1.10	0.002	0.73	0.0002	0.07	0.78	285.85	0.0155	5.68	15.605	5718.92
1:00	44	in	-247572	0.04	-9.90	0.002	-0.50	0.002	-0.50	0	0.00	0.7	-173.30	0.0144	-3.57	3.26	-807.08
2:00	60	in	-1055880	0.025	-26.40	0.0015	-1.58	0.002	-2.11	0	0.00	0.5855	-618.22	0.014	-14.78	11.54	-12184.86
3:00	76	in	-2138040	0.024	-51.31	0.009	-19.24	0.0017	-3.63	0	0.00	0.53	-1133.16	0.011	-23.52	8.35	-17852.63
4:00	83	in	-2910960	0.0215	-62.59	0.0215	-62.59	0.0015	-4.37	0	0.00	0.444	-1292.47	0.007	-20.38	7.765	-22603.60
5:00	92	in	-4329360	0.021	-90.92	0.016	-69.27	0.0013	-5.63	0	0.00	0.44	-1904.92	0.0075	-32.47	6.86	-29699.41
6:00	88	out	3629160	0.0215	78.03	0.0105	38.11	0.001	3.63	0	0.00	0.4265	1547.84	0.0085	30.85	7	25404.12
7:00	83	out	2910960	0.02325	67.68	0.0095	27.65	0.0014	4.08	0	0.00	0.492	1432.19	0.0082	23.87	8.25	24015.42
8:00	74	out	1957320	0.025	48.93	0.007	13.70	0.002	3.91	0	0.00	0.52	1017.81	0.0073	14.29	10	19573.20
9:00	70	out	1640880	0.024	39.38	0.0049	8.04	0.0025	4.10	0	0.00	0.61	1000.94	0.0065	10.67	12.2	20018.74
1st Cycle			-323208		158.95		81.97		15.81		-0.85		4026.93		59.74		77889.84
2nd Cycle			-1944435		-47.85		-126.98		-5.34		3.12		-774.74		-20.86		5951.11
Day			-2267643		111.10		-45.01		10.48		2.27		3252.19		38.88		83840.95

Table 6. April 1997 Treatment Scrub load and flux data.

Time	Staff	Direction	Discharge (l/hr)	N+N (PPM)	N+N Load (g/hr)	NO2 (PPM)	NO2 Load (g/hr)	NH4 (PPM)	NH4 Load (g/hr)	SRP (PPM)	SRP Load (g/hr)	TN (PPM)	TN Load (g/hr)	TP (PPM)	TP Load (g/hr)	TOC (PPM)	TOC Load (g/hr)
8:00	8.0	Out	0.00	0.0020	0.0000	0.0020	0.0000	0.0105	0.0000	0.0000	0.0000	0.7490	0.0000	0.0040	0.0000	15.4100	0.0000
9:00	8.5	Out	0.00	0.0013	0.0000	0.0020	0.0000	0.0130	0.0000	0.0003	0.0000	0.7300	0.0000	0.0042	0.0000	15.9000	0.0000
10:00	7.0	Out	0.00	0.0016	0.0000	0.0020	0.0000	0.0150	0.0000	0.0005	0.0000	0.6990	0.0000	0.0045	0.0000	16.0400	0.0000
11:00	6.0	Out	0.00	0.0020	0.0000	0.0020	0.0000	0.0195	0.0000	0.0005	0.0000	0.7000	0.0000	0.0050	0.0000	16.1350	0.0000
12:00	5.8	Out	0.00	0.0015	0.0000	0.0020	0.0000	0.0150	0.0000	0.0003	0.0000	0.7300	0.0000	0.0050	0.0000	16.2000	0.0000
13:00	5.8	Out	0.00	0.0010	0.0000	0.0020	0.0000	0.0115	0.0000	0.0000	0.0000	0.7530	0.0000	0.0050	0.0000	16.4700	0.0000
14:00	9.0	In	-2916.00	0.0015	-0.0044	0.0023	-0.0067	0.0130	-0.0379	0.0000	0.0000	0.7300	-2.1287	0.0050	-0.0146	17.1000	-49.8636
15:00	16.0	In	-32889.60	0.0020	-0.0658	0.0025	-0.0822	0.0135	-0.4440	0.0003	-0.0082	0.6890	-22.6609	0.0050	-0.1644	17.7900	-585.1060
16:00	22.3	In	-93348.00	0.0025	-0.2334	0.0023	-0.2147	0.0160	-1.4936	0.0003	-0.0233	0.6500	-60.6762	0.0055	-0.5134	13.4000	-1250.8632
17:00	24.2	In	-111996.00	0.0030	-0.3360	0.0020	-0.2240	0.0205	-2.2959	0.0003	-0.0336	0.5970	-66.8616	0.0060	-0.6720	10.1400	-1135.6394
18:00	17.0	Out	59760.00	0.0020	0.1195	0.0020	0.1195	0.0195	1.1653	0.0003	0.0179	0.6800	40.6368	0.0065	0.3884	14.0000	836.6400
19:00	9.9	Out	0.00	0.0010	0.0000	0.0020	0.0000	0.0185	0.0000	0.0005	0.0000	0.7575	0.0000	0.0070	0.0000	17.6150	0.0000
20:00	9.9	Out	0.00	0.0015	0.0000	0.0023	0.0000	0.0180	0.0000	0.0005	0.0000	0.8000	0.0000	0.0070	0.0000	18.0000	0.0000
21:00	9.8	Out	0.00	0.0020	0.0000	0.0025	0.0000	0.0180	0.0000	0.0012	0.0000	0.8500	0.0000	0.0070	0.0000	18.4650	0.0000
22:00	9.8	Out	0.00	0.0013	0.0000	0.0027	0.0000	0.0175	0.0000	0.0012	0.0000	0.8000	0.0000	0.0060	0.0000	18.1000	0.0000
23:00	9.0	Out	0.00	0.0005	0.0000	0.0030	0.0000	0.0170	0.0000	0.0009	0.0000	0.7520	0.0000	0.0050	0.0000	17.7850	0.0000
0:00	2.0	Out	0.00	0.0007	0.0000	0.0026	0.0000	0.0155	0.0000	0.0009	0.0000	0.7400	0.0000	0.0046	0.0000	17.7600	0.0000
1:00	2.0	Out	0.00	0.0010	0.0000	0.0020	0.0000	0.0145	0.0000	0.0003	0.0000	0.7075	0.0000	0.0045	0.0000	17.7550	0.0000
2:00	9.0	In	-2916.00	0.0005	-0.0015	0.0020	-0.0058	0.0130	-0.0379	0.0003	-0.0007	0.7100	-2.0704	0.0042	-0.0122	17.8000	-51.9048
3:00	12.0	In	-5760.00	0.0000	0.0000	0.0020	-0.0115	0.0100	-0.0576	0.0007	-0.0040	0.7120	-4.1011	0.0040	-0.0230	17.8550	-102.8448
4:00	21.0	In	-79416.00	0.0011	-0.0874	0.0018	-0.1429	0.0090	-0.7147	0.0007	-0.0556	0.5800	-46.0613	0.0045	-0.3574	13.4000	-1064.1744
5:00	25.0	In	-116643.60	0.0025	-0.2916	0.0015	-0.1750	0.0075	-0.8748	0.0007	-0.0758	0.4465	-52.0814	0.0050	-0.5832	9.2050	-1073.7043
6:00	29.0	In	-153864.00	0.0024	-0.3693	0.0016	-0.2462	0.0080	-1.2309	0.0007	-0.1000	0.5000	-76.9320	0.0049	-0.7539	10.7000	-1646.3448
7:00	22.0	Out	0.00	0.0023	0.0000	0.0017	0.0000	0.0085	0.0000	0.0008	0.0000	0.5500	0.0000	0.0046	0.0000	11.9000	0.0000
8:00	18.0	Out	69552.00	0.0022	0.1530	0.0018	0.1252	0.0090	0.6260	0.0006	0.0383	0.6000	41.7312	0.0044	0.3060	13.1000	911.1312
9:00	15.0	Out	40752.00	0.0021	0.0856	0.0019	0.0774	0.0095	0.3871	0.0004	0.0163	0.6800	27.7114	0.0042	0.1712	14.8000	603.1296
10:00	9.0	Out	0.00	0.0020	0.0000	0.0020	0.0000	0.0105	0.0000	0.0002	0.0000	0.7490	0.0000	0.0040	0.0000	16.0400	0.0000
1st Cycle			-181389.60		-0.5200		-0.4081		-3.1061		-0.0472		-111.6906		-0.9760		-2184.8322
2nd Cycle			-248295.60		-0.5111		-0.3788		-1.9029		-0.1816		-111.8036		-1.2526		-2424.7123
Day			-429685.20		-1.0311		-0.7869		-5.0090		-0.2289		-223.4942		-2.2286		-4609.5446

