Chevron

Chevron

October 22, 1996

Chevron ~~U.S.A.~~ Products Company
6001 Bollinger Canyon Road
Building L
San Ramon, CA 94583
P.O. Box 5004
San Ramon, CA 94583-0804

Marketing – ~~Northwest Region –~~
Phone 510 842 9500

Ms. Amy Leach
Alameda County Health Care Services
Department of Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

Re: Chevron Service Station #9-0504
15900 Hesperian Blvd., San Lorenzo, California

Dear Ms. Leech:

ACo requested data Re: gw velocity for this site.

Enclosed is the Groundwater Transport Evaluation report, that was prepared by our Chevron Research and Technology department., for the above noted site. This evaluation was conducted at your request to determine the velocity of benzene in the groundwater, the timeframe for benzene to reach monitoring well C-10 from C-8, and to determine if natural attenuation is occurring.

Based on the results of the calculations in this evaluation, the velocity of benzene in the groundwater is approximately 0.18 feet per day; therefore, calculating that the source is occurring at monitoring well C-8, it will take approximately 275 days for detectable concentrations of benzene to reach monitoring well C-10. Using a software program called "PRINCE", it was calculated that the concentration of benzene at monitoring well C-10 after one year and after ten years would be approximately 2ppb and 8ppb respectively. However, groundwater analytical data shows that well C-10 has not been impacted by benzene although the upgradient well C-8 has been impacted by dissolved hydrocarbons the last seven years. Therefore, the modeling parameter of biodegradation is probably too small and the other parameters that effect natural attenuation could also be incorrect , however the biodegradation rate is the dominant factor in natural attenuation and has the greatest effect on the plume attenuation.

Based on this evaluation it appears that natural attenuation is occurring at this site, and Chevron requests that the sampling program be adjusted to an annual basis for monitoring wells C-4, C-5, C-6, C-9, C-10 and C-11, with the remaining wells continue to be sampled quarterly. If you have any questions or comments, call me at (510) 842-9136.

Sincerely,
CHEVRON PRODUCTS COMPANY

Philip R. Briggs

Philip R. Briggs
Site Assessment and Remediation Project Manger

Enclosure

cc. Mr. Bill Scudder, Chevron

Mr. Ron Sykora
David E. Bohannon Organization
60 Hillsdale Mall
San Mateo, CA 94403

October 18, 1996
Richmond, California

Chevron
Research and Technology

RE: Groundwater Transport Evaluation
Chevron Station 9-0504
15900 Hesperian Boulevard
San Lorenzo, California

P. Briggs,
Northwest Marketing:

Chevron Research and Technology Company (CRTC) has evaluated the groundwater data at the above referenced service station. The intent of the evaluation was to determine the dissolved benzene velocity in groundwater, the timeframe for benzene breakthrough in well C10, and the maximum concentration of benzene within well C10 if benzene breakthrough occurs. To conduct this evaluation, CRTC utilized the software program PRINCE by Waterloo Hydrogeologic Software. The software program uses analytical solutions to the groundwater transport equation in order to predict contaminant behavior.

Site-specific information for this evaluation was collected by CRTC from the *Quarterly Groundwater Monitoring Reports* by Gettler-Ryan Incorporated, and the *Additional Pump Test Data* by Weiss Associates.

CONCLUSIONS

1) Benzene Velocity. The velocity of benzene through the aquifer is approximately 0.18 feet per day.

2) Benzene Breakthrough. The breakthrough of benzene at detectable concentrations should occur in well C10 in approximately 275 days.

3) Maximum Benzene Concentration. The modeling predicts that the maximum benzene concentration reaching well C10 is approximately 8 parts per billion (ppb).

4) Biodegradation Rate. The biodegradation rate for benzene at the site is probably greater than 0.34 percent per day.

BENZENE VELOCITY IN GROUNDWATER

Contaminant velocity can be determined through a linear relationship between the groundwater seepage velocity and the aquifer retardation coefficient, as follows (Fetter, 1993):

$$v_c = \frac{v_x}{R_f}$$

where:

v_c	=	0.18 feet per day (contaminant velocity)
R_f	=	5.7 (retardation coefficient)
v_x	=	1.04 feet per day (groundwater seepage velocity)

The retardation coefficient and the groundwater seepage velocity were determined from the following equations:

$$v_x = \frac{Ki}{n_e}$$

$$R_f = 1 + \frac{K_d \rho_b}{n_e}$$

where:

