GeoPentech

HYDROGEOLOGIC STUDY
LOWER TOPANGA CREEK WATER SHED
LOS ANGELES COUNTY, CALIFORNIA

For

Resource Conservation District of the Santa Monica Mountains
122 North Topanga Canyon Boulevard
Topanga, CA 90290

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Table of Contents

EXECUTIVE SUMMARY

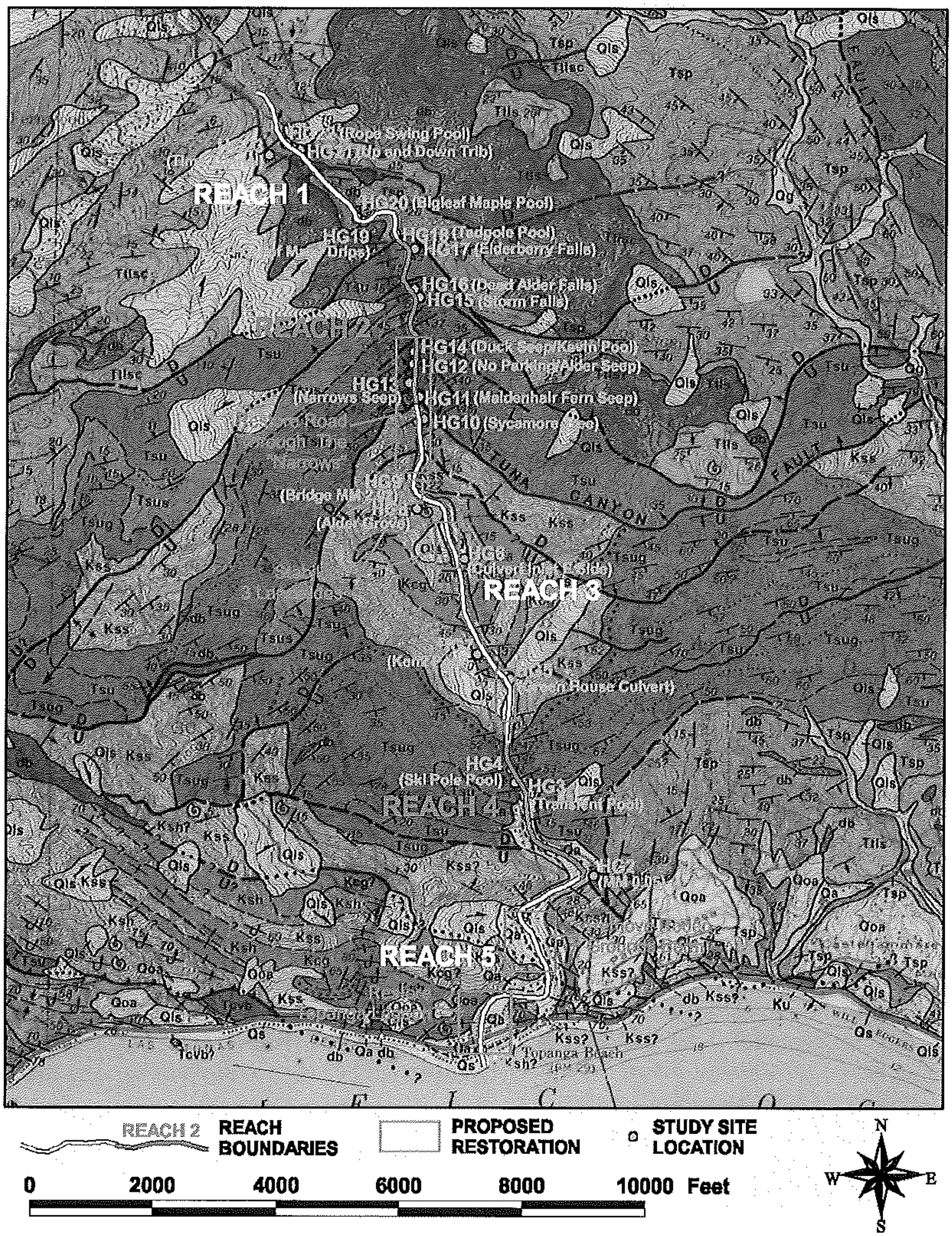
This hydrogeologic evaluation of the lower portion of the Topanga Creek Watershed was performed to evaluate the water quality of groundwater resources (i.e., stream, springs, and seeps) as a function of time and distance along the lower 6 km of Topanga Creek, as well as, the effects the groundwater resources have on the quality of the fish habitat. This report also evaluates potential effects to the ground water resources from the proposed Topanga Creek restoration projects being considered by the California Department of Parks and Recreation (including restoration of Topanga Lagoon, removal of Rodeo Grounds berm, relocation of Topanga Canyon Boulevard through the "Narrows", and stabilization of 3 landslides). The locations of the proposed restoration projects are shown on Figure ES-1.

The study area is located in the Santa Monica Mountains between the southern boundary of the town of Topanga and the Pacific Ocean. Geologically the study area consists predominantly of faulted marine and nonmarine sedimentary rocks with lesser volcanic rocks and landslide deposits, as shown on Figure ES-1. Sources of human impacts to the creek within the study area include 1) runoff from the town of Topanga, 2) runoff from Topanga Canyon Boulevard, which parallels the creek, 3) runoff from commercial and residential developments and Pacific Coast Highway near Topanga Lagoon, and 4) runoff and constriction to the creek from imported fills such as Rodeo Grounds berm, Topanga Lagoon, and fills used to construct Topanga Canyon Boulevard. Also, all residences and commercial businesses in the canyon use on site waste disposal septic and gray water systems.

The hydrogeologic evaluation of lower Topanga Creek involved identifying and monitoring groundwater resources in the study area. A total of 24 stream and spring sites were monitored monthly between March and December 2005. Also, the study area was divided at geologic boundaries into 5 reaches for discussion purposes. The locations of the monitoring sites and stream reaches are shown on Figure ES-1. The monitoring consisted of field measurements (including flow rate, water temperature, conductivity, pH, dissolved oxygen, and salinity), nutrient testing (including nitrates (as nitrogen), ammonia (as nitrogen), and phosphates (orthophosphates)), general mineral testing (including ionic concentration, alkalinity, hardness, and total dissolved solids), and stable water isotope testing (including oxygen-18 and deuterium). Results of the study were assembled in ESRI ArcView GIS and Microsoft Access databases.

During 2005, Topanga Creek maintained a year-round surface flow from the town of Topanga to the ocean due to the abnormally high precipitation during this time period. The 2005 precipitation total was one of the wettest years on record with 62 inches of rain measured at Topanga Patrol Station in the town of Topanga, compared to a normal year average of approximately 25 inches.

Figure ES-1: Topanga Creek Study Area Reach Boundaries and Restoration Areas



The results of the hydrogeologic study of the Lower Topanga Creek Watershed are summarized below.

Relationship between the Groundwater Resources and the Surrounding Geology: In general, the locations of springs and seeps within the study area are controlled by the surrounding geologic structure and lithology. The majority of springs and seeps monitored had sources that emanated at fault and landslide boundaries and to a lesser degree were located within shale beds. Also, the sedimentary rocks within the study area yielded very hard water with high ionic concentrations of calcium, magnesium, and carbonate.

Based on isotopic analysis, it appears that the springs, excluding HG2 (MM 0.05 TC Blvd) in Reach 4, and stream within the study area are generally recharged locally by precipitation, which enters the groundwater system relatively quickly with little to no evaporative effects. Also, the isotopic grouping of the spring and stream data does not appear to have a significant mixing component from the discharge of recycled wastewater, which would expect to have some evaporative effects. The water emanating from HG2 (MM 0.05 TC Blvd) may have been derived from precipitation during a different time period or location with different climatic conditions with respect to the other sites. It is also possible that the water at site HG2 (MM 0.05 TC Blvd) is being mixed with LA City water emanating from water usage from the housing development immediately upslope of this site.

Variation of Groundwater Trends as a Function of Time (Seasonal Trends): A total of 13 spring sites continually flowed or seeped throughout the 2005 monitoring period. Since the 2005 precipitation total was more than twice the average, it is suspected that many of these sites have the potential to become dry during years with normal to below normal rainfall. As would be expected, the highest site flows were monitored in the spring time and the lowest flows were monitored in summer/fall.

In general, the dissolved oxygen levels remained relatively constant throughout the 2005 monitoring period. Also, the ionic concentrations of the groundwater sites remained relatively constant with the exception of HG1 (Topanga Lagoon), which varied due to its proximity to the ocean and influences of salt water intrusion. The conductivity and TDS measurements generally increased between spring and fall 2005. This trend may be a result of lower site flow, evaporation of water from pools concentrating dissolved solids, and the decrease of the effects of less conductive rainwater dilution at the sites between the spring and fall months. The pH at many sites had a slight upward trend between spring and fall 2005, which may be a result of a decrease in the effect of neutral pH rainwater dilution at the sites during this time period.

Variation of Groundwater Trends as a Function of Distance along the Study Area: During the 2005 monitoring period, the stream conductivity and TDS generally decreased as a function of distance from within the town of Topanga through stream Reach 4. This distribution of stream conductivity suggests that runoff from the town of Topanga may be a source of the high conductivity and TDS water. Also, elevated stream conductivity and TDS concentrations were measured within Reach 5 at Topanga Lagoon. The high conductivity and TDS values measured at Topanga Lagoon are most likely a result of salt water intrusion due to its proximity to the ocean; however, effects of runoff from adjacent commercial and residential developments and Pacific Coast Highway cannot be discounted.

The sulfate concentration measured within the town of Topanga was more than 250% higher than the average sulfate concentration measured in Reach 1 immediately downstream of Topanga. Also, the average sulfate concentration measured within HG1 (Topanga Lagoon) was approximately 50% higher than that measured immediately upstream in Reach 4. The stream sulfate concentrations were approximately constant between Reach 1 and Reach 4 (no measurement in Reach 2). The relatively elevated stream sulfate concentrations within the town of Topanga and at Topanga Lagoon may be a product of pollutants such as fertilizer or human and animal waste most likely entering the stream from the town of Topanga upstream of Reach 1 or from commercial and residential developments and Pacific Coast Highway adjacent to Topanga Lagoon in Reach 5. The presence of elevated sulfate at HG1 (Topanga Lagoon) may also be an indicator of sea water intrusion.

The average 2005 nutrient concentrations measured at the springs and streams within the study area were below TMDL thresholds (1 mg/L) recommended by the RWQCB for the Malibu Creek and Lagoon and below nutrient criteria (0.5 mg/L) developed by the EPA to represent rivers and streams that are minimally impacted by human activities. However, 2005 stream ammonia and nitrate concentrations spiked above EPA minimally impacted levels within the town of Topanga and immediately downstream of Topanga within Reach 1. Sources of the high nutrient levels may be due to human influence (i.e. discharge of human or animal waste) most likely emanating from the town of Topanga. Also, spring ammonia and nitrate concentrations spiked above TMDL thresholds and EPA minimally impacted thresholds during 2005. The suspected elevated ammonia and nitrate level spikes at the spring sites may be a result of animal waste that may have collected and concentrated (due to low flow and evaporation) at these sites.

<u>Spring and Stream Water quality as it Relates to RWQCB and EPA Protection of Aquatic Life Thresholds</u>: During the 2005 monitoring period, the site pH measurements ranged from 6.5 to 9, which were within the range of pH values determined by the EPA to be harmless to fish (6.5 to 9.0). In general, the dissolved oxygen levels measured in the stream were above the EPA minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L) with the exception of measurements collected upstream of HG18 (Tadpole Pool) in June and August 2005 and upstream of HG21 (Up and Down Trib) in October 2005. For the most part, the dissolved oxygen levels measured in the springs were above the EPA minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L) with the exception of HG8 (Alder Grove) in September 2005, HG15 (Storm Falls) in November 2005, HG18 (Tadpole Pool) in May through August 2005, and HG21 (Up and Down Trib) in August 2005. The lower dissolved oxygen measurements may be a result of reduced pool surface areas due to low flow and evaporation, which may reduce the intake of dissolved oxygen. Also, the 2005 alkalinity (>20 mg/L), hardness, and TDS (<15,000 mg/L) values were within ranges tolerable or beneficial to aquatic life. The 2005 nitrate concentrations measured within the springs and stream were below the EPA drinking water standard limit (<10 mg/L). The ammonia levels measured during this time period within the stream were below continuous criteria no-effect

levels for aquatic life (<1.5 mg/L); however, these levels were exceeded at spring sites HG7 (Ken2 Pool) in October 2005, HG10 (Sycamore Tree) in October 2005, and HG 16 (Dead Alder Falls) during December 2005. The desired average phosphate concentrations (<0.1 mg/L) was exceeded throughout the 2005 monitoring period within all reaches, except Reach 3. The phosphate threshold was exceeded at stream sites HG1 (Topanga Lagoon), HG3 (Transient Pool), and HG22 (Rope Swing Pool); and at spring sites HG7 (Ken2 Pool), HG11 (Maidenhair Fern Seep), HG12 (No Parking/Alder Seep), HG13 (Narrows Seep), HG15 (Storm Falls), HG17 (Elderberry Falls), HG18 (Tadpole Pool), HG19 (Pool of Many Drips), and HG20 (Bigleaf Maple Pool).

Comparison of Spring and Stream Groundwater Trends: Based on comparison of creek flow rates to monitored spring flow rates during the 2005 monitoring period, it appears that the springs monitored above HG9 (Bridge MM 2.02) as part of this study contributed approximately 1% of the total flow to the creek; therefore, the influence of the monitored springs on the creek flow volume and chemistry was probably minimal during 2005. Since the springs are diluted by flow from the creek within the study area, it is suspected that the spring flow contribution to the creek would become more substantial when the creek flow becomes low in the summer and fall months during years with average to below average rainfall totals. Additional monitoring during years with average to below average precipitation would be necessary to quantify this assumption.

The average pH and salinity measurements collected at the springs were within similar ranges as measurements collected in the stream. The dissolved oxygen values measured in the creek were generally higher than those measured at the springs, due to the larger surface area of the stream, which allows a larger amount of oxygen to enter the water, and the greater affects of photosynthesis within the stream. The spring conductivity and TDS measurements were generally lower than the corresponding stream conductivity and TDS measurements suggesting a relatively higher concentration of dissolved solids within the stream perhaps due to urban runoff. The average spring alkalinity and hardness concentrations for the springs were slightly higher than those measured within the stream.

The ionic concentrations of the springs with measurable flows throughout the 2005 monitoring period were of the magnesium carbonate, calcium carbonate, magnesium sulfate, and calcium sulfate types. The ionic concentration of the stream ranged from calcium sulfate to calcium-magnesium sulfate types. High sulfate content within the stream may be derived from weathering of sedimentary rocks, but can also be a product of pollutants such as fertilizers and wastes. The 2005 average sulfate concentrations measured within Reach 1 and Reach 5 were above the RWQCB objective of <500 mg/L.

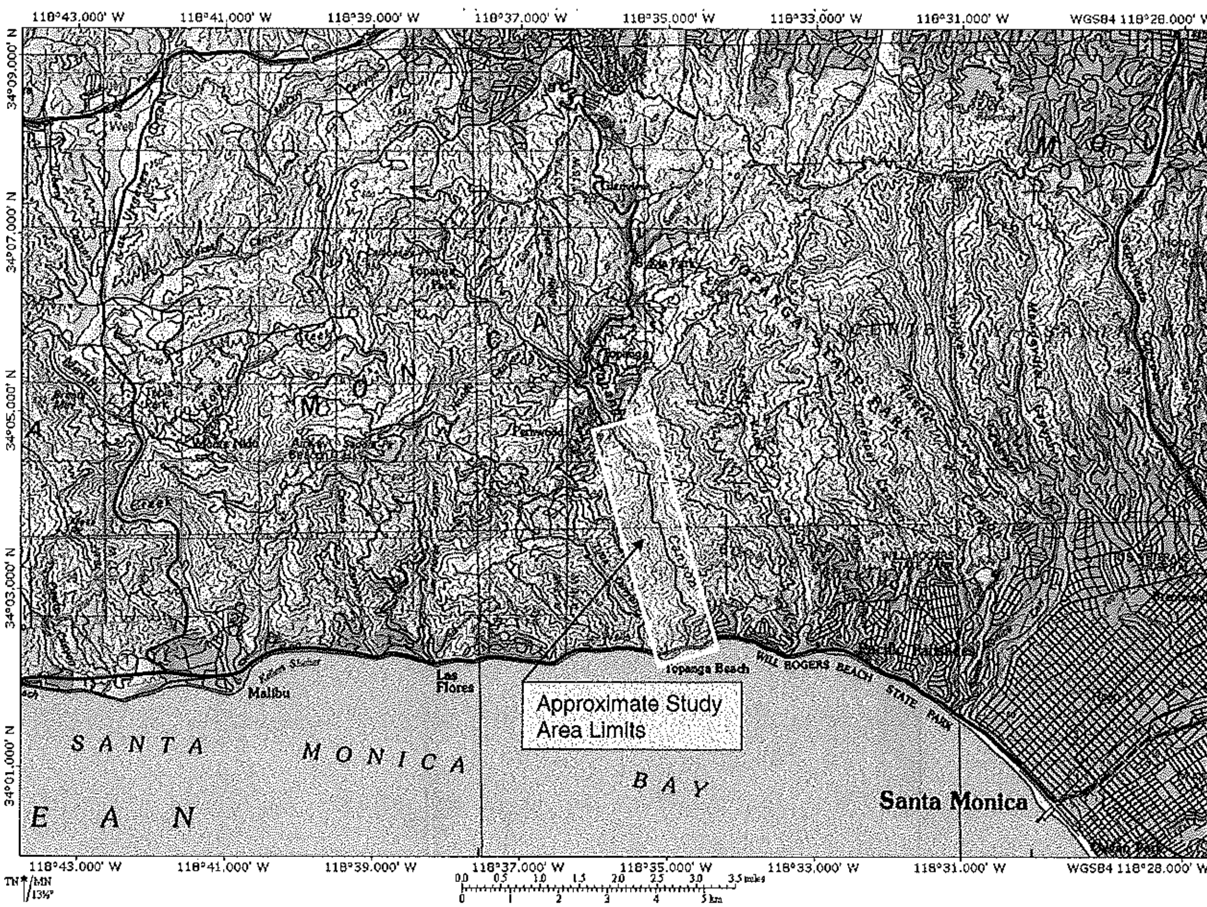
Potential impacts to Groundwater Resources during Proposed Restoration: In general, 9 of the 18 springs and seeps monitored within the study area have the potential to become impacted by the proposed restoration activities. The highest potentials for impacts are at sites HG7 (Ken2 Pool) and HG13 (Narrows Seep). The spring flow at HG7 (Ken2 Pool), which is located along the base of a landslide proposed for mitigation, has the potential to reduce or dry up surface flow due to alteration of the landslide and planting of the slope. This impact could be minimized by minimizing the amount of grading and planting of the slope within the area of the spring. Also, spring flow at HG13 (Narrows Seep) has the potential to become reduced or dry up due to road grading or tunneling adjacent or beneath the spring. This impact to HG13 (Narrows Seep) could be minimized by reconstructing Topanga Canyon Boulevard with a bridge that would span the spring site. Other sites have the potential to become impacted during restoration activities including HG5 (Green House Culvert), HG6 (Culvert Inlet E Side), HG8 (Alder Grove), HG10 (Sycamore Tree), HG11 (Maidenhair Fern Seep), HG12 (No Parking/Alder Seep), and HG14 (Duck Seep/Kevin Pool); however, the possibilities of impacts to these sites are considered lower.

1.0 INTRODUCTION

This report presents the results of GeoPentech's hydrogeologic study of the lower portion of the Topanga Creek Watershed, in Los Angeles County, California. GeoPentech's study of the lower portion of Topanga Creek was completed under an agreement dated February 11, 2005 between GeoPentech and the Resource Conservation District of the Santa Monica Mountains (RCDSMM).

The Topanga Creek watershed covers approximately 47 square kilometers (18 square miles, 12,400 acres) on the south side of the Santa Monica Mountains, about 19 miles west of downtown Los Angeles, and drains southward into the Santa Monica Bay. The extent of the study area within the lower portion of the watershed is shown on Figure 1.

Figure 1: General Location Map of Topanga Creek Study Area



The California Department of Parks and Recreation (CDPR) is proposing to restore the lower potion of Topanga Creek, between the town of Topanga and Santa Monica Bay, to more natural conditions in order to protect and enhance the habitat of the southern steelhead trout found in that portion of the creek. The potential restoration projects include: 1) the restoration of Topanga Lagoon at the mouth of Topanga Creek; 2) the removal of Rodeo Grounds berm, 3) the relocation of Topanga Canyon Boulevard through the "Narrows" portion of the Creek, and 4) the stabilization of 3 landslides currently constricting the flow in Topanga Creek.

1.1 Study Purpose

Based on our discussions with Ms. Rosi Dagit of the RCDSMM, it is our understanding that RCDSMM's ongoing study of southern steelhead trout in the lower 6 km of Topanga Creek has identified a need to better understand what contribution groundwater resources (i.e., streams, springs, and seeps) have on the fish habitat distribution and abundance along the creek. The results of this study will provide information necessary for the RCDSMM to identify factors that may limit fish distribution or the fish carrying capacity of the creek. Ultimately, the results will assist CDPR to evaluate how to most effectively improve and protect the quality of the fish habitat, particularly during the proposed Topanga Creek restoration efforts.

The hydrogeologic evaluation of lower Topanga Creek involved identifying and monitoring the surface groundwater resources in the study area to provide a database for use in characterizing the groundwater regime and to establish baseline information for use in a long-term groundwater monitoring program. The results of this study were used, in part, to 1) understand the relationship between the groundwater resources and the surrounding geology and anthropogenic features, 2) assess variations in groundwater characteristics as a function of distance along the study area and as a function of time (seasonal trends), 3) understand the contributions that flow from the springs and seeps and their chemistry have on the overall Topanga Creek (instream) flow and chemistry, 4) evaluate the spring and stream water quality as it relates to the protection of aquatic life thresholds determined by the US Environmental Protection Agency (EPA) and locally by the Los Angeles Regional Water Quality Control Board (RWQCB) basin plan, and 5) identify potential impacts and develop a future monitoring plan to help protect groundwater resources during proposed restoration construction.

1.2 Scope of Work

The following tasks were performed by GeoPentech in order to assemble the groundwater database and complete the hydrogeologic evaluation:

1. Reviewed existing data from reports and air photos concerning hydraulic and geologic conditions in the study area.
2. Generated electronic files suitable for use in Arc View GIS, including site topography (CDPR, 2003), aerial photography (CDPR, 2003), geology (Dibblee, 1992), and groundwater resources.

3. Identified existing and suspected groundwater resources and characterized these resources with respect to the geology.
4. Performed monthly monitoring of selected groundwater resource features between March and December 2005. The monitoring included performing field measurements (flow, conductivity, pH, salinity, and dissolved oxygen) at spring and stream sites. Groundwater samples were also collected each month at selected monitoring sites for laboratory analysis of general minerals, stable water isotopes, and groundwater nutrients.
5. Compiled groundwater resource data into ESRI ArcView GIS version 3.2a and Microsoft Access databases.
6. Prepared this report to present the results of the hydrogeologic investigation.

2.0 METHODOLOGY

The following sections describe in more detail the methods used to research and investigate the location and characteristics of groundwater resources, to perform a series of monthly site visits to monitor physical and chemical properties of the identified groundwater resources, and to compile the resulting groundwater resource data in Arc View GIS and Microsoft Access.

2.1 Review of Existing Relevant Data

Cataloging the groundwater resources in the study area began by first performing a review of existing relevant information, including:

1. Geologic maps of the lower Topanga Creek watershed produced by Dibblee (1992) and Yerkes and Campbell (1994) were reviewed. These maps show the lithology, geologic structure, and some historic spring activity in the area.
2. Approximately 50 aerial photographs flown between 1928 and 2004 over the area of the site were reviewed to evaluate historic creek activity and potential groundwater resource locations. Stereo aerial photographic pairs flown during October 1997 were analyzed in more detail using stereoscopic methods to access spring activity and to evaluate geologic conditions. Features suspected of representing springs were selected based on apparent contrasts in vegetation appearance. The suspected features were added to the groundwater resource catalog and base maps as possible groundwater resource features. Accessible suspected groundwater features were subsequently field checked during the field reconnaissance, which is discussed in more detail below.
3. Three topographic maps produced in 1876, 1924, and 2004 were reviewed to evaluate historic creek activity.
4. Available and applicable data and reports prepared by RCDSMM were reviewed, including *Southern Steelhead Trout Survey of Topanga Creek Draft Report* (Dagit and Reagan, 2005), *Topanga Creek Watershed Water Quality Study Final Report October 2003-2004* (Dagit et. al., 2004), and *Topanga Creek Watershed Southern Steelhead Trout Preliminary Watershed Assessment and Restoration Plan Report* (Dagit et. al., 2003).
5. Historic stream flow and precipitation data collected by the County of Los Angeles, Department of Public Works were also compiled and reviewed.

A list of the relevant references reviewed is provided below in Section 8.0. Based on the results of this review, preliminary maps and tables were prepared showing locations and geologic characteristics of suspected groundwater features.

2.2 Identification of Groundwater Resources and Monitoring Locations

Following the compilation of data on known and suspected groundwater features, a field reconnaissance was conducted. The reconnaissance was completed to confirm the current status and location of the known groundwater resources and to resolve the status of suspected features. The field reconnaissance focused on the spring and stream locations near the base of Topanga Canyon within the study area. The reconnaissance was completed on March 1, 2005 and April 26, 2005 by vehicle and on foot. During the reconnaissance of known and suspected features, we also observed and cataloged additional features, which were previously undocumented.

Where physical access allowed, each identified or suspected feature was field checked. In general, the field reconnaissance was limited to the areas immediately adjacent to the canyon bottom due to the thick vegetation and steep slopes making areas above the canyon bottom inaccessible. Other inaccessible groundwater features could be seen in higher elevations above the canyon bottom, especially during the March 1, 2005 field reconnaissance, which was performed shortly after a period of continuous rainfall. Measurements were collected and documented at features that could be visited in the field, including pH, conductivity, temperature, dissolved oxygen, salinity, and flow. Field information, including notes on access and sampling location, was added to the catalog of data. Inaccessible groundwater features that were seen above the canyon bottom were also documented, and their corresponding flows were visually estimated, if possible.

The groundwater resource features including: 1) verified features, 2) suspected features that were noted during the data review task, especially during the air photo review, 3) a Topanga Creek gaging station, and 4) instream sample locations were all cataloged under a site reference number. A portion of the identified sites were selected for monthly groundwater monitoring based on site location relative to geologic formation and faulting, flow volume, seasonal duration of flow, source of groundwater (regional, local, runoff), and site location relative to fish habitat.

2.3 Monitoring of Groundwater Resources

Monthly monitoring of selected springs, seeps, and stream sites was performed between March 2005 and December 2005, during times when access to the creek and sites were safe. Physical and chemical data were collected in the field at each site during each monitoring period. Also, during the months of April 2005 and May 2005 RCDSMM personnel made botanical observations of the monitored sites. Field notebooks containing site information and monthly groundwater monitoring results for each of the identified features are on file at RCDSMM for future reference. The methods used to monitor the physical and chemical parameters are discussed in more detail below.

2.3.1 Physical Parameters Measured in the Field

The physical parameters measured in the field included site flow rate, water temperature at the site and nearest upstream main creek location, air temperature, and any applicable comments regarding the conditions at the site. Photographs were taken each month of the groundwater sites to document site conditions.

Flow Rate: The flow rate at the sites was calculated, if possible, by collecting flow into a calibrated container during a timed measurement interval. Oftentimes, plastic sheeting was placed under the flow to capture total flow volume and to help direct flow into the calibrated container. Flow rate measurements were collected two times to improve accuracy. In the instance that the flow rate was too small to be captured and measured, the site was documented as seeping, and no flow rate was measured.

Water Temperature: At each site and at the nearest main upstream creek location, water temperature was measured using the YSI Model 55 Dissolved Oxygen meter probe, which was given time to equilibrate before reading.

2.3.2 Chemical Parameters Measured in the Field

The chemical parameters measured in the field included conductivity, pH, dissolved oxygen, and salinity. These parameters were measured at the groundwater sites, and when possible, at the nearest upstream main creek location. The instrumentation and methods used to collect the chemical field parameters are discussed below.

Conductivity: A WP Oakton ECTestr probe was used to collect conductivity data. Both a high (0-19.90 mS) and low (200 uS to 1990 uS) range probe were used to adequately measure the conditions. Each probe was calibrated prior to the sampling event by immersion in a solution of know conductivity and making any necessary adjustments to the probe. Readings were recorded to the nearest hundredth place in micro-siemens (uS).

pH: An Oakton Water proof pH Testr2 was used to collect pH data at each location. Prior to each sampling event, the probe was calibrated to a neutral 7 solution and either a 10 or 4 solution. Adjustments were made for calibration as necessary, and measurements were recorded to the nearest tenth place.

Dissolved Oxygen: Dissolved oxygen was measured in the field using a YSI Model 55 Dissolved Oxygen probe. This probe was calibrated prior to each sampling event by setting the altitude and salinity for the RCDSMM office and ensuring that it matched the requisite 97.5% expected using distilled water at 700 feet. The meter was kept on during the entire sampling event. At each monitoring site, both salinity and altitude were entered, and the probe was gently swirled at approximately 6 cm depth until both water temperature and dissolved oxygen readings stabilized. Values were recorded in milligrams per liter (mg/L), to the nearest hundredth place.

Salinity: Salinity was tested at each location by using a Vista Model A366ATC refractometer, which was calibrated prior to each sampling event by rinsing the lens with distilled water and adjusting the scale to 0. Measurements were recorded to the nearest whole number in parts per thousand (ppt).

2.3.3 Laboratory Testing

Water samples were collected in the field from selected sites during the monthly site visits between June 2005 and December 2005. The samples were sent to laboratories for analysis. The analysis performed included general mineral, nutrients, and stable water isotope. The locations of the samples selected for laboratory testing were chosen to provide relatively uniform coverage of springs and stream sites within the geologic units along the study area. Procedures used to collect samples are described below, followed by explanations of the laboratory testing.

Laboratory Water Sample Collection

A consistent sampling protocol was followed during each sampling event to obtain complete and consistent data. For each sampling event, samples were collected at or in close proximity to the same location relative to established landmarks. Water was collected in plastic bottles for testing. To avoid collecting algae, sediments or insects, the sample bottle was submerged below the water surface approximately 5 cm with the lid intact. While under water, the lid was removed for the bottle to fill, and was replaced before lifting the bottle out of the water. When the depth was shallow, the deepest area of the sampling location was used and the bottle submerged as deep as possible. If no pool was available for submersion, as was the case for many of the springs and seeps, the bottle was held underneath a drip or trickle, or in many cases, the flow was consolidated into the sample bottle using plastic sheeting. Flow from springs and seeps were allowed to run for 30 sec or more to remove any contaminants. All samples were immediately labeled with the site number and stored in a cooler with ice.

Nutrient Testing

Nutrients tested in the groundwater samples included nitrate (as nitrogen), ammonia (as nitrogen), and phosphates (orthophosphates) as discussed in more detail below. RCDSMM personnel performed the nutrient testing at the RCDSMM office.

Nitrate (as Nitrogen): The cadmium reduction method was used to determine levels of low range (0.00 – 3.00 ppm) nitrate (as nitrogen). All samples were tested within 8 hours of collection. The sample was transferred to a testing bottle, treated according to the protocol in the Smart 2 Colorimeter procedure manual using reagents from the appropriate test kit. Measurements were recorded to the nearest hundredth parts per million (ppm).

Ammonia (as Nitrogen): The saliccylate method for freshwater was used to test for the low range (0.00-1.00 ppm) ammonia (as nitrogen). If a sample was higher than 1 ppm, then the sample was tested again using the high range (0.00-4.00 ppm) Nesslerization method. All samples were tested within 8 hours of collection. The sample was transferred to a testing bottle, treated according to the protocol in the Smart 2 Colorimeter procedure manual using reagents from the appropriate test kit. Measurements were recorded to the nearest hundredth parts per million (ppm).

Phosphates (Orthophosphates): The ascorbic acid reduction method was used to test for the low range (0.00-3.00 ppm) orthophosphate. All samples were tested within 8 hours of collection. The sample was transferred to a testing bottle, treated according to the protocol in the Smart 2 Colorimeter procedure manual using reagents from the appropriate test kit. Measurements were recorded to the nearest hundredth parts per million (ppm).

General Mineral Testing

Calscience Environmental Laboratories, Inc., located in Garden Grove, California, performed the general mineral analysis. The testing included basic anion and cation analysis, total hardness, alkalinity, total dissolved solids (TDS), conductance, pH, and some inorganic/trace metals data. The tests were performed in general accordance with applicable procedures of the American Society for Testing and Materials (ASTM). These tests provide a signature for each water sample and allow comparison of the water chemistry between samples.

Stable Water Isotope Testing

The stable water isotope analysis was performed at ZymaX Envirotechnology, Inc. in San Luis Obispo, California. These analyses were performed on select spring and stream samples collected in June 2005 and October 2005. The stable isotopes measured were of oxygen-18 (^{18}O) and deuterium (^{2}H). These analyses provide a means for tracing groundwater from various sources.

Isotopes of a particular element have the same atomic number but different atomic weights due to a varying number of neutrons in the nucleus. Stable isotopes are not involved with any natural radioactive decay process. Stable-isotope studies are based on the tendency of some pairs of isotopes to fractionate, or separate into light and heavy fractions. Ratios of these isotopes can be more precisely measured than their absolute abundance, and the isotope ratios measured for a sample are reported in delta notation (δ) as per mil (parts per thousand) relative to the Vienna Standard Mean Ocean Water (VSMOW) standard (Gonfiantini, 1978). Positive values represent enrichment in the heavier isotope relative to the standard, whereas, negative values represent a sample where the heavier isotope is depleted relative to the standard.

2.3.4 QA/QC Protocol

A consistent sampling protocol was performed during each sample event in order to provide a more accurate and complete data set. All equipment was calibrated prior to each day's monitoring.

During each sampling event, attempts were made to sample each location within approximately the same daily time frame and water depth. This was particularly important for comparison of seasonal water temperature and dissolved oxygen fluctuations, since water temperature and dissolved oxygen levels may be subject to high variability during the day.

2.4 Compilation of Groundwater Resource Data

A catalog of the collected information on the groundwater resources identified within the study area was developed in ESRI ArcView GIS version 3.2a and Microsoft Access databases. These databases include:

ESRI ArcView GIS: The ArcView GIS database spatially references the groundwater resources with respect to geographic data. This database shows the location of the known and suspected groundwater resources relative to

1. the topography (California Department of Parks and Recreation, Nov. 2003) at a contour interval of 5 feet,
2. the aerial photography (California State Parks, Nov. 2003), and
3. the geology as mapped by Dibblee (1992).

This information was compiled in California State Plane Coordinate System Zone 5 in the North American Datum of 1983 (NAD 83). The vertical data shown on the contour map is reference to the North American Vertical Datum of 1988 (NAVD 88).