Table 7. April 1997 Control Fringe load and flux data.

Time	Staff	Dir	Discharge (l/hr)	N+N (ppm)	N+N Load (g/hr)	NO2 (ppm)	NO2 Load (g/hr)	NH4 (ppm)	NH4 Load (g/hr)	SRP (ppm)	SRP Load (g/hr)	TN (ppm)	TN Load (g/hr)	TP (ppm)	TP Load (g/hr)	TOC (ppm)	TOC Load (g/hr)
8:00	8.5	Out	75924.00	0.006	0.46	0.0035	0.27	0.0245	1.86	0.0005	0.04	0.634	48.14	0.0115	0.87	17.215	1307.03
9:00	6.0	Out	0.00	0.006	0.55	0.003	0.28	0.029	2.66	0.001	0.09	0.64	58.71	0.0118	1.08	17.89	1641.01
10:00	2.5	Out	0.00	0.006	0.00	0.003	0.00	0.034	0.00	0.0015	0.00	0.647	0.00	0.012	0.00	18.575	0.00
11:00	5.0	In	-92448.00	0.0065	-0.60	0.0035	-0.32	0.051	-4.71	0.002	-0.18	0.66	-61.02	0.0129	-1.19	19	-1756.51
12:00	7.5	In	-106272.00	0.007	-0.74	0.004	-0.43	0.069	-7.33	0.0025	-0.27	0.687	-73.01	0.014	-1.49	19.535	-2076.02
13:00	15.0	In	-161532.00	0.0075	-1.21	0.003	-0.48	0.047	-7.59	0.0023	-0.37	0.56	-90.46	0.0119	-1.92	14.9	-2406.83
14:00	19.0	In	-201888.00	0.008	-1.62	0.0015	-0.30	0.0175	-3.53	0.002	-0.40	0.4635	-93.58	0.008	-1.62	8.635	-1743.30
15:00	22.0	In	-238680.00	0.0065	-1.55	0.001	-0.24	0.021	-5.01	0.001	-0.24	0.48	-114.57	0.0072	-1.72	8.62	-2057.42
16:00	26.5	In	-306828.00	0.005	-1.53	0.0005	-0.15	0.0245	-7.52	0	0.00	0.507	-155.56	0.006	-1.84	8.605	-2640.25
17:00	25.5	Out	0.00	0.0053	0.00	0.001	0.00	0.0175	0.00	0	0.00	0.49	0.00	0.0065	0.00	8.61	0.00
18:00	19.5	Out	106056.00	0.0055	0.58	0.0015	0.16	0.009	0.95	0	0.00	0.4775	50.64	0.007	0.74	8.615	913.67
19:00	15.0	Out	74088.00	0.0069	0.51	0.0021	0.16	0.005	0.37	0.0015	0.11	0.054	4.00	0.0085	0.63	10.5	777.92
20:00	12.7	Out	68040.00	0.0095	0.65	0.003	0.20	0.088	5.99	0.0035	0.24	0.598	40.69	0.01	0.68	12.61	857.98
21:00	10.0	Out	70488.00	0.0095	0.67	0.003	0.21	0.055	3.88	0.002	0.14	0.61	43.00	0.0105	0.74	14.21	1001.63
22:00	8.7	Out	75924.00	0.0095	0.72	0.003	0.23	0.027	2.05	0.0005	0.04	0.615	46.69	0.011	0.84	16.605	1260.72
23:00	5.0	Out	0.00	0.0085	0.85	0.003	0.30	0.035	3.51	0.0002	0.02	0.64	64.26	0.012	1.20	17.67	1774.14
0:00	2.9	Out	0.00	0.0075	0.91	0.003	0.37	0.0415	5.05	0	0.00	0.678	82.57	0.014	1.71	19.085	2324.32
1:00	10.0	In	-122184.00	0.0065	-0.79	0.0025	-0.31	0.035	-4.28	0.0003	-0.04	0.6	-73.31	0.0128	-1.56	15	-1832.76
2:00	21.9	In	-238680.00	0.0045	-1.07	0.002	-0.48	0.026	-6.21	0.0005	-0.12	0.4875	-116.36	0.009	-2.15	9.875	-2356.97
3:00	33.0	In	-440964.00	0.0043	-1.90	0.002	-0.88	0.021	-9.26	0.0003	-0.13	0.47	-207.25	0.008	-3.53	9.6	-4233.25
4:00	48.7	In	-1047240.00	0.004	-4.19	0.002	-2.09	0.016	-16.76	0	0.00	0.4695	-491.68	0.0075	-7.85	8.965	-9388.51
5:00	52.5	In	-1309103.28	0.0043	-5.63	0.0015	-1.96	0.0165	-21.60	0	0.00	0.48	-628.37	0.007	-9.16	8.7	-11389.20
6:00	47.0	Out	0.00	0.0045	0.00	0.001	0.00	0.015	0.00	0	0.00	0.506	0.00	0.0065	0.00	7.91	0.00
7:00	37.0	Out	488880.00	0.0062	3.03	0.0012	0.59	0.016	7.82	0	0.00	0.504	246.40	0.007	3.42	7.8	3813.26
8:00	29.8	Out	274428.00	0.008	2.20	0.0015	0.41	0.017	4.67	0	0.00	0.502	137.76	0.0085	2.33	9.365	2570.02
9:00	28.0	Out	240620.40	0.007	1.68	0.0025	0.60	0.002	0.48	0.0003	0.07	0.55	132.34	0.0092	2.21	13.14	3161.75
10:00	26.5	Out	209808.00	0.006	1.26	0.0035	0.73	0.0245	5.14	0.0005	0.10	0.634	133.02	0.0115	2.41	17.215	3611.84
1st Cycle			-1031724.00		-1.35		0.24		-9.37		-0.79		-149.49		-1.28		-821.90
2nd Cycle			-2763575.28		-5.41		-3.39		-39.99		-0.11		-867.45		-13.88		-16043.81
Day			-3795299.28		-6.77		-3.15		-49.36		-0.90		-1016.94		-15.16		-16865.71