K	=	39.0 feet per day (hydraulic conductivity; taken from Weiss Associates)
i	=	0.004 (groundwater gradient; taken from Gettler-Ryan)
n_e	=	0.15 (estimate of effective porosity for a clayey silt)
K_d	=	$K_{oc} \times f_{oc}$ (distribution coefficient)
K_{oc}	=	83 milliliters per gram (organic carbon partitioning coefficient for benzene)
f_{oc}	=	0.005 (estimate of fraction organic carbon in the aquifer)
ρ_b	=	1.7 grams per milliliter (estimate of dry bulk density)

DISCUSSION OF PRINCE

PRINCE is the Princeton Analytical Models of Flow and Mass Transport. The mass transport models within the package are for unsteady-state, multi-dimensional problems. The package was originally created at Princeton University for use by the United States Environmental Protection Agency. The analytical models within PRINCE were developed for testing the results of numerical models. The solutions were derived using integral transform techniques (Cleary and Ungs, 1978).

CRTC used Model 4 of the PRINCE software to evaluate the contaminant flow at the service station. The model simulates a two-dimensional concentration distribution downgradient from a strip source. For modeling purposes, the benzene impact in well C8 was approximated by a 50 foot strip source. The concentration of the strip source was assumed to be constant through time. The strip source was inferred to contain 81 ppb benzene, which is the arithmetic mean of the benzene concentrations in the well over the last twelve groundwater monitoring events. Other input parameters for PRINCE Model 4 included:

1) Longitudinal Dispersivity. The longitudinal dispersivity was assumed to be 12 feet. This value represents ten percent of the flow field of the hydrocarbon plume, which is ten percent of the plume length of 120 feet (ASTM, 1995).

2) Transverse Dispersivity. The transverse dispersivity was assumed to be 4 feet. This value represents thirty-three percent of the longitudinal dispersivity (ASTM, 1995).

3) Retardation Coefficient. The retardation coefficient was determined using the above relationship.

4) Groundwater Velocity. The groundwater seepage velocity was determined using the above relationship.

5) First Order Decay Rate. The biological decay rate was assumed to be 0.34 percent per day. Buscheck and others (1993) published eleven examples of benzene decay rates where the rate ranged from 0.055 to 1.2 percent per day. The arithmetic average of these eleven values were used for modeling purposes. cannot assume — took average of eleven.

6) Hydrocarbon source => Well C-8

7) 125' away => Observation Point

TIMEFRAME OF BENZENE BREAKTHROUGH IN WELL C10

The PRINCE software program calculates the temporal hydrocarbon concentration at any location downgradient from a hydrocarbon source. For the modeling of the service station, the benzene source was placed near well C8, which is located 125 feet upgradient from well C10 (Figure 1). Accordingly, a graph of benzene concentration through time for well C10 was generated. Benzene concentrations above the analytical detection limit should reach the well in approximately 275 days (Figure 2).

MAXIMUM BENZENE CONCENTRATION IN WELL C10

The modeling indicates that the maximum benzene concentration in well C10 should be approximately 8 ppb (Figure 2). As seen on the graph, the concentration of benzene in the well remains constant through time due to the assumption that the hydrocarbon source at well C8 remains steady.

Additionally, the PRINCE software program calculates the spatial hydrocarbon concentration in any direction from a hydrocarbon source. For comparative purposes, two spatial hydrocarbon concentration graphs were produced with end members being wells C8 and C10. The graphs show how the benzene concentrations attenuate downgradient from well C8 in the direction of C10. The graphs represent two time increments, the concentrations at one year and at ten years (Figures 3 and 4, respectively). After one year, the benzene concentration in well C10 is approximately 2 ppb and after ten years the concentration is approximately 8 ppb.

NATURAL ATTENUATION

The PRINCE model shows that benzene breakthrough should occur in well C10 in approximately 275 days and that the benzene concentrations in the well should maximize at approximately 8 ppb. However, groundwater analytical data shows that well C10 has not been impacted with benzene although upgradient dissolved hydrocarbons have been observed in well C8 for the past six years. This observation implies that the natural attenuation at the site is greater than that predicted by the model. Accordingly, the modeling input parameter of a biodegradation rate of 0.34 percent per day is probably too small. Additionally, the other parameters that effect natural attenuation, dispersion, advection, and retardation, could also be incorrect. However, the biodegradation rate is the dominant factor in natural attenuation and has the greatest effect on the plume attenuation. Therefore, altering dispersion, advection, and retardation would be less justifiable.

REFERENCES

1) American Society for Testing and Materials. 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. ASTM E1739-95, Philadelphia, PA.