Microsoft Access Database: The Access database is a compilation of data collected during the field reconnaissance and monthly monitoring of the groundwater resources. This database is organized into the following tables:

1. Static Data: This table provides a summary of available static information about each identified groundwater feature including site number (original reference number assigned to all identified groundwater sites), study site number (different reference number assigned to only those groundwater sites monitored during this study), site name, instream mapping distance (distance in meters from the ocean following the creek bed to the site), sampling location, northing, easting, elevation, geologic formation at the site, geologic structure, if any, at the site, and applicable comments.
2. Field Data: This table summarizes the field parameters measured during the monthly site visits including site number, sample date, sample time, site flow rate, site flow calculation method (either visual estimation or volumetric calculation), site temperature, site conductivity, site pH, site salinity, site dissolved oxygen, site air temperature, site upstream temperature (if applicable), site upstream conductivity (if applicable), upstream pH (if applicable), upstream salinity (if applicable), upstream dissolved oxygen (if applicable), and applicable comments.
3. Lab Data: This table summarizes the general mineral laboratory data results and includes the site number, date collected, compound name, concentration, and units.
4. RCD Data: This table summarizes the nutrient testing performed by RCDSMM (nitrates, ammonia, and phosphates) and includes the site number, date collected, compound name, concentration, and units.
5. Isotope Data: This table summarizes the results of the isotope analyses including the site number, date collected, δ18O isotope ratio, and δD isotope ratio.
6. Botanical Data: This table summarizes the botanical observations performed by RCDSMM personnel at the groundwater sites and includes the site number, observation date, and vegetation.

3.0 RESULTS

A description of the Topanga Creek Watershed and surrounding geology, RWQCB and EPA water quality criteria for the protection of aquatic life, as well as, the results of the groundwater resource characterization, groundwater resource monitoring, and laboratory testing are discussed below.

3.1 Topanga Creek Watershed Description

The Topanga Creek Watershed and the extent of the study area are shown on the topographic map presented in Figure 2. The watershed is located in the southern portion of the Santa Monica Mountains, which separate the San Fernando Valley on the north from the Pacific Ocean and the Los Angeles Basin on the south. The drainage divide that separates the upper portion of the Topanga Creek watershed from San Fernando Valley on the north is at an elevation of approximately 1400 feet. The watershed drains southward into Santa Monica Bay and the Pacific Ocean. The main stream draining the water shed is the north-south trending 16 km (10 mile) long Topanga Creek. The Santa Maria and Garapito sub-drainages merge with Topanga Creek in the northeast portion of the watershed. The Old Topanga Creek sub-drainage merges with Topanga Creek in the central portion of the watershed. Within the study area, Topanga Creek maintains a single dominant channel, which is at an elevation of approximately 600 feet at the northern boundary of the study area.

Topanga Creek is classified on the USGS topographic map as an intermittent stream. However, it has been observed to have year-round (perennial) flow in its lower reaches, even during drought periods. Pools and small sections of the creek are fed by springs and seeps, which contribute to the perennial flows in the creek. The location of one of the previously identified springs is published on the USGS topographic map and is highlighted on Figure 2.

Figure 3 illustrates the type of vegetation found in the Topanga Creek Watershed and in the study area within the lower portion of the creek. Sharp contrasts in the vegetation, visible on aerial photographs provide clues to the presence of springs or seeps.

Topanga Creek also serves as habitat for a variety of sensitive fish and reptile species including Steelhead Trout, CA Newts, CA Tree Frogs, Western Toads, Pacific Tree Frogs, and Two-striped Garter Snakes.

There are approximately 2,400 single-family homes supporting a population of 12,000 residents that live in the watershed, with approximately 200 residents that live immediately adjacent to the creek. As shown on Figure 3, development within the watershed is generally concentrated within the upper two-thirds of the watershed, which encompasses the town of Topanga. The residents and small businesses within the watershed use water imported from Los Angeles County Waterworks District 9, and there are no substantial agricultural or industrial water uses. Also, all residences and commercial businesses in the canyon use on site waste disposal septic and gray water systems.

Figure 2 Topographic Map of the Topanga Creek Watershed and the Study Area

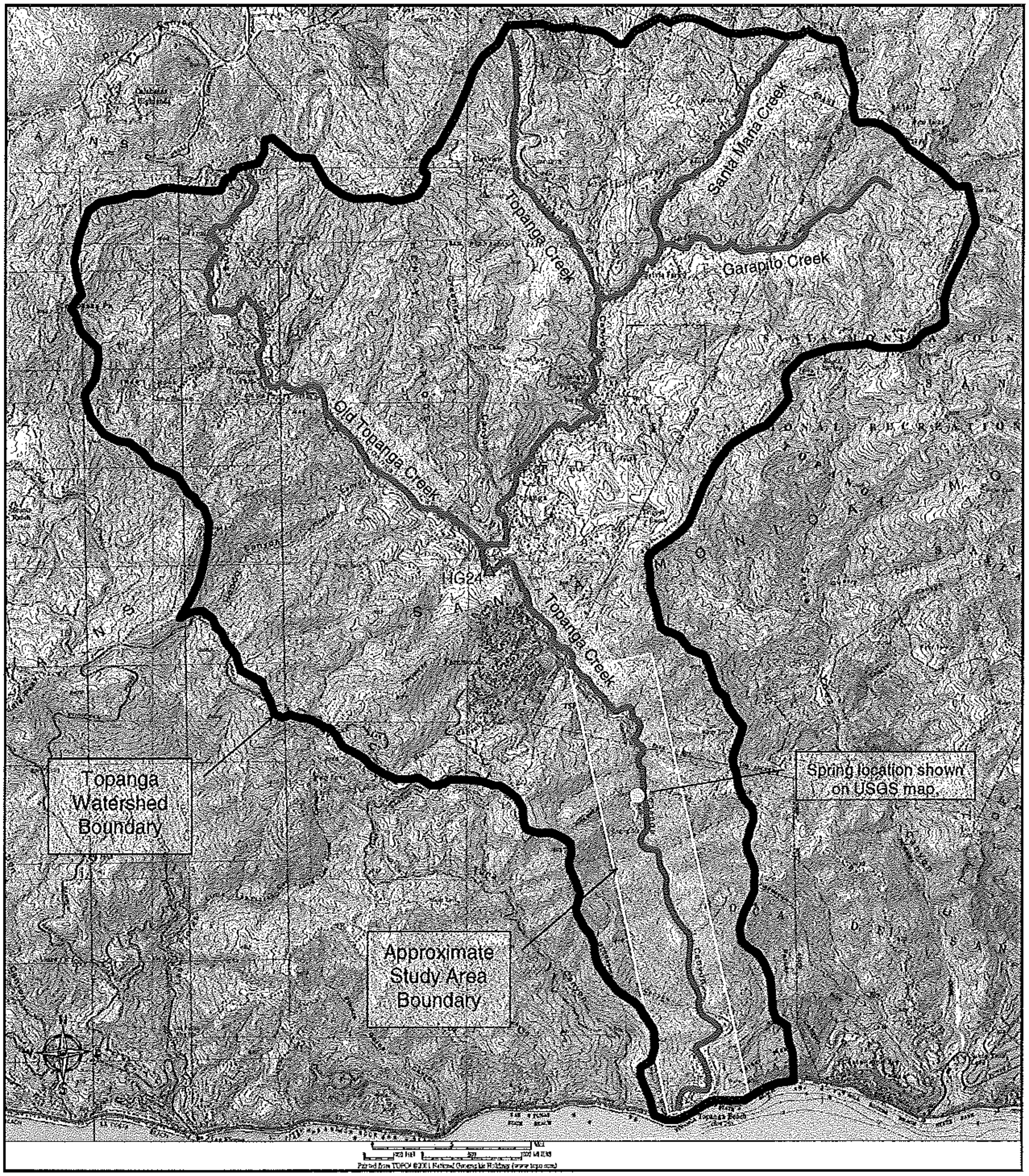
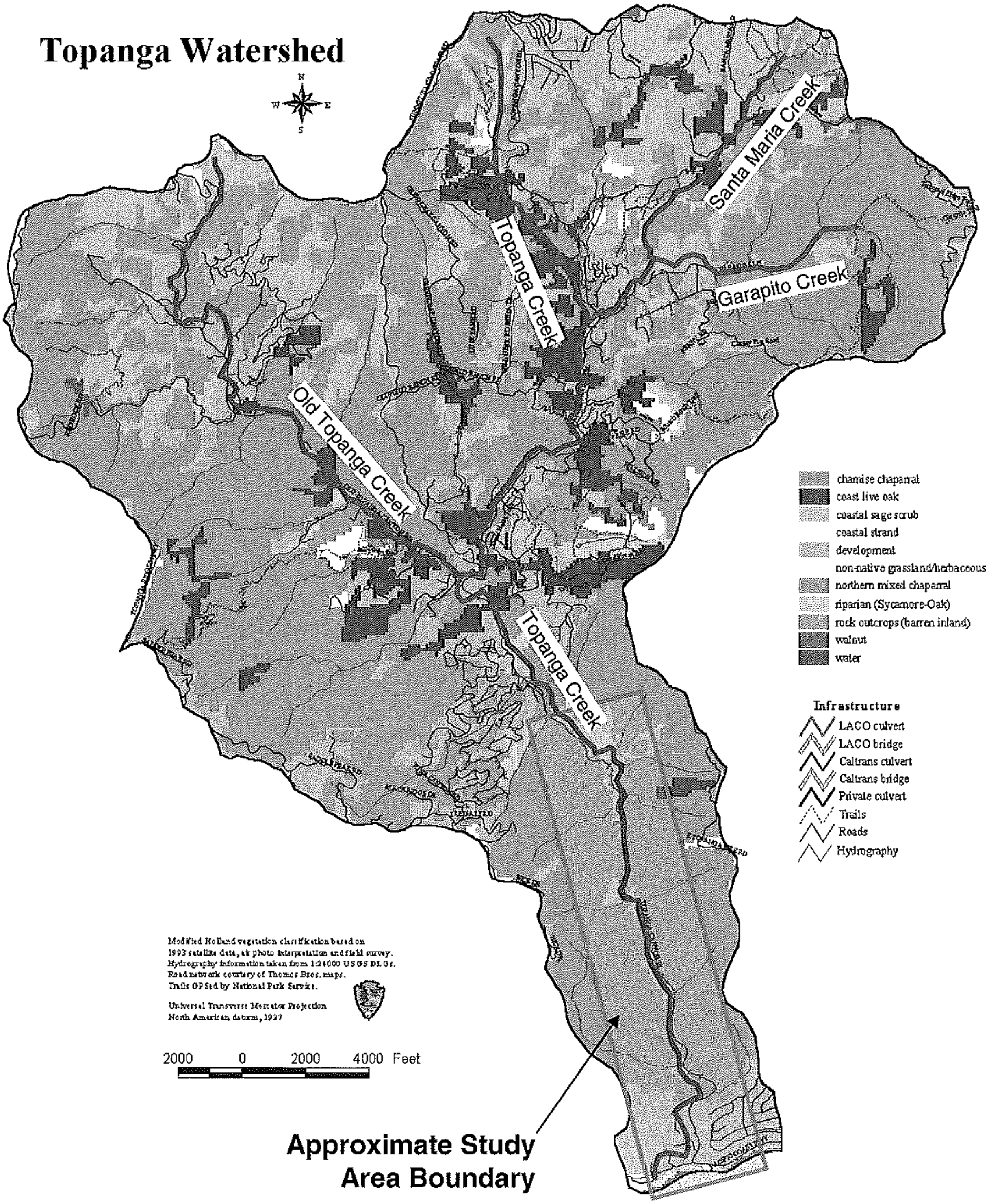


Figure 3: Vegetation in the Topanga Creek Watershed



Within the study area, the region around the creek is mostly undeveloped with the majority of development confined to the southern 1,000 meters of the stream, as shown on Figure 3. In the study area, the sources of human impacts to the creek include: 1) runoff from the town of Topanga, 2) runoff from Topanga Canyon Boulevard, which parallels the creek; 3) creek constrictions and contamination from imported fills used to construct and maintain roads; and 4) man-placed fill material, such as the Rodeo Grounds berm, which was placed along the creek to protect downstream residents and 35 vertical feet of fill material placed in the 1930s to construct Pacific Coast Highway across the historic 30 acre Topanga Lagoon near the mouth of Topanga Creek. The Rodeo Grounds berm constrains creek flows in the lower 1,000 meters of the drainage and raises the elevation of the floodplain upstream of the berm due to sediment accumulation behind the berm. Typically, surface flows go dry for 3-5 months each year between the flood plain upstream of Rodeo Grounds Berm and immediately upstream of Topanga Lagoon. A natural sand berm also exists across the mouth of Topanga Creek, and this berm breaches during storm events establishing a surface connection between the creek and the ocean until the breach is closed.

3.2 Geologic Conditions

A key variable in understanding the presence of groundwater and its flow characteristics, which lead to surface groundwater resources such as streams, springs and seeps is the underlying geology. Starting from a regional perspective of the geology, the Topanga Creek watershed and the Santa Monica Mountains are located in California's Transverse Range Physiographic Province, which is California's most seismically and tectonically active province. This activity is reflected in the province's high topographic relief underlain by relatively young geologic formations, which have been compressed into east-west trending folds and dissected by active east-west trending left-lateral strike-slip faults.

The portion of the Santa Monica Mountains underlying the Topanga Creek watershed are underlain by volcanic rocks and nonmarine and marine sedimentary rocks, as shown on a geologic map and legend by Dibblee (1992), which are copied herein as Figures 4a and 4b, respectively. These rocks have been faulted and folded into a large anticline and through several stages of deformation since the Jurassic period (i.e., 140 million years ago).

As can be seen on Figure 4, the northern portion of the study area is underlain by marine and nonmarine sandstone and siltstones of the middle Miocene-aged lower Topanga Formation (Ttls on Figure 4) and the Oligocene to early Miocene-aged Sespe Formation (Tsp on Figure 4). The Sespe Formation consists of nonmarine sandstone, conglomeratic sandstone, and conglomerate. Middle Miocene-aged diabase and basaltic volcanic rocks (db on Figure 4) have intruded into the lower Topanga and Sespe Formations in the northern portion of the study area. The middle of the study area is underlain by the Paleocene-aged Coal Canyon Formation (Tsu, Tsus, and Tsug on Figure 4). The Coal Canyon Formation consists of interbeds of marine claystone, siltstone, sandstone, and conglomerate. The central and southern portions of the study area are also underlain by the upper Cretaceous Tuna Canyon Formation (Kss, Ksh, and Kcg on Figure 4). The Tuna Canyon Formation consists of marine and nonmarine sandstone with shale and conglomerate beds.

Figure 4a: Geologic Map by Dibblee (1992) of Topanga Creek Study Area

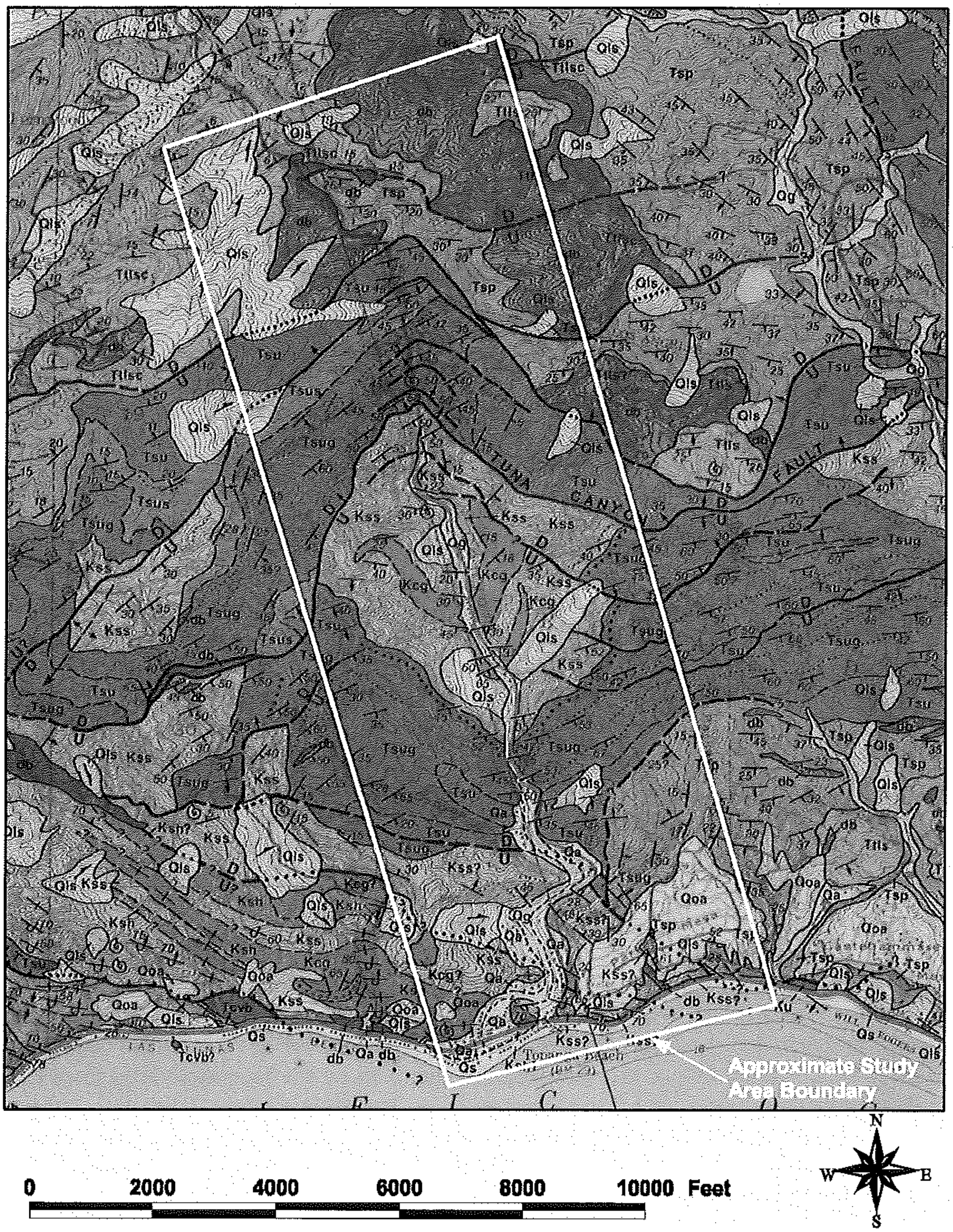
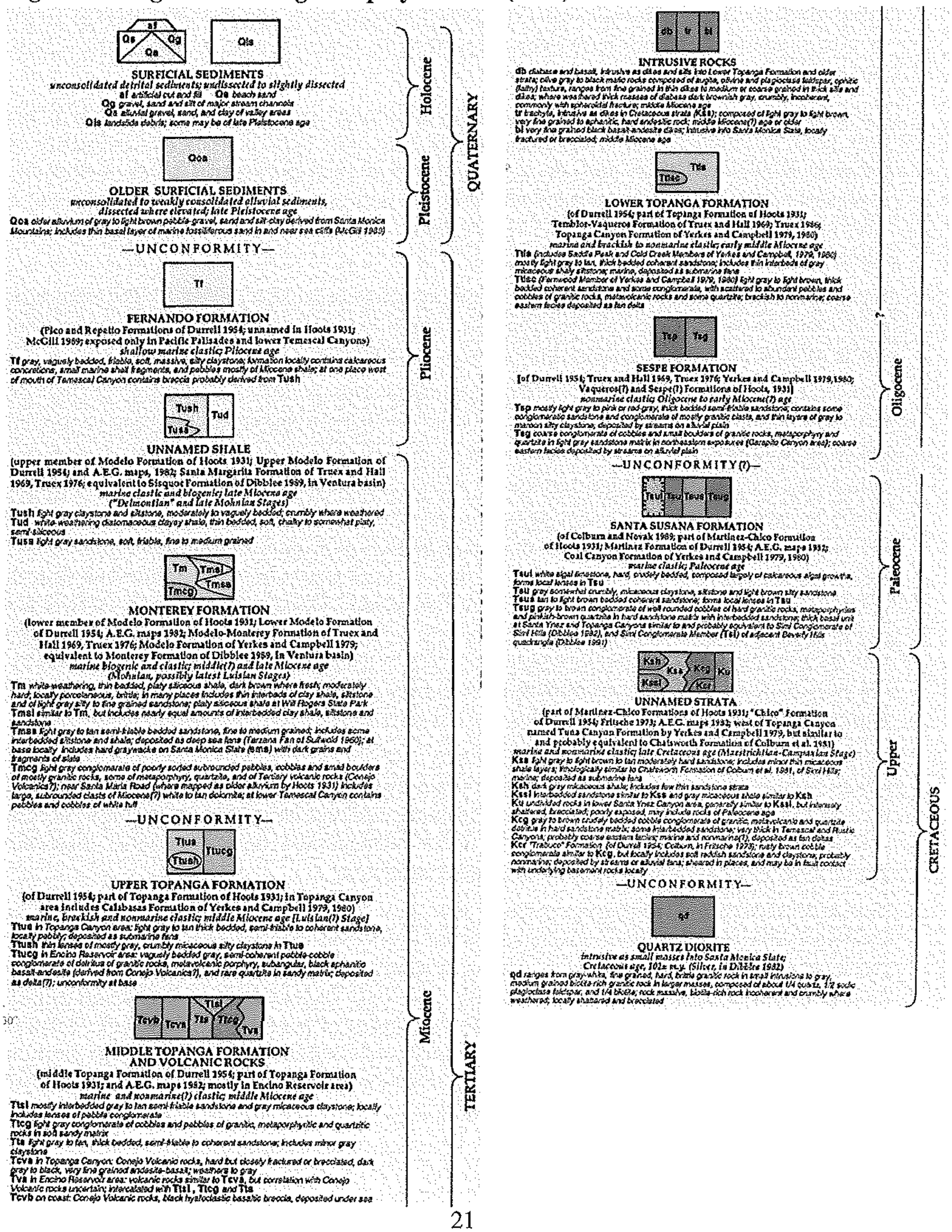


Figure 4b: Legend to Geologic Map by Dibblee (1992)



The slopes in the study area are locally covered by Holocene colluvium. The stream deposits along the base of the canyon consist of alluvial gravel, sand, and clay (Qa and Qg on Figure 4). Also, several landslides have been mapped in the region around the study area (shown as Qls on Figure 4a).

Numerous sub parallel faults have been mapped through the study area (shown with heavier font lines on Figure 4a). According to this map, the fault orientations primarily strike between N60E and N80E and dip approximately 35 and 60 degrees to the northwest and southeast. Dibblee (1992) mapped the contact between the Tuna Canyon and the Coal Canyon Formations as the Tuna Canyon Fault. This fault crosses the Topanga Canyon Boulevard near milepost 2.25.

Bedding plane orientation data are also shown on Figure 4a. According to this map, bedding plan orientations exposed within the study area primarily strike between approximately north-south to east-west and dips between 15 and 50 degrees to the south and east.

Man-placed artificial fills are present, primarily due to the construction of the Rodeo Grounds berm, Pacific Coast Highway across the lagoon, and Topanga Canyon Boulevard along the sides and center of canyon.

When rain falls on the ground surface, it can travel downslope with little of no infiltration, which is termed runoff, or it can percolate into the subsurface formational material. Within the sedimentary and volcanic rocks that underlie the study area, appreciable groundwater can flow only through the fracture systems within the rock mass. In general, the rock near faults is typically more fractured and may contain clay gouge. This clay gouge may create a barrier in the rock mass system and may direct water to the surface as a seep or spring. Perennial springs are oftentimes related to regional sources of groundwater that upwell along faults and are not as dependent on precipitation. Examples of perennial springs located adjacent to faults were mapped by Dibblee (1992) and are shown on the geology map on Figure 4a.

Ephemeral seeps and springs are oftentimes heavily dependent on precipitation and are related to more local sources of water that drain with little or no flow during times of little or no precipitation. In the study area, for example, springs are noted at the base of several landslides. These landslides break up the rocks forming local, more permeable, reservoirs of groundwater that are heavily dependant on precipitation.

Topanga Creek has a continuous summer low flow, referred to as baseflow. Baseflow is the limiting factor for supporting steelhead habitat during the summer months when parts of the creek can go dry, and the aquatic habitat is restricted to isolated pools or reaches of water that remain wet all year (Harrison et. al. 2005). Geologic factors such as faults and landslides provide important point-sources (i.e. springs or seeps) of baseflow to the creek. Also, more permeable bedrock units, such as the sandstone and conglomerate found in the study area, have the capability to store more significant amounts of water which help maintain baseflow to the creek during the critical summer months.

3.3 Characterization of Groundwater Resources

Known and suspected groundwater resources were identified in the Topanga Creek study area based on the analysis of published topographic and geologic maps, and based on the analysis of vegetation patterns and potentially fault related lineaments visible on aerial photographs. The locations of these known and suspected groundwater resources are shown on Figure 5. Table 1 provides a summary of information about each identified feature. Each groundwater resource feature shown on Figure 5 is cataloged under a site reference number that is cross-referenced on Table 1. A total of 56 groundwater springs, spring runoff at the mouth of tributary drainages into Topanga Canyon, and seeps were verified in the field. These sites were assigned numbers that range from 1 to 56.

Other suspected groundwater resource sites that were noted during the data review task, especially during the air photo review, were assigned site numbers that range between 101 and 121. Los Angeles County stream flow gage station (LACDPW #F54), located near the bridge approximately 3.2 km (2 miles) upstream from the mouth of the creek in the middle of the study area was assigned a site number of 201. Also, instream sample locations were assigned site numbers that range between 301 and 305.

Table 1 summarizes the characteristics of the groundwater resource sites with respect to their underlying geologic formation, geologic structure, such as a fault, source of water (regional, local, spring runoff at mouth of tributary drainages), seasonality of resource (perennial or ephemeral), and applicable comments. (Refer to Figure 5 for site locations).

Twenty four of the identified sites were selected for monthly groundwater monitoring, including 19 spring, seep, and spring runoff locations, and 5 instream sample locations. These sites were assigned study site numbers HG1 through HG24 and were assigned site names. The locations of the study sites are shown on Figure 6, and the study site numbers are cross-referenced on Table 1. Study site HG24 is located approximately 1,500 meters north of the study area boundary within the town of Topanga and is shown separately on Figure 2.

3.4 Water Quality Criteria for the Protection of Aquatic Life

The Los Angeles Regional Water Quality Control Board (RWQCB) and the US Environmental Protection Agency (EPA) as part of the Clean Water Act have developed water quality standards for the protection of aquatic life (RWQCB 1994, EPA 1976, and EPA 1986a). These criteria were derived from scientific data obtained from experimental or in situ observations of aquatic organism responses to a defined stimulus or material under known environmental conditions for a known period of time. The resulting criteria are not intended to provide 100 percent protection of all aquatic species, but are intended to protect most species in a balanced, healthy aquatic community. The EPA criteria include maximum and continuous concentration levels. The maximum concentration level is the estimate of the highest concentration of a material to which an aquatic community can be exposed briefly without resulting in an unacceptable effect, and the continuous concentration level is the estimate of the highest concentration of a material to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

Figure 5: Location of Suspected and Verified Groundwater Sites

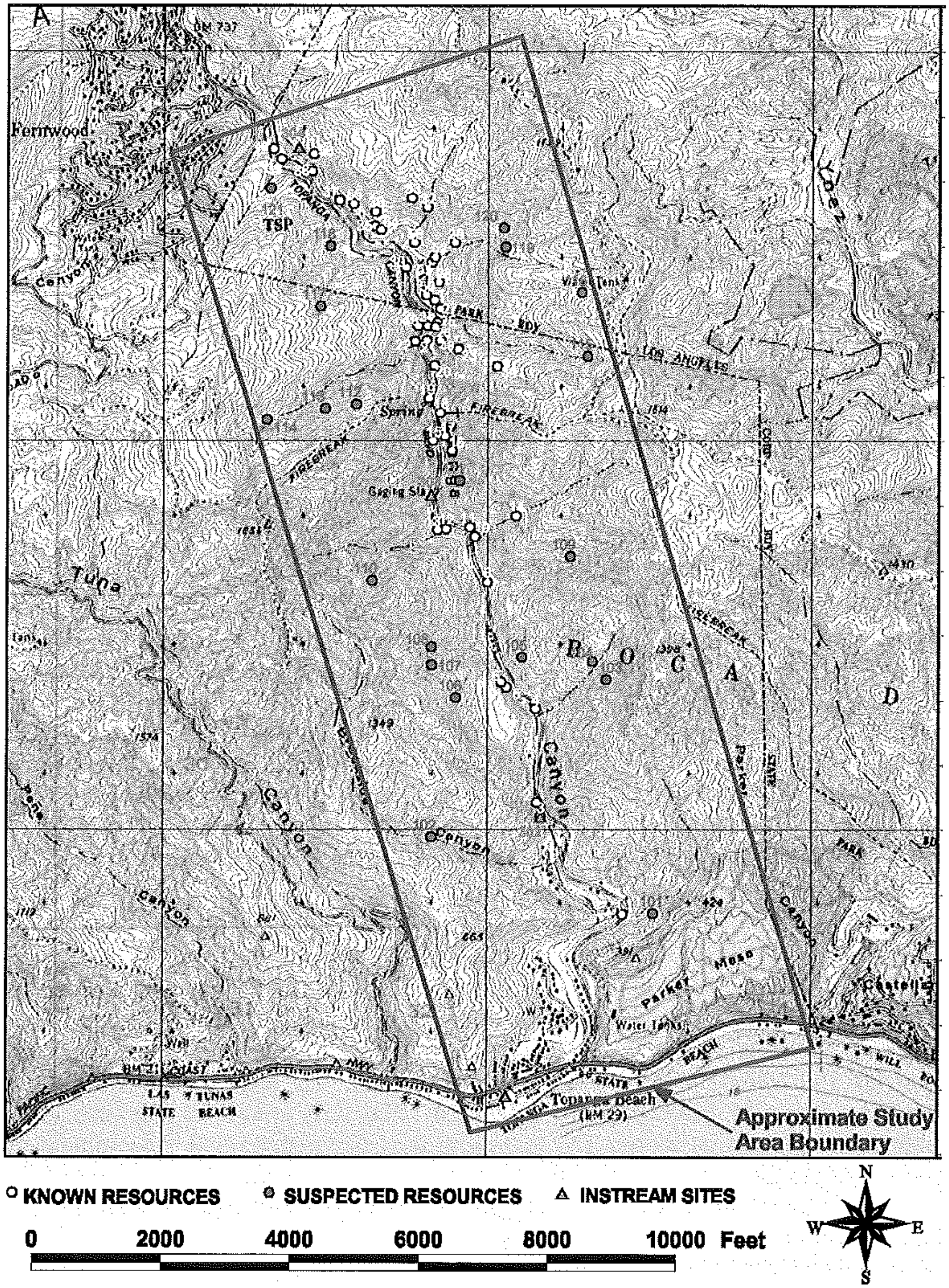


Table 1: Geologic Characterization of Groundwater Sites

Site No.	Study Site No.	Site Name	Instream Distance (m)	Northing	Easting	Approximate Elevation (ft, MSL)	Geology		Possible Water Source	Comments
							Formation	Structure		
RESOURCES OBSERVED IN THE FIELD										
1	HG2	MM 0.05	1100	1839733	6386829	60	Tsug	Fault	Regional	Perennial spring associated with large vegetation (willows and exotic trees). Dibblee mapped springs associated with same fault on west side of drainage divide.
2	HG4	Ski Pole Pool	2000	1841464	6385494	110	Tsug	---	Instream Pool	Fish pool location.
3/302	HG3	Transient Pool	1900	1841251	6385553	100	Tsug	---	Instream Pool	Perennial fish pool location, which may fed by a perennial spring.
4	HG5	Green House Culvert	2430	1842921	6385468	170	Kss	---	Runoff	Surface flow associated with Sites 103 and 104. Flows along corrugated pipe drainage under road.
5				1843251	6385015	200	Qls/Kss	Landslide	Local	Possible spring site within landslide toe. White fungus growing from side of slope under landslide.
6	HG7	Ken2 Pool	2600	1843330	6384933	210	Qls/Kss	Landslide	Local	Site is wet perennially. Typically only a seep, but flowed consistently during study.
8	HG6	Culvert Inlet E side	3100	1844883	6384717	240	Kss	---	Runoff	Runoff possibly associated with fault controlled springs upstream (ie. Site 109). Typically dry.
10				1845590	6384526	280	Kss	---	Runoff	Possibly runoff associated with fault controlled springs upstream (ie. Site 14). Typically dry.
11				1845738	6384446	335	Kss	Fault	Regional	Ephemeral seep may be associated with mapped fault (Dibblee), similar to Sites 12 and 14.
12				1845712	6384068	260	Kss	Fault	Regional	Area of site contains cape ivy and alder trees. Only area of creek where alders are present (alders like constant root saturation). Also, knutes and trout present in stream. May be related to the same mapped fault (Dibblee) as Sites 11 and 14. Dibblee mapped this spring. No visible surface flow associated with this feature; however feature is associated with shallow water vegetation.
13	HG8	Alder Grove	3450	1845693	6383940	280	Kss	---	Runoff	Surface flow at mouth of drainage associated with Site 110, becomes subsurface in lower portion of drainage.
14				1845910	6385160	690	Kss	Fault	Regional/Runoff	Possible spring associated with the same mapped fault (Dibblee) as Sites 11 and 12. Viewed as a waterfall within drainage above Site 10 on March 1, 2005.
15				1847080	6383867	350	Qls/Kss	Landslide	Local	Landslide related spring. Does not flow year-round.
16				1846915	6384157	420	Kss/Tsug	Fault	Regional	Possible spring associated with Tuna Canyon Fault. Large vegetation (bay tree) in area.
17	HG10	Sycamore Tree	3950	1847144	6384053	340	Kss/Tsug	Fault	Regional	Spring associated with Tuna Canyon Fault.
18	HG11	Maidenhair Fern Seep	4060	1847510	6383974	410	Tsug	Fault	Regional	Perennial spring/seep.
19	HG13	Narrows Seep	4130	1847728	6383807	400	Tsug	Fault	Regional	Perennial spring shown on USGS and Dibblee maps.
20	HG14	Duck Seep/ Kevin Pool	4540	1848238	6383888	360	Tsug	Fault	Regional	Spring in creek; at least one seep with measurable flow is observed when water level in creek is low enough. Flow and temperature change is noticable in creek. (Fish are attracted to flow and temp change).
21				1848622	6383980	400	Tsug	---	Runoff	Associated with large trees at base of canyon. Feature has been previously observed.
22				1848610	6383587	460	Tsug/Tsus	---	Runoff	Possibly runoff related to springs at Sites 112, 113, and 114
23				1848487	6384260	760	Tsug	---	Runoff	Runoff typically flows during rainy times and forms a waterfall.
24				1848846	6383781	440	Tsu/Tsus	Shale Beds	Local	Seeps associated with shale beds.
25				1848899	6383931	420	Tsu/Tsus	Shale Beds	Local	Seeps associated with shale beds.
26				1848831	6383903	400	Tsug/Tsus	Fault	Regional	Perennial seep associated with dense vegetation.
27	HG15	Storm Falls	4580	1849113	6383975	510	Tsug	---	Runoff	Typically flows during rainy times and forms two waterfalls up drainage. Within same drainage as Site 31. May be associated with springs up drainage (Site 115).
28				1849531	6383954	510	Tsus/Tsu	---	Runoff	Typically flows during rainy times and forms a waterfall.
29				1850143	6384204	650	Tsu/Tsp	Fault	Regional	Spring associated with thick vegetation.
30				1849752	6383444	600	Tsu	---	Runoff	Runoff related to flow along tributary drainage.
31	HG16	Dead Alder Falls	4660	1849247	6383884	460	Tsu	---	Runoff	Surface flow at mouth of drainage and within same drainage as Site 27. May be associated with springs up drainage (Site 115).
32				1850689	6383771	680	Tsp	---	Runoff	Runoff/spring associated with thick vegetation and forms a waterfall.
33				1850839	6383536	650	Tsp	---	Runoff	Runoff/spring associated with thick vegetation and forms a waterfall.
34	HG12	No Parking/ Alder Seep	4270	6383875	1848031	340	Tsug	Fault	Regional	Perennial spring/seep.
35	HG20	Bigleaf Maple Pool	5280	1850395	6382956	580	Tsu/Tsp/db	---	Runoff	Runoff related to flow along major tributary drainage, possibly associated from same drainage as Site 54. Flows under road. Thick vegetation up drainage.
36				1850626	6382969	660	Tsp	---	Local	Spring observed on March 1, 2005. Vegetation not as thick.
37				1850792	6382413	650	db	---	Local	Seeps observed on March 1, 2005 on road cut over a distance of approximately 200 to 300 feet.
38				1851250	6381984	700	db	---	Local	Seeps observed on March 1, 2005 on road cut adjacent to Feb. 2005 road failure.
39	HG23	Time Tunnel	5850	1851428	6381513	720	Ttlsc	---	Runoff	Concrete-lined drainage that flows under road. Thick vegetation up drainage. Possible runoff from Site 121.
40				1851590	6381395	720	Ttlsc	---	Local	Seeps observed on March 1, 2005 on road cut.
48				1848629	6383770	540	Tsu	Shale Beds	Local	Seeps associated with shale beds.
49				1848847	6383633	500	Tsus	---	Runoff	Runoff related to flow along tributary drainage.
50				1849324	6383757	440	Tsu	Shale Beds	Local	Seeps associated with shale beds.
51				1849842	6383843	450	Tsu	---	Local	Approximately 50-foot wide seep at creek level. Located across from path up to mile marker 2.75
52	HG17	Elderberry Falls	4980	1849909	6383890	460	Tsu	---	Runoff	Surface flow at mouth of drainage; may be associated with springs up drainage.
53	HG18	Tadpole Pool	5150	1850142	6383575	460	Tsp	Fault	Regional	Perennial spring/seep that collects in a pool and flows down to main creek.
54	HG19	Pool of Many Drips	5250	1850343	6383053	500	Tsp/db	---	Runoff	Runoff possibly associated from same drainage as Site 35.
55				1850745	6382633	560	Tsp	---	Local	Seep below an old road repair on west side of creek below overhanging rock face
56	HG21	Up and Down Trib	5760	1851510	6382016	700	Ttlsc	Fault	Regional	Surface flow during wet seasons at higher "waterfall" near dead log; flow comes out of ground during dry seasons.