Table 8. April 1997 Control Scrub load and flux data.

Time	Staff	Tide	Discharge (l/hr)	N & N ppm	N+N Load (g/hr)	NO2 ppm	NO2 Load (g/hr)	NH4 ppm	NH4 Load (g/hr)	SRP ppm	SRP Load (g/hr)	TN ppm	TN Load (g/hr)	TP ppm	TP Load (g/hr)	TOC ppm	TOC load (g/hr)
8:00	32.5	OUT	452.52	0.0025	0.001	0.0025	0.001	0.018	0.008	0.014	0.006	0.819	0.371	0.0165	0.007	26.99	12.214
9:00	31.2	OUT	315	0.0022	0.001	0.0027	0.001	0.018	0.006	0.0245	0.008	0.84	0.265	0.014	0.004	27.1	8.537
10:00	28.7	OUT	172.44	0.002	0.000	0.003	0.001	0.018	0.003	0.0015	0.000	0.8615	0.149	0.01	0.002	27.485	4.740
11:00	25.0	OUT	74.16	0.0035	0.000	0.0035	0.000	0.0037	0.000	0.0028	0.000	0.82	0.061	0.0105	0.001	27.29	2.024
12:00	17.5	OUT	0	0.005	0.000	0.004	0.000	0.0505	0.000	0.004	0.000	0.732	0.000	0.011	0.000	27.18	0.000
13:00	23.0	IN	-45.72	0.0035	0.000	0.0035	0.000	0.0038	0.000	0.003	0.000	0.78	-0.036	0.01	0.000	26.82	-1.226
14:00	26.5	IN	-106.56	0.002	0.000	0.003	0.000	0.025	-0.003	0.002	0.000	0.8415	-0.090	0.0095	-0.001	26.59	-2.833
15:00	28.5	IN	-172.44	0.005	-0.001	0.003	-0.001	0.05	-0.009	0.003	-0.001	0.81	-0.140	0.011	-0.002	23.01	-3.968
16:00	30.5	IN	-279.36	0.0075	-0.002	0.003	-0.001	0.0705	-0.020	0.004	-0.001	0.7825	-0.219	0.0155	-0.004	20.88	-5.833
17:00	32.9	IN	-510.12	0.007	-0.004	0.003	-0.002	0.05	-0.026	0.003	-0.002	0.74	-0.377	0.015	-0.008	19.67	-10.034
18:00	35.0	IN	-825.84	0.006	-0.005	0.003	-0.002	0.034	-0.028	0.002	-0.002	0.711	-0.587	0.0135	-0.011	18.265	-15.084
19:00	33.7	OUT	0	0.003	0.000	0.003	0.000	0.03	0.000	0.002	0.000	0.74	0.000	0.0125	0.000	22.25	0.000
20:00	32.2	OUT	0	0.0005	0.000	0.003	0.000	0.026	0.000	0.002	0.000	0.7665	0.000	0.0095	0.000	26.24	0.000
21:00	31.0	OUT	315	0.001	0.000	0.0032	0.001	0.019	0.006	0.001	0.000	0.78	0.246	0.0085	0.003	26.51	8.351
22:00	29.9	OUT	247.68	0.0015	0.000	0.0035	0.001	0.0115	0.003	0	0.000	0.8005	0.198	0.0075	0.002	26.9	6.663
23:00	29.2	OUT	194.652	0.003	0.001	0.0038	0.001	0.012	0.002	0.0003	0.000	0.78	0.152	0.0077	0.001	26.46	5.150
0:00	28.7	OUT	0	0.004	0.000	0.002	0.000	0.0125	0.000	0.0005	0.000	0.7635	0.000	0.008	0.000	26.085	0.000
1:00	30.4	IN	0	0.004	0.000	0.002	0.000	0.0128	0.000	0.0007	0.000	0.75	0.000	0.007	0.000	25.92	0.000
2:00	33.8	IN	-660.24	0.004	-0.003	0.002	-0.001	0.013	-0.009	0.001	-0.001	0.7385	-0.488	0.0065	-0.004	25.08	-16.559
3:00	36.1	IN	-1050.84	0.0052	-0.005	0.0025	-0.003	0.011	-0.012	0.0007	-0.001	0.715	-0.751	0.0075	-0.008	23.54	-24.737
4:00	31.7	OUT	355.5	0.0065	0.002	0.003	0.001	0.008	0.003	0.0005	0.000	0.707	0.251	0.0085	0.003	21.165	7.524
5:00	20.0	OUT	22.266	0.0048	0.000	0.0025	0.000	0.006	0.000	0.002	0.000	0.6	0.013	0.0055	0.000	16.76	0.373
6:00	13.4	OUT	4.644	0.0025	0.000	0.002	0.000	0.005	0.000	0	0.000	0.468	0.002	0.0045	0.000	10.155	0.047
7:00	12.9	OUT	4.14	0.0033	0.000	0.0023	0.000	0.005	0.000	0	0.000	0.48	0.002	0.004	0.000	12.05	0.050
8:00	12.8	OUT	4.14	0.0045	0.000	0.0025	0.000	0.005	0.000	0	0.000	0.5055	0.002	0.0055	0.000	13.365	0.055
1st Cycle			-890.73		-0.004		-0.001		-0.039		0.011		-0.017		-0.001		3.619
2nd Cycle			-1182.71		-0.009		-0.003		-0.034		-0.002		-0.959		-0.014		-28.166
Day			-2073.44		-0.014		-0.003		-0.073		0.009		-0.976		-0.015		-24.547

Table 9. Comparison between summary nutrient data between stations and between inflowing and outflowing waters.