2) Buscheck, T. E., K. T. O'Reilly, and S. N. Nelson. 1993. Evaluation of Intrinsic Bioremediation at Field Sites. Proceedings, Petroleum Hydrocarbons and Organic Chemical in Ground Water: Prevention, Detection, and Restoration, p. 367-381. National Ground Water Association/API, Houston, TX.

3) Cleary, R. W., and M. J. Ungs. Groundwater Pollution and Hydrology: Mathematical Models and Computer Programs. Water Resources Program, Department of Civil Engineering, Princeton University, Report No. 78-WR-15.

4) Fetter, C. W. 1993. Contaminant Hydrogeology. Macmillan Publishing Company, New York, NY.

If you have any questions, or require additional information, please contact me at (510) 242-1284.

Very truly yours,

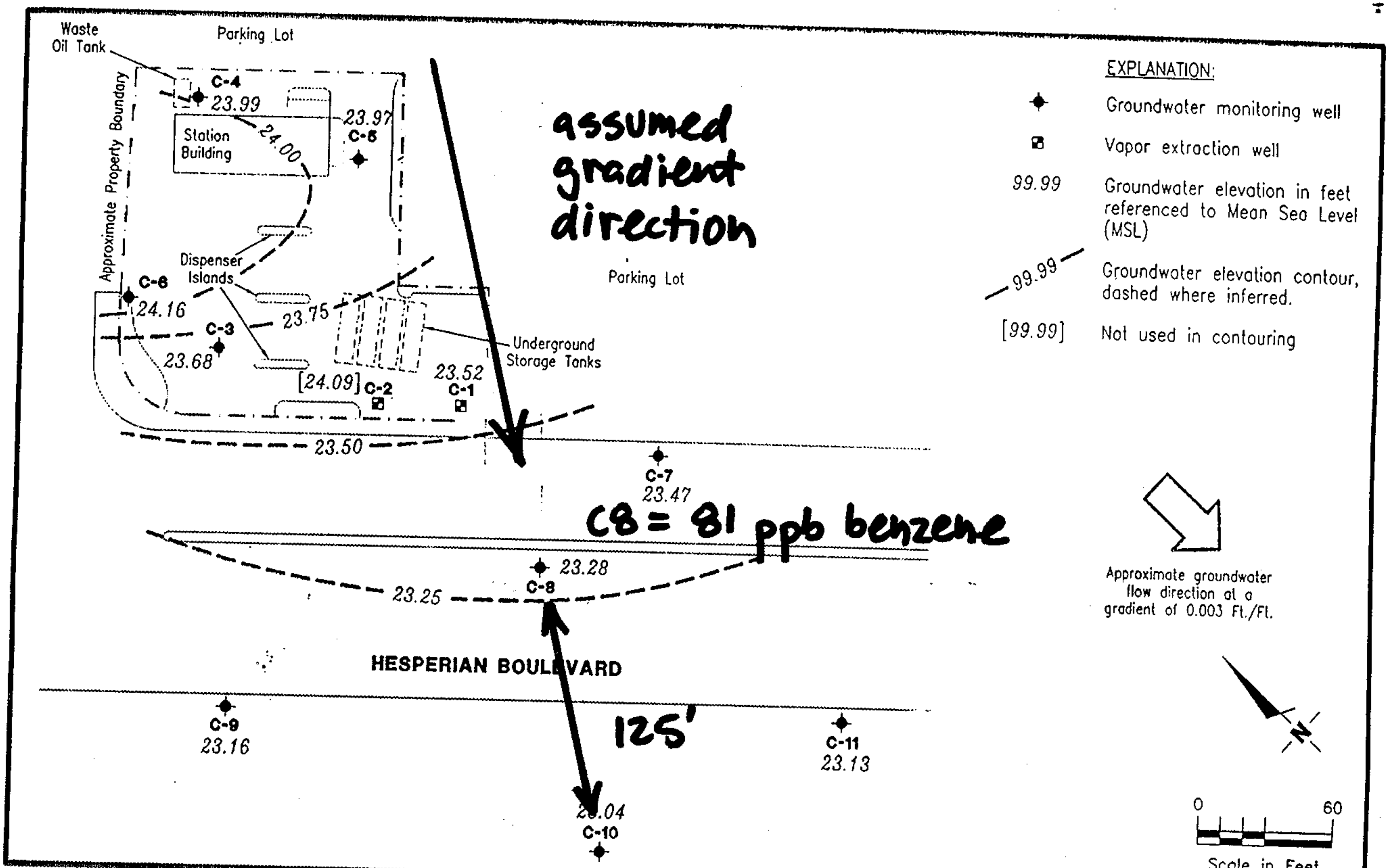
Fax: 510-242-1380

Dan Gallagher

Dan Gallagher
Hydrogeologist

Attachments

cc: G. Jauregui, CPDS
T. Buscheck, CRTC



Gettler - Ryan Inc.