[shaded box] = 2005 Study Site Locations

Table 1 (continued): Geologic Characterization of Groundwater Sites

Site No.	Study Site No.	Site Name	Instream Distance (m)	Northing	Easting	Approximate Elevation (ft, MSL)	Geology		Possible Water Source	Comments
							Formation	Structure		
SUSPECTED RESOURCES OBSERVED ON AERIAL PHOTOGRAPHS										
101				1839754	6387305	100	Tsp	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
102				1840942	6383853	400	Tsug	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
103				1843380	6386571	750	Kss	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
104				1843648	6386354	710	Kss/Qls	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
105				1843716	6385259	390	Kcg	---	Regional	Air photo dense vegetation.
106				1843095	6384231	600	Kss/Qls	Landslide	Local	Dense vegetation along headscarp of landslide.
107				1843604	6383853	610	Kss	---	Regional	Air photo dense vegetation.
108				1843884	6383848	620	Kss	---	Regional	Air photo dense vegetation.
109				1845277	6386008	690	Kss	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
110				1844904	6382929	790	Kss	---	Regional	Air photo dense vegetation.
111				1846457	6384288	420	Kss	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
112				1847642	6382686	1120	Tsug	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
113				1847570	6382200	1100	Tsus	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
114				1847398	6381296	1180	Tsu/Qls	Fault	Regional	Air photo dense vegetation. Possibly fault or landslide controlled.
115				1848382	6386272	1100	Tsp/db	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
116				1849367	6386179	1150	db	---	Regional	Air photo dense vegetation.
117				1849155	6382128	1000	db/Qls	Landslide	Local	Air photo dense vegetation. Possibly landslide controlled.
118				1850095	6382278	700	db/Qls	Landslide	Local	Air photo dense vegetation. Possibly landslide controlled.
119				1850079	6384990	880	Tsp/db	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
120				1850367	6384959	900	Tsp/db	Fault	Regional	Air photo dense vegetation. Possibly fault controlled.
121				1850976	6381348	800	Ttlsc/Qls	Landslide	Local	Air photo dense vegetation. Possibly landslide controlled.
STREAM GAGING STATION										
201				1846213	6383829	300				Los Angeles County stream flow gage station (LACDPW #F54)
INSTREAM SAMPLING LOCATIONS										
301	HG1	Topanga Lagoon	0	1836913	6385022	0	Qa	---	Instream	Topanga Lagoon
302/3	HG3	Transient Pool	1900	1841251	6385553	100	Tsus	---	Instream	Perennial fish pool location, which is possibly fed by a perennial spring.
303	HG9	Bridge MM 2.02	3600	1850030	6383505	300	Kss	---	Instream	Bridge Location
304	HG22	Rope Swing Pool	5900	1852229	6381555	640	Ttlsc	---	Instream	Upstream of Time Tunnel and other study sites, below town.
305	HG24	Abuelitas						---	Instream	Behind Abuelitas; in town upstream of study area.

[shaded box] = 2005 Study Site Locations

Figure 6: Location of 2005 Monitored Groundwater Sites

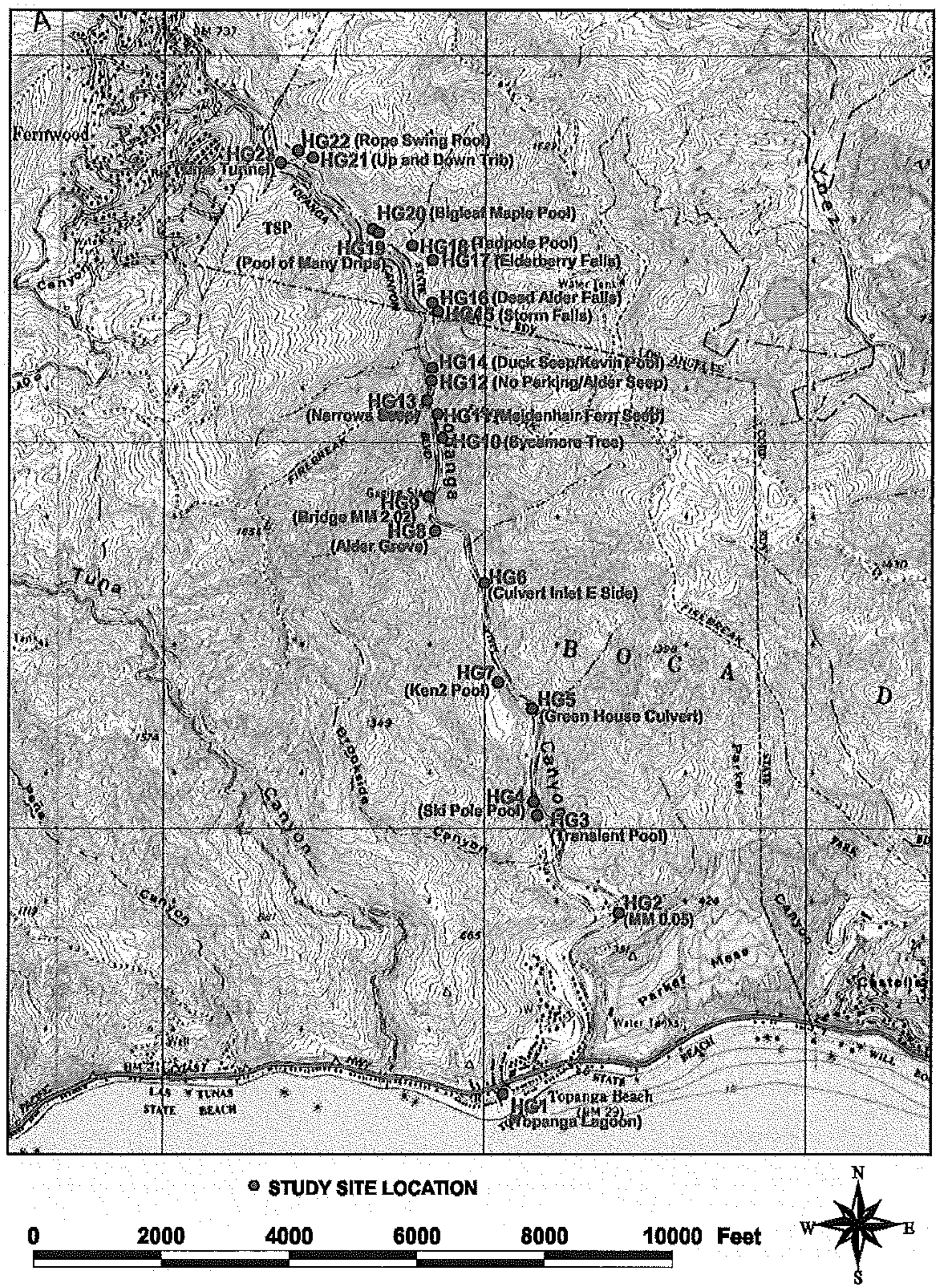


Table 2 summarizes the RWQCB and EPA water quality guidelines for the protection of freshwater aquatic life for various water quality parameters including pH, dissolved oxygen, ammonia, nitrates, phosphates, alkalinity, hardness, sulfate, chloride, and TDS. These guidelines were assembled from (RWQCB 1994, EPA 1976, EPA 1986a, EPA 1986b, and EPA 1998). Table 2 shows the RWQCB and EPA maximum and continuous concentration criteria, if established. Table 2 also contains applicable comments for the water quality parameters noted in the RWQCB and EPA references.

Table 2: RWQCB and US EPA Water Quality Criteria for Protection of Aquatic Life

Parameter	Criterion Maximum Concentration (mg/L) [1]		Criterion Continuous Concentration mg/L [2]		Comments
	RWQCB	EPA	RWQCB	EPA	
pH				6.5 - 9.0	The pH from 6.5 to 9.0 was determined by EPA to be harmless to fish, although the toxicity of other poisons may be affected by changes within this range. RWQCB requires that waste discharges do not lower pH below 6.5 or raise pH above 8.5.
Dissolved Oxygen		5.0 [3]			Early life stages
		3.0	5.0	5.5	Other life stages
Ammonia	3.8	3.8	1.5	1.5	RWQCB adopted EPA criteria. The toxicity of ammonia increases as a function of pH. An average pH of 8.2 was used to calculate the ammonia criterion.
Nitrates					EPA standard for drinking water is <10 mg/L. RWQCB determined nitrate levels >45 mg/L to adversely affect any designated beneficial use of surface waters. EPA determined levels of nitrates at or below 90 mg/L would have no adverse effects on warmwater fish.
Phosphates					A desired goal for the prevention of plant nuisances in streams is 0.1 mg/L.
Alkalinity				20	Alkalinity is important to fish in freshwater systems because if buffers pH changes that occur naturally.
Hardness					No hardness criteria were set; however, increased hardness has the effect of reducing the toxicity of metals in water.
Sulfate					RWQCB objective in Topanga Canyon is <500 mg/L.
Chloride					RWQCB objective in Topanga Canyon is <500 mg/L.
TDS					Total Dissolved Solids in excess of 15,000 mg/L was determined unsuitable for most fresh water fish. RWQCB objective in Topanga Canyon is <2,000 mg/L.

NOTES:

[1] The Criterion Maximum Concentration is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect.

[2] The Criterion Continuous Concentration is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

[3] Early life stages criteria: Includes all embryonic and larval stages and juvenile forms to 30-days following hatching.

3.5 Field Measurement Results

The site photographs taken during the monthly site visits are shown in Appendix A. The results of the physical and chemical field measurements, including flow, pH, conductivity, dissolved oxygen, and salinity, collected at each study site monthly between March and December 2005 are shown on the graphs in Appendix B. These graphs also show the measurements performed at the nearest upstream main creek location for those sites where this data could be collected.

It is noted that 2005 was one of the wettest years on record. The 2005 precipitation total at the Topanga Patrol Station in the town of Topanga was 62 inches, compared to a normal year average of approximately 25 inches. The effects of the much higher than average precipitation are that sites will flow at a relatively higher discharge rate for a relatively longer period of time. Also, the increased precipitation may dilute spring and creek flows with relatively low TDS and neutral pH rainwater, which may have the effect of lowering conductivity and salinity values and neutralizing pH values when compared to years with average precipitation.

Flow: Table 3 summarizes the observed spring flows monitored between March and December 2005. This table includes the minimum and maximum observed flows as well as the date or date range of these measurements.

Table 3: 2005 Spring Site Flow Summary

Site	# of Samples	Flow (gpm)			
		min.	Date	max	Date
HG2 (MM 0.05)	4	Dry	Aug. - Dec. 2005	10	3/1/05
HG5 (Green House Culvert)	8	3	9/28/05	15	4/26/05
HG6 (Culvert Inlet E side)	8	Dry	Sept - Dec. 2005	50	3/1/05
HG7 (Ken2 Pool)	8	3.45	12/19/05	15	3/1/05 and 4/26/05
HG8 (Alder Grove)	8	0.75	9/28/05	6	6/14/05
HG10 (Sycamore Tree)	9	0.25	6/15/05	30	3/1/05
HG11 (Maidenhair Fern Seep)	8	Seeping	Jun. - Dec. 2005	0.5	3/1/05 and 4/26/05
HG12 (No Parking/Alder Seep)	5	Seeping	Jun. - Dec. 2005	Seeping	Jun. - Dec. 2005
HG13 (Narrows Seep)	9	1	6/15/05	40	3/1/05
HG14 (Duck Seep/Kevin Pool)	7	0.06	11/22/05	0.15	8/16/05
HG15 (Storm Falls)	9	Dry	Oct. - Dec. 2005	150	3/1/05
HG16 (Dead Alder Falls)	8	Seeping	10/7/05	18	5/31/05
HG17 (Elderberry Falls)	8	0.3	12/20/05	24	5/31/05
HG18 (Tadpole Pool)	8	Dry	Sept - Dec. 2005	1.5	5/31/05
HG19 (Pool of Many Drips)	8	1.4	12/20/05	6	5/31/05
HG20 (Bigleaf Maple Pool)	8	0.3	12/20/05	12	5/31/05
HG21 (Up and Down Trib)	7	0.375	12/20/05	9	5/31/05
HG23 (Time Tunnel)	4	Dry	Jul. - Dec. 2005	50	3/1/05

As shown on Table 3 and the graphs in Appendix B, measured site flows ranged from dry/seeping to approximately 150 gallons per minute (gpm). In general, the minimum site flows were measured between June and December 2005, and the maximum site flows were measured between March and May 2005. The highest flows were observed during the March 2005 field visit at HG10 (Sycamore Tree) – 30 gpm, HG13 (Narrows Seep) – 40 gpm, HG6 (Inlet E Side) – 50 gpm, HG23 (Time Tunnel) – 50 gpm, and HG15 (Storm Falls) – 150 gpm. Many sites went from flowing to dry-seeping during the 2005 monitoring period including, HG2 (MM 0.05), HG6 (Culvert Inlet E Side), HG11 (Maidenhair Fern Seep), HG15 (Storm Falls), HG16 (Dead Alder Falls), HG18 (Tadpole Pool), and HG23 (Time Tunnel).

Conductivity: Table 4 summarizes the observed spring and stream conductivity measurements performed between March and December 2005. At the spring sites, the stream measurements were taken at the nearest upstream location. This table includes the minimum and maximum conductivity measurements as well as the date or date range of these measurements.

Table 4: 2005 Site Conductivity Summary

Site	# of Tests	Spring Conductivity (uS)				# of Tests	Stream Conductivity (uS)			
		min.	Date	max	Date		min.	Date	max	Date
HG1 (Topanga Lagoon)	NA	NA	NA	NA	NA	7	1100	12/19/05	3600	10/17/05
HG2 (MM 0.05)	2	1130	6/13/05	1400	4/26/05	NM	NM	NM	NM	NM
HG3 (Transient Pool)	NA	NA	NA	NA	NA	8	1160	9/28/05	1630	11/21/05
HG4 (Ski Pole Pool)	NA	NA	NA	NA	NA	7	1180	9/28/05	1650	11/21/05
HG5 (Green House Culvert)	8	1850	6/14/05	2700	4/26/05	6	1140	9/28/05	1620	11/21/05
HG6 (Culvert Inlet E Side)	4	1040	6/14/05	1400	4/26/05	NM	NM	NM	NM	NM
HG7 (Ken2 Pool)	8	1020	6/14/05	1400	4/26/05	5	990	6/14/05	1630	11/21/05
HG8 (Alder Grove)	8	670	4/26/05	1110	11/21/05	6	1110	9/28/05	1640	11/21/05
HG9 (Bridge MM 2.02)	NA	NA	NA	NA	NA	6	1110	9/28/05	1670	11/21/05
HG10 (Sycamore Tree)	8	830	4/26/05	1230	11/21/05	5	1060	9/28/05	1630	11/21/05
HG11 (Maidenhair Fern Seep)	7	880	4/26/05	1230	11/21/05	6	1090	9/28/05	1620	11/21/05
HG12 (No Parking/Alder Seep)	4	820	8/15/05	970	10/17/05	5	1100	9/28/05	1630	11/21/05
HG13 (Narrows Seep)	8	860	4/26/05	1190	11/21/05	NM	NM	NM	NM	NM
HG14 (Duck Seep/Kevin Pool)	7	930	6/15/05	1090	10/7/05	7	1130	10/18/05	1720	11/22/05
HG15 (Storm Falls)	7	870	5/31/05	1130	11/22/05	7	1210	8/16/05	1730	11/22/05
HG16 (Dead Alder Falls)	8	980	5/31/05	1290	11/22/05	8	1210	8/16/05	1750	11/22/05
HG17 (Elderberry Falls)	8	810	5/31/05	1250	11/22/05	8	1220	8/16/05	1750	11/22/05
HG18 (Tadpole Pool)	4	1390	5/31/05	1830	8/16/05	8	1310	10/7/05	1760	6/16/05
HG19 (Pool of Many Drips)	8	970	5/31/05	1240	11/22/05	8	1220	8/16/05	1760	6/16/05
HG20 (Bigleaf Maple Pool)	8	880	5/31/05	1180	11/22/05	7	1220	8/16/05	1670	6/16/05
HG21 (Up and Down Trib)	7	1200	5/31/05	1980	11/22/05	7	1240	8/16/05	1990	10/18/05
HG22 (Rope Swing Pool)	NA	NA	NA	NA	NA	7	1220	9/16/05	1750	11/22/05
HG23 (Time Tunnel)	2	920	5/31/05	1060	6/16/05	1	1480	5/31/05	1480	5/31/05
HG24 (Abuelita's)	NA	NA	NA	NA	NA	1	2700	12/20/05	2700	12/20/05

In general, conductivity is related to the ion concentration or dissolved solids in the water. Sources of increased dissolved solids within the study area include urban runoff from the town of Topanga, Topanga Canyon Boulevard, and the commercial and residential development and Pacific Coast Highway near Topanga Lagoon. At Topanga Lagoon, the conductivity is also influenced by the intrusion of higher TDS salt water. Also, evaporation of water from pools concentrates the dissolved solids in the remaining water, which leads to higher conductivity values. The geology and an increased amount of water contact with soil can also increase the conductivity.

As shown on Table 4 and the graphs in Appendix B, the measured site conductivities ranged from 670 to 3,600 uS. The highest conductivities (>2,000 uS) were measured at HG1 (Topanga Lagoon), HG5 (Green House Culvert), and HG-24 (Abuelita's). These relatively high conductivities may be a result of urban runoff in these areas and also the effects of salt water intrusion in the case of HG1 (Topanga Lagoon). As shown on Table 4, the conductivity of the spring sites generally varied less than about 500 uS during the 2005 monitoring period with the exception of Green House Culvert (HG5) and HG21 (Up and Down Trib), which varied on the order of 800 to 850 uS. In general, the stream site conductivities varied more than the spring sites during the 2005 monitoring period. The stream site conductivities on average varied between 500 and 750 uS with HG1 (Topanga Lagoon) varying 2,500 uS due to its close proximity and influence from the ocean. Many of the site's conductivity readings show a general trend that slightly increased between late spring and fall. This trend may be a result of lower site flow, evaporation of water from pools concentrating dissolved solids, and the decrease of the effects of less-conductive rainwater dilution at the sites between the spring and fall months.

pH: Table 5 summarizes the observed minimum and maximum spring and stream pH measurements performed between March and December 2005. At the spring sites, the stream measurements shown on the table were taken at the nearest upstream location.

The pH of a sample of water is the measure of the concentration of hydrogen ions. As shown on Table 5 and the graphs in Appendix B, the site pH measurements ranged from 6.5 to 9. This pH range is within the range of pH values determined by the EPA to be harmless to fish, as shown on Table 2. The majority of the site measurements had a pH greater than 7.5 indicating that the water was alkaline (basic). In general, the individual site pH measurements varied less than about 1.5 pH units during the 2005 monitoring period, as shown on Table 5 and the graphs in Appendix B. The pH of many of the sites generally had a slight upward trend between late spring and fall, indicating that the water decreases in acidity between the spring and fall months. Again, this trend may be due to effects of lower site flow and the decrease of the effects of neutral pH rainwater dilution at the sites between the spring and fall months. The pH measurements taken at the spring sites were generally slightly lower than the pH measurements taken at the nearest upstream location. In general, the nearest upstream pH measurements were within approximately 10% of the value measured at the spring sites. The exception to this was the HG14 (Duck Seep/ Kevin Pool) upstream pH, which was about 25% higher (more basic) than the spring pH, which was more neutral.

Table 5: 2005 Site pH Summary

Site	# of Tests	Spring pH min.	Spring pH Date	Spring pH max	Spring pH Date	# of Tests	Stream pH min.	Stream pH Date	Stream pH max	Stream pH Date
HG1 (Topanga Lagoon)	NA	NA	NA	NA	NA	7	7.4	6/13/05	8.2	11/21/05
HG2 (MM 0.05)	2	7.5	6/13/05	7.7	4/26/05	NM	NM	NM	NM	NM
HG3 (Transient Pool)	NA	NA	NA	NA	NA	8	7.6	6/14/05	8.8	11/21/05
HG4 (Ski Pole Pool)	NA	NA	NA	NA	NA	7	7.6	6/14/05	8.7	11/21/05
HG5 (Green House Culvert)	8	7.6	6/14/05	8.7	11/21/05	6	8.1	8/15 and 10/17/05	8.5	11/21/05
HG6 (Culvert Inlet E Side)	4	7.7	6/14/05	8.3	7/13 and 8/15/05	NM	NM	NM	NM	NM
HG7 (Ken2 Pool)	8	7.6	4/26 and 6/14/05	8.5	11/21/05	5	7.6	6/14/05	8.7	11/21/05
HG8 (Alder Grove)	8	7.1	7/13/05	8.3	11/21/05	6	8.1	8/15 and 10/17/05	8.6	11/21/05
HG9 (Bridge MM 2.02)	NA	NA	NA	NA	NA	6	8.1	10/17/05	8.2	7/13, 8/15, 9/28, and 12/19/05
HG10 (Sycamore Tree)	8	7.5	6/15/05	8.5	12/19/05	5	8.4	7/13, 9/28, 10/17/05	8.7	11/21/05
HG11 (Maidenhair Fern Seep)	7	7.6	6/15/05	8.9	11/21/05	6	8.4	7/13, 9/28, 1017/05	8.8	11/21/05
HG12 (No Parking/Alder Seep)	4	7.3	6/15/05	8.4	10/17/05	5	7.6	6/15/05	8.7	11/21/05
HG13 (Narrows Seep)	8	7.4	6/15/05	8.8	11/21/05	NM	NM	NM	NM	NM
HG14 (Duck Seep/Kevin Pool)	7	6.5	6/15/05	7.7	11/22/05	7	7.8	6/15/05	8.9	11/22/05
HG15 (Storm Falls)	7	7.7	12/20/05	8.5	7/14/05	7	7.7	6/15/05	8.7	11/22/05
HG16 (Dead Alder Falls)	8	8.1	5/31 and 6/15/05	8.9	11/22/05	8	7.7	6/15/05	8.9	11/22/05
HG17 (Elderberry Falls)	8	7.9	5/31/05	9	11/22/05	8	7.7	5/31 and 6/15/05	8.7	11/22/05
HG18 (Tadpole Pool)	4	6.9	5/31 and 6/16/05	7.8	8/16/05	8	6.8	5/31/05	8.7	11/22/05
HG19 (Pool of Many Drips)	8	7.6	5/31 and 6/16/05	8.9	11/22/05	8	7.6	6/16/05	8.8	11/22/05
HG20 (Bigleaf Maple Pool)	8	7.6	5/31 and 6/16/05	8.9	11/22/05	7	7.6	6/16/05	8.5	8/16 and 10/7/05
HG21 (Up and Down Trib)	7	7.3	12/20/05	8.4	7/14/05	7	7.5	10/18/05	8.7	11/22/05
HG22 (Rope Swing Pool)	NA	NA	NA	NA	NA	7	7.7	6/16/05	8.6	11/22/05
HG23 (Time Tunnel)	2	7.9	5/31/05	8.1	6/16/05	1	NM	NM	NM	NM
HG24 (Abuelita's)	NA	NA	NA	NA	NA	1	8.2	12/20/05	8.2	12/20/05

Dissolved Oxygen: Table 6 summarizes the observed minimum and maximum spring and stream dissolved oxygen measurements performed between March and December 2005. At the spring sites, the stream measurements shown on the table were taken at the nearest upstream location.

Sources of dissolved oxygen include diffusion of oxygen in the air into the water at the air-water interface and photosynthesis. Respiration and decomposition of organic matter consume oxygen. Also, water temperature affects dissolved oxygen concentrations, where warmer water cannot hold as much dissolved oxygen as colder water. Because of these factors, dissolved oxygen concentrations vary during the day with the dissolved oxygen value typically being lowest just before dawn. Care was taken to collect site dissolved oxygen values at the same time during the day, so that dissolved oxygen concentrations could be compared from month to month.

Table 6: 2005 Site Dissolved Oxygen Summary

Site	# of Tests	Spring Dissolved Oxygen (mg/L)				# of Tests	Stream Dissolved Oxygen (mg/L)			
		min.	Date	max	Date		min.	Date	max	Date
HG1 (Topanga Lagoon)	NA	NA	NA	NA	NA	7	6.67	8/15/05	15.2	11/21/05
HG2 (MM 0.05)	2	NM	NM	NM	NM	NM	NM	NM	NM	NM
HG3 (Transient Pool)	NA	NA	NA	NA	NA	8	7.06	4/26/05	11.96	11/21/05
HG4 (Ski Pole Pool)	NA	NA	NA	NA	NA	7	9.04	7/14/05	11.8	12/19/05
HG5 (Green House Culvert)	8	6.84	4/26/05	11	12/19/05	6	9.03	8/15/05	10.7	12/19/05
HG6 (Culvert Inlet E Side)	4	6.53	4/26/05	9.23	7/13/05	NM	NM	NM	NM	NM
HG7 (Ken2 Pool)	8	6.39	4/26/05	10	11/21/05	5	8.86	6/14/05	10.63	11/21/05
HG8 (Alder Grove)	8	5.13	9/28/05	8.7	6/14/05	6	8.5	8/15/05	10.71	12/19/05
HG9 (Bridge MM 2.02)	NA	NA	NA	NA	NA	6	8.1	8/15/05	10.7	11/21/05
HG10 (Sycamore Tree)	8	6.7	4/26/05	10.48	12/19/05	5	9.42	7/13/05	12.99	12/19/05
HG11 (Maidenhair Fern Seep)	7	9.67	7/13/05	9.67	7/13/05	6	9.35	6/15/05	13.5	11/21/05
HG12 (No Parking/Alder Seep)	4	NM	NM	NM	NM	5	9.67	6/15/05	10.76	9/28/05
HG13 (Narrows Seep)	8	NM	NM	NM	NM	NM	NM	NM	NM	NM
HG14 (Duck Seep/Kevin Pool)	7	9.18	6/15/05	9.18	6/15/05	7	8.92	7/14/05	11.13	12/20/05
HG15 (Storm Falls)	7	2.85	11/22/05	9.42	7/14/05	7	9	8/16/05	11.8	6/15/05
HG16 (Dead Alder Falls)	8	6.56	5/31/05	9.73	12/20/05	8	7.68	5/31/05	10.97	6/15/05
HG17 (Elderberry Falls)	8	6.48	5/31/05	10.62	12/20/05	8	9.14	6/15/05	11.11	12/20/05
HG18 (Tadpole Pool)	4	2.01	6/16/05	5.26	8/16/05	8	4.78	6/16/05	11.16	12/20/05
HG19 (Pool of Many Drips)	8	9.22	11/22/05	9.74	10/7/05	8	8.72	5/31/05	11.22	12/20/05
HG20 (Bigleaf Maple Pool)	8	8.67	11/22/05	10.21	12/20/05	7	8.9	5/31/05	12.12	12/20/05
HG21 (Up and Down Trib)	7	3.37	8/16/05	9.43	6/16/05	7	4.36	10/18/05	11.26	6/16/05
HG22 (Rope Swing Pool)	NA	NA	NA	NA	NA	7	9.31	10/18/05	11.9	9/16/05
HG23 (Time Tunnel)	2	8.4	5/31/05	9.71	6/16/05	1	NM	NM	NM	NM
HG24 (Abuelita's)	NA	NA	NA	NA	NA	1	14.6	12/20/05	14.6	12/20/05

During the 2005 monitoring period, the dissolved oxygen ranged from 2.01 to 11.0 mg/L at the spring sites and 4.36 to 15.2 mg/L at the stream sites, as shown on Table 6 and the graphs in Appendix B. The highest dissolved oxygen measurements (>10 mg/L) were generally measured within the stream. Also, the dissolved oxygen measurements taken at the spring sites were generally slightly lower than the dissolved oxygen measurements taken at the nearest upstream location. In general, the nearest upstream dissolved oxygen measurements were within approximately 10% of the value measured at the spring sites. The fact that the stream measurements generally had larger dissolved oxygen concentrations relative to the spring sites may be due to the larger surface area of the stream, which causes more oxygen diffusion into the water at the stream sites, and due to the greater affects of photosynthesis within the stream. The dissolved oxygen levels slightly increased between late spring and late fall 2005, as can be seen on the graphs in Appendix B.

As summarized on Table 2, the EPA has determined that aquatic life in early life stages and other life stages can be briefly exposed to minimum dissolved oxygen levels of 5.0 mg/L and 3.0 mg/L, respectively with no negative effects. Also, the EPA has determined that aquatic life outside of early life stage development can be continuously exposed to a minimum dissolved oxygen level of 5.5 mg/L with no negative effects, while the RWQCB established a level of 5.0 mg/L. In general, the dissolved oxygen levels measured in the stream were above the EPA minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L) with the exception of measurements collected upstream of HG18 (Tadpole Pool) in June and August 2005 and upstream of HG21 (Up and Down Trib) in October 2005. For the most part, the dissolved oxygen levels measured in the springs were above the EPA minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L) with the exception of HG8 (Alder Grove) in September 2005, HG15 (Storm Falls) in November 2005, HG18 (Tadpole Pool) in May through August 2005, and HG21 (Up and Down Trib) in August 2005.

In general, the dissolved oxygen measurement seasonal trends were relatively flat between spring and fall 2005. The dissolved oxygen measured at spring sites generally varied less than about 5 mg/L with the exception of HG15 (Storm Falls) and HG21 (Up and Down Trib), which varied on the order of 6 to 7 mg/L. The dissolved oxygen variation at HG21 (Up and Down Trib) may be a result of a change in sample location, where the original location was moved downslope after it dried up. Also, the dissolved oxygen levels measured in the stream varied less than 5 mg/L with the exception of HG1 (Topanga Lagoon) and immediately upstream of site HG18 (Tadpole Pool), which varied on the order of 6 to 9 mg/L.

Salinity: Table 7 summarizes the observed minimum and maximum spring and stream salinity measurements performed between March and December 2005. At the spring sites, the stream measurements shown on the table were taken at the nearest upstream location.

TDS and salinity are sometimes used interchangeably with salinity referring to all anions and cations dissolved in water. Similar to conductivity and TDS, sources of increased salinity within the study area include urban runoff from the town of Topanga, Topanga Canyon Boulevard, and the commercial and residential development and Pacific Coast Highway near Topanga Lagoon. At Topanga Lagoon, the salinity is also influenced by the intrusion of higher TDS salt water. Also, evaporation of water from pools concentrates the ions in the remaining water, which leads to higher salinity values. The marine sedimentary rock geology and an increased amount of water contact with soil can also increase the salinity.

The spring and stream salinity measurements ranged from 0 to 4 ppt with the exception of site HG1 (Topanga Lagoon), which ranged between 1 and 8 ppt, as shown on Table 7 and the graphs in Appendix B. These data have no obvious seasonal trends. The high variance in the HG1 (Topanga Lagoon) salinity is due to its close proximity to the Pacific Ocean and influence from salt water intrusion from ocean water.