		CF - April	CF - Dec	CS - April	CS - Dec	TF - April	TF - Dec	TS - April	TS - Dec
N+N	Mean inflow	0.0058	0.0170	0.0051	0.0097	0.0068	0.0088	0.0017	0.0073
	St Dev.	0.0014	0.0046	0.0017	0.0018	0.0068	0.0019	0.0010	0.0010
	Mean outflow	0.0070	0.0139	0.0029	0.0072	0.0047	0.0105	0.0016	0.0065
	St. Dev	0.0016	0.0019	0.0013	0.0023	0.0023	0.0035	0.0006	0.0008
	Mean flow	0.0065	0.0153	0.0038	0.0082	0.0055	0.0098	0.0016	0.0068
	St. Dev	0.0016	0.0036	0.0018	0.0024	0.0046	0.0030	0.0007	0.0009
NO2	Mean inflow	0.0021	0.0015	0.0028	0.0016	0.0015	0.0009	0.0020	0.0016
	St Dev.	0.0011	0.0005	0.0005	0.0006	0.0006	0.0003	0.0003	0.0002
	Mean outflow	0.0024	0.0016	0.0029	0.0017	0.0019	0.0010	0.0021	0.0014
	St. Dev	0.0009	0.0003	0.0006	0.0003	0.0006	0.0007	0.0003	0.0001
	Mean flow	0.0023	0.0016	0.0029	0.0016	0.0018	0.0010	0.0021	0.0015
	St. Dev	0.0010	0.0004	0.0006	0.0004	0.0006	0.0006	0.0003	0.0002
NH4	Mean inflow	0.0313	0.0410	0.0278	0.0296	0.0355	0.0367	0.0123	0.0132
	St Dev.	0.0173	0.0044	0.0225	0.0035	0.0172	0.0065	0.0042	0.0026
	Mean outflow	0.0275	0.0428	0.0160	0.0269	0.0305	0.0330	0.0145	0.0125
	St. Dev	0.0212	0.0055	0.0125	0.0032	0.0121	0.0031	0.0038	0.0042
	Mean flow	0.0291	0.0420	0.0207	0.0280	0.0324	0.0344	0.0137	0.0127
	St. Dev	0.0194	0.0050	0.0177	0.0035	0.0141	0.0050	0.0040	0.0036
SRP	Mean inflow	0.0010	0.0031	0.0020	0.0014	0.0004	0.0010	0.0004	0.0021
	St Dev.	0.0010	0.0022	0.0012	0.0004	0.0007	0.0005	0.0003	0.0009
	Mean outflow	0.0007	0.0033	0.0036	0.0018	0.0003	0.0008	0.0005	0.0025
	St. Dev	0.0010	0.0021	0.0067	0.0002	0.0003	0.0005	0.0004	0.0024
	Mean flow	0.0008	0.0032	0.0030	0.0016	0.0004	0.0009	0.0005	0.0024
	St. Dev	0.0010	0.0021	0.0053	0.0003	0.0005	0.0005	0.0003	0.0019
TN	Mean inflow	0.5331	0.6104	0.7576	0.6973	0.5477	0.5744	0.6238	0.5977
	St Dev.	0.0814	0.0737	0.0450	0.0636	0.0933	0.0148	0.1005	0.0217
	Mean outflow	0.5487	0.6336	0.7171	0.7062	0.6078	0.5728	0.7237	0.4836
	St. Dev	0.1477	0.0809	0.1347	0.0540	0.1201	0.0368	0.0698	0.1324
	Mean flow	0.5424	0.6234	0.7333	0.7025	0.5847	0.5734	0.6904	0.5264
	St. Dev	0.1233	0.0771	0.1084	0.0570	0.1126	0.0297	0.0927	0.1184
TP	Mean inflow	0.0095	0.0148	0.0104	0.0130	0.0097	0.0085	0.0049	0.0091
	St Dev.	0.0028	0.0036	0.0033	0.0088	0.0029	0.0007	0.0006	0.0025
	Mean outflow	0.0098	0.0128	0.0090	0.0114	0.0093	0.0096	0.0051	0.0118
	St. Dev	0.0023	0.0036	0.0035	0.0066	0.0033	0.0026	0.0011	0.0058
	Mean flow	0.0097	0.0137	0.0096	0.0121	0.0095	0.0092	0.0051	0.0108
	St. Dev	0.0025	0.0036	0.0034	0.0075	0.0031	0.0021	0.0009	0.0049
TOC	Mean inflow	11.9486	10.3807	23.0940	11.3974	8.9705	7.5898	14.1544	8.1012
	St Dev.	4.3337	1.8798	3.0168	2.9048	3.2363	1.1767	3.5805	1.1839
	Mean outflow	13.5634	10.6409	22.8547	12.8143	12.8972	7.3124	16.1931	8.3342
	St. Dev	4.2413	2.3765	6.3536	3.1751	3.7196	0.7798	1.8325	0.9077
	Mean flow	12.9056	10.5264	22.9504	12.2239	11.3869	7.4209	15.5135	8.2468
	St. Dev	4.2726	2.1328	5.1938	3.0837	3.9834	0.9391	2.6645	1.0012

Table 10. Comparison of Particulate Organic Carbon flux data between stations
(grams/day)

	CF - Dec	CF-Apr	CS - Dec	CS - Apr	TF - Dec	TF - Apr	TS - Dec	TS - Apr
Net In	544.248	259.177	194.52	no data	2453.774	239.877	426.079	162.684
Net Out	2286.206	287.239	192.67		4152.955	182.199	185.369	124.388
Marine In	331.373	115.685	1.625		1961.898	203.894	1.21	36.899
Mangrove Out	1257.955	187.201	168.493		1385.472	81.617	165.009	94.946