6747 Sierra Ct., Suite J
Dublin, CA 94568
(510) 551-7555

POTENTIOMETRIC MAP
Chevron Service Station No. 9-0504
15900 Hesperian Boulevard
San Lorenzo, California

FIGURE 1

JOB NUMBER 5259

REVIEWED BY

DATE June 21, 1996

REVISED DATE

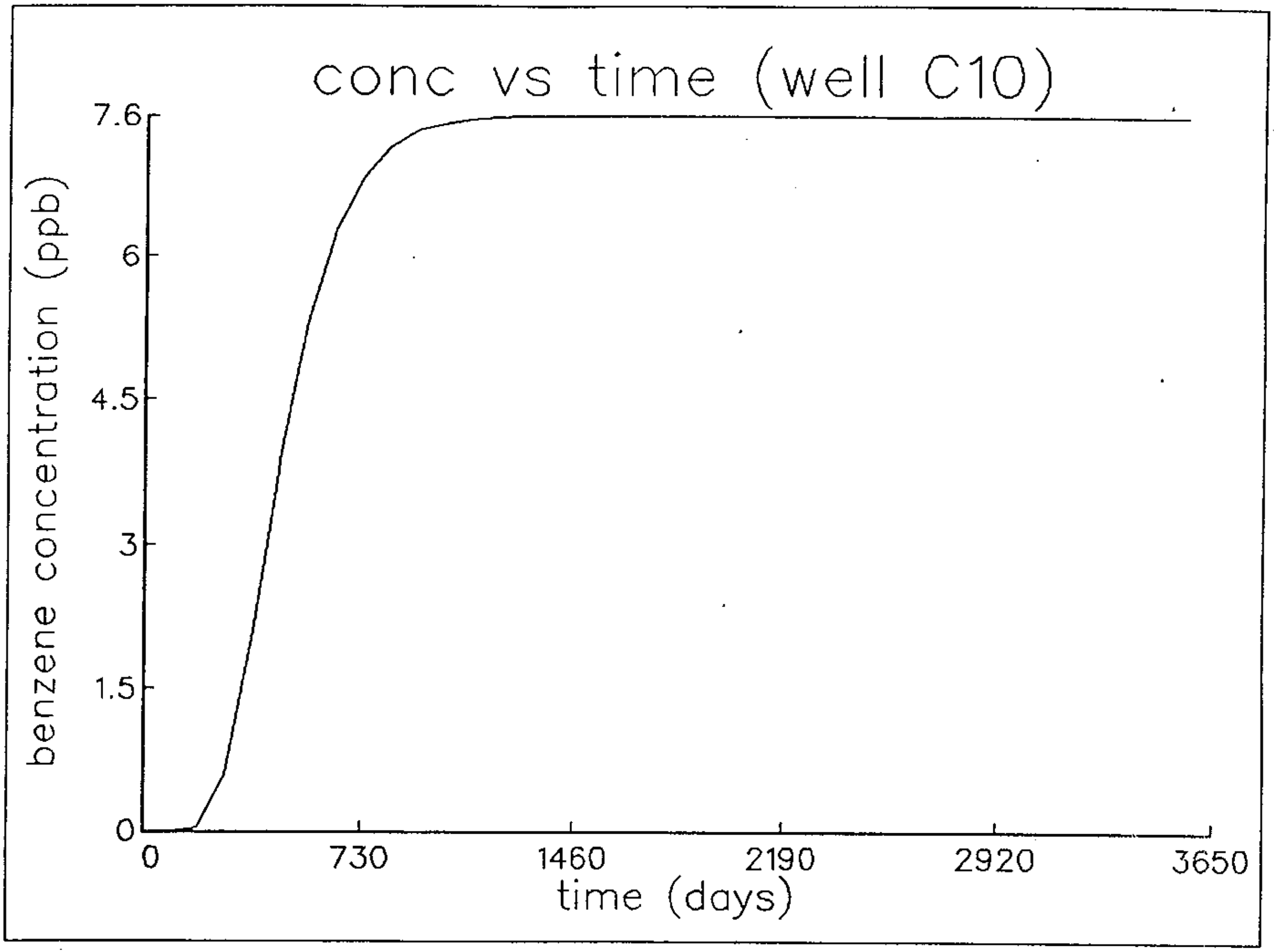
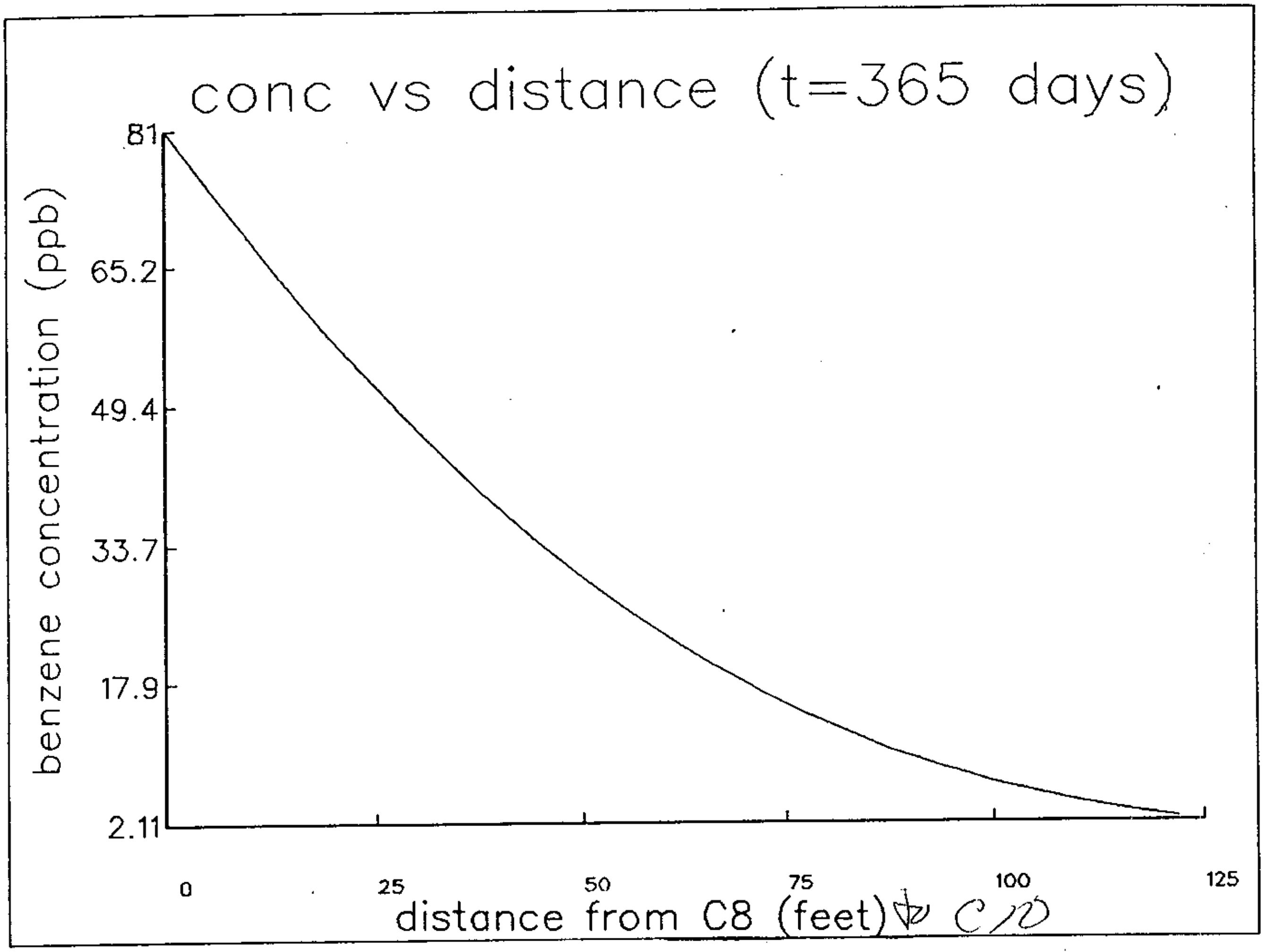


Figure 2: Plot of benzene concentration versus time for service station 9-0504. The plot shows the concentration of benzene in well C10 over a ten year period. The maximum benzene concentration that occurs in the well is approximately 8 parts per billion. The upgradient benzene source is located at well C8 and is approximated by a strip source 50 feet in length with a constant concentration of 81 parts per billion.