Table 7: 2005 Site Salinity Summary

Site	# of Tests	Spring Salinity (ppt)				# of Tests	Stream Salinity (ppt)			
		min.	Date	max	Date		min.	Date	max	Date
HG1 (Topanga Lagoon)	NA	NA	NA	NA	NA	7	1	7/13 and 8/15/05	8	12/19/2005
HG2 (MM 0.05)	2	0	4/26 and 6/13/05	0	4/26 and 6/13/05	NM	NM	NM	NM	NM
HG3 (Transient Pool)	NA	NA	NA	NA	NA	8	0	4/26, 8/15, and 9/28/05	2	7/14, 10/17, 11/21, and 12/19/05
HG4 (Ski Pole Pool)	NA	NA	NA	NA	NA	7	0	8/15, 9/28, and 10/17/05	2	11/21 and 12/19/05
HG5 (Green House Culvert)	8	1	7/13 and 10/17/05	4	4/26/2005	6	0	7/13, 8/15, and 10/17/05	2	11/21 and 12/19/05
HG6 (Culvert Inlet E Side)	4	0	6/14 and 8/15/05	3	4/26/2005	NM	NM	NM	NM	NM
HG7 (Ken2 Pool)	8	0	6/14, 8/15, 9/28, and 10/17/05	2	4/26/2005	5	0	6/14 and 8/15/05	2	11/21 and 12/19/05
HG8 (Alder Grove)	8	0	8/15 and 11/21/05	3	4/26/2005	6	0	7/13/2005	1	8/15, 9/28, 10/17, 11/21, and 12/19/05
HG9 (Bridge MM 2.02)	NA	NA	NA	NA	NA	6	1	7/13, 8/15, 9/28, 10/17, 11/21/05	2	12/19/2005
HG10 (Sycamore Tree)	8	0	7/13 and 10/17/05	3	4/26/05	5	0	9/28 and 10/17/05	3	11/21 and 12/19/05
HG11 (Maidenhair Fern Seep)	7	0	7/13, 8/15, and 9/28/05	4	4/26/2005	6	0	7/13, 8/15, and 9/28/05	3	11/21/2005
HG12 (No Parking/Alder Seep)	4	0	6/15, 8/15, and 9/28/05	1	10/17/2005	5	0	8/15 and 10/17/05	3	11/21/2005
HG13 (Narrows Seep)	8	0	8/15, 9/28, 11/21, and 12/19/05	4	4/26/2005	NM	NM	NM	NM	NM
HG14 (Duck Seep/Kevin Pool)	7	0	6/15/2005	2	7/14/2005	7	1	10/7 and 10/18/05	2	6/15, 7/14, 8/16, 11/22, and 12/20/05
HG15 (Storm Falls)	7	0	10/18/2005	2	5/31 and 11/22/05	7	1	8/16, 10/7, and 10/18/05	3	11/22/2005
HG16 (Dead Alder Falls)	8	1	8/16, 10/7, and 10/18/05	2	5/31, 6/15, 7/14, 11/22, and 12/20/05	8	1	8/16, 10/7, and 10/18/05	3	11/22 and 12/20/05
HG17 (Elderberry Falls)	8	0	5/31, 8/16, and 10/7/05	3	11/22/2005	8	0	10/7/2005	3	11/22/2005
HG18 (Tadpole Pool)	4	2	5/31, 6/16, 7/14, and 8/16/05	2	5/31, 6/16, 7/14, and 8/16/05	8	0	10/7/2005	3	6/16, 7/14, and 11/22/05
HG19 (Pool of Many Drips)	8	0	8/16/2005	3	5/31/2005	8	1	8/16, 10/7, and 10/18/05	3	6/16/2005
HG20 (Bigleaf Maple Pool)	8	0	8/16/2005	2	5/31, 6/16, 10/7, and 12/20/05	7	0	8/16/2005	2	6/16, 7/14, 10/7, 10/18, and 12/20/05
HG21 (Up and Down Trib)	7	2	5/31, 6/16, 7/14, 8/16, and 10/18/05	3	11/22 and 12/20/05	7	1	8/16/2005	4	11/22/2005
HG22 (Rope Swing Pool)	NA	NA	NA	NA	NA	7	0	10/7/2005	2	6/16, 10/18, 11/22, and 12/20/05
HG23 (Time Tunnel)	2	2	5/31 and 6/16/05	2	5/31 and 6/16/05	1	NM	NM	NM	NM
HG24 (Abuelita's)	NA	NA	NA	NA	NA	1	2	12/20/2005	2	12/20/2005 0:00

3.6 Nutrient Testing Results

The results of the nutrient testing, including nitrate (as nitrogen), ammonia (as nitrogen), and phosphates (orthophosphates) measured between June and December 2005 are shown for each site as a function of time on the graphs in Appendix C. Also, Table 8 summarizes the observed minimum and maximum nutrient concentrations as well as the dates of these measurements.

Table 8: 2005 Site Nutrient Summary

Site	# of Tests	Nitrate (as Nitrogen) (mg/L)				Ammonia (as Nitrogen) (mg/L)				Phosphates (as orthophos.) (mg/L)			
		min.	Date	max	Date	min.	Date	max	Date	min.	Date	max	Date
HG1 (Topanga Lagoon)	7	0.1	12/19/05	0.43	11/21/05	0.02	6/13/05	0.46	11/21/05	0.05	6/13/05	0.17	10/17/05
HG2 (MM 0.05)	1	0.07	6/13/05	0.07	6/13/05	0.11	6/13/05	0.11	6/13/05	0.06	6/13/05	0.06	6/13/05
HG3 (Transient Pool)	6	0.08	11/21/05	0.3	12/19/05	0.05	7/13/05	0.4	12/19/05	0.01	7/13/05	0.12	8/16 and 12/19/05
HG4 (Ski Pole Pool)	2	0.04	11/21/05	0.06	10/17/05	0.06	10/17/05	0.1	11/21/05	0	11/21/05	0.05	10/17/05
HG5 (Green House Culvert)	7	0.26	10/17/05	0.73	6/14/05	0.05	8/15/05	0.73	12/19/05	0.02	9/28/05	0.05	8/15 and 11/21/05
HG6 (Culvert Inlet E Side)	3	0.38	8/15/05	1.48	6/14/05	0.06	8/15/05	1	7/13/05	0.04	7/13/05	0.05	6/14 and 8/15/05
HG7 (Ken2 Pool)	7	0.42	9/28/05	1.44	6/14/05	0.02	8/15/05	1.65	10/17/05	0.02	10/17/05	0.1	8/15/05
HG8 (Alder Grove)	6	0.1	12/19/05	0.22	8/15/05	0.04	8/15/05	1.04	10/17/05	0	12/19/05	0.07	8/15/05
HG9 (Bridge MM 2.02)	6	0.09	7/13/05	0.24	11/21/05	0.04	8/15/05	0.37	12/19/05	0.02	7/13 and 10/17/05	0.07	11/21/05
HG10 (Sycamore Tree)	6	0.07	7/13/05	0.26	10/17/05	0.04	8/16/05	3.06	10/17/05	0	11/21/05	0.2	12/19/05
HG11 (Maidenhair Fern Seep)	7	0.02	8/16/05	0.21	6/15/05	0.06	7/13/05	0.54	12/19/05	0.01	8/16 and 9/28/05	0.13	7/13/05
HG12 (No Parking/Alder Seep)	4	0.02	6/15 and 9/28/05	0.18	10/17/05	0.12	10/17/05	0.75	9/28/05	0	9/28/05	0.22	7/13/05
HG13 (Narrows Seep)	6	0.03	10/17/05	0.38	6/15/05	0.05	7/14/05	0.58	8/15/05	0	11/21/05	0.23	8/15/05
HG14 (Duck Seep/Kevin Pool)	5	0.06	10/18/05	0.25	10/7/05	0.05	11/22/05	0.54	12/20/05	0.02	8/16 and 11/22/05	0.07	10/7/05
HG15 (Storm Falls)	6	0.07	8/16/05	1.86	10/18/05	0.03	6/15 and 7/14/05	0.39	12/20/05	0	11/22/05	0.14	7/14/05
HG16 (Dead Alder Falls)	7	0.01	8/16/05	2.49	10/18/05	0.01	6/15/05	2.67	12/20/05	0	10/18 and 11/22/05	0.09	8/16/05
HG17 (Elderberry Falls)	7	0.03	10/18/05	0.61	6/15/05	0.02	10/18/05	0.79	12/20/05	0.03	10/18/05	0.14	8/16/05
HG18 (Tadpole Pool)	2	0.06	8/16/05	0.07	7/14/05	0.15	7/14/05	0.31	8/16/05	0.08	7/14/05	0.57	8/16/05
HG19 (Pool of Many Drips)	7	0.08	12/20/05	0.3	7/14/05	0.04	10/7/05	0.59	10/18/05	0.01	11/22/05	0.14	6/16/05
HG20 (Bigleaf Maple Pool)	7	0.05	10/18/05	0.14	7/14/05	0.02	7/14/05	0.99	6/15/05	0.02	11/22/05	0.7	7/14/05
HG21 (Up and Down Trib)	6	0.02	7/14/05	0.12	6/16/05	0.03	10/18/05	0.72	6/16/05	0.05	7/14/05	0.09	10/18/05
HG22 (Rope Swing Pool)	6	0.11	7/14/05	0.72	10/7/05	0.01	10/18/05	0.89	12/20/05	0.06	6/16/05	0.31	10/7/05
HG23 (Time Tunnel)	1	0.17	6/16/05	0.17	6/16/05	0.24	6/16/05	0.24	6/16/05	0.19	6/16/05	0.19	6/16/05
HG24 (Abuelita's)	1	0.07	12/20/05	0.07	12/20/05	0.6	12/20/05	0.6	12/20/05	0.09	12/20/05	0.09	12/20/05

During the 2005 monitoring period the nitrate (as nitrogen) levels ranged between 0.01 and 2.49 mg/L, the ammonia levels ranged between 0.01 and 3.06 mg/L, and the phosphate levels ranged between 0.0 and 0.7 mg/L, as shown on Table 8 and the graphs in Appendix C.

The EPA has developed nutrient criteria to represent rivers and streams that are minimally impacted by human activities (EPA, 2000). The EPA nutrient criteria were developed by statistically analyzing historic nutrient data within individual ecoregions. Based on this analysis, the EPA has determined the total nitrogen level associated with minimally impacted conditions within the ecoregion that encompasses the study area to be at or below 0.5 mg/L. Generally, nutrient concentrations above this level are indicative of outside influences on the quality of the groundwater. Potential nutrient sources include human and animal waste and fertilizers.

The assumption is made the total nitrogen in the collected nutrient samples is in the form of either nitrate or ammonia and other forms, such as organic based nitrates, are either absent of insignificant. Therefore, measured nitrate and ammonia concentrations are representative of the total nitrogen concentration. Based on this assumption, nitrate concentrations above EPA minimally impacted conditions were measured at spring sites HG5 (Green House Culvert), HG6 (Culvert Inlet E Side), HG7 (Ken2 Pool), HG15 (Storm Falls), HG16 (Dead Alder Falls), HG17 (Elderberry Falls), and at the stream site HG22 (Rope Swing Pool). The suspected elevated nitrate levels at the spring sites may be a result of animal waste that may have collected and concentrated, especially during low flow periods, in the water pools sampled. The elevated nitrate levels measured in the stream at site HG22 (Rope Swing Pool) may also be a result of animal waste accumulation or may be due to human influence (i.e. discharge of human waste) emanating from the town of Topanga.

The Los Angeles Regional Water Quality Control Board (RWQCB) has recommended the total maximum daily load (TMDL) target for total nitrogen to be 1.0 mg/L for the Malibu Creek and Lagoon. No instream samples collected as part of this study exceeded the TMDL threshold established for Malibu Creek; however spring sites HG6 (Culvert Inlet E Side), HG7 (Ken2 Pool), HG15 (Storm Falls), and HG16 (Dead Alder Falls) exceeded these TMDL thresholds. Spring site HG7 (Ken2 Pool) was above the nitrogen TMDL threshold during 5 of the 7 months of sampling. The source of the relatively higher nitrogen concentrations is uncertain, since there does not appear to be any anthropogenic influences nearby. Additional testing (i.e. nitrogen isotope) at this site may help evaluate the source of the higher nitrogen concentrations. The EPA maximum nitrate level established for drinking water, 10 mg/L, was not exceeded at any site sampled during the 2005 study.

As summarized on Table 2, the EPA has determined that freshwater aquatic life can be exposed to nitrate concentrations of 90 mg/L or less with no adverse effects. The nitrate levels measured as part of this study were well below this threshold; and therefore, are not a concern to the fish. The RWQCB and EPA has determined that aquatic life can be briefly and continuously exposed to maximum ammonia levels of 3.8 mg/L and 1.5 mg/L, respectively with no negative effects. The ammonia levels measured in the stream were below these thresholds. The ammonia levels measured in the springs were below the maximum concentration threshold; however exceeded the continuous concentration no-effect level for aquatic life at sites HG7 (Ken2 Pool) in October 2005, HG10 (Sycamore Tree) in October 2005, and HG 16 (Dead Alder Falls) during December 2005. As shown on Table 2, the EPA has determined that phosphate concentrations should be kept below 0.1 mg/L for the prevention of plant nuisances in streams. This threshold was exceeded throughout the 2005 monitoring period at stream sites HG1 (Topanga Lagoon), HG3 (Transient Pool), and HG22

(Rope Swing Pool); and at spring sites HG7 (Ken2 Pool), HG11 (Maidenhair Fern Seep), HG12 (No Parking/Alder Seep), HG13 (Narrows Seep), HG15 (Storm Falls), HG17 (Elderberry Falls), HG18 (Tadpole Pool), HG19 (Pool of Many Drips), and HG20 (Bigleaf Maple Pool).

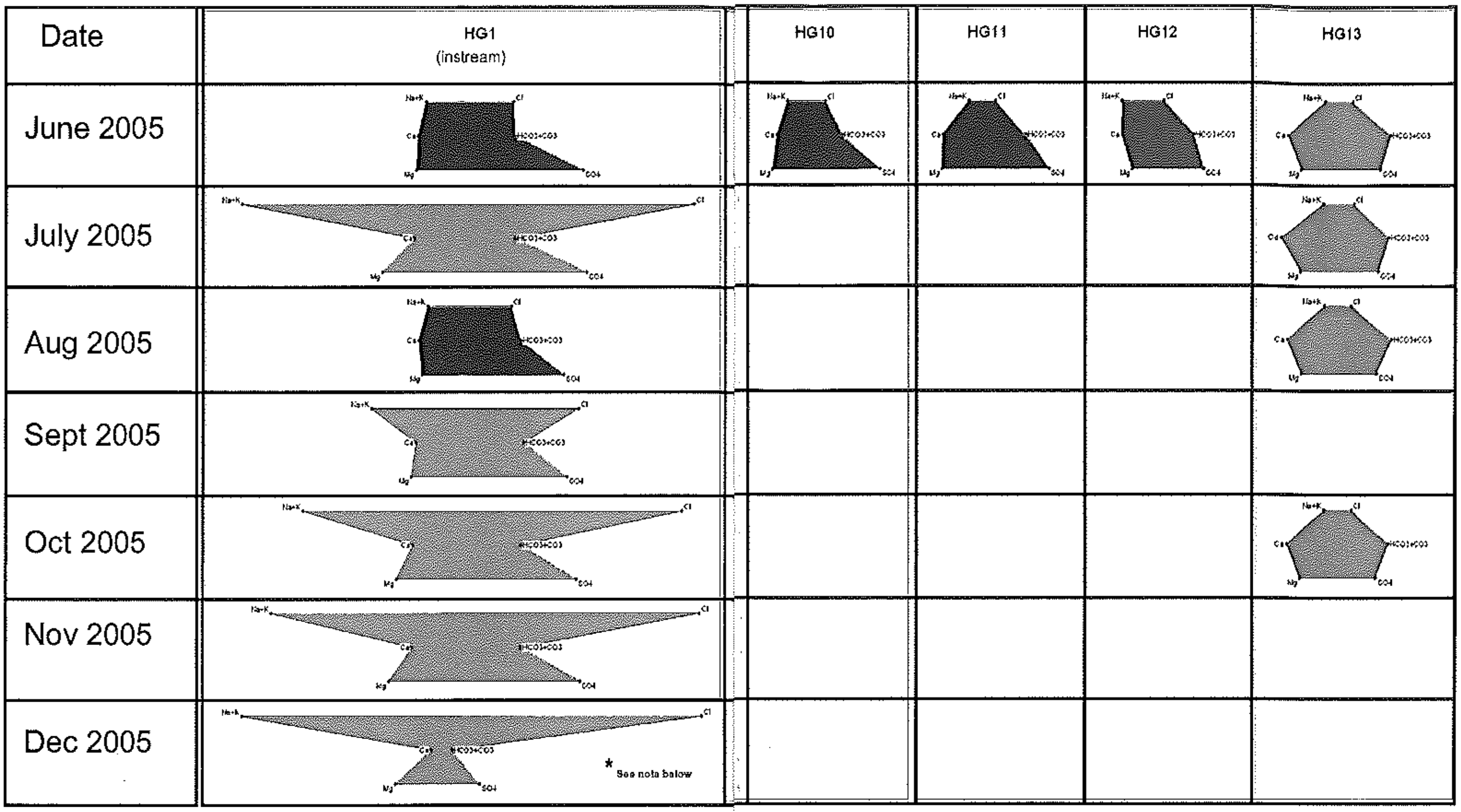
3.7 General Mineral Chemistry Results

The general mineral chemistry results for each spring, seep, and instream study site as a function of time are shown on the graphs in Appendix D. The graphs in Appendix D show the concentrations of sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), chloride (Cl), alkalinity ($CaCO_3$), bicarbonate ($CaCO_3$), carbonate ($CaCO_3$); sulfate (SO_4), total hardness and TDS as a function of time between June and December 2005 for each study site. General mineral laboratory samples were collected monthly at spring and stream sites between June and August 2005; however, because the general mineral chemistry at the spring sites remained relatively constant from month to month during this time, monitoring of the spring sites for general mineral chemistry was changed to a quarterly schedule. As a result, general mineral samples were only collected at select instream locations during the September, November, and December 2005 monitoring periods.

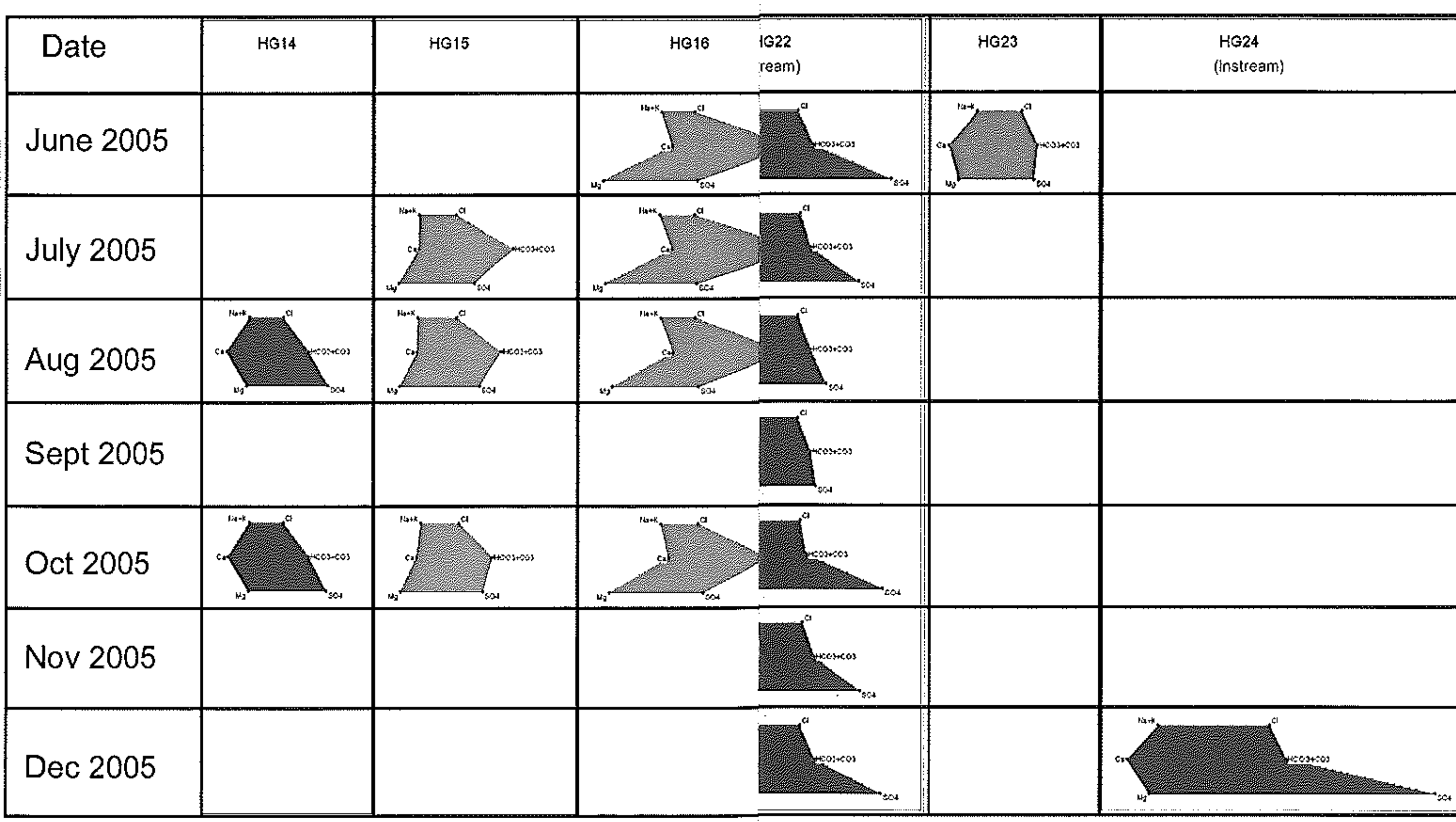
Stiff diagrams showing the equivalent concentrations of 6 constituent ions (Na+K, Ca, Mg, Cl, HCO_3+CO_3, and SO_4) are presented for each study site on Figure 7. A Stiff diagram is a useful visual tool that can be used to help interpret water chemistry. The cations are plotted on the left side of the scale, anions on the right, and the connected dots form a simple pattern. The patterns for different water samples can easily be compared, and changes in the water as it moves through the environment can be identified. The water chemistry is also presented on Piper diagrams by month on Figure 8. A Piper diagram is a trilinear diagram, which shows the relative concentrations of cations and anions, and is also used to identify major groupings and geochemical trends. The Piper diagram displays charge-equivalent concentrations of cations in the left diagram; anions in the right diagram, and integrates both sets of data into the central diamond.

The spring, seep, and instream samples collected at the study sites generally yielded water in which the dominant cations were Ca or Mg and the dominant anions were SO_4 or HCO_3+CO_3. Ca ions are released by the weathering of sedimentary rocks and are often grouped with Mg to describe hardness, where "hard" water is Ca-Mg rich and "soft" water is Ca-Mg poor. Calcium carbonate is also commonly present in sandstone and conglomerate rocks, such as those found in the study area, as a cement that binds the rock particles together. SO_4 is derived from weathering of sedimentary rocks and can also be a product of pollutants such as fertilizers or human and animal wastes. As shown on Figure 7, the samples collected within the stream were rich in sulfate, which may be an indicator of pollutants within the stream. HCO_3+CO_3 ions are continually generated indirectly in river water by the process of respiration, in which the production of CO_2 promotes the production of HCO_3+CO_3. HCO_3+CO_3, or alkalinity, resist changes in the water's pH, and acts like a buffer, which neutralizes the pH.

Figure 7: Stiff Diagrams Showing Results of General



* Horizontal Scale Reduced 70



Legend

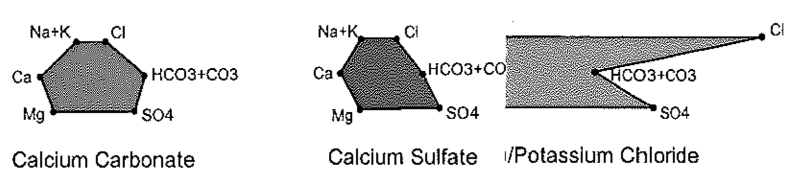
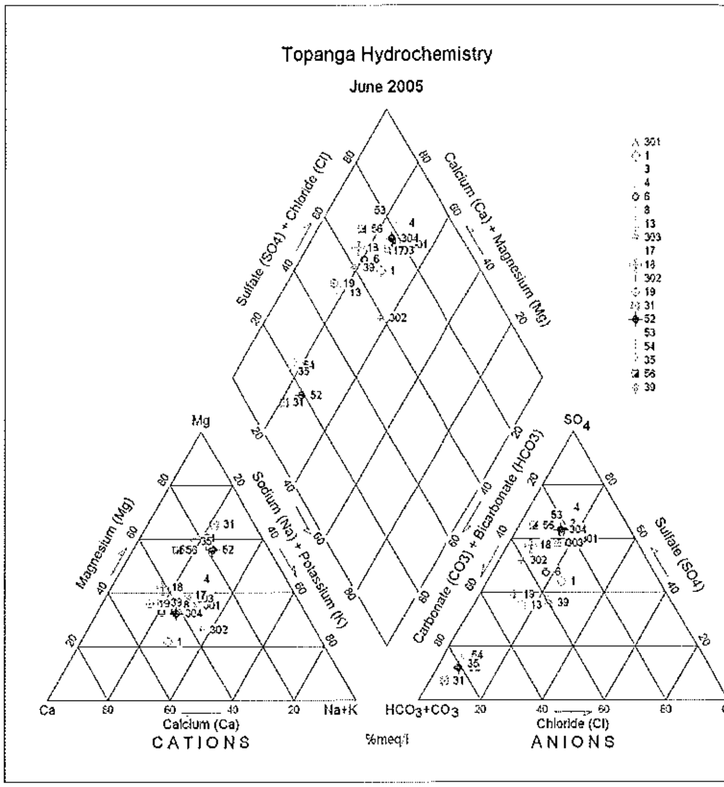
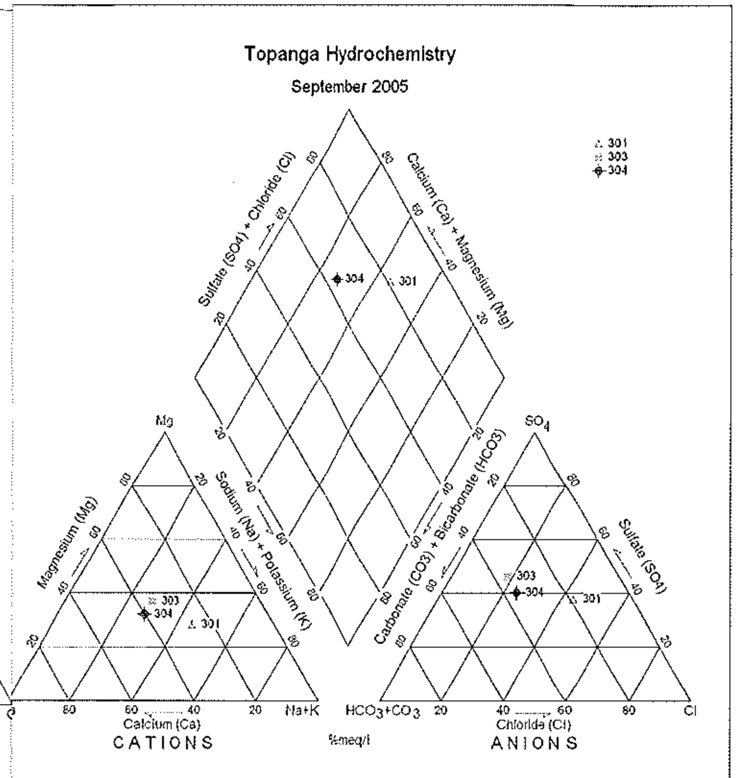
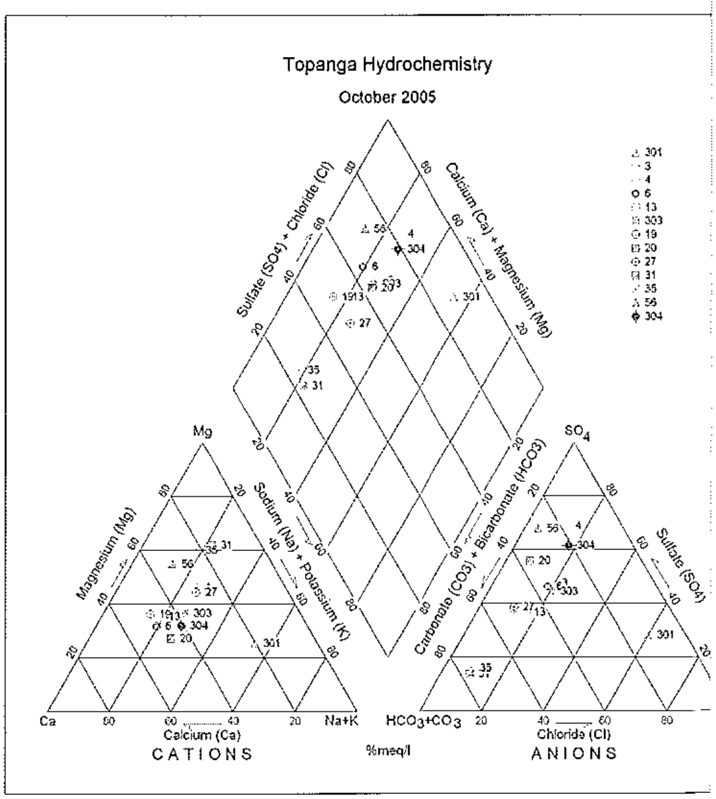


Figure 8: Piper Diagrams Showing Results of Ge







Relative Na+K and Cl percentages were generally low for all study sites with the exception of the instream sample collected at Topanga Lagoon (HG1). The samples collected at the Topanga Lagoon during July, September, October, November, and December 2005 had elevated relative sodium and chloride percentages, which is evidence of seawater intrusion. As can seen on the stiff diagrams, the ion distribution at each site did not change appreciably as a function of time between June and December 2005 with the exception of the instream sample collected at Topanga Lagoon (HG1), which varied do to the influence of seawater intrusion into the lagoon.

Alkalinity, Hardness, and TDS: Table 9 summarizes the observed minimum and maximum spring and stream alkalinity, hardness, and total dissolved solids (TDS) measurements performed between March and December 2005. At the spring sites, the stream measurements shown on the table were taken at the nearest upstream location.

Alkalinity is a measure of the ability of water to resist changes in pH caused by the addition of acids or bases (buffering capacity as mentioned above), and is due primarily to the presence of bicarbonates and carbonates. Hardness is due to the presence of calcium and magnesium, as mentioned above. The TDS is a measure of the sum of the concentrations of the dissolved major ions. As mentioned previously, sources of increased TDS within the study area may include urban runoff from the town of Topanga, Topanga Canyon Boulevard, and the commercial and residential development and Pacific Coast Highway near Topanga Lagoon. At Topanga Lagoon, the TDS is also influenced by the intrusion of salt water. Also, evaporation of water from pools concentrates the TDS in the remaining water, which leads to higher TDS values. The marine sedimentary rock geology and an increased amount of water contact with soil can also increase the TDS. Hem (1985) assigned terms for water within certain TDS and hardness ranges, as shown on Table 10.

As shown on Table 9 and the graphs in Appendix D, the measured site alkalinity, hardness, and TDS concentrations ranged from 200 to 730 mg/L, 330 to 2,600 mg/L, and 570 to 10,000 mg/L, respectively. During the 2005 monitoring period, the individual site alkalinity concentrations varied less than 200 mg/L. The site hardness concentrations varied less than 250 mg/L with the exception of HG1 (Topanga Lagoon) and HG21 (Up and Down Trib), which varied 1,900 and 500 mg/L, respectively. The hardness variations measured at HG1 (Topanga Lagoon) may be due to this sites close proximity and influence from the ocean, and the hardness variation measured at HG21 (Up and Down Trib) may be a result of a change in sample location, where the original location was moved downslope after it dried up.

The 2005 spring and stream TDS concentrations were predominantly in the fresh range (ranged from fresh to highly brackish), as delineated on Table 10. Brackish water (TDS = 1,000 to 5,000 mg/L) was measured at stream sites HG1 (Topanga Lagoon), HG3 (Transient Pool), HG-9 (Bridge), HG22 (Rope Swing Pool), and HG-24 (Abuelita's), and at spring sites HG4 (Green House Culvert), HG18 (Tadpole Pool), and HG21 (Up and Down Trib). The sample collected at HG1 Topanga Lagoon in December 2005 had a TDS of 10,000 mg/L, which was in the highly brackish range. Many of the site's TDS readings remained relatively constant and others showed a general trend that slightly increased between late spring and fall. This trend is similar to the conductivity measurement and may be a result of lower site flow, evaporation of water from pools concentrating dissolved solids, and the decrease of the effects of relatively lower TDS rainwater dilution at the sites between the spring and fall months.

Table 9: 2005 Site Alkalinity, Hardness, and TDS Summary

Site	#	Alkalinity (mg/L)				Hardness (mg/L)				TDS (mg/L)			
	Tests	min.	Date	max	Date	min.	Date	max	Date	min.	Date	max	Date
HG1 (Topanga Lagoon)	7	230	12/19/05	310	9/28/05	670	6/14 and 8/15/05	2600	12/19/05	1100	8/15/05	10000	12/19/05
HG2 (MM 0.05)	1	320	6/14/05	320	6/14/05	700	6/14/05	700	6/14/05	590	6/14/05	590	6/14/05
HG3 (Transient Pool)	6	240	6/14/05	280	8/15, 10/17, 11/21, and 12/19/05	540	8/15 and 10/17/05	670	11/21/05	810	10/17/05	1100	11/21 and 12/19/05
HG5 (Green House Culvert)	4	310	10/17/05	330	6/14/05	1100	6/14, 7/13, 8/15, and 10/17/05	1100	6/14, 7/13, 8/15, and 10/17/05	1700	10/17/05	2000	7/13/05
HG6 (Culvert Inlet E Side)	2	230	6/14/05	240	7/13/05	520	6/14/05	540	7/13/05	830	6/14/05	860	7/13/05
HG7 (Ken2 Pool)	4	270	7/13 and 8/15/05	290	6/14/05	520	6/14/05	570	10/17/05	800	10/17/05	820	7/13/05
HG8 (Alder Grove)	4	300	6/14 and 7/13/05	320	8/15/05	440	6/14/05	480	10/17/05	620	10/17/05	640	8/15/05
HG9 (Bridge MM 2.02)	7	260	6/27/05	290	8/15, 9/28, 11/21, and 12/19/05	500	10/17/05	690	12/19/05	780	10/17/05	1100	11/21 and 12/19/05
HG10 (Sycamore Tree)	1	200	6/15/05	200	6/15/05	440	6/15/05	440	6/15/05	700	6/15/05	700	6/15/05
HG11 (Maidenhair Fern Seep)	1	270	6/15/05	270	6/15/05	510	6/15/05	510	6/15/05	740	6/15/05	740	6/15/05
HG12 (No Parking/Alder Seep)	1	260	6/15/05	260	6/15/05	330	6/15/05	330	6/15/05	570	6/15/05	570	6/15/05
HG13 (Narrows Seep)	4	340	7/13 and 10/17/05	360	8/15/05	490	8/15/05	530	10/17/05	600	10/17/05	710	7/13/05
HG14 (Duck Seep/Kevin Pool)	2	230	8/16 and 10/18/05	230	8/16 and 10/18/05	430	10/18/05	440	8/16/05	700	8/16/05	720	10/18/05
HG15 (Storm Falls)	3	310	10/18/05	430	7/14/05	410	8/16/05	450	10/18/05	610	8/16/05	680	10/18/05
HG16 (Dead Alder Falls)	4	550	10/18/05	730	7/14/05	560	6/15, 7/14, and 10/18/05	590	8/16/05	670	6/15 and 8/16/05	750	7/14/05
HG17 (Elderberry Falls)	2	500	6/15/05	560	8/16/05	460	6/15/05	510	8/16/05	580	6/15/05	620	8/16/05
HG18 (Tadpole Pool)	2	370	6/16/05	390	7/14/05	1000	6/16/05	1100	7/14/05	1400	6/16/05	1500	7/14/05
HG19 (Pool of Many Drips)	1	560	6/16/05	560	6/16/05	540	6/16/05	540	6/16/05	620	6/16/05	620	6/16/05
HG20 (Bigleaf Maple Pool)	4	490	10/18/05	600	7/14/05	500	8/16/05	570	7/14/05	600	6/16/05	820	7/14/05
HG21 (Up and Down Trib)	4	340	7/14/05	470	10/18/05	790	7/14/05	1300	10/18/05	1200	6/16/05	1800	10/18/05
HG22 (Rope Swing Pool)	7	250	10/18/05	310	11/22 and 12/20/05	540	10/7/05	790	12/20/05	930	8/16/05	1300	6/16, 10/18, and 12/20/05
HG23 (Time Tunnel)	1	260	6/16/05	260	6/16/05	480	6/16/05	480	6/16/05	720	6/16/05	720	6/16/05
HG24 (Abuelita's)	1	350	12/20/05	350	12/20/05	1000	12/20/05	1000	12/20/05	1900	12/20/05	1900	12/20/05

Table 10: TDS and Hardness Terminology

TDS Range (mg/L)	TDS Term	Hardness Range (mg/L)	Hardness Term
<1,000	Fresh	<75	Soft
1,000 to 5,000	Brackish	75 to 150	Mod. Hard
5,000 to 15,000	Highly Brackish	150 to 300	Hard
15,000 to 30,000	Saline	>300	Very Hard

The EPA has determined that TDS in excess of 15,000 mg/L was determined unsuitable for most fresh water fish (see Table 2). As shown on Table 9 and the graphs in Appendix D, the TDS concentrations measured as part of this study were below this threshold; and therefore, are not a concern to the fish. The EPA has determined that alkalinity is important to fish in freshwater systems because it buffers pH changes that occur naturally, and the EPA has set a desired minimum alkalinity threshold of 20 mg/L, as shown on Table 2. As shown on Table 9 and the graphs in Appendix D, the alkalinity concentrations measured in 2005 were above this minimum desired value. No hardness criteria were set by EPA; however, it was noted that increased hardness has the effect of reducing the toxicity of metals in water. As shown on Table 9 and the graphs in Appendix D, the total hardness concentrations measured in 2005 were in the "very hard" range, as shown on Table 10.