Table 11. Comparison of flux data between stations. (negative numbers indicate movement inland, Discharge measurements are l3/day; other flux measurements are g/day)

	cs		ts		cf		tf	
	December	April	December	April	December	April	December	April
Tidal Cycle 1 Q	-50460.3	-890.73	-174240	-181390	-3450168	-1031724	-5035500	-323208
N+N	-0.3826	-0.0045	-1.4	-0.52	-63	-1.3524	-6.76	42.52
NO2	-0.055398	-0.0006	-0.3	-0.408	-4.7	0.23734	-0.993137	11.3
NH4	-1.34483	-0.03947	-1.1	-3.106	-129.3	-9.3744	-158.3	60.618
SRP	-0.083969	0.011	-0.3	-0.047	-8.1	-0.7866	-2.06	-1.3089
TN	-38.834	-0.0165	-121.4	-111.7	-1934.6	-149.492	-3079.9	2226.28
TP	-1.5455	-0.001	-1.6	-0.976	-55.5	-1.284	-43.25	25.45
TC	-415.0895	3.61877	-1044.1	-2184.8	-29659	-821.9	-17482.9	46847.37
tide amp	17.3	17.5	12.9	18.4	61.6	24	59	48.5
Tidal Cycle 2 Q	-125562	-1182.71	-192060	-248296	-4013280	-2763575	1877796	-1944435
N+N	-1.7846	-0.0093	-1.7	-0.511	-68.9	-5.4128	28.965	-120.95
NO2	-0.344	-0.0027	-0.4	-0.3788	-5.2	-3.3887	3.05	-135.35
NH4	-5.1967	-0.03401	-3.5	-1.902	-181.2	-39.99	51.91	-8.979
SRP	-0.1871	-0.0025	-0.4	-0.182	-11.2	-0.1112	2.66	2.461
TN	-72.8945	-0.9594	-150.9	-111.8	-2354.5	-867.451	1142.3	-2341.42
TP	-0.91297	-0.0141	-2	-1.253	-57.6	-13.877	31.59	-45.47
TC	-768.347	-28.166	-1595.3	-2424.7	-30453.3	-16043.8	11449.8	-23637.7
tide amp	16	23.3	25	27	62.7	49.6	53	54.8
Diurnal Flux Q	-176022.3	-2073.44	-366300	-429685	-7463448	-3795299	-3157704	-2267643
N+N	-2.1673	-0.0138	-3.1	-1.03	-131.95	-6.7652	22.19	-60.333
NO2	-0.39929	-0.0033	-0.7	-0.787	-9.9	-3.1514	2.059	-92.83
NH4	-6.5416	-0.07348	-4.5	-5.009	-310.557	-49.36	-106.35	2.32
SRP	-0.271	0.00855	-0.6	-0.229	-19.24	-0.8978	0.599	1.152
TN	-111.7286	-0.9759	-272.3	-223.5	-4289.14	-1016.94	-1937.6	-115.13
TP	-2.45847	-0.0151	-3.6	-2.229	-113.087	-15.16	-11.654	-20.02
TC	-1183.44	-24.547	-2639.4	-4609.5	-60112.27	-16865.7	-6033.1	23209.68

Table 12. Daily flux of TOC, TN, TP, and NH₄ / m² of drainage basin. Negative values indicate net flux into the wetlands and positive values, net flux into Biscayne Bay.

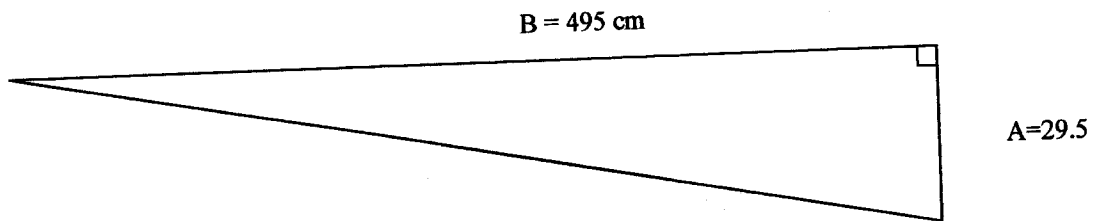
	CS		TS		CF		TF	
	Dec	Apr	Dec	Apr	Dec	Apr	Dec	Apr
TOC	-0.009	-0.0002	-0.025	-0.044	-0.53	-0.15	-0.07	0.25
TN	-0.009	-0.000007	-0.025	-0.002	-0.038	-0.0089	-0.021	-0.0013
TP	-0.00002	-0.0000002	-0.00003	-0.00002	-0.00099	-0.00013	-0.00013	-0.0002
NH ₄	-0.00005	-0.0000005	-0.00004	-0.00005	-0.0027	-0.0004	-0.0012	0.0003

Appendix 1. Cross sections of stream channels.