Conc. Profile Over Distance

Figure 3: Plot of benzene concentration versus distance for service station 9-0504. The plot shows the concentration of benzene along a line between wells C8 and C10 at a time of one year. The benzene source is located at well C8 and is approximated by a strip source 50 feet in length with a constant concentration of 81 parts per billion.

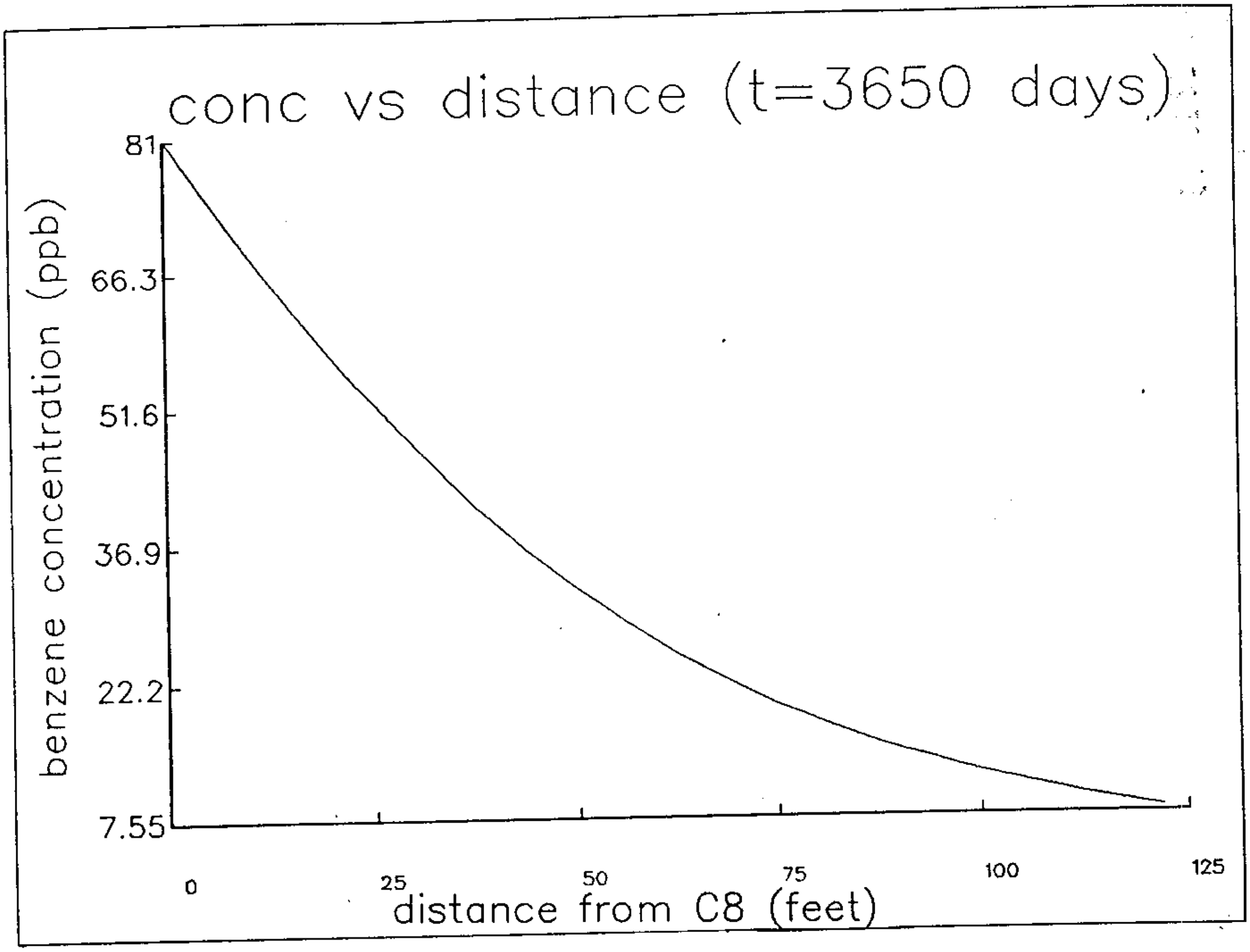


Figure 4: Plot of benzene concentration versus distance for service station 9-0504. The plot shows the concentration of benzene along a line between wells C8 and C10 at a time of ten years. The benzene source is located at well C8 and is approximated by a strip source 50 feet in length with a constant concentration of 81 parts per billion.