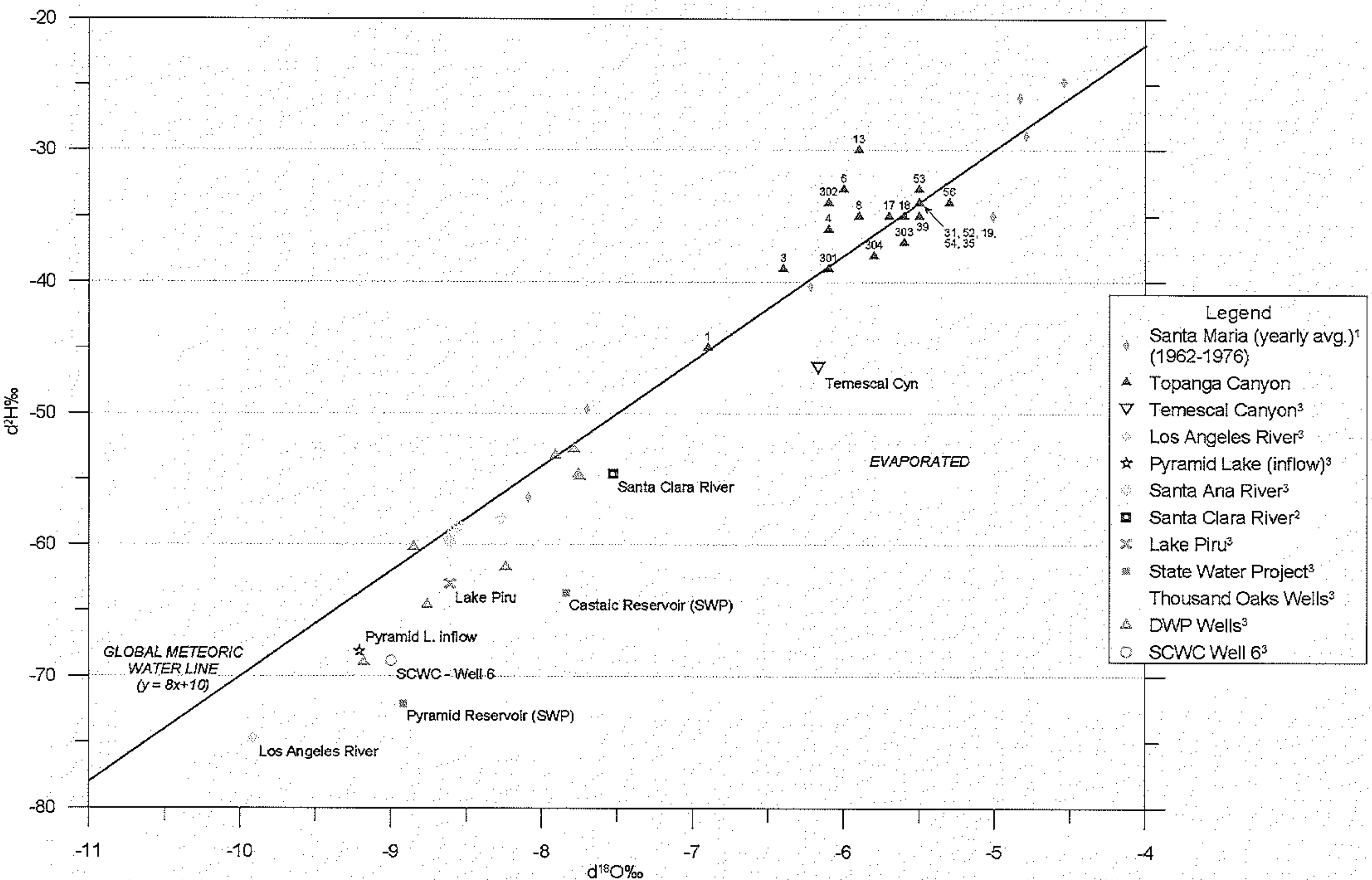
3.8 Stable Water Isotope Results

Stable isotopes of water can provide an indication of the geographic source and evaporative effects related to the water's source and provide a means for tracing groundwater from various sources. In general, water from higher altitudes or colder and wetter climates tends to be depleted in the heavy isotopes with very negative $\delta^{18}O$ and $\delta^{2}H$ values. Water from lower, warmer, and drier climates is more enriched in the heavier isotopes and has a larger $\delta^{18}O$ and $\delta^{2}H$ values.

Most precipitation throughout the world originates from the evaporation of seawater and, as a result, the $\delta^{18}O$ and $\delta^{2}H$ composition of precipitation throughout the world is linearly correlated in a relationship referred to as the Global Meteoric Water Line (GMWL) (Craig, 1961). Precipitation samples will tend to group close to this line. Deviations from the meteoric water line can be interpreted as being caused by precipitation that occurred during a warmer or colder climate than at present or by geochemical changes that occurred when the water was underground. Precipitation near the coast and at low altitudes will tend to have higher $\delta^{18}O$ and $\delta^{2}H$ values than precipitation farther inland and at high altitudes. Similarly, water that has been partly evaporated is enriched by fractionation of the heavier isotopes relative to the original isotopic composition; these values plot to the right of the GMWL. Oceanic water will fall below the meteoric water line as it is isotopically enriched (Craig, 1961).

Results of the stable water isotope analyses for the spring, seep, and instream samples collected in June 2005 (blue triangles) and October 2005 (purple squares) are shown on Figure 9 along with the GMWL for reference. Also shown in this figure are $\delta^{18}O$ and $\delta^{2}H$

FIGURE 9: STABLE WATER ISOTOPE PLOT



REFERENCES

[1] Isotope Hydrology Databases (http://isohis.iaea.org), Global Network of Isotopes in Precipitation (GNIP) and the Isotope Hydrology Information System (ISOHIS)

[2] Coplen, T.B., and Kendall, C., Stable Hydrogen and Oxygen Isotope Ratios for Selected Sites of the U.S. Geological Survey's NASQAN and Benchmark Surface-water Networks, *U.S. Geological Survey Open-File report 00-160*, pp.

[3] Williams, A.E. and Rodoni, D.P., Regional isotope effects and application to hydrologic investigations in southwestern California, *Water Resour. Res., 33*, 1721-1729, 1997.

concentrations reported for Temescal Canyon groundwater (Williams and Rodoni, 1997), Santa Clara River water (Coplen and Kendall), groundwater wells in Thousand Oaks (Williams and Rodoni, 1997), and Los Angeles Department of Water and Power water wells (Williams and Rodoni, 1997). Additionally, $\delta^{18}O$ and $\delta^{2}H$ concentrations reported for precipitation in Santa Maria are shown on Figure 9. It is noted that water from like sources group together on this plot, and when water from different sources are mixed together, they will plot differently.

The isotopic compositions of the Topanga Canyon samples ranged from -6.9 to -5.1 for $\delta^{18}O$ and from -45 to -30 for $\delta^{2}H$, which fall on or near the GMWL. The fact that the isotopic composition of the water falls on or near the GMWL and not far to the right of the GMWL suggests the springs and streams within the Topanga Canyon study area are generally recharged locally by precipitation, which enters the groundwater system relatively quickly with little to no evaporative effects. For the most part, the Topanga Canyon sites are grouped together on Figure 9 with the exception of HG2 (MM 0.05 TC Blvd.), which shows the largest difference in isotopic composition. This suggests that the groundwater tested, with the exception of HG2, originated within the same climatic conditions. The small scatter in the isotope concentration for the 2005 Topanga Canyon data, excluding HG2 (MM 0.05 TC Blvd.), may come as a result of the elevation differences throughout the sample locations. The isotopic grouping of the Topanga Canyon data does not appear to have a significant mixing component from the discharge of recycled wastewater, which would be expected to have a large evaporative component.

HG2 (MM 0.05 TC Blvd) is much lighter (more negative) than water from the other sites sampled and plots to the lower left along the GMWL. The water emanating from HG2 (MM 0.05 TC Blvd) may have been derived from precipitation during a different time period or location with respect to the other sites (i.e. regional water that enters the groundwater system at a different location or during a different time period relative to the other sites), perhaps at a relatively higher altitude and/or lower temperature. It is also possible that the water at site HG2 (MM 0.05 TC Blvd) is being mixed with LA City water emanating from water usage from the housing development immediately upslope of HG2 (MM 0.05 TC Blvd).

HG9 (Bridge MM 2.02), HG21 (Up and Down Trib), HG22 (Rope Swing Pool), and HG23 (Time Tunnel) from the June 2005 monitoring event and HG1 (Topanga Lagoon) and HG3 (Transient Pool) from the October 2005 monitoring event are composed with heavy (less negative) isotopic ratios that plot to the right of the meteoric line and may reflect some component of evaporative effects at these sites.

4.0 DISCUSSION

For discussion purposes, the study area was divided at geologic boundaries into five reaches (Reaches 1 through 5), which are shown on Figure 10. Reaches 1 through 5 occur between instream distances of 5,100 and 6,000 meters, 4,100 and 5,100 meters, 2,100 and 4,100 meters, 1,100 and 2,100 meters, and 0 and 1,100 meters, respectively.

The northern limit of Reach 1 is just south of the town of Topanga. As shown on Figure 10, the boundary between Reach 1 and Reach 2 occurs at an unnamed fault which juxtaposes sedimentary rocks of the Sespe Formation and volcanic rocks on the north and sedimentary rocks of the Coal Canyon Formation on the south. The boundary between Reach 2 and Reach 3 occurs at the Tuna Canyon Fault, which juxtaposes sedimentary rocks of the Coal Canyon Formation on the north and Tuna Canyon Formation on the south. The boundary between Reaches 3 and 4 occur at the lithologic boundary (no mapped fault) between sedimentary rocks of the Tuna Canyon Formation to the north and the Coal Canyon Formation to the south. An unnamed fault divides the boundary between Reaches 4 and 5. This unnamed fault separates sedimentary rocks of the Coal Canyon Formation on the north from Tuna Canyon Formation on the south. The south end of Reach 5 terminates at the Pacific Ocean.

A plot of the monthly field physical and chemical measurements, including conductivity, pH, salinity, and dissolved oxygen, as a function of instream distance (with reach breaks) is shown on Figure 11. Figure 11 highlights the spatial variation and range of these data. In general, these measurements did not vary significantly as a function of distance along the stream with some individual sites showing data spikes that deviate above and below the average range. These data will be described in further detail by individual reach below.

Results of the hydrogeologic study of the lower Topanga Creek Watershed for the five stream reaches are discussed in more detail below with respect to the geology, physical and chemical measurements, fish habitat, and proposed restoration and the effects on groundwater resources. It is noted that for the spring sites, physical and chemical field measurements were also collected at the nearest upstream location relative to the spring site, if possible, in addition to the field measurements collected at the spring site itself. These data were incorporated into the stream discussion below. Also, the description of fish habitat quality in each reach is based on analysis using the Habitat Suitability Index documented by Dagit et al, 2006, and reflects the availability of suitable depth, substrate, canopy cover, instream shelter and habitat type for all life stages of steelhead trout. The barriers were assessed using FishXing software in compliance with the California Department of Fish and Game protocol (CalTrout, 2006).

Figure 10: Topanga Creek Study Area Reach Boundaries and Restoration Areas

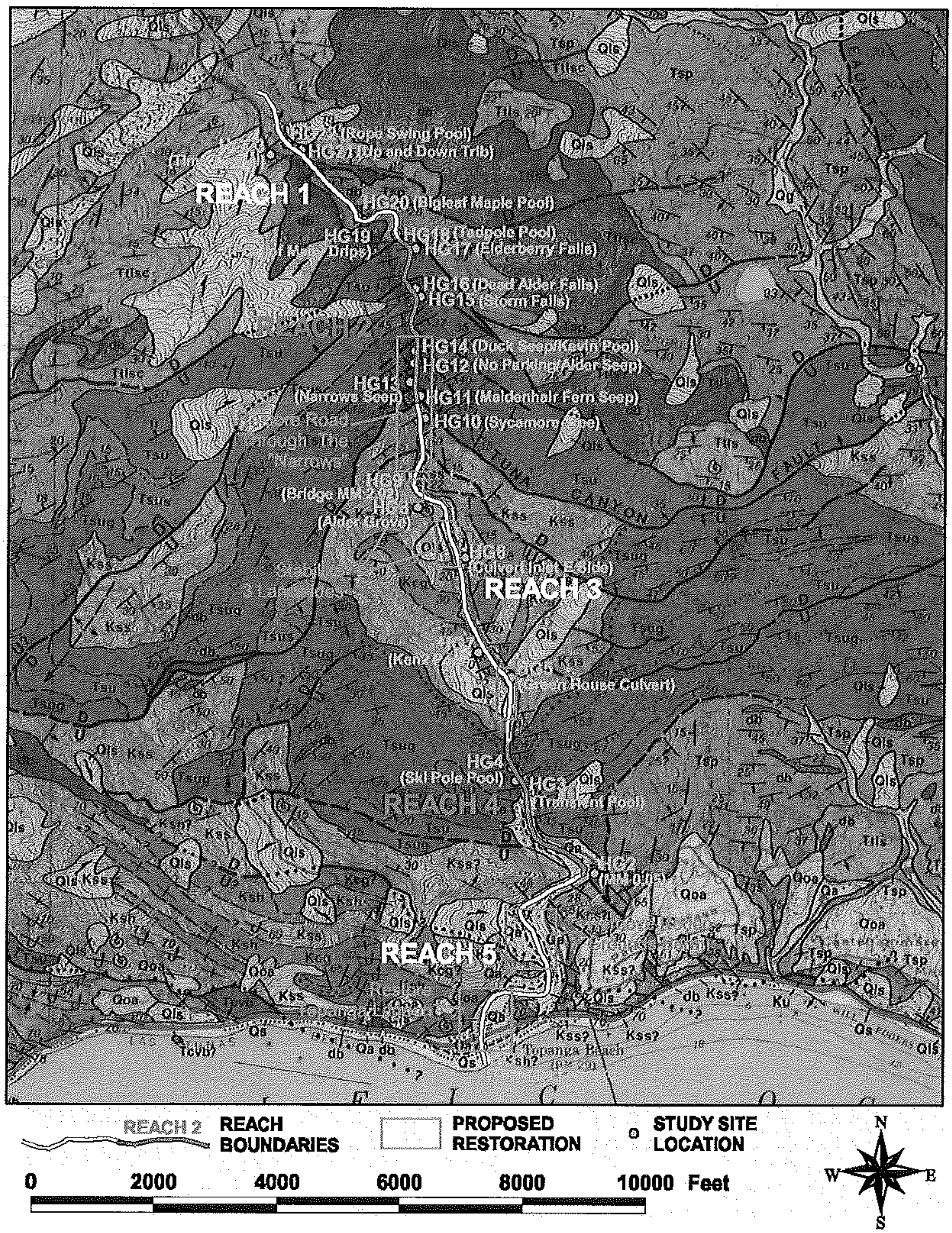
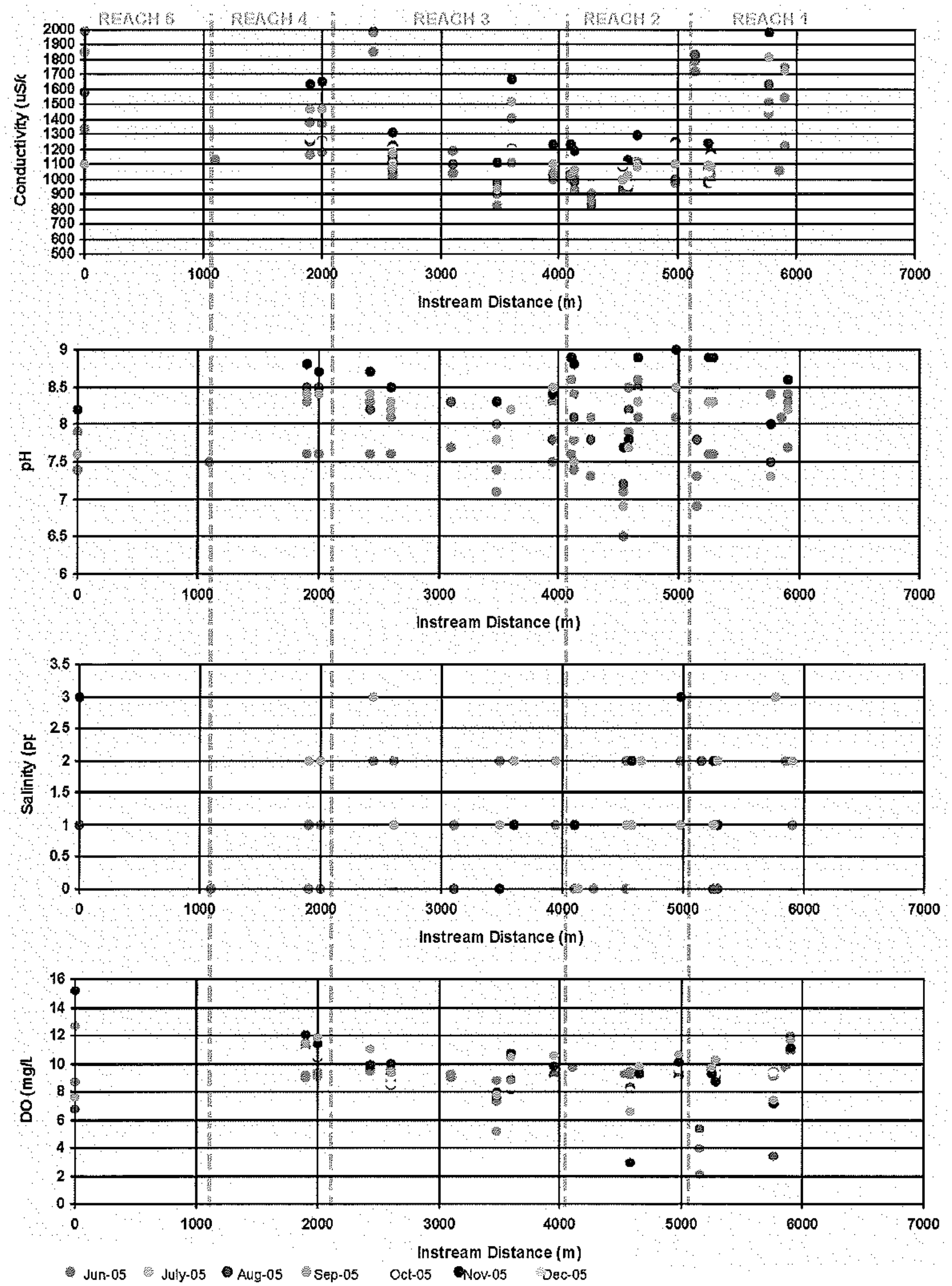
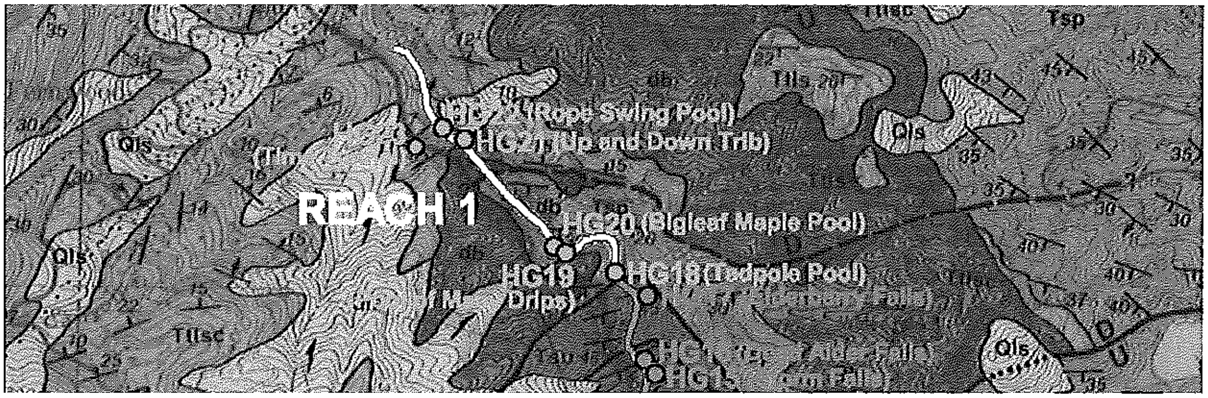


Figure 11: 2005 Field Measurements as a Function of Instream Distance



4.1 Reach 1 (Instream Distance 5,100 to 6,000 meters)



General (Reach 1): Reach 1 is located in the northernmost section of the study area immediately south of the town of Topanga and is approximately 900 meters long. This section of the creek consistently has perennial flows, even during drought years. In all, a total of 13 groundwater sites were identified, and based on air photo analysis, 3 groundwater sites were suspected within this reach. Of these sites, a total of 5 sites, consisting of springs, seeps, and spring runoff, [HG18 (Tadpole Pool), HG19 (Pool of Many Drips), HG20 (Bigleaf Maple Pool), HG21 (Up and Down Trib), and HG23 (Time Tunnel)], were selected for monitoring. In addition, field measurements within the stream were collected at the nearest upstream location relative to the spring sites. Also, monitoring was performed at one instream monitoring location HG22 (Rope Swing Pool) within this reach and at instream site HG24 (Albuelitas) located within the town of Topanga approximately 1,200 meters upstream from Reach 1.

Geology (Reach 1): Reach 1 is underlain by sandstone with interbeds of shaly siltstone of the Lower Topanga Formation and by semi-friable sandstone with conglomeratic sandstone and conglomerate of the Sespe Formation. Within a large portion of this reach, the Lower Topanga Formation has been intruded with volcanic diabase and basalt. Also, several landslides have been mapped by Dibblee (1992) above the base of the canyon. The largest landslide has been mapped on the west side of Topanga Canyon Boulevard and extends the entire length of Reach 1. Spring activity related to this landslide is suspected based on air photo anaysis. Two faults have been mapped by Dibblee (1992) within this reach. One fault occurs near the middle of Reach 1, and the other fault is located at the geologic contact between the Sespe and Coal Canyon Formations at the southern boundary of this reach. Spring activity appears to be associated with these mapped faults.

Field Measurements (Reach 1): As summarized on Table 11 and shown on the graphs in Appendix B, the 2005 individual spring flows within Reach 1 ranged from springtime highs of between 1.5 and 50 gpm to summer/fall lows of dry to 1.4 gpm. In total, these springs contributed approximately 5 to 80 gpm to the overall creek flow within this reach during the monitored summer/fall low and springtime high events, respectively. During 2005, spring sites HG19 (Pool of Many Drips), HG20 (Bigleaf Maple Pool), and HG21 (Up and Down

Trib) flowed continuously (perennially). Since the 2005 precipitation total was more than twice average, it is suspected that all the sites within this reach have the potential to become dry during years with normal to below normal rainfall.

Table 11: Reach 1 - 2005 Spring Flow Summary

Site	# of Samples	Flow (gpm)			
		min.	Date	max	Date
HG18 (Tadpole Pool)	8	Dry	Sept - Dec. 2005	1.5	5/31/05
HG19 (Pool of Many Drips)	8	1.4	12/20/05	6	5/31/05
HG20 (Bigleaf Maple Pool)	8	0.3	12/20/05	12	5/31/05
HG21 (Up and Down Trib)	7	0.375	12/20/05	9	5/31/05
HG23 (Time Tunnel)	4	Dry	Jul. - Dec. 2005	50	3/1/05

The Reach 1 and HG24 (Albuelitas) minimum, maximum and average conductivity, pH, salinity, and dissolved oxygen measurements collected within the springs and stream during the 2005 monitoring period are summarized in Table 12 and shown on the graphs in Appendix B.

Table 12: Reach 1 and HG24 (Albuelitas)- 2005 Spring and Stream Field Measurements

Site	# of Tests	Conductivity (uS)			pH			Salinity (ppt)			DO (mg/L)		
		min	max	avg	min	max	avg	min	max	avg	min	max	avg
HG24 (Albuelitas) Upstream of Reach 1	1	2700	2700	2700	8.2	8.2	8.2	2	2	2	14.60	14.60	14.60
HG23 (Time Tunnel)	2	920	1060	990	7.9	8.1	8.0	2	2	2	8.40	9.71	9.06
	1	1480	1480	1480	7.8	7.8	7.8	3	3	3	10.38	10.38	10.38
HG22 (Rope Swing Pool)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	7	1220	1750	1566	7.7	8.6	8.2	0	2	1	9.31	11.90	10.99
HG21 (Up and Down Trib)	7	1200	1980	1580	7.3	8.4	7.8	2	3	2	3.37	9.43	7.73
	7	1240	1990	1604	7.5	8.7	8.0	1	4	2	4.36	11.26	9.33
HG20 (Big Leaf Maple Pool)	8	880	1180	1035	7.6	8.9	8.2	0	2	1	8.67	10.21	9.26
	7	1220	1670	1413	7.6	8.5	8.2	0	2	2	8.90	12.12	10.02
HG19 (Pool of Many Drips)	8	970	1240	1061	7.6	8.9	8.3	0	3	2	9.22	9.74	9.52
	8	1220	1760	1486	7.6	8.8	8.3	1	3	2	8.72	11.22	9.86
HG18 (Tadpole Pool)	4	1390	1830	1683	6.9	7.8	7.2	2	2	2	2.01	5.26	3.84
	8	1310	1760	1528	6.8	8.7	7.8	0	3	2	4.78	11.16	8.05
Spring Total	**29**	**880**	**1980**	**1260**	**6.9**	**8.9**	**8.0**	**0**	**3**	**2**	**2.01**	**10.21**	**8.16**
Stream Total	**38**	**1220**	**1990**	**1518**	**6.8**	**8.8**	**8.1**	**0**	**4**	**2**	**4.36**	**12.12**	**9.63**

Spring Measurement
Stream Measurement

As shown on Table 12, the average pH and salinity measurements collected at the springs within Reach 1 were within similar ranges as measurements collected in the stream. The spring conductivities measured within Reach 1 are generally lower than the corresponding stream conductivities suggesting a relatively higher concentration of dissolved solids within the stream. Also, the stream conductivity measured at HG24 (Albuelitas) within the town of

Topanga was on the order of two-times higher than the average stream conductivity measured within Reach 1. Sources of the higher conductivity stream water may include runoff from the town of Topanga and Topanga Canyon Boulevard. The dissolved oxygen values measured in the creek were generally higher than those measured at the springs, due to the larger surface area of the stream and the greater affects of photosynthesis within the stream. For the most part, the Reach 1 spring and stream dissolved oxygen levels were above the minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L), as shown on Table 2, with the exception of HG18 (Tadpole Pool) and HG21 (Up and Down Trib) during occasional summer months. During these times, decreased pool surface areas and increased water temperatures may have lowered the dissolved oxygen concentrations at these sites.

Water Chemistry (Reach 1): The ionic concentration of the springs tested within Reach 1 during 2005 showed relatively high magnesium sulfate content [HG18 (Tadpole Pool) and HG21 (Up and Down Trib)], relatively high magnesium carbonate content [HG19 (Pool of Many Drips) and HG20 (Bigleaf Maple Pool)], and relatively high calcium carbonate content [HG23 (Time Tunnel)] (see Figure 7). The stream ionic concentration tested within Reach 1 at HG22 (Rope Swing Pool) and upstream of Reach 1 in the town of Topanga at HG24 (Albuelitas) contained high calcium sulfate content. High sulfate content within the stream may be derived from weathering of marine sedimentary rocks, but can also be a product of pollutants such as fertilizers and wastes. Therefore, the source of the elevated sulfate in the stream water may be a product of pollutants possibly entering the stream from the town of Topanga. Also, the dominant ionic concentration of the creek is generally different than the dominant ionic concentration of the springs, suggesting that the ionic contribution to the creek from the springs in Reach 1 may not be considerable.

The Reach 1 and HG24 (Albuelitas) minimum, maximum and average alkalinity, hardness, and TDS measurements collected within the springs and stream during the 2005 monitoring period are summarized in Table 13 and shown on the graphs in Appendix D.

The Reach 1 alkalinity, hardness, and TDS values were within ranges tolerable or beneficial to aquatic life, as shown on Table 2 above. The 2005 spring and stream hardness and TDS concentrations are within the ranges of very hard, fresh to brackish water (see Table 10 above). The Reach 1 average spring alkalinity and hardness concentrations were slightly higher than those measured within the stream at HG22 (Rope Swing Pool). The average spring TDS concentration was slightly lower than the average stream TDS measured at HG22 (Rope Swing Pool), similar to the pattern observed for the spring and stream conductivity measurements. Also, the stream TDS measured at HG24 (Albuelitas) within the town of Topanga was on the order of two-times higher than the stream TDS measured at HG22 (Rope Swing Pool) within Reach 1, which is again similar to the pattern observed for the conductivity measurements. Sources of the higher TDS stream water may include runoff from the town of Topanga and Topanga Canyon Boulevard.

Table 13: Reach 1 and HG24 (Albuelitas) - 2005 Alkalinity, Hardness, and TDS

Site	# of Tests	Alkalinity (mg/L)			Hardness (mg/L)			TDS (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
HG24 (Albuelitas) Upstream of Reach 1	1	350	350	350	1000	1000	1000	1900	1900	1900
HG23 (Time Tunnel)	1	260	260	260	480	480	480	720	720	720
HG22 (Rope Swing Pool)	7	250	310	287	540	790	687	930	1300	1159
HG21 (Up and Down Trib)	4	340	470	393	790	1300	1005	1200	1800	1450
HG20 (Big Leaf Maple Pool)	4	490	600	548	500	570	533	600	820	663
HG19 (Pool of Many Drips)	1	560	560	560	540	540	540	620	620	620
HG18 (Tadpole Pool)	2	370	390	380	1000	1100	1050	1400	1500	1450
Spring Total	**12**	**260**	**600**	**445**	**480**	**1300**	**773**	**600**	**1800**	**1058**
Stream Total (HG22 only)	**7**	**250**	**310**	**287**	**540**	**790**	**687**	**930**	**1300**	**1159**

Spring Measurement
Stream Measurement

The Reach 1 and HG24 (Albuelitas) minimum, maximum and average nutrient levels of nitrate, ammonia, and phosphates collected within the springs and stream during the 2005 monitoring period are summarized in Table 14 and shown on the graphs in Appendix C.

Table 14: Reach 1 and HG24 (Albuelitas) - 2005 Ammonia, Nitrates, and Phosphates

Site	# of Tests	Ammonia (mg/L)			Nitrates (mg/L)			Phosphates (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
HG24 (Albuelitas) Upstream of Reach 1	1	0.60	0.60	0.60	0.07	0.07	0.07	0.09	0.09	0.09
HG23 (Time Tunnel)	1	0.24	0.24	0.24	0.17	0.17	0.17	0.19	0.19	0.19
HG22 (Rope Swing Pool)	6	0.01	0.89	0.21	0.11	0.72	0.45	0.06	0.31	0.14
HG21 (Up and Down Trib)	6	0.03	0.72	0.28	0.02	0.12	0.07	0.05	0.09	0.07
HG20 (Big Leaf Maple Pool)	7	0.02	0.99	0.28	0.05	0.14	0.07	0.02	0.70	0.15
HG19 (Pool of Many Drips)	7	0.04	0.59	0.18	0.08	0.30	0.15	0.01	0.14	0.08
HG18 (Tadpole Pool)	2	0.15	0.31	0.23	0.06	0.07	0.07	0.08	0.57	0.25
Spring Total	**23**	**0.02**	**0.99**	**0.25**	**0.02**	**0.30**	**0.10**	**0.01**	**0.70**	**0.12**
Stream Total (HG22 only)	**6**	**0.01**	**0.89**	**0.21**	**0.11**	**0.72**	**0.45**	**0.06**	**0.31**	**0.14**

Spring Measurement
Stream Measurement

The average 2005 nutrient concentrations measured at the springs and streams within Reach 1 were below TMDL thresholds (1 mg/L) recommended by the RWQCB for the Malibu Creek and Lagoon and below nutrient criteria (0.5 mg/L) developed by the EPA to represent rivers and streams that are minimally impacted by human activities, as discussed in Section 3.6 above. However, the instream ammonia concentrations during December 2005 and nitrate concentration during October and November 2005 measured at HG22 (Rope Swing Pool) spiked above EPA minimally impacted thresholds. Also, the ammonia concentration measured in December 2005 at HG24 (Albuelitas) within the town of Topanga was above EPA minimally impacted thresholds. Sources of the high nutrient levels may be due to human influence (i.e. discharge of human or animal waste) most likely emanating from the town of Topanga. Also, the ammonia levels at spring sites HG21 (Up and Down Trib), HG20 (Big Leaf Maple Pool), and HG19 (Pool of Many Drips) appear slightly elevated compared to EPA minimally impacted levels. The suspected elevated ammonia levels at the spring sites may be a result of animal waste that may have collected and concentrated (due to low flow and evaporation) at these sites. The nitrate and ammonia concentrations measured within the springs and stream are within limits tolerable to aquatic life, as shown on Table 2 above; however, the desired average phosphate concentrations (<0.1 mg/L) was exceeded at all the sites except HG21 (Up and Down Trib) and HG19 (Pool of Many Drips).