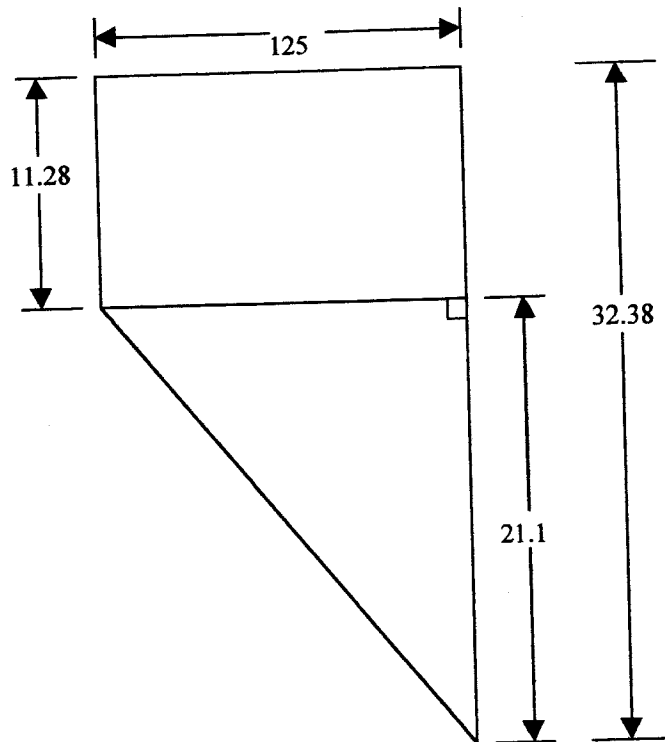
Control Fringe

Staff = 19 cm

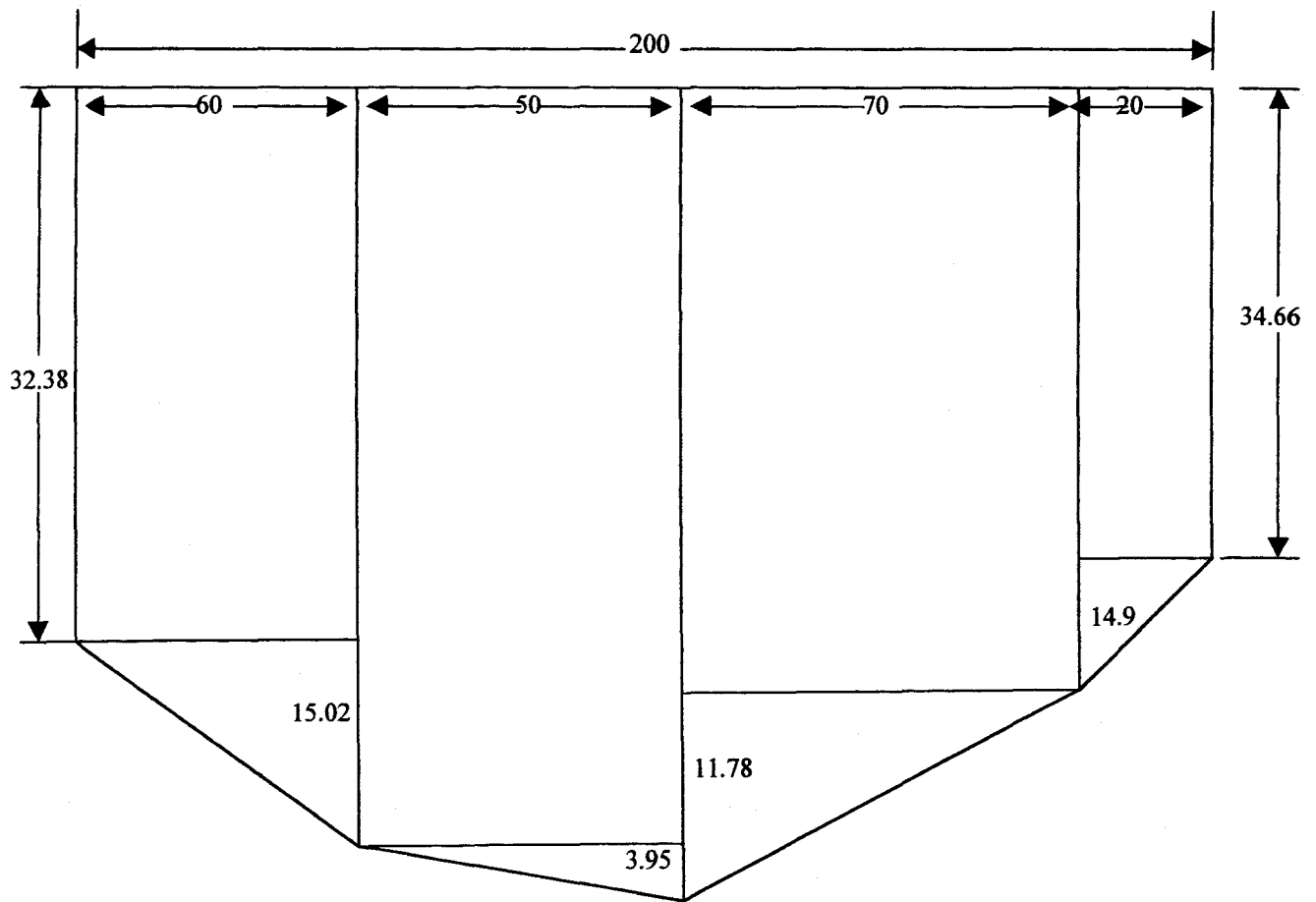
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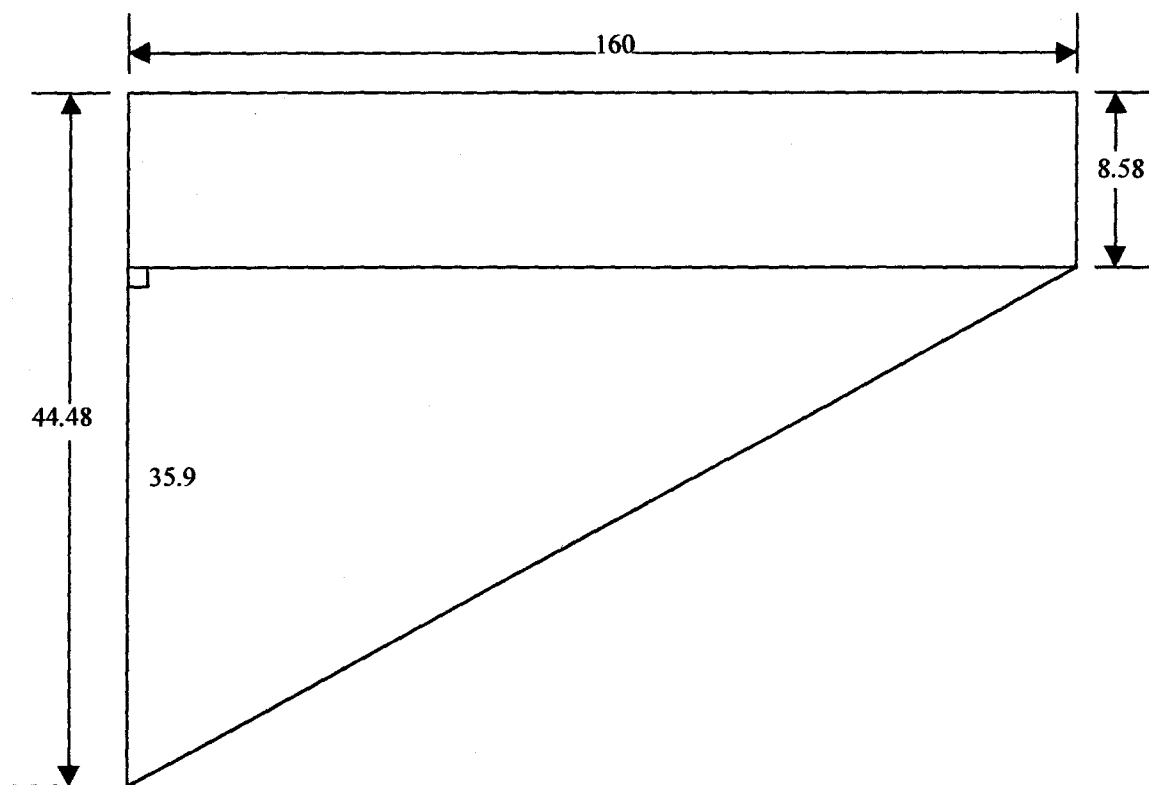
B