Fish Habitat (Reach 1): This high gradient reach (6%) is characterized by a series of large deep pools, shaped by bedrock and boulder controls. Habitat quality is considered to be very good to excellent. However, the current configuration of the boulder cascades present impassable barriers for upstream migration and the barrier at 5300m (known as the Grotto) is the present upstream limit of anadromy. A series of two upstream pools, locally referred to as Lower and Upper Twin Pools, present additional upstream barriers at 5400m and 5550m. These pools hosted steelhead in 1979, but no trout have been observed this high up in the creek since the 1980 flood event.

Proposed Restoration Effects on Groundwater Resources (Reach 1): No areas within Reach 1 are proposed for restoration.

4.2 Reach 2 (Instream Distance 4,100 to 5,100 meters)

General (Reach 2): Reach 2 is approximately 1,000 meters long within a section of the creek referred to as the "Narrows". Creek flow in this reach is consistently perennial, even during drought years. In all, a total of 21 groundwater sites were identified or suspected within this reach. Of these sites, a total of 7 monitoring sites consisting of springs, seeps, and spring runoff [HG11 (Maidenhair Fern Seep), HG12 (No Parking/Alder Seep), HG13 (Narrows Seep), HG14 (Duck Seep/Kevin Pool), HG15 (Storm Falls), HG16 (Dead Alder Falls), and HG17 (Elderberry Falls)] were selected for monitoring. This reach does not contain instream monitoring sites, although, field measurements within the stream were collected at the nearest upstream location relative to the spring sites.

Geology (Reach 2): Reach 2 is underlain by somewhat crumbly claystone, siltstone, and silty sandstone; coherent sandstone, and coherent conglomerate of the Coal Canyon Formation. Seeps associated with the presence of the claystone and siltstone bedding were observed. Also, two landslides have been mapped within this reach by Dibblee (1992). These landslides are located high on the canyon slopes and do not extend to the base of the canyon. Numerous faults have been mapped by Dibblee (1992) within this reach, including the Tuna Canyon Fault, which forms the southern boundary of Reach 2 and the unnamed fault that forms the northern boundary of this reach (discussed in previous reach summary). Spring activity caused by the presence of the faults was observed and also mapped by Dibblee (1992).

Field Measurements (Reach 2): As summarized on Table 15 and shown on the graphs in Appendix B, the 2005 monitored flows from individual spring located within Reach 2 ranged from a springtime high of between approximately 0.5 and 150 gpm to a summer/fall low of between dry to 1 gpm. The combined spring flow contributed between approximately 3 and 250 gpm to the overall creek flow within this reach during the monitored summer/fall low and springtime high events, respectively. During 2005, the spring sites that flowed continuously (perennially) were HG11 (Maidenhair Fern Seep), HG12 (No Parking/Alder Seep), HG13 (Narrows Seep), HG14 (Duck Seep/Kevin Pool), HG16 (Dead Alder Falls), and HG17 (Elderberry Falls). Since the 2005 precipitation total was more than twice average, it is suspected that all the sites within this reach have the potential to become dry during years with normal to below normal rainfall.

Table 15: Reach 2 - 2005 Spring Flow Summary

Site	# of Samples	Flow (gpm)			
		min.	Date	max	Date
HG11 (Maidenhair Fern Seep)	8	Seeping	Jun. - Dec. 2005	0.5	3/1/05 and 4/26/05
HG12 (No Parking/Alder Seep)	5	Seeping	Jun. - Dec. 2005	Seeping	Jun. - Dec. 2005
HG13 (Narrows Seep)	9	1	6/15/05	40	3/1/05
HG14 (Duck Seep/Kevin Pool)	7	0.06	11/22/05	0.15	8/16/05
HG15 (Storm Falls)	9	Dry	Oct. - Dec. 2005	150	3/1/05
HG16 (Dead Alder Falls)	8	Seeping	10/7/05	18	5/31/05
HG17 (Elderberry Falls)	8	0.3	12/20/05	24	5/31/05

The Reach 2 minimum, maximum and average conductivity, pH, salinity, and dissolved oxygen measurements collected within the springs and stream during the 2005 monitoring period are summarized in Table 16 and shown on the graphs in Appendix B.

As shown on Table 16, the average pH and salinity measurements collected at the springs within Reach 2 were generally within similar ranges as measurements collected in the stream. The spring conductivities measured within Reach 2 are generally lower than the corresponding stream conductivities suggesting a relatively higher concentration of dissolved solids within the stream. Sources of the higher conductivity stream water relative to the spring water may include runoff from the town of Topanga and Topanga Canyon Boulevard.

The dissolved oxygen values measured in the creek were generally higher than those measured at the springs, due to the larger surface area of the stream and the greater affects of photosynthesis within the stream. The Reach 2 average spring and stream dissolved oxygen levels were above the minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L), as shown on Table 2 above. However, only spring HG15 (Storm Falls) during November 2005 had a measured dissolved oxygen value lower than 5.5 mg/L.

Table 16: Reach 2- 2005 Spring and Stream Field Measurements

Site	# of Tests	Conductivity (uS)			pH			Salinity (ppt)			DO (mg/L)		
		min	max	avg	min	max	avg	min	max	Avg	min	max	avg
HG17 (Elderberry Falls)	8	810	1250	1055	7.9	9.0	8.5	0	3	1	6.48	10.62	9.15
	8	1220	1750	1461	7.7	8.7	8.2	0	3	1	9.14	11.11	9.91
HG16 (Dead Alder Falls)	8	980	1290	1118	8.1	8.9	8.4	1	2	2	6.56	9.73	8.85
	8	1210	1750	1433	7.7	8.9	8.2	1	3	2	7.68	10.97	9.67
HG15 (Storm Falls)	7	870	1130	973	7.7	8.5	8.0	0	2	1	2.85	9.42	7.23
	7	1210	1730	1437	7.7	8.7	8.2	1	3	2	9.00	11.80	9.84
HG14 (Duck Seep/Kevin Pool)	7	930	1090	1003	6.5	7.7	7.2	0	2	1	9.18	9.18	9.18
	7	1130	1720	1430	7.8	8.9	8.3	1	2	2	8.92	11.13	9.79
HG13 (Narrows Seep)	8	860	1190	1013	7.4	8.8	7.9	0	4	1	NM	NM	NM
	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
HG12 (No Parking/Alder Seep)	4	820	970	888	7.3	8.4	7.9	0	1	0	NM	NM	NM
	5	1100	1630	1312	7.6	8.7	8.3	0	3	1	9.67	10.76	10.18
HG11 (Maidenhair Fern Seep)	7	880	1230	1044	7.6	8.9	8.2	0	4	1	9.67	9.67	9.67
	6	1090	1620	1292	8.4	8.8	8.5	0	3	1	9.35	13.50	10.67
Spring Total	**49**	**810**	**1290**	**1024**	**6.5**	**9.0**	**8.0**	**0**	**4**	**1**	**2.85**	**10.62**	**8.54**
Stream Total	**41**	**1090**	**1750**	**1406**	**7.6**	**8.9**	**8.3**	**0**	**3**	**2**	**7.68**	**13.50**	**9.98**

Spring Measurement
Stream Measurement

Water Chemistry (Reach 2): The ionic concentration of the springs tested within Reach 2 during 2005 showed relatively high magnesium carbonate content [HG15 (Storm Falls), HG16 (Dead Alder Falls), and HG17 (Elderberry Falls)], relatively high magnesium-calcium sulfate content [HG11 (Maidenhair Fern Seep) and HG14 (Duck Seep/Kevin Pool)], relatively high calcium carbonate content HG13 (Narrows Seep), and relatively high sodium-potassium sulfate content HG12 (No Parking/Alder Seep) (see Figure 7). No instream ionic concentrations were measured within Reach 2 during 2005.

The Reach 2 minimum, maximum and average alkalinity, hardness, and TDS measurements collected within the springs during the 2005 monitoring period are summarized in Table 17 and shown on the graphs in Appendix D. These measurements were not performed within the stream along Reach 2 during the 2005 monitoring period.

Table 17: Reach 2 - 2005 Alkalinity, Hardness, and TDS

Site	# of Tests	Alkalinity (mg/L)			Hardness (mg/L)			TDS (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
HG17 (Elderberry Falls)	2	500	560	530	460	510	485	580	620	600
HG16 (Dead Alder Falls)	4	550	730	650	560	590	568	670	750	700
HG15 (Storm Falls)	3	310	430	370	410	450	427	610	680	637
HG14 (Duck Seep/Kevin Pool)	2	230	230	230	430	440	435	700	720	710
HG13 (Narrows Seep)	5	340	360	346	490	530	508	600	710	644
HG12 (No Parking/Alder Seep)	1	260	260	260	330	330	330	570	570	570
HG11 (Maidenhair Fern Seep)	1	270	270	270	510	510	510	740	740	740
Spring Total	**18**	**230**	**730**	**416**	**330**	**590**	**486**	**570**	**750**	**659**

The Reach 2 alkalinity, hardness, and TDS values were within ranges tolerable or beneficial to aquatic life, as shown on Table 2 above. The 2005 spring hardness and TDS concentrations are within the ranges of very hard, fresh water (see Table 10 above).

The Reach 2 minimum, maximum and average nutrient levels of nitrate, ammonia, and phosphates collected within the springs during the 2005 monitoring period are summarized in Table 18 and shown on the graphs in Appendix C. Nutrient concentrations were not measured within the stream along Reach 2 during the 2005 monitoring period.

Table 18: Reach 2 - 2005 Ammonia, Nitrates, and Phosphates

Site	# of Tests	Ammonia (mg/L)			Nitrates (mg/L)			Phosphates (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
HG17 (Elderberry Falls)	7	0.02	0.79	0.19	0.03	0.61	0.18	0.03	0.14	0.07
HG16 (Dead Alder Falls)	7	0.01	2.67	0.45	0.01	2.49	0.45	0.00	0.09	0.05
HG15 (Storm Falls)	6	0.03	0.39	0.11	0.07	1.86	0.53	0.00	0.14	0.04
HG14 (Duck Seep/Kevin Pool)	5	0.05	0.54	0.19	0.06	0.25	0.14	0.02	0.07	0.04
HG13 (Narrows Seep)	6	0.05	0.58	0.23	0.03	0.38	0.18	0.00	0.23	0.10
HG12 (No Parking/Alder Seep)	4	0.12	0.75	0.32	0.02	0.18	0.10	0.00	0.22	0.09
HG11 (Maidenhair Fern Seep)	7	0.06	0.54	0.23	0.02	0.21	0.13	0.01	0.13	0.05
Spring Total	**42**	**0.01**	**2.67**	**0.25**	**0.01**	**2.49**	**0.25**	**0.00**	**0.23**	**0.06**

The average 2005 nutrient concentrations measured at the springs within Reach 2 were below TMDL thresholds (1 mg/L) recommended by the RWQCB for the Malibu Creek and Lagoon and below nutrient criteria (0.5 mg/L) developed by the EPA to represent rivers and streams that are minimally impacted by human activities, as discussed in Section 3.6 above. However, slightly elevated ammonia and/or nitrate concentrations compared to EPA minimally impacted thresholds were measured at all the spring sites in Reach 2. Concentrations of nutrients above the recommended TMDL thresholds were measured at spring sites HG16 (Dead Alder Falls) during October and December 2005 and HG15 (Storm Falls) during October 2005. The suspected elevated ammonia and nitrate levels at the spring sites may be a result of animal waste that may have collected and concentrated (due to low flow and evaporation) at these sites. The nitrate concentrations are within limits tolerable to aquatic life, as shown on Table 2 above; however, the desired average phosphate concentrations (<0.1 mg/L) was exceeded at all the sites except HG16 (Dead Alder Falls) and HG14 (Duck Seep/Kevin Pool).

Fish Habitat (Reach 2): The canyon is quite constrained in this 4-6 % gradient reach, with an almost vertical bedrock cliff on the east, and encroachment by Caltrans riprap materials on the west. The step pools are interspersed with step runs and high gradient riffles. The numerous seeps and springs in this reach appear to enhance habitat quality, which is considered to be good to very good, despite the impacts to channel capacity from the riprap. There are several barriers within this reach, but all are passable under high flow conditions. The barriers consist mainly of large boulder jams that create deep plunge pools under narrow chutes of flow. The exception to this is at 4400m, known as the Barrier Falls. This is a more stepped transverse outcrop of Coal Canyon Formation sandstone. Until the high rainfall year of 2005, this was the functional upper limit for steelhead distribution.

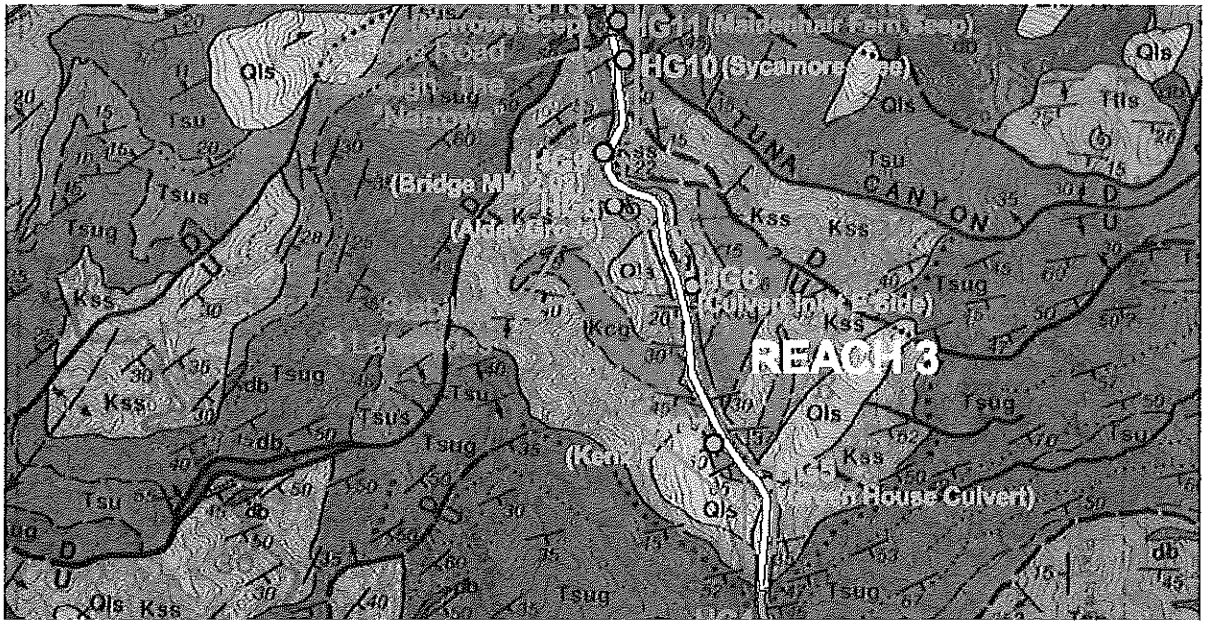
Proposed Restoration Effects on Groundwater Resources (Reach 2): The proposed restoration of the "Narrows" section within Reach 2 of the creek involves the reconstruction of Topanga Canyon Boulevard, and the approximate location of this restoration project is shown on Figure 10. This reconstruction would remove road fill within the creek and restore creek channel capacity, while at the same time improving road safety and maintenance.

Groundwater features that have the potential to become impacted due to the proposed "Narrows" reconstruction restoration activities within Reach 2 and the anticipated impact to those features as a result of the restoration are summarized in the Table 19.

Table 19: Reach 2 - Groundwater Features within Proposed "Narrows" Restoration Area and Potential Impacts Resulting From Restoration Activities

Site	Type	Potential Impact	Potential Impact Avoidance
HG11 (Maidenhair Fern Seep)	2005 Perennial Spring/Seep	Spring located at base of creek on east side of canyon. Probably no impact; however, spring could become covered during fill removal or grading operations.	Careful fill removal/grading operations that minimize equipment operation and fill placement in the area of the spring.
HG12 (No Parking/Alder Seep)	2005 Perennial Spring/Seep	Spring located at base of creek on east side of canyon. Probably no impact; however, spring could become covered during fill removal or grading operations.	Careful fill removal/grading operations that minimize equipment operation and fill placement in the area of the spring.
HG13 (Narrows Seep)	2005 Perennial Spring	Spring located adjacent to Topanga Canyon Boulevard on west side of canyon. It is possible that a portion of this spring is covered by road fill. Removal of this road fill and reconstruction of Topanga Canyon Boulevard on a bridge that would span the spring has the potential to restore spring to full capacity. However, spring flow could be reduced or dried up due to road grading within the spring or tunneling beneath the spring.	Road grading and tunneling within the area of the spring have the highest potential for impact. Reconstruction of road on a bridge which would span the spring has the least potential for impact and may help to restore spring to full capacity.
HG14 (Duck Seep/Kevin Pool)	2005 Perennial Spring/Seep	Spring located at base of creek on west side of canyon. Probably no impact; however, spring could become covered during fill removal or grading operations.	Careful fill removal/grading operations that minimize equipment operation and fill placement in the area of the spring.

4.3 Reach 3 (Instream Distance 2,100 to 4,100 meters)



General (Reach 3): Reach 3 is approximately 2,000 meters long and consistently has perennial flow, even during drought years. In all, a total of 20 groundwater sites were identified or suspected within this reach. Of these sites, a total of 5 monitoring sites consisting of springs, seeps, and spring runoff [HG5 (Green House Culvert), HG6 (Culvert Inlet E Side), HG7 (Ken2 Pool), HG8 (Alder Grove), HG10 (Sycamore Tree)] were selected for monitoring. In addition, field measurements within the stream were collected at the nearest upstream location relative to the spring sites. Also, monitoring was performed at one instream location HG9 (Bridge MM 2.02). In addition, Los Angeles County has a stream flow gage monitoring station (LACDPW #F54), located at study site number HG9 (Bridge MM 2.02), within this reach.

Geology (Reach 3): Reach 3 is underlain by moderately hard sandstone with some shale layers and coherent conglomerate of the Tuna Canyon Formation. Also, three landslides have been mapped by Dibblee (1992) within this reach, and these landslides extend to the base of the canyon. Spring activity related to the presence of the landslides was observed. Several faults have also been mapped by Dibblee (1992) within this reach, including the Tuna Canyon Fault, which forms the boundary between Reach 2 and 3. Spring activity related to the presence of the mapped faults was observed.

Field Measurements (Reach 3): As summarize in Table 20 and shown on the graphs in Appendix B, the 2005 individual spring flows measured within Reach 3 ranged from a springtime high of between 6 and 50 gpm to a summer/fall low between dry to 3.45 gpm. Together all the springs contributed between approximately 8 and 120 gpm to the overall creek flow within this reach during the monitored summer/fall low and springtime high events, respectively. During 2005, the spring sites that flowed continuously (perennially) were HG5 (Green House Culvert), HG7 (Ken2 Pool), HG8 (Alder Grove), and HG10

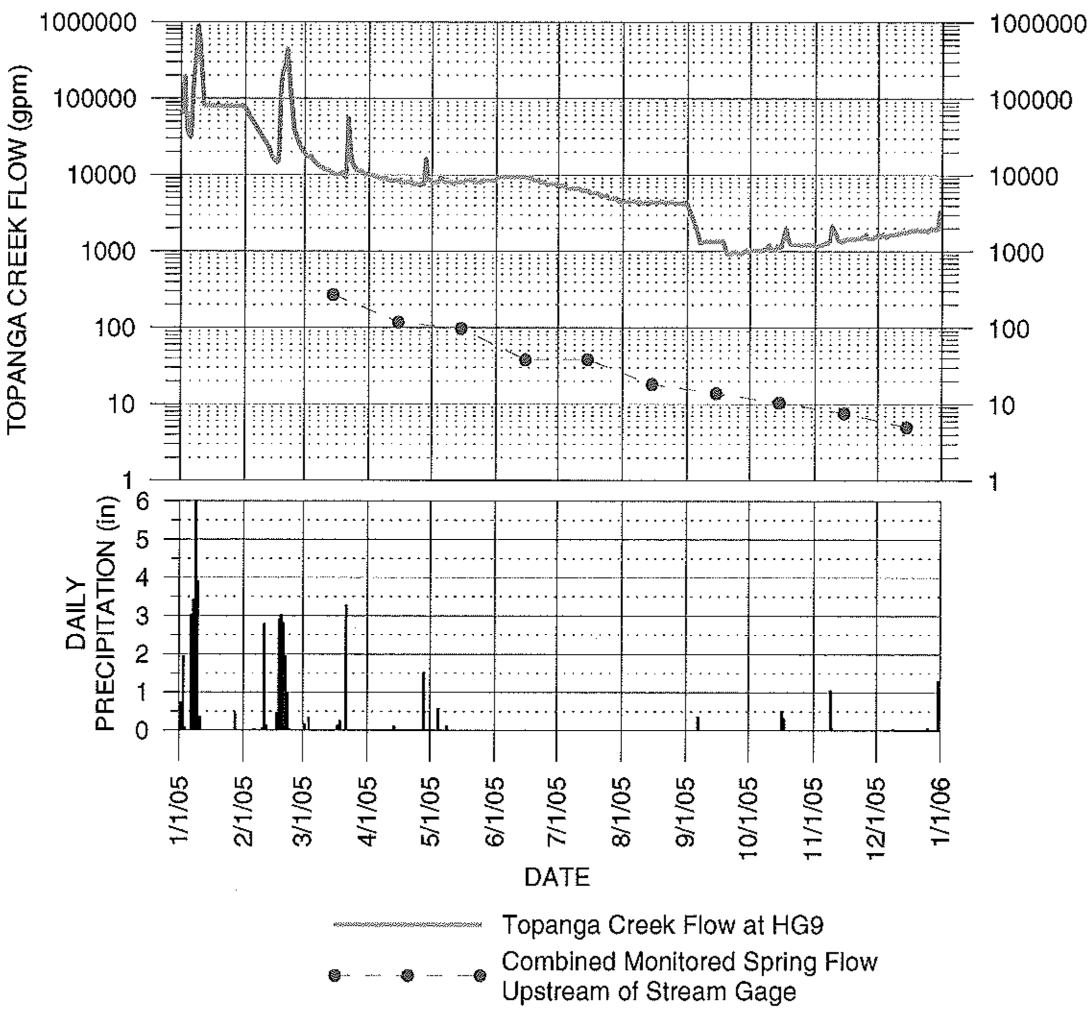
(Sycamore Tree). Since the 2005 precipitation total was more than twice average, it is suspected that during years with normal to below normal rainfall all the sites within this reach have the potential to become dry.

Table 20: Reach 3 - 2005 Spring Flow Summary

Site	# of Samples	Flow (gpm)			
		min.	Date	max	Date
HG5 (Green House Culvert)	8	3	9/28/05	15	4/26/05
HG6 (Culvert Inlet E side)	8	Dry	Sept - Dec. 2005	50	3/1/05
HG7 (Ken2 Pool)	8	3.45	12/19/05	15	3/1/05 and 4/26/05
HG8 (Alder Grove)	8	0.75	9/28/05	6	6/14/05
HG10 (Sycamore Tree)	9	0.25	6/15/05	30	3/1/05

Figure 12 shows the 2005 creek flows monitored at HG9 (Bridge MM 2.02) and the 2005 daily precipitation measured at the Topanga Patrol Station rain gage in the town of Topanga.

Figure 12: Creek and Spring Flows Within Reach 3



As shown on Figure 12, the 2005 Topanga Creek flows measured at site HG9 (Bridge MM 2.02) ranged between approximately 940 gpm and 900,000 gpm. As would be expected, it appears that spikes in the creek flow generally correlate with spikes in precipitation, corresponding to increased rain runoff into the creek. The combined flows from spring sites HG10 through HG23, located upstream of the creek flow gage within Reaches 1 through 3, are also shown on Figure 12. As shown on this figure, the combined spring flows and creek flows follow a similar seasonal pattern, and the combined spring flows are generally 100 times less than the creek flows. This suggests that the input from the monitored springs upstream of the creek's flow gage generally comprise about 1% of the total creek flow; therefore, the influence of the monitored springs on the creek flow volume and chemistry was probably minimal during 2005. It is noted that the springs with the highest flow volume and longest flow durations were selected for monitoring; however, it is recognized that other springs that were not monitored could also contribute to overall creek flow.

The Reach 3 minimum, maximum and average conductivity, pH, salinity, and dissolved oxygen measurements collected within the springs and stream during the 2005 monitoring period are summarized in Table 21 and shown on the graphs in Appendix B.

Table 21: Reach 3 - 2005 Spring and Stream Field Measurements

Site	# of Tests	Conductivity (uS)			pH			Salinity (ppt)			DO (mg/L)		
		min	max	avg	min	max	avg	min	max	avg	min	max	avg
HG10	8	830	1230	1055	7.5	8.5	8.1	0	3	1	6.70	10.48	8.96
(Sycamore Tree)	5	1060	1630	1340	8.4	8.7	8.5	0	3	2	9.42	12.99	11.07
HG9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(Bridge MM 2.02)	6	1110	1670	1353	8.1	8.2	8.2	1	2	1	8.10	10.70	9.15
HG8	8	670	1110	923	7.1	8.3	7.7	0	3	1	5.13	8.70	7.14
(Alder Grove)	6	1110	1640	1347	8.1	8.6	8.3	0	1	1	8.50	10.71	9.54
HG7	8	1020	1400	1171	7.6	8.5	8.1	0	2	1	6.39	10.00	8.73
(Ken2 Pool)	5	990	1630	1316	7.6	8.7	8.2	0	2	1	8.86	10.63	9.75
HG6	4	1040	1400	1183	7.7	8.3	8.0	0	3	1	6.53	9.23	8.24
(Culvert Inlet E side)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
HG5	8	1850	2700	2274	7.6	8.7	8.2	1	4	2	6.84	11.00	9.55
(Green House Culvert)	6	1140	1620	1345	8.1	8.5	8.3	0	2	1	9.03	10.70	9.66
Spring Total	**28**	**670**	**2700**	**1290**	**7.1**	**8.7**	**8.0**	**0**	**4**	**1**	**5.13**	**11.00**	**8.57**
Stream Total	**28**	**990**	**1670**	**1341**	**7.6**	**8.7**	**8.3**	**0**	**3**	**1**	**8.10**	**12.99**	**9.79**

Spring Measurement
Stream Measurement

As shown on Table 21, the average pH and salinity measurements collected at the springs within Reach 3 were generally within similar ranges as measurements collected in the stream. The spring conductivities measured within Reach 3 are generally lower than the corresponding stream conductivities, with the exception of HG5 (Green House Culvert), suggesting a relatively higher concentration of dissolved solids within the stream. Sources of the higher conductivity stream water relative to the spring water may include runoff from the town of Topanga and Topanga Canyon Boulevard. It is noted that spring site HG5 (Green House Culvert) consists of spring runoff most likely from landslide deposits on the east side of the canyon and is located adjacent to Topanga Canyon Boulevard. Increased conductivity measurements at HG5 (Green House Culvert) may be heavily influenced due to runoff from the landslide deposits and from Topanga Canyon Boulevard. The dissolved oxygen values measured in the creek were generally higher than those measured at the springs, due to the larger surface area of the stream and the greater affects of photosynthesis within the stream. The Reach 3 average spring and stream dissolved oxygen levels were above the minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L), as shown on Table 2 above. However, only spring HG8 (Alder Grove) during September 2005 had a measured dissolved oxygen value lower than 5.5 mg/L.

Water Chemistry (Reach 3): The ionic concentration of the springs tested within Reach 3 during 2005 showed high magnesium sulfate content [HG5 (Green House Culvert) and HG10 Sycamore Tree), high calcium sulfate content [HG6 (Culvert Inlet E Side) and HG7 (Ken2 Pool), and high calcium carbonate content HG8 (Alder Grove) (see Figure 7). The Reach 3 instream ionic concentrations measured at HG9 (Bridge MM 2.02) contained high calcium-magnesium sulfate content. The high sulfate content measured within the stream and at some spring sites may be derived from weathering of marine sedimentary rocks, but can also be a product of pollutants such as fertilizers and wastes. Therefore, the source of the elevated sulfate in the stream water may be a product of pollutants possibly entering the stream from the town of Topanga or as runoff from Topanga Canyon Boulevard.

The Reach 3 minimum, maximum and average alkalinity, hardness, and TDS measurements collected within the springs and stream during the 2005 monitoring period are summarized in Table 22 and shown on the graphs in Appendix D.

Table 22: Reach 3 - 2005 Alkalinity, Hardness, and TDS

Site	# of Tests	Alkalinity (mg/L)			Hardness (mg/L)			TDS (mg/L)		
		min	Max	avg	min	max	avg	min	max	avg
HG10 (Sycamore Tree)	1	200	200	200	440	440	440	700	700	700
HG9 (Bridge MM 2.02)	7	260	290	280	500	690	584	780	1100	981
HG8 (Alder Grove)	4	300	320	308	440	480	458	620	640	630
HG7 (Ken2 Pool)	4	270	290	278	520	2000	548	800	820	810
HG6 (Culvert Inlet E side)	2	230	240	235	520	540	530	830	860	845
HG5 (Green House Culvert)	4	310	330	320	1100	1100	1100	1700	2000	1825
Spring Total	**15**	**200**	**330**	**286**	**440**	**1100**	**661**	**620**	**2000**	**1030**
Stream Total (HG9 only)	**7**	**260**	**290**	**280**	**500**	**690**	**584**	**780**	**1100**	**981**

Spring Measurement
Stream Measurement

The Reach 3 alkalinity, hardness, and TDS values were within ranges tolerable or beneficial to aquatic life, as shown on Table 2 above. The 2005 spring and stream hardness and TDS concentrations are within the ranges of very hard, fresh to brackish water (see Table 10 above). The Reach 3 average spring alkalinity concentrations were close to the same concentration measured within the stream at HG9 (Bridge MM 2.02). The Reach 3 average spring hardness concentrations were slightly higher than those measured within the stream with spring site HG5 (Green House Culvert) having on the order of two-times the hardness concentration as the other sites. Also, the stream TDS measured at site HG9 (Bridge MM 2.02) was generally higher than the TDS measured within the springs except for spring site HG5 (Green House Culvert), which had on the order of two-times the TDS concentration as the other sites. The generally higher stream TDS concentrations relative to the spring concentrations show a similar pattern to that observed for the conductivity measurements. It is noted that site HG5 (Green House Culvert) consists of spring runoff most likely from landslide deposits and is located adjacent to Topanga Canyon Boulevard. Increased TDS measurements at HG5 (Green House Culvert) may be heavily influenced due to runoff over the landslide deposits and from Topanga Canyon Boulevard.

The Reach 3 minimum, maximum and average nutrient levels of nitrate, ammonia, and phosphates collected within the springs and stream during the 2005 monitoring period are summarized in Table 23 and shown on the graphs in Appendix C.

Table 23: Reach 3 - 2005 Ammonia, Nitrates, and Phosphates

Site	# of Tests	Ammonia (mg/L)			Nitrates (mg/L)			Phosphates (mg/L)		
		min	max	avg	min	max	avg	min	max	Avg
HG10 (Sycamore Tree)	6	0.04	3.06	0.61	0.07	0.26	0.14	0.00	0.20	0.06
HG9 (Bridge MM 2.02)	6	0.04	0.37	0.13	0.09	0.24	0.16	0.02	0.07	0.04
HG8 (Alder Grove)	6	0.04	1.04	0.40	0.10	0.22	0.17	0.00	0.07	0.04
HG7 (Ken2 Pool)	7	0.02	1.65	0.34	0.42	1.44	1.09	0.02	0.10	0.05
HG6 (Culvert Inlet E side)	3	0.06	1.00	0.38	0.38	1.48	0.88	0.04	0.05	0.05
HG5 (Green House Culvert)	7	0.05	0.73	0.21	0.26	0.73	0.44	0.02	0.05	0.04
Spring Total	**29**	**0.02**	**3.06**	**0.40**	**0.07**	**1.48**	**0.52**	**0.00**	**0.20**	**0.05**
Stream Total (HG9 only)	**6**	**0.04**	**0.37**	**0.13**	**0.09**	**0.24**	**0.16**	**0.02**	**0.07**	**0.04**

Spring Measurement
Stream Measurement

The average 2005 nutrient concentrations measured at the springs and streams within Reach 3 were below TMDL thresholds (1 mg/L) recommended by the RWQCB for the Malibu Creek and Lagoon with the exception of the nitrate concentrations measured at HG7 (Ken2 Pool) that averaged 1.09 mg/L for the 2005 monitoring period. The Reach 3 nutrient concentrations within the stream monitored at HG9 (Bridge MM 2.02) did not exceed nutrient criteria (0.5 mg/L) developed by the EPA to represent rivers and streams that are minimally impacted by human activities, as discussed in Section 3.6 above. However, the spring ammonia and/or nitrate concentrations measured at all the spring sites were elevated compared to EPA minimally impacted thresholds. The suspected elevated ammonia levels at the spring sites may be a result of animal waste that may have collected and concentrated (due to low flow and evaporation) at these sites. The nitrate and ammonia concentrations measured within the springs and stream are generally within limits tolerable to aquatic life, as shown on Table 2 above; however, the continuous criteria ammonia threshold (1.5 mg/L) was exceeded at spring sites HG10 (Sycamore Tree) and HG7 (Ken2 Pool) in October 2005. The desired average phosphate concentration (<0.1 mg/L) was only exceeded at site HG10 (Sycamore Tree) in December 2005.

Fish Habitat (Reach 3): This reach of creek includes three active landslides which have deposited a significant amount of debris and sediment into the channels, and the east bank of the creek is armored with riprap for almost the entire length of the creek. The average gradient is 3%. Habitat includes a mix of step pools, step runs and riffles. Habitat quality is considered to be good to very good. The barriers in this reach are all passable downstream at all times, but upstream passage is limited when flows diminish during the dry season. The most significant barrier is located at 2700m and known as Shale Falls. It is an outcrop of Tuna Canyon Formation shale that creates a vertical obstacle over 2 meters high. The depth of the plunge pool under the waterfall varies, but is not sufficiently deep to allow trout to move upstream in low flow conditions.

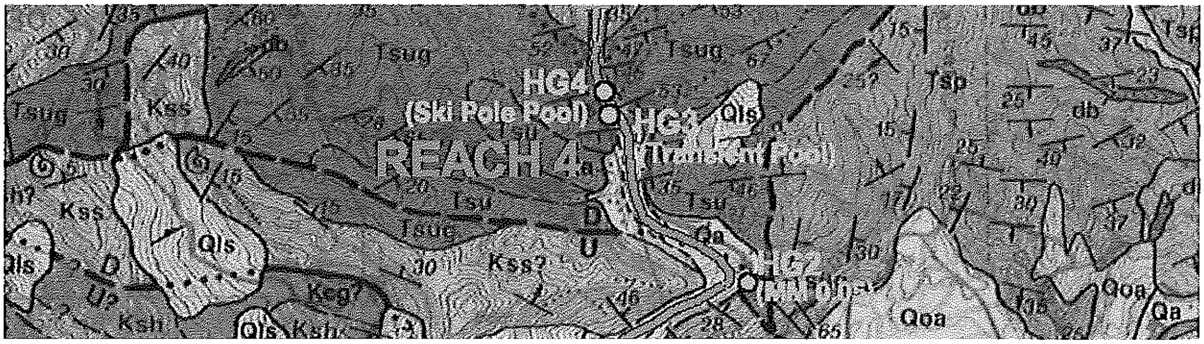
Proposed Restoration Effects on Groundwater Resources (Reach 3): The restoration projects proposed within Reach 3 involves the stabilization of Topanga Canyon Boulevard through the "Narrows" as discussed above and the stabilization of 3 large landslides on the west bank of Topanga Creek. The locations of the landslides are shown on Figure 10. The proposed landslide stabilization involves removing excess sediment blocking the creek channel to restore capacity and using bio-engineering strategies (i.e. planting riparian vegetation) to stabilize the toes of the landslides. The stabilization of the landslides would help improve year-round surface flows and to reduce sediment loads downstream.