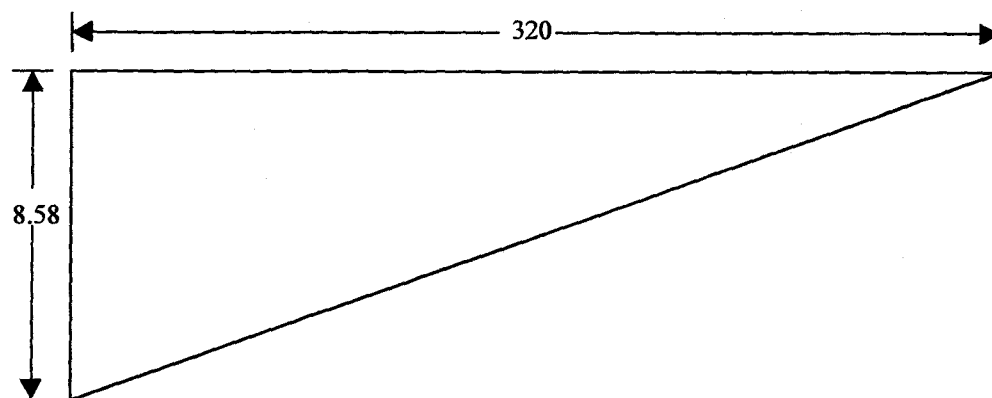
C



D



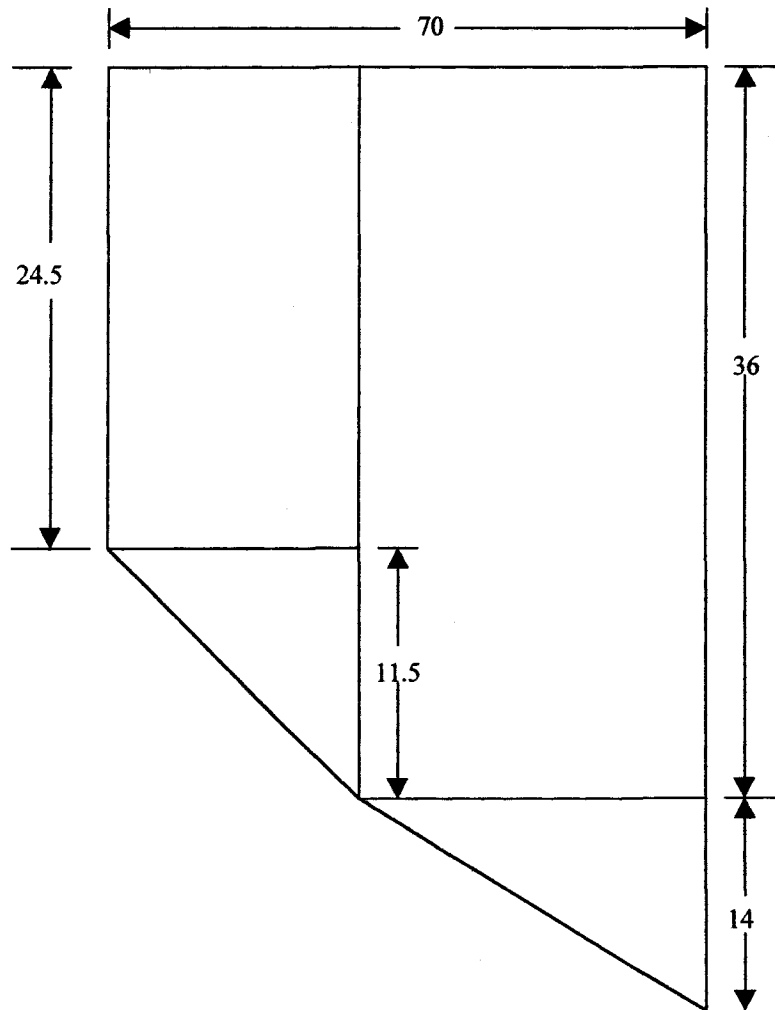
E



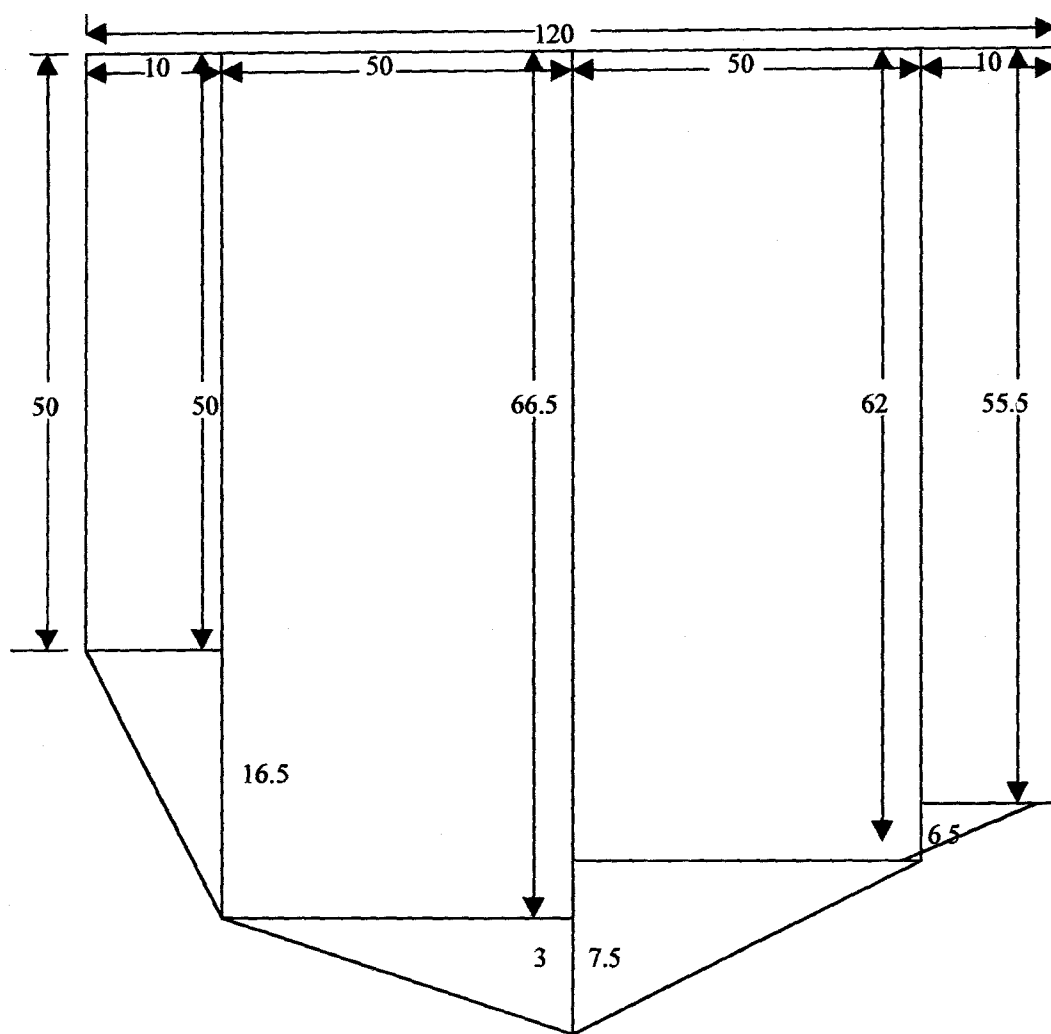
Treatment Fringe

Staff = 42.5 cm

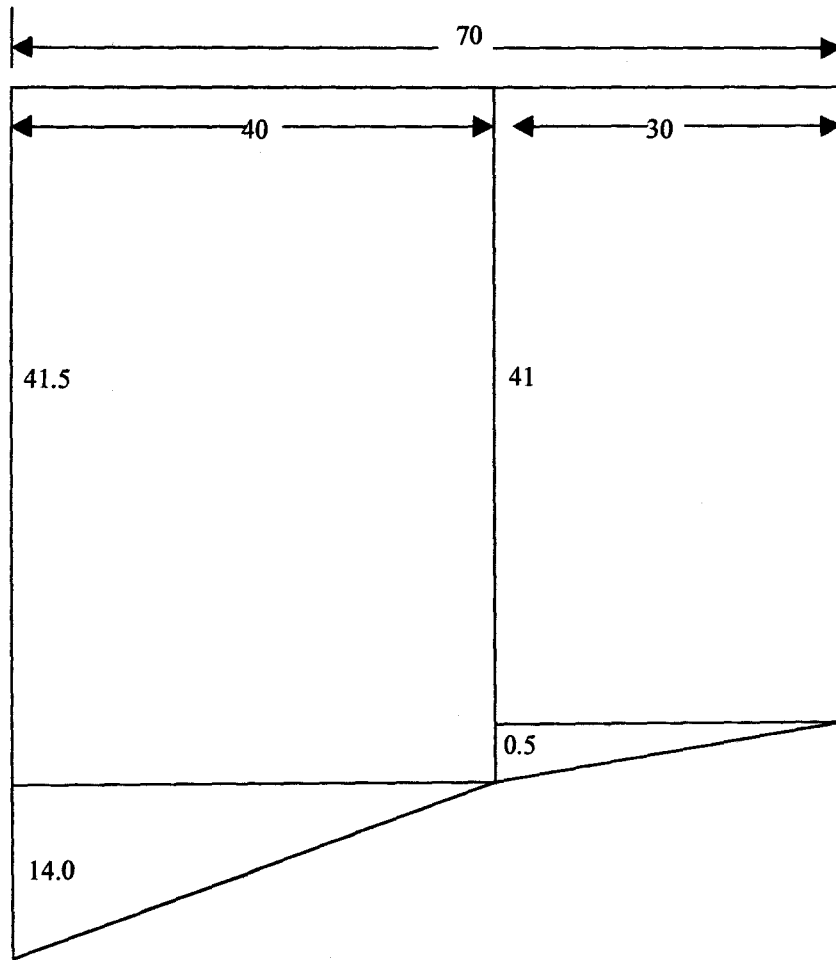
A



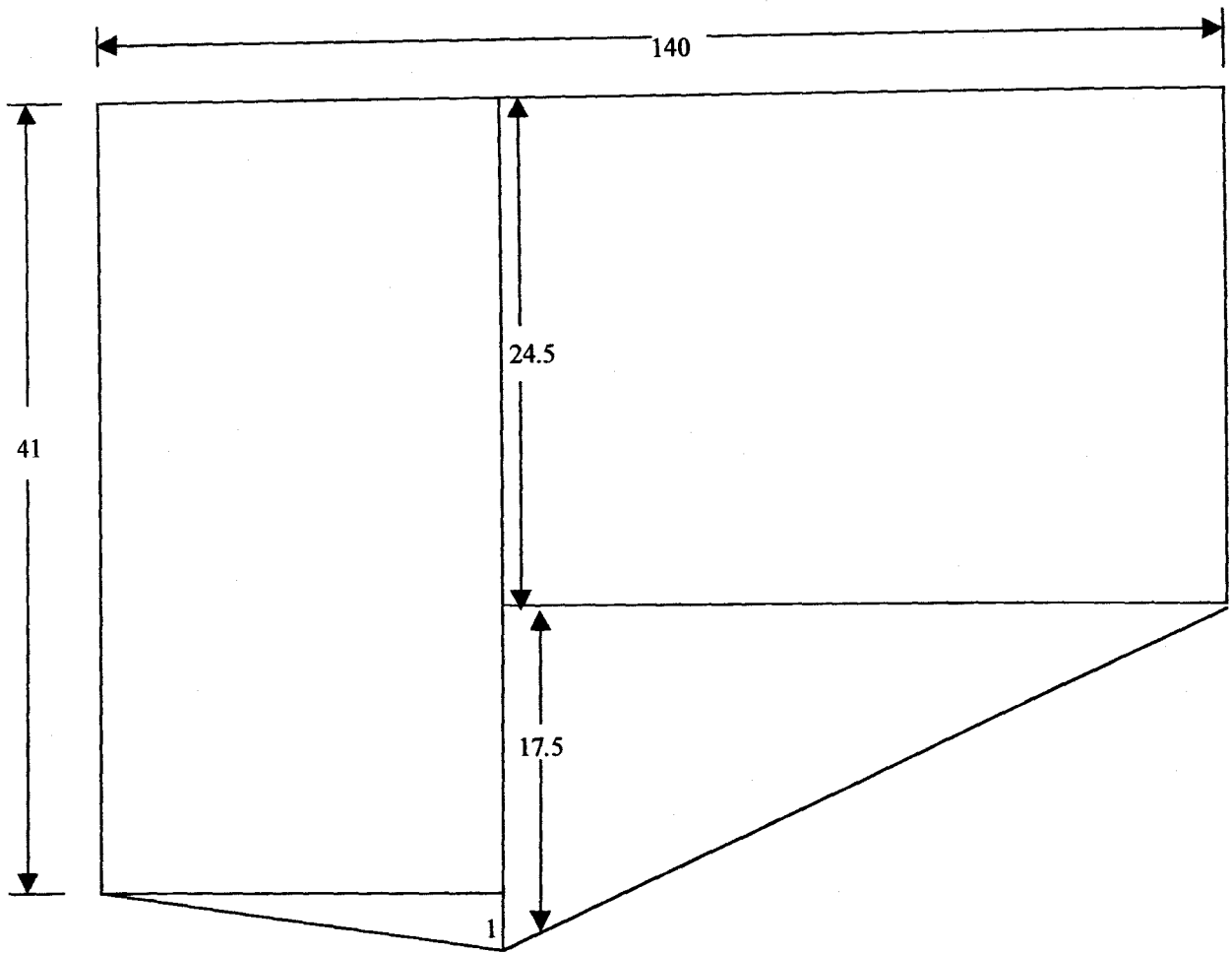
B



C



D



E.