Groundwater features that have the potential to become impacted due to the proposed restoration activities within Reach 3 and the anticipated impact to those features as a result of the restoration are summarized in the Table 24.

Table 24: Reach 3 - Groundwater Features within Proposed "Narrows" and Landslide Restoration Areas and Potential Impacts from Restoration Activities

Site	Type	Potential Impact	Potential Impact Avoidance
HG5 (Green House Culvert)	Spring Runoff	Landslide Restoration: Spring runoff from east side of canyon through culvert. Probably no impact.	Not Applicable
HG6 (Culvert Inlet E Side)	Spring Runoff	Landslide Restoration: Spring runoff from east side of canyon through culvert. Probably no impact.	Not Applicable
HG7 (Ken2 Pool)	2005 Perennial Spring	Landslide Restoration: Site on west side of canyon and flows through base of landslide. Alteration of landslide and planting of slope has the potential to reduce or dry up spring surface flow.	Minimize grading and planting of slope within area of spring.
HG8 (Alder Grove)	Spring Runoff	Landslide Restoration: Spring runoff from west side of canyon. Probably no impact.	Not Applicable
HG10 (Sycamore Tree)	2005 Perennial Spring	"Narrows" Restoration: Spring located at base of creek on east side of canyon. Probably no impact; however, spring could become covered during grading operations.	Careful fill removal/grading operations that minimize equipment operation and fill placement in the area of the spring.

4.4 Reach 4 (Instream Distance 1,100 to 2,100 meters)



General (Reach 4): Reach 4 is approximately 1,000 meters long, and consistently has perennial flow, even during drought years. In all, a total of 3 groundwater sites were identified or suspected within this reach. Of these sites, one spring HG2 (MM 0.05) was monitored. Also, monitoring was performed at 2 instream monitoring locations [HG3 (Transient Pool) and HG4 (Ski Pole Pool)].

Geology (Reach 4): Reach 4 is underlain by somewhat crumbly claystone, siltstone, and silty sandstone; and coherent conglomerate of the Coal Canyon Formation. One fault, which forms the southern boundary of this reach, has been mapped by Dibblee (1992). Spring activity caused by the presence of this fault was observed and mapped by Dibblee.

Field Measurements (Reach 4): As shown on the graph in Appendix B, the 2005 monitored spring flow from the one site monitored within Reach 4, HG2 (MM 0.05), ranged from a springtime high of approximately 10 gpm to a summer/fall low of dry.

Table 25: Reach 4 - 2005 Spring Flow Summary

Site	# of Samples	Flow (gpm)			
		min.	Date	max	Date
HG2 (MM 0.05)	4	Dry	Aug. - Dec. 2005	10	3/1/05

The Reach 4 minimum, maximum and average conductivity, pH, salinity, and dissolved oxygen measurements collected within spring site HG2 (MM 0.05) and stream during the 2005 monitoring period are summarized in Table 26 and shown on the graphs in Appendix B.

As shown on Table 26, the average pH and salinity measurements collected at spring site HG2 (MM 0.05) within Reach 4 was generally within similar ranges as measurements collected in the stream. The Reach 4 spring conductivity measured at site HG2 (MM 0.05) within is generally lower than the Reach 4 stream conductivities suggesting a relatively higher concentration of dissolved solids within the stream. Sources of the higher conductivity stream water relative to the spring water may include urban runoff possibly from Topanga Canyon Boulevard. The Reach 4 stream dissolved oxygen levels were above the minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L), as shown on Table 2 above.

Table 26: Reach 4 - 2005 Spring and Stream Field Measurements

Site	# of Tests	Conductivity (uS)			pH			Salinity (ppt)			DO (mg/L)		
		min	max	avg	min	max	avg	min	max	Avg	min	max	avg
HG4 (Ski Pole Pool)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	7	1180	1650	1353	7.6	8.7	8.4	0	2	1	9.04	11.80	10.39
HG3 (Transient Pool)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8	1160	1630	1345	7.6	8.8	8.3	0	2	1	7.06	11.96	10.19
HG2 (MM 0.05)	2	1130	1400	1265	7.5	7.7	7.6	0	0	0	NM	NM	NM
	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Spring Total (HG2)	**2**	1130	1400	1265	7.5	7.7	7.6	0	0	0	NM	NM	NM
Stream Total	**15**	1160	1650	1349	7.6	8.8	8.3	0	2	1	7.06	11.96	10.28

Spring Measurement
Stream Measurement

Water Chemistry (Reach 4): The ionic concentration of the one spring tested during 2005 within Reach 4, HG2 (MM 0.05), showed relatively high calcium sulfate content (see Figure 7). The Reach 4 instream ionic concentration tested at site HG3 (Transient Pool), contained relatively high magnesium sulfate content. The high sulfate content measured within the stream and spring sites may be derived from weathering of marine sedimentary rocks, but can also be a product of pollutants such as fertilizers and wastes. Therefore, the source of the elevated sulfate in the stream water may be a product of pollutants most likely entering the stream from the town of Topanga, runoff from Topanga Canyon Boulevard, or residential development upslope of site HG2 (MM 0.05).

The Reach 4 minimum, maximum and average alkalinity, hardness, and TDS measurements collected at spring HG2 (MM 0.05) and stream site HG3 (Transient Pool) during the 2005 monitoring period are summarized in Table 27 and shown on the graphs in Appendix D.

Table 27: Reach 4 - 2005 Alkalinity, Hardness, and TDS

Site	# of Tests	Alkalinity (mg/L)			Hardness (mg/L)			TDS (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
HG3 (Transient Pool)	6	240	280	270	540	670	608	810	1100	998
HG2 (MM 0.05)	1	320	320	320	700	700	700	590	590	590

Spring Measurement
Stream Measurement

The Reach 4 alkalinity, hardness, and TDS values were within ranges tolerable or beneficial to aquatic life, as shown on Table 2 above. The 2005 spring and stream hardness and TDS concentrations are within the ranges of very hard, fresh to brackish water (see Table 10 above). The stream TDS measured at site HG3 (Transient Pool) was higher than the TDS measured at spring HG2 (MM 0.05). The higher stream TDS concentrations relative to the TDS concentration measured at spring HG2 (MM 0.05) show a similar pattern to that observed for the conductivity measurements. Sources of the higher TDS stream water may include urban runoff possibly from Topanga Canyon Boulevard.

The Reach 4 minimum, maximum and average nutrient levels of nitrate, ammonia, and phosphates collected within the spring HG2 (MM 0.05) and stream during the 2005 monitoring period are summarized in Table 28 and shown on the graphs in Appendix C.

Table 28: Reach 4 - 2005 Ammonia, Nitrates, and Phosphates

Site	# of Tests	Ammonia (mg/L)			Nitrates (mg/L)			Phosphates (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
HG4 (Ski Pole Pool)	2	0.06	0.10	0.08	0.04	0.06	0.05	0.00	0.05	0.03
HG3 (Transient Pool)	6	0.05	0.40	0.16	0.08	0.30	0.18	0.01	0.12	0.06
HG2 (MM 0.05)	1	0.11	0.11	0.11	0.07	0.07	0.07	0.06	0.06	0.06
Spring Total (HG2 only)	**1**	**0.11**	**0.11**	**0.11**	**0.07**	**0.07**	**0.07**	**0.06**	**0.06**	**0.06**
Stream Total	**8**	**0.05**	**0.40**	**0.14**	**0.04**	**0.30**	**0.15**	**0.00**	**0.12**	**0.05**

Spring Measurement

Stream Measurement

The 2005 nutrient concentrations measured at spring HG2 (MM 0.05) and stream within Reach 4 were below TMDL thresholds (1 mg/L) recommended by the RWQCB for the Malibu Creek and Lagoon and below nutrient criteria (0.5 mg/L) developed by the EPA to represent rivers and streams that are minimally impacted by human activities, as discussed in Section 3.6 above. The nitrate concentrations are within limits tolerable to aquatic life, as shown on Table 2 above. The desired average phosphate concentration (<0.1 mg/L) was only exceeded at site HG3 (Transient Pool) during August and December 2005.

Fish Habitat (Reach 4): Although the creek channel is constrained by the canyon and road at the top of this reach creating a series of 3-4% gradient step pools and runs, the lower segment of the reach spreads out into a wider, more alluvial deposition zone with a gradient averaging 1%. The habitat quality in this reach is good to very good. Between 1800-2000 meters, there is a series of three large pools controlled by boulder jams which create waterfall cascades of more than 1.5 meters. These are considered to be low flow barriers, passable downstream at all times, but with upstream passage limited to higher flow stages. Steelhead have been consistently found in this reach since 2001.

Proposed Restoration Effects on Groundwater Resources (Reach 4): No areas within this reach are proposed for restoration.

4.5 Reach 5 (Instream Distance 0 to 1,100 meters)

General (Reach 5): Reach 5 is approximately 1,100 meters long and is located at the southern end of the study area. Surface flows within this section of the creek typically go dry for 6 to 9 months during the year; however during 2005, this section of the creek flowed continuously due to the large amounts of precipitation. No spring activity was observed within this reach of the creek. This reach contains one instream monitoring location HG1 (Topanga Lagoon).

Geology (Reach 5): Reach 5 is underlain by moderately hard sandstone with some shale layers and coherent conglomerate of the Tuna Canyon Formation. Also, a landslide, which extends to the base of the canyon, was mapped in this reach by Dibblee (1992) on the west side of the canyon near Rodeo Grounds Berm. Two faults have been mapped by Dibblee (1992) within this reach, including an unnamed fault, which forms the northern boundary of Reach 5.

Field Measurements (Reach 5): The Reach 4 minimum, maximum and average conductivity, pH, salinity, and dissolved oxygen measured at stream site HG1 (Topanga Lagoon) during the 2005 monitoring period are summarized in Table 29 and shown on the graphs in Appendix B.

Table 29: Reach 5 - 2005 Stream Field Measurements

Site	# of Tests	Conductivity (uS)			pH			Salinity (ppt)			DO (mg/L)		
		min	max	avg	min	max	avg	min	max	avg	min	max	avg
HG1 (Topanga Lagoon)	7	1100	3600	1966	7.4	8.2	7.8	1	8	3	6.67	15.20	9.45

Stream Measurement

As shown on Table 29, the relatively high conductivity and salinity values measured at HG1 (Topanga Lagoon) are most likely a result of salt water intrusion due to its proximity to the ocean as well as runoff from commercial and residential developments and Pacific Coast Highway. Also, the HG1 (Topanga Lagoon) dissolved oxygen levels were above the minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L), as shown on Table 2 above.

Water Chemistry (Reach 5): The ionic concentration of HG1 (Topanga Lagoon) ranged between high magnesium sulfate content to sodium/potassium chloride content (see Figure 7). Elevated relative sulfate concentration may be evidence for pollutants that may have entered the lagoon most likely from the adjacent commercial and residential developments or Pacific Coast Highway. The presence of elevated sulfate at this location may also be an indicator of sea water intrusion. Also, elevated relative sodium and chloride concentrations are evidence of seawater intrusion.

The HG1 (Topanga Lagoon) minimum, maximum and average alkalinity, hardness, and TDS measurements collected during the 2005 monitoring period are summarized in Table 30. The 2005 hardness and TDS concentrations are within the ranges of very hard, fresh to brackish water (see Table 10 above). It appears that the instream samples collected at HG1 during July, September, October, November, and December 2005 were influenced by seawater intrusion due to elevated relative sodium and chloride percentages and high TDS values. Other sources of high TDS water include runoff from Topanga Canyon Boulevard, Pacific Coast Highway, and the commercial and residential properties adjacent to Topanga Lagoon.

Table 30: Reach 5 - 2005 Alkalinity, Hardness, and TDS

Site	# of Tests	Alkalinity (mg/L)			Hardness (mg/L)			TDS (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
HG1 (Topanga Lagoon)	7	230	310	273	670	2600	1034	1100	10000	3057

Stream Measurement

The HG1 (Topanga Lagoon) minimum, maximum and average nutrient levels of nitrate, ammonia, and phosphates collected during the 2005 monitoring period are summarized in Table 31 and shown on the graphs in Appendix C.

Table 31: Reach 5 - 2005 Ammonia, Nitrates, and Phosphates

Site	# of Tests	Ammonia (mg/L)			Nitrates (mg/L)			Phosphates (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
HG1 (Topanga Lagoon)	7	0.02	0.46	0.18	0.10	0.43	0.18	0.05	0.17	0.10

Stream Measurement

The 2005 nutrient concentrations measured at HG1 (Topanga Lagoon) within Reach 1 were below TMDL thresholds (1 mg/L) recommended by the RWQCB for the Malibu Creek and Lagoon and below nutrient criteria (0.5 mg/L) developed by the EPA to represent rivers and streams that are minimally impacted by human activities, as discussed in Section 3.6 above. The nitrate concentrations are within limits tolerable to aquatic life, as shown on Table 2 above. The desired average phosphate concentration (<0.1 mg/L) was exceeded at site HG1 (Topanga Lagoon) during July and September through November 2005.

Fish Habitat (Reach 5): This low gradient (1%) section of the creek is altered by the Rodeo Grounds Berm, located at 600 meters. The berm bisects the floodplain along the base of an ancient landslide and has resulted in the accumulation of sediments in the creek channel that causes sub-surface flows during the dry season. The habitat in this reach consists of a series of riffles and runs, which when flow is present provide good to very good habitat, especially suitable for supporting juveniles. However, it becomes poor when there is no flow to support the fish. The other barrier in this reach is the box culvert bridge under Pacific Coast Highway. Together with the berm, these two barriers have been identified as the keystone barriers impacting movement of steelhead trout into and out of Topanga Creek.

Proposed Restoration Effects on Groundwater Resources (Reach 5): As shown on Figure 10, two restoration projects are proposed within Reach 1 including

1. Restoration of Topanga Lagoon: The Topanga Lagoon restoration involves the removal of approximately 35 feet of fill material placed within the area of the original lagoon to construct Pacific Coast Highway. The removal of this fill would restore approximately 11 out of 30 acres of the lagoon to its former extent. This restoration would help flush out Topanga Lagoon by clearing the channel obstruction at the mouth of Topanga Creek, which would help reduce sedimentation and pollutant buildup at the lagoon.
2. Removal of the Rodeo Grounds Road Berm: The Rodeo Grounds berm has restricted the creek flow upstream causing heavy sediment accumulation and subsurface flow for much of the year. This sediment accumulation is evidenced in boreholes that were performed within the berm by GeoPentech (GeoPentech 2005). The boreholes showed that the base of the berm was approximately 5 to 7 feet below the base of the creek adjacent to the berm, which would suggest approximately 5 to 7 feet of sediment accumulation at the berm. The removal of this channel obstruction would help to flush out the heavy sediment accumulation upstream, which would improve and increase fish habitat. It is noted that a landslide was mapped by Dibblee (1992) on the west side of the canyon adjacent to Rodeo Grounds berm as shown on Figure 10. Based on the analysis of historic topographic maps and air photos between 1877 and 1997, it appears that the toe of this landslide has historically been separated from the main creek channel by an alluvial terrace. Therefore, the removal of Rodeo Grounds berm and the restoration of the creek to its former condition would not appear to have the effect of undercutting and destabilizing this landslide.

No springs or seeps were identified within or immediately adjacent to the restoration projects proposed within this reach; therefore these restoration projects would not have an impact to springs or seeps. However, the removal of fill within the Topanga Lagoon and the removal of the berm at Rodeo Grounds Road would help to flush out accumulated sediment upstream, which would potentially improve and increase fish habitat.

5.0 CONCLUSIONS

During 2005, Topanga Creek maintained a year-round surface flow from the town of Topanga to the ocean due to the abnormally high precipitation during this time period. The 2005 precipitation total was one of the wettest years on record with 62 inches of rain measured at Topanga Patrol Station in the town of Topanga, compared to a normal year average of approximately 25 inches. Effects of the much higher than average 2005 precipitation were that spring sites flowed at a relatively higher discharge rate for a relatively longer period of time. Also, the increased precipitation may have diluted spring and creek flows with relatively low TDS and neutral pH rainwater, which may have the effect of lowering conductivity and salinity values and neutralizing pH values when compared to years with average precipitation. During years with normal precipitation, the lower portion of the creek (Reach 5) typically has interrupted surface flows for 6 to 9 months. The flows become subsurface within this meandering section of the creek due to the sediment buildup upstream of Rodeo Grounds Berm, which reduces creek flows.

Based on comparison of creek flow rates to monitored spring flow rates during the 2005 monitoring period, it appears that the springs monitored above HG9 (Bridge MM 2.02) as part of this study contributed approximately 1% of the total flow to the creek; therefore, the influence of the monitored springs on the creek flow volume and chemistry was probably minimal during 2005. Since the springs are diluted by flow from the creek within the study area, it is suspected that the spring flow contribution to the creek would become more substantial when the creek flow becomes low in the summer and fall months during years with average to below average rainfall totals. Additional monitoring during years with average to below average precipitation would be necessary to quantify this assumption.

The minimum, maximum and average Reach 1 through Reach 5 conductivity, pH, salinity, and dissolved oxygen values within the springs and stream during the 2005 monitoring period are summarized on Table 32. As shown on Table 32, the average pH and salinity measurements collected at the springs were within similar ranges as measurements collected in the stream. The spring conductivities are generally lower than the corresponding stream conductivities suggesting a relatively higher concentration of dissolved solids within the stream. Also, the stream conductivities generally decrease as a function of distance from HG24 (Albuelitas) within the town of Topanga through Reach 4. This distribution of stream conductivity suggests that runoff from the town of Topanga may be a source of the high conductivity water. It is noted that the elevated average stream conductivity measured within Reach 5 at Topanga Lagoon is most likely a result of salt water intrusion due to its proximity to the ocean; however effects of runoff from adjacent commercial and residential developments and Pacific Coast Highway cannot be discounted. The dissolved oxygen values measured in the creek were generally higher than those measured at the springs, due to the larger surface area of the stream, which allows a larger amount of oxygen to enter the water, and the greater affects of photosynthesis within the stream. The average spring and stream dissolved oxygen levels were above the minimum continuous criteria no-effect levels for aquatic life (5.5 mg/L), as shown on Table 2 above.

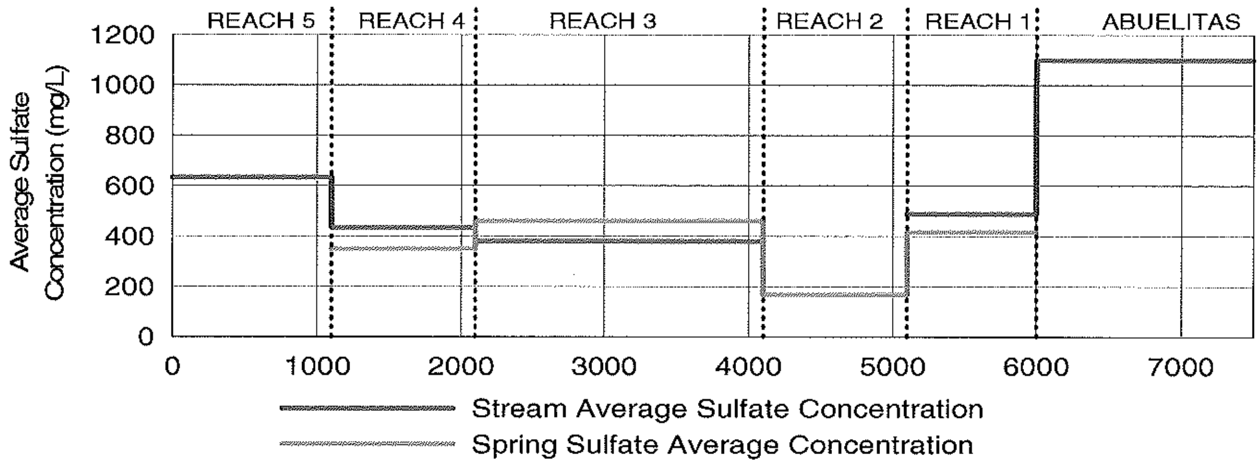
Table 32: 2005 Spring and Stream Field Measurement Summary

Location	# of Tests	Conductivity (uS)			pH			Salinity (ppt)			DO (mg/L)		
		min	max	avg	min	max	avg	min	max	avg	min	max	avg
Upstream of Study Area (HG24)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	1	2700	2700	2700	8.2	8.2	8.2	2	2	2	14.60	14.60	14.60
Reach 1 Total	29	880	1980	1260	6.9	8.9	8.0	0	3	2	2.01	10.21	8.16
	38	1220	1990	1518	6.8	8.8	8.1	0	4	2	4.36	12.12	9.63
Reach 2 Total	49	810	1290	1024	6.5	9.0	8.0	0	4	1	2.85	10.62	8.54
	41	1090	1750	1406	7.6	8.9	8.3	0	3	2	7.68	13.50	9.98
Reach 3 Total	28	670	2700	1290	7.1	8.7	8.0	0	4	1	5.13	11.00	8.57
	28	990	1670	1341	7.6	8.7	8.3	0	3	1	8.10	12.99	9.79
Reach 4 Total	2	1130	1400	1265	7.5	7.7	7.6	0	0	0	NM	NM	NM
	15	1160	1650	1349	7.6	8.8	8.3	0	2	1	7.06	11.96	10.28
Reach 5 Total	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	7	1100	3600	1966	7.4	8.2	7.8	1	8	3	6.67	15.20	9.45
All Reaches Spring Total	**108**	**670**	**2700**	**1174**	**6.5**	**9.0**	**8.0**	**0**	**4**	**1**	**2.01**	**11.00**	**8.44**
All Reaches Stream Total	**129**	**990**	**3600**	**1449**	**6.8**	**8.9**	**8.2**	**0**	**8**	**2**	**4.36**	**15.20**	**9.84**
All Reaches (excluding HG1) Stream Total	**122**	**990**	**1990**	**1419**	**6.8**	**8.9**	**8.2**	**0**	**4**	**1**	**4.36**	**13.50**	**9.86**

Spring Measurement
Stream Measurement

The ionic concentration of the springs with measurable flows throughout the 2005 monitoring period were magnesium carbonate, calcium carbonate, magnesium sulfate, and calcium sulfate types. The ionic concentration of the stream ranged from calcium sulfate to calcium-magnesium sulfate types. High sulfate content within the stream may be derived from weathering of sedimentary rocks, but can also be a product of pollutants such as fertilizers and wastes. Figure 13 shows the average 2005 stream and spring sulfate concentrations as a function of reach. As shown on this figure, the sulfate concentration measured at HG24 (Albuelitas) within the town of Topanga was more than 250% higher than the average sulfate concentration measured in Reach 1 immediately downstream of Topanga. Also, the average sulfate concentration measured within HG1 (Topanga Lagoon) was approximately 50% higher than that measured immediately upstream in Reach 4. The stream sulfate concentrations were approximately constant between Reach 1 and Reach 4 (no measurement in Reach 2), and were within similar ranges as measured within the springs. The relatively elevated stream sulfate concentrations at HG24 (Albuelitas) and HG1 (Topanga Lagoon) may be a product of pollutants most likely entering the stream from the town of Topanga upstream of Reach 1 or from commercial and residential developments and Pacific Coast Highway adjacent to Topanga Lagoon in Reach 5. The presence of elevated sulfate at HG1 (Topanga Lagoon) may also be an indicator of sea water intrusion. The 2005 average sulfate concentrations measured within Reach 1 and Reach 5 were above the RWQCB objective of <500 mg/L.

Figure 13: Average Stream and Spring Sulfate Concentration by Reach



The minimum, maximum and average Reach 1 through Reach 5 alkalinity, hardness, and TDS measurements collected within the springs during the 2005 monitoring period are summarized in Table 33.

Table 33: 2005 Spring and Stream Alkalinity, Hardness, and TDS

Location	# of Tests	Alkalinity (mg/L)			Hardness (mg/L)			TDS (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
Upstream of Study Area (HG24)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	1	350	350	350	1000	1000	1000	1900	1900	1900
Reach 1 Total	12	260	600	445	480	1300	773	600	1800	1058
	7	250	310	287	540	790	687	930	1300	1159
Reach 2 Total	18	230	730	416	330	590	486	570	750	659
	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Reach 3 Total	15	200	330	286	440	1100	661	620	2000	1030
	7	260	290	280	500	690	584	780	1100	981
Reach 4 Total	1	320	320	320	700	700	700	590	590	590
	6	240	280	270	540	670	608	810	1100	998
Reach 5 Total	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	7	230	310	273	670	2600	1034	1100	10000	3057
All Reaches Spring Total	**46**	**200**	**730**	**379**	**330**	**1300**	**626**	**570**	**2000**	**882**
All Reaches Stream Total	**27**	**230**	**310**	**278**	**500**	**2600**	**744**	**780**	**10000**	**1548**
All Reaches (excluding HG1) Stream Total	**20**	**240**	**310**	**280**	**500**	**790**	**628**	**780**	**1300**	**1045**

Spring Measurement
Stream Measurement

As shown on Table 33, the alkalinity, hardness, and TDS values were within ranges tolerable or beneficial to aquatic life, as shown on Table 2 above. The 2005 spring and stream hardness and TDS concentrations are within the ranges of very hard, fresh to brackish water (see Table 9 above). The average spring alkalinity and hardness concentrations for the reaches were slightly higher than those measured within the stream. Also, the average spring TDS concentrations were slightly lower than the average stream TDS concentrations for the reaches, similar to the pattern observed for the spring and stream conductivity measurements. Also, the stream TDS generally decreases as a function of distance from HG24 (Albuelitas) within the town of Topanga through Reach 4, which is again similar to the pattern observed for the conductivity measurements. This distribution of stream TDS suggests that runoff from the town of Topanga may be a source of the relatively high TDS water. Also, the elevated average stream TDS measured within Reach 5 at Topanga Lagoon is most likely a result of salt water intrusion due to its proximity to the ocean; however effects of runoff from adjacent commercial and residential developments and Pacific Coast Highway cannot be discounted.

The minimum, maximum and average Reach 1 through Reach 5 nutrient concentrations of nitrate, ammonia, and phosphates collected within the springs and stream during the 2005 monitoring period are summarized in Table 34.

Table 34: 2005 Spring and Stream Ammonia, Nitrates, and Phosphates

Location	# of Tests	Ammonia (mg/L)			Nitrates (mg/L)			Phosphates (mg/L)		
		min	max	avg	min	max	avg	min	max	avg
Upstream of Study Area (HG24)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	1	0.60	0.60	0.60	0.07	0.07	0.07	0.09	0.09	0.09
Reach 1 Total	23	0.02	0.99	0.25	0.02	0.30	0.10	0.01	0.70	0.12
	6	0.01	0.89	0.21	0.11	0.72	0.45	0.06	0.31	0.14
Reach 2 Total	42	0.01	2.67	0.25	0.01	2.49	0.25	0.00	0.23	0.06
	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Reach 3 Total	29	0.02	3.06	0.40	0.07	1.48	0.52	0.00	0.20	0.05
	6	0.04	0.37	0.13	0.09	0.24	0.16	0.02	0.07	0.04
Reach 4 Total	1	0.11	0.11	0.11	0.07	0.07	0.07	0.06	0.06	0.06
	8	0.05	0.40	0.14	0.04	0.30	0.15	0.00	0.12	0.05
Reach 5 Total	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
	7	0.02	0.46	0.18	0.10	0.43	0.18	0.05	0.17	0.10
All Reaches Spring Total	**95**	**0.01**	**3.06**	**0.29**	**0.01**	**2.49**	**0.30**	**0.00**	**0.70**	**0.07**
All Reaches Stream Total	**27**	**0.01**	**0.89**	**0.16**	**0.04**	**0.72**	**0.22**	**0.00**	**0.31**	**0.08**

Spring Measurement
Stream Measurement

The average 2005 nutrient concentrations measured at the springs and streams within the study area were below TMDL thresholds (1 mg/L) recommended by the RWQCB for the Malibu Creek and Lagoon and below nutrient criteria (0.5 mg/L) developed by the EPA to represent rivers and streams that are minimally impacted by human activities, as discussed in Section 3.6 above. However, 2005 stream ammonia and nitrate concentrations spiked above EPA minimally impacted levels within the town of Topanga at HG24 (Albuelitas) and immediately downstream of Topanga within Reach 1. Sources of the high nutrient levels may be due to human influence (i.e. discharge of human or animal waste) most likely emanating from the town of Topanga. Also, spring ammonia and nitrate concentrations spiked above TMDL thresholds and EPA minimally impacted thresholds during 2005. The suspected elevated ammonia and nitrate level spikes at the spring sites may be a result of animal waste that may have collected and concentrated at these sites. The nitrate and ammonia concentrations measured within the springs and stream are within limits tolerable to aquatic life, as shown on Table 2 above. The desired average phosphate concentrations (<0.1 mg/L) was generally exceeded within all reaches, excluding Reach 3.

Based on isotopic analysis, it appears that the springs, excluding HG2 (MM 0.05 TC Blvd) in Reach 4, and stream within the study area are generally recharged locally by precipitation, which enters the groundwater system relatively quickly with little to no evaporative effects. Also, the isotopic grouping of the spring and stream data does not appear to have a significant mixing component from the discharge of recycled wastewater. The water emanating from HG2 (MM 0.05 TC Blvd) may have been derived from precipitation during a different time period or location with different climatic conditions with respect to the other sites. It is also possible that the water at site HG2 (MM 0.05 TC Blvd) is being mixed with LA City water emanating from water usage from the housing development immediately upslope of HG2 (MM 0.05 TC Blvd).

In general, 9 of the 18 springs and seeps monitored within the study area have the potential to become impacted by the proposed restoration activities. The highest potentials for impacts are at sites HG7 (Ken2 Pool) and HG13 (Narrows Seep). The spring flow at HG7 (Ken2 Pool), which is located along the base of a landslide proposed for mitigation, has the potential to reduce or dry up surface flow due to alteration of the landslide and planting of the slope. This impact could be minimized by minimizing the amount of grading and planting of the slope within the area of the spring. Also, spring flow at HG13 (Narrows Seep) has the potential to become reduced or dry up due to road grading or tunneling adjacent or beneath spring. This impact to HG13 (Narrows Seep) could be minimized by reconstructing Topanga Canyon Boulevard with a bridge that would span the spring site. Other sites have the potential to become impacted during restoration activities including HG5 (Green House Culvert), HG6 (Culvert Inlet E Side), HG8 (Alder Grove), HG10 (Sycamore Tree), HG11 (Maidenhair Fern Seep), HG12 (No Parking/Alder Seep), and HG14 (Duck Seep/Kevin Pool); however, the possibilities of impacts are considered lower.

6.0 RECOMMENDATIONS

Based on the data collected and analysis completed during this study, it is recommended that a long-term groundwater investigation program be implemented. The primary objective of such investigations would be to:

1. Further improve the present understanding of the physical and chemical groundwater characteristics, especially during normal to less than normal precipitation years,
2. Provide verification of the magnitude and duration of spring and stream groundwater effects during restoration activities, if any
3. Provide a basis for triggering mitigation measures, if needed.

The following is a general summary of the recommended long-term groundwater monitoring plan.

- Regular monitoring of the physical and chemical properties at 4 instream sites (HG1, HG3, HG9, and HG22)
- Regular monitoring of the physical and chemical properties at the 2005 perennial spring sites located within or adjacent to proposed restoration areas including: HG2, HG5, HG6, HG7, HG8, HG10, HG11, HG12, HG13, HG14, and HG15
- Bi-annual sampling of spring and instream samples and laboratory testing of general minerals and nutrients
- Development of action levels or "triggers" for implementating mitigation measures if sites becomes impacted due to restoration activity
- Identify generic mitigation measures

The sites proposed for future monitoring are shown on Figure 14. It is also recommended that stream flow measurements be collected within the various stream reaches to better quantify spring flow contribution to overall stream flow, especially during years with average to below average precipitation. Also, additional stream chemistry measurements are suggests within and upstream of the town of Topanga to better quantify the anthropogenic influences from the town.

Figure 14: Sites Proposed for Future Monitoring

7.0 GENERAL CONDITIONS

Conclusions and recommendations presented in this report are based upon GeoPentech's understanding of the project derived from reports of previous investigations performed by others, the field investigation and monitoring completed for this report by GeoPentech, and the assumption that the subsurface conditions do not deviate appreciably from those disclosed by GeoPentech's field reconnaissance. In the event that the locations, configurations, layout, or features of the project are changed, the recommendations presented in this report may not be applicable. It is the responsibility of the Owner to bring any such changes of the proposed project to the attention of GeoPentech. In this way, supplemental recommendations, if required, can be made without delay to the project.

Professional judgments presented in this report are based on an evaluation of the technical information gathered and GeoPentech's general experience in the field of geology and hydrology. GeoPentech does not guarantee the performance of the project in any respect, only that the geologic work and judgment rendered herein meet the standard of care of the geotechnical and engineering geophysics profession at this time.

8.0 REFERENCES

California Regional Water Quality Control Board, Los Angeles Region 4, 1994, Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties.

California State Parks, 2003, Lower Topanga State Park Topographic and Boundary Survey Map and October 2003 Aerial Photograph.

Coplen, T.B., and Kendall, C., 2000, Stable Hydrogen and Oxygen Isotope Ratios for Selected Sites of the U.S. Geological Survey's NASQAN and Benchmark Surface-water Networks, U.S. Geological Survey Open-File Report 00-160.

Craig, H., 1961, Isotopic Variations in Meteoric Waters, Science, v. 133, p. 1702-1703.

Dibblee, 1992, "Geologic Map of Topanga and Conoga Park (South ½) Quadrangles, Los Angeles County, California", Dibblee Geologic Foundation Map #DF-35, Map Scale=1:24,000.

Dagit, R., K. Reagan and C. Swift, 2003, Topanga Creek Watershed Southern Steelhead Trout: Preliminary Watershed Assessment and Restoration Plan Report, Prepared for CA Department of Fish and Game, March 2003, Resource Conservation District of the Santa Monica Mountains, Topanga, CA.

Dagit, R., S. Williams and J. Fuhrman, 2004, Topanga Creek Watershed Water Quality Study Final Report, December 2004, Resource Conservation District of the Santa Monica Mountains, Topanga, CA.

Dagit, R and K. Reagan, 2005, Southern Steelhead Trout Survey of Topanga Creek: Monitoring Summary June 2001 – September 2005 Draft, November 2005, Resource Conservation District of the Santa Monica Mountains, Topanga, CA.

Environmental Protection Agency, 1976, Quality Criteria for Water, "Red Book", EPA 440/9-76-023.

Environmental Protection Agency, 1986a, Quality Criteria for Water 1986, "Gold Book", EPA 440/5-86-001.

Environmental Protection Agency, 1986b, Ambient Water Quality Criteria for Dissolved Oxygen, EPA 440/5-86-003.

Environmental Protection Agency, 1998, 1998 Update of Ambient Water Quality Criteria for Ammonia, EPA 822-R-98-008.

Environmental Protection Agency, 2000, Ambient Water Quality Criteria Recommendations, Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion III, EPA 822-B-00-016.

GeoPentech, 2005, Rodeo Grounds Berm Removal Study Soil Characterization, April 2005.

Gonfiantini, R., 1978, Standards for Stable Isotope Measurements in Natural Compounds, Nature, v. 271, pp. 534-536.

Harrison, Lee, Edward Keller and Matt Sallee, 2005, Santa Monica Mountains Steelhead Habitat Assessment: Watershed Analysis.

Hem, John D., 1985, Study and Interpretation of the Chemical Characteristics of Natural Water, US Geological Survey Water-Supply Paper 2254.

Piper, A.M., 1944, A Graphic Procedure in the Geochemical Interpretation of Water Analyses, American Geophysical Union Transactions, v. 25, p. 914-923.

Los Angeles Regional Water Quality Control Board, 1996, Water Quality Assessment and Documentation. 305(b), August 1998.

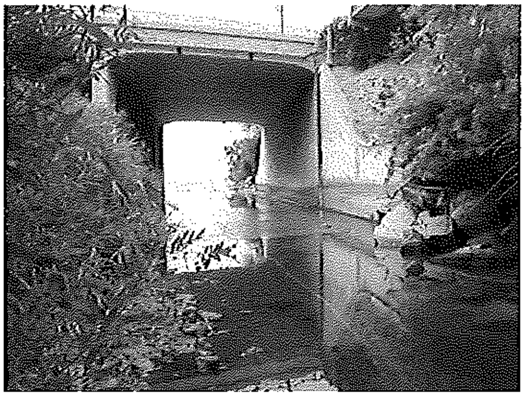
Los Angeles Regional Water Quality Control Board, 1994, Water Quality Control Plan (Basin Plan).

Williams, A.E. and Rodoni, D.P., 1997, Regional Isotope Effects and Application to Hydrologic Investigations in Southwestern California, Water Resour. Res., 33, p. 1721-1729

Yerkes and Campbell, 1994, "Preliminary Geologic Map of the Topanga Quadrangle, Southern California", USGS Open File Report 94-266, Map Scale=1:24,000.

APPENDIX A
SITE PHOTOGRAPHS

HG 1 – Topanga Lagoon



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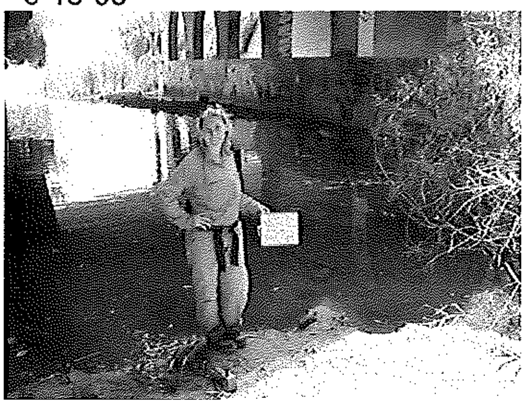
7-13-05



8-15-05

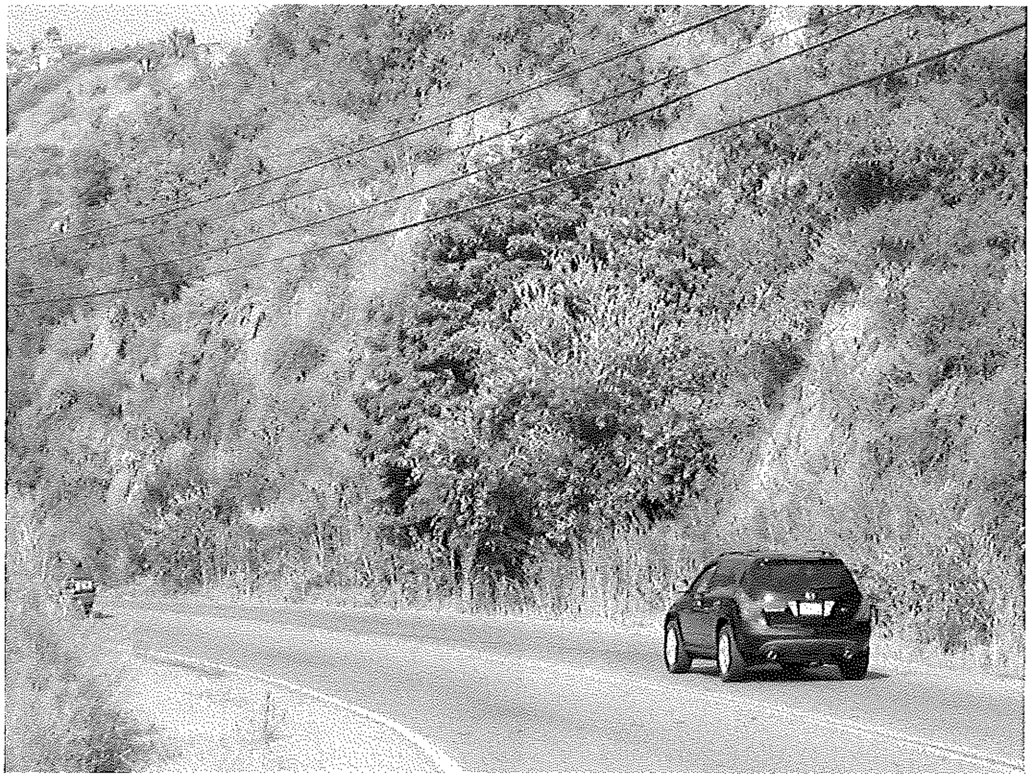
9-28-05

10-17-05

11-21-05

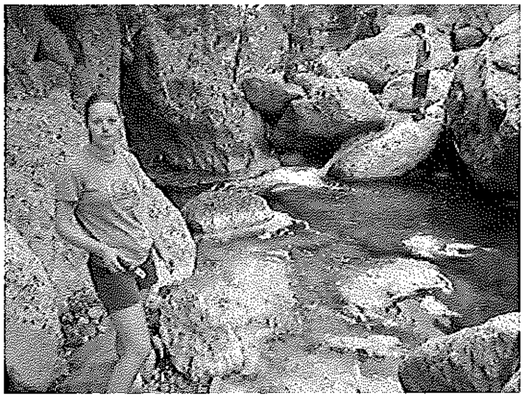
12-19-05

HG 2 – MM 0.05

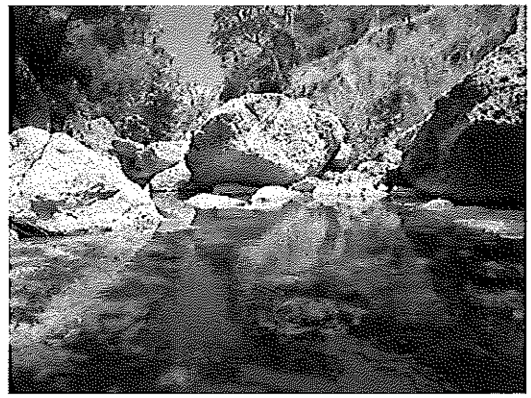


6-13-05

HG 3 - Transient Pool



6-14-05



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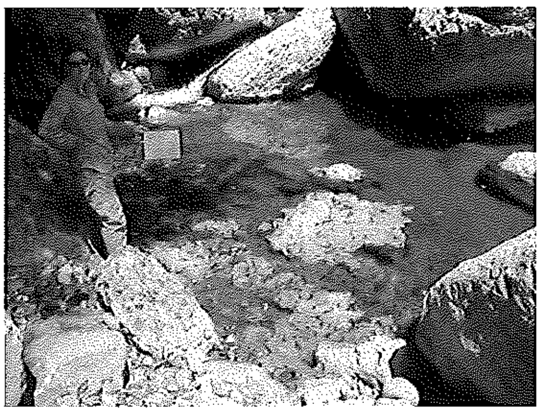

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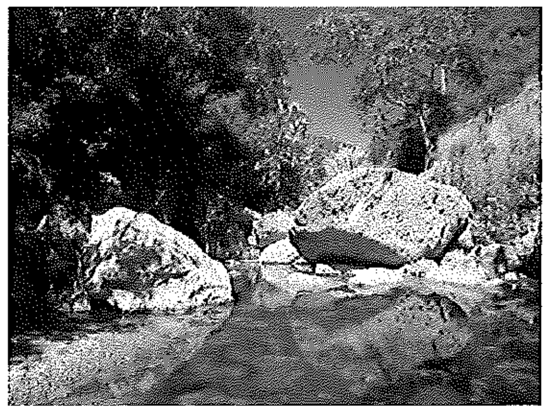

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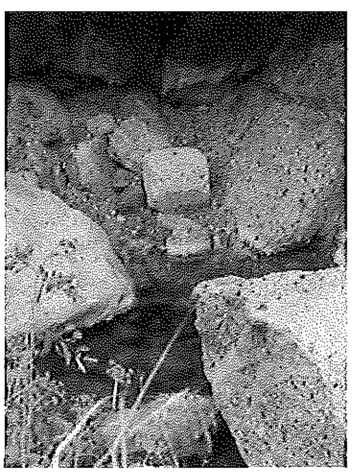

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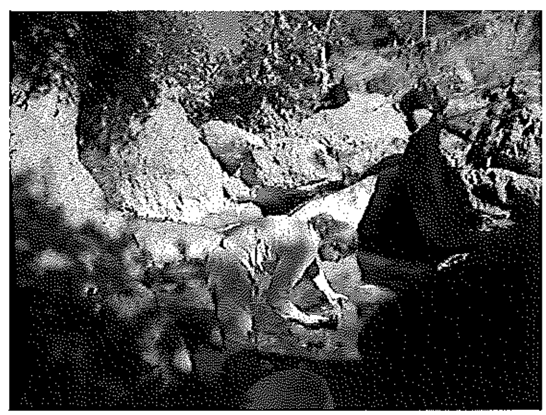

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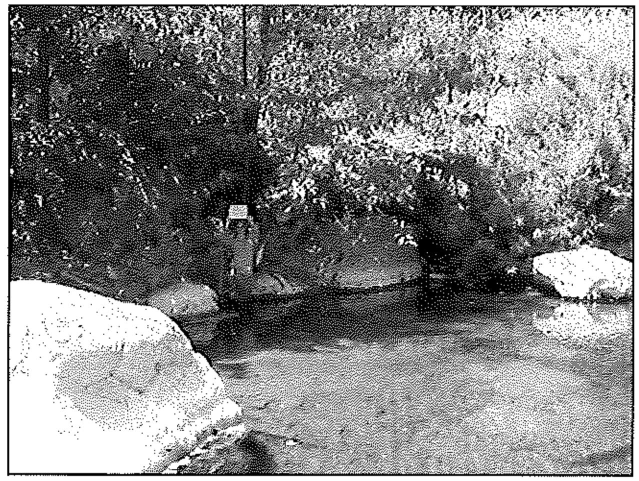
HG 4 – Ski Pole Pool

6-13-05



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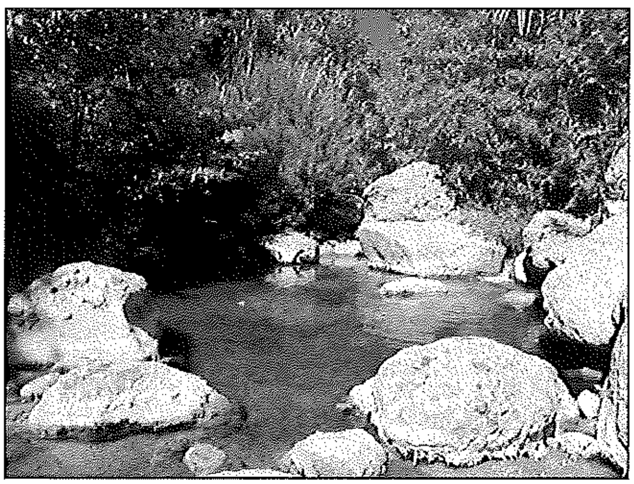

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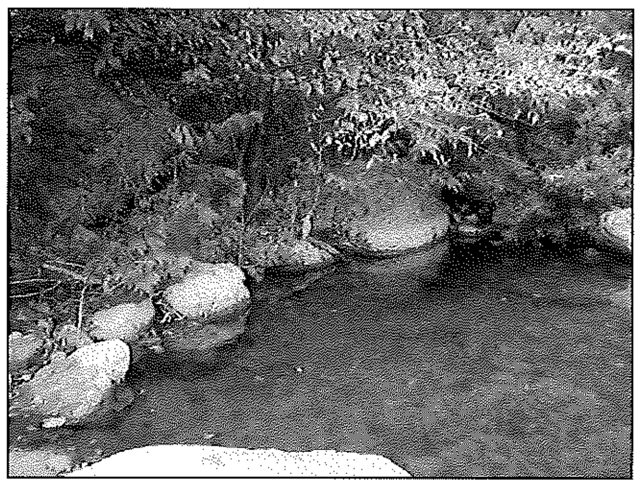

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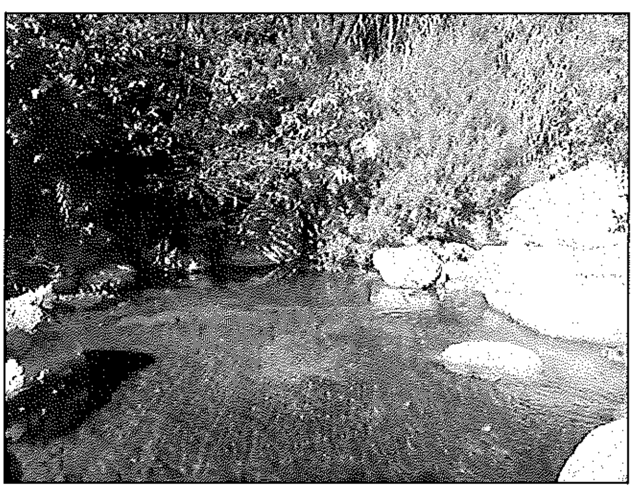

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12-19-05

HG 5 - Green House Culvert

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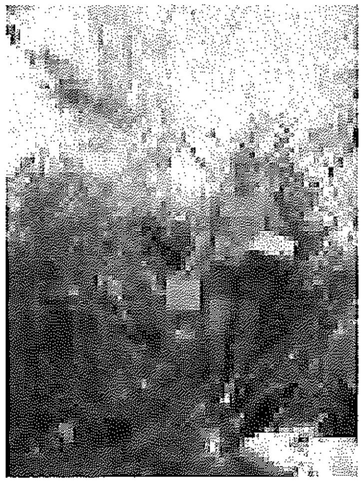

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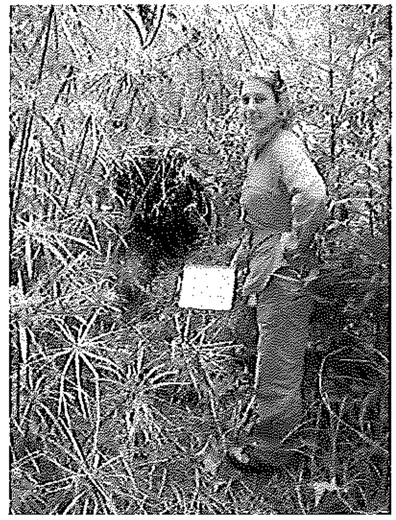

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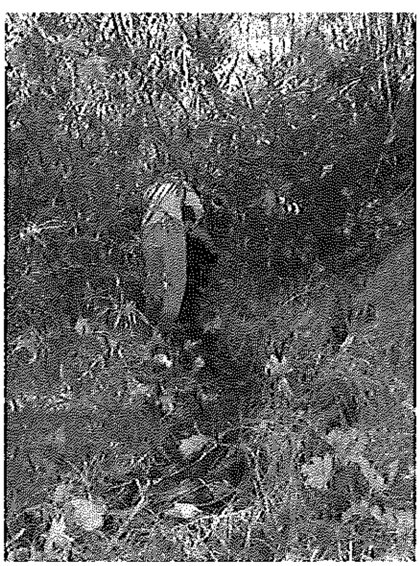

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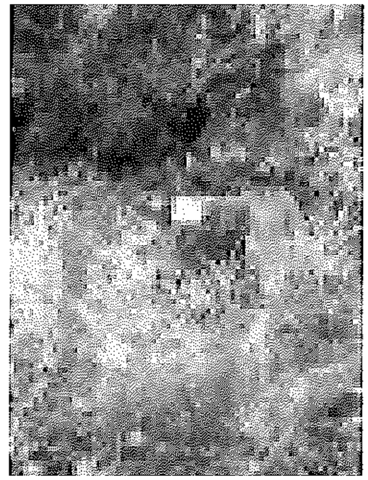
12-19-05

HG 6 - Culvert Inlet E. Side

6-13-05



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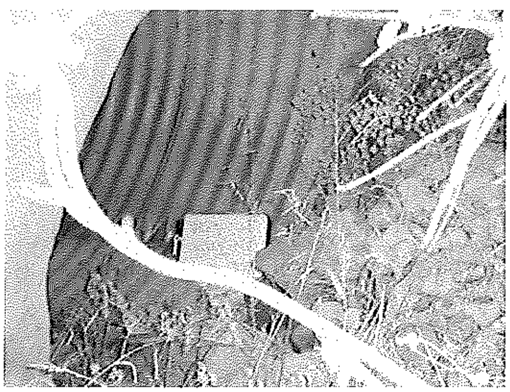

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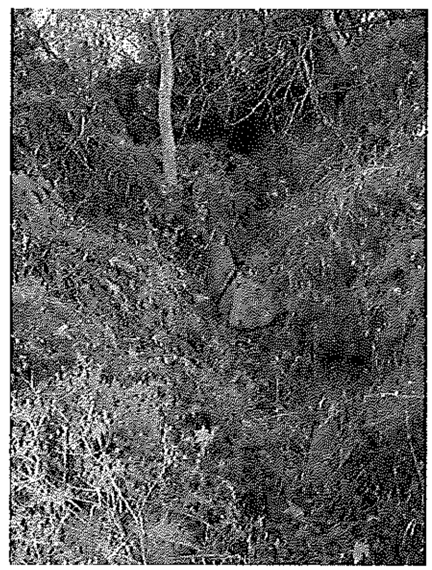

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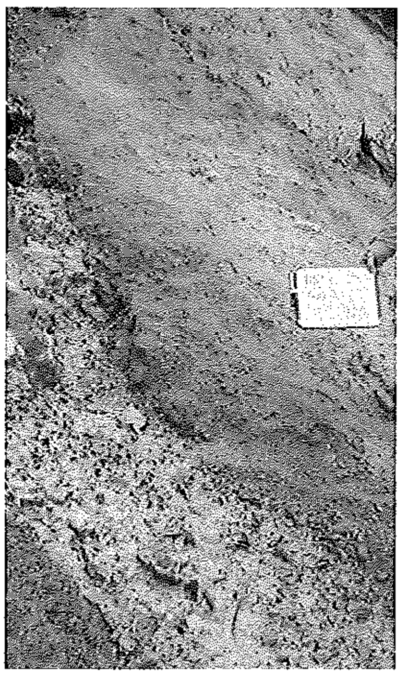
11-21-05

12-19-05

HG 7 - Ken2Pool

6-13-05

7-13-05



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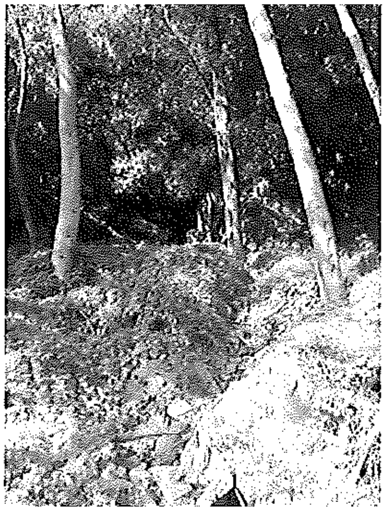
8-15-06

10-17-05

11-21-05

12-19-05

HG 8 - Alder Grove



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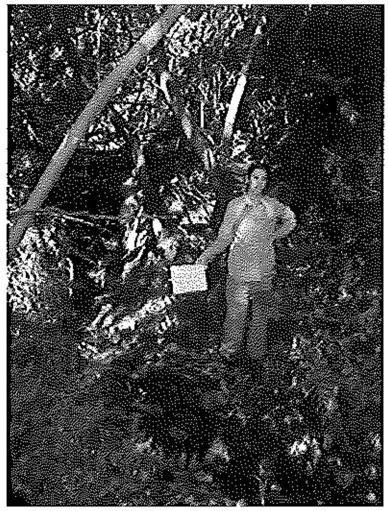

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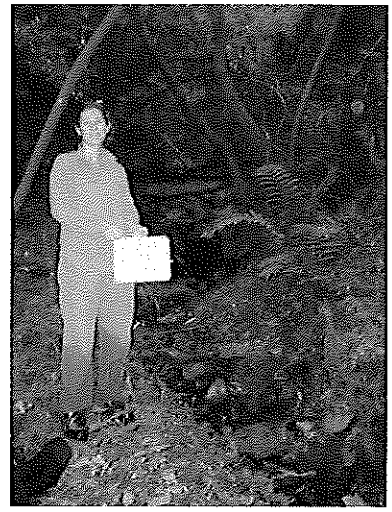

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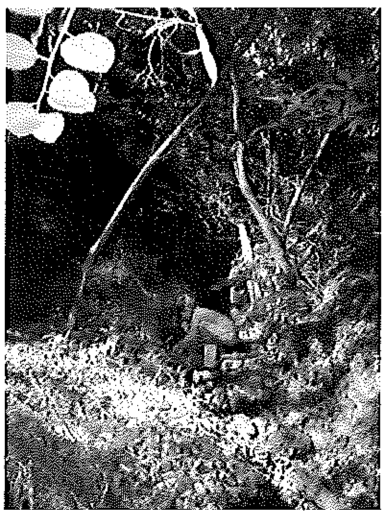

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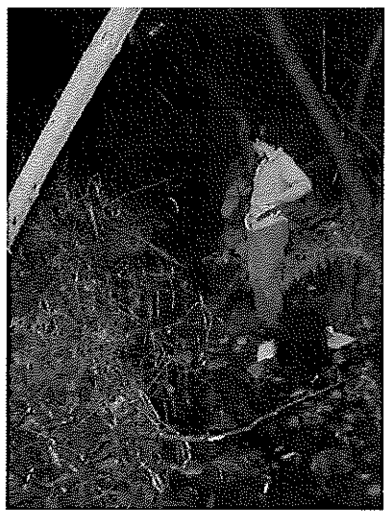

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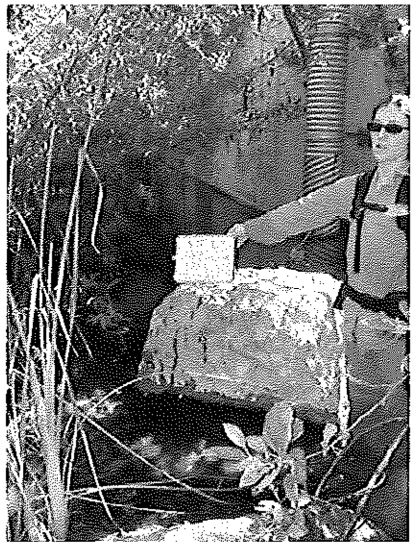
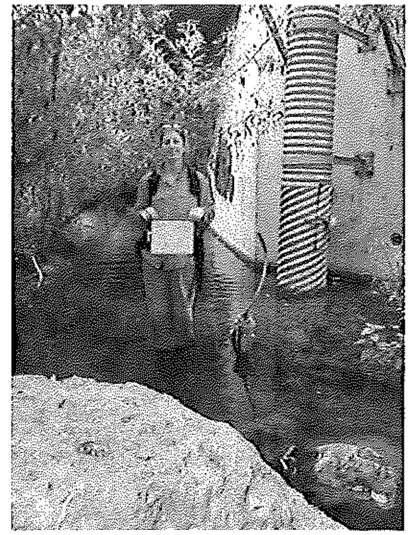
11-21-05

12-19-05

HG 9 - Bridge





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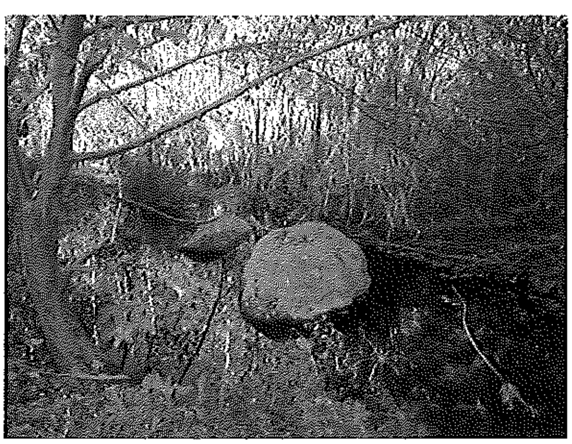
7-13-05

8-15-05

9-28-05

10-17-05



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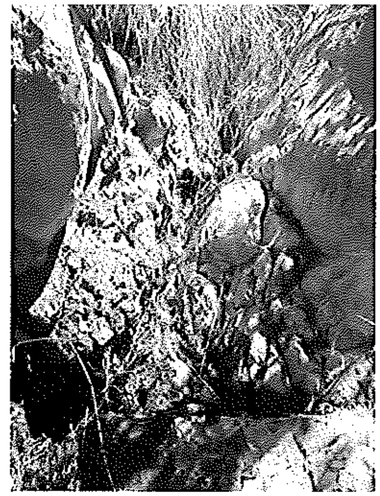
12-19-05

HG 10 - Sycamore Tree

6-13-05

7-13-05



8-15-05

9-28-05

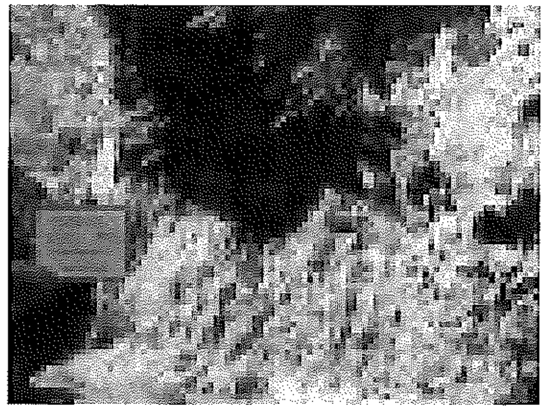
10-17-05

11-21-05

12-19-05

HG 11 - Maidenhair Fern

6-13-05



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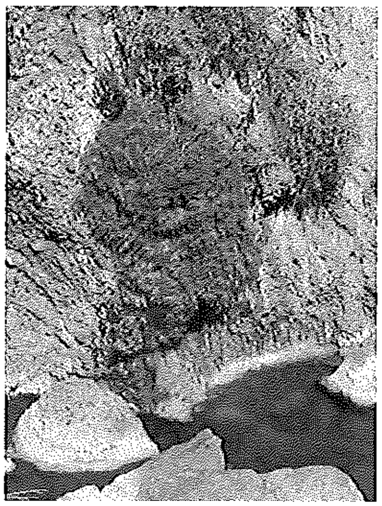

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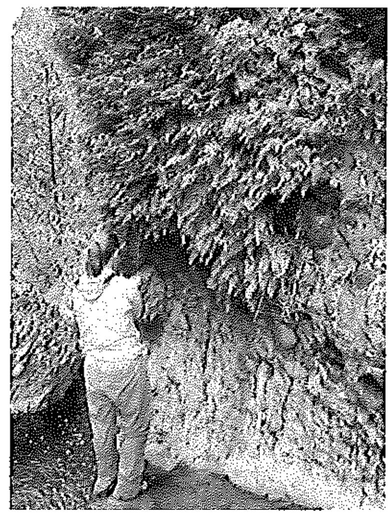
9-28-05



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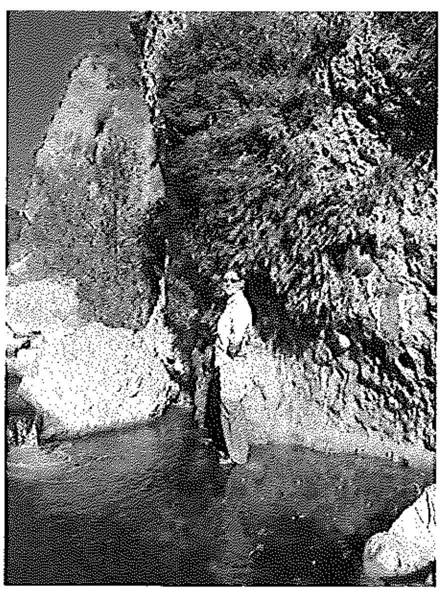

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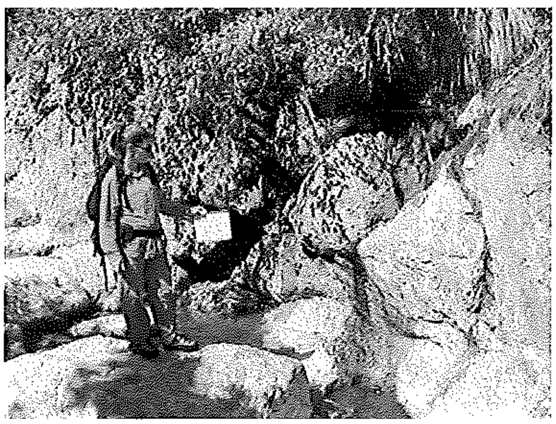
12-19-05

HG 12 - No Parking-Alder Seep

6-13-05

7-13-05



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9-28-05

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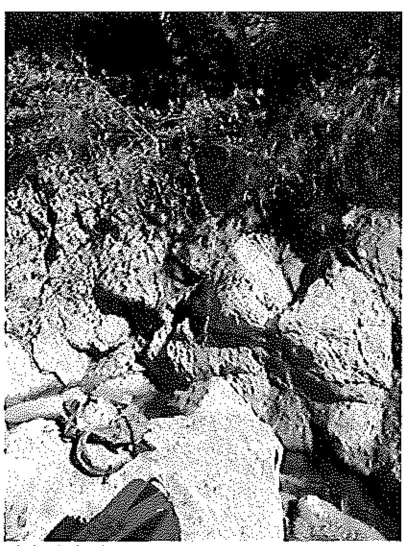

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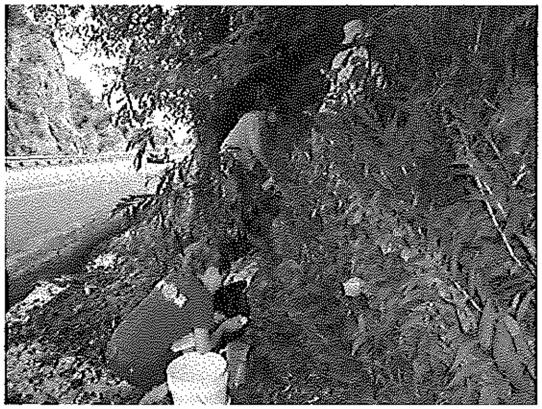
12-19-05

HG 13 – Narrows Seep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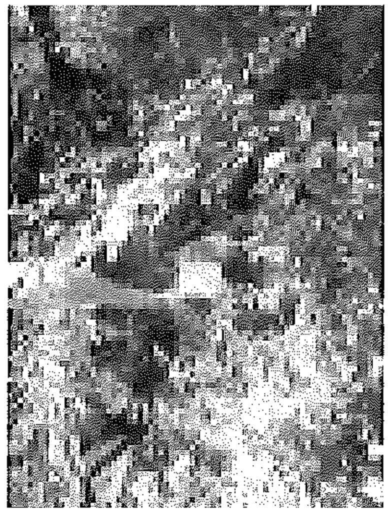
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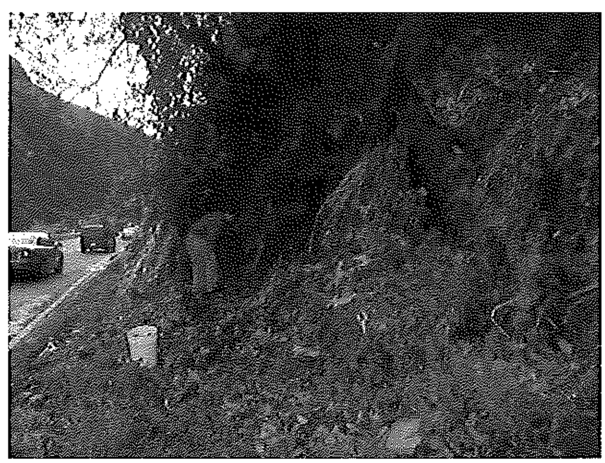
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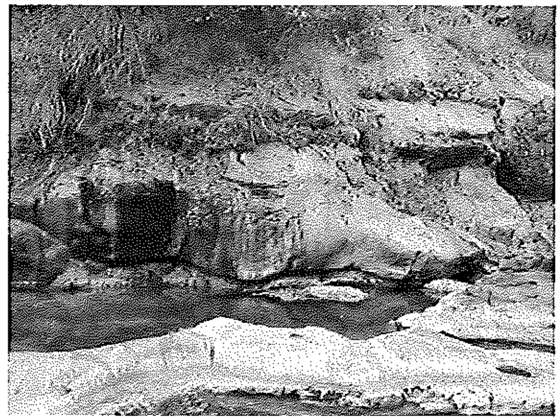
HG 14 - Duck Seep/Kevin Pool

6-14-05

7-14-05



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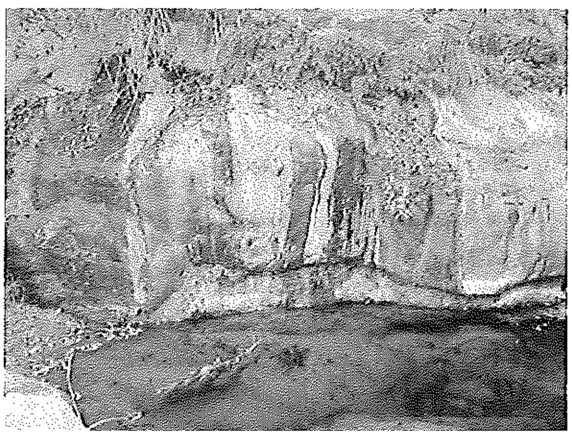

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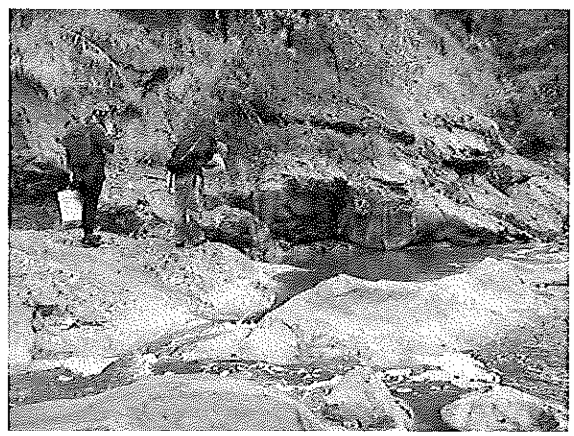

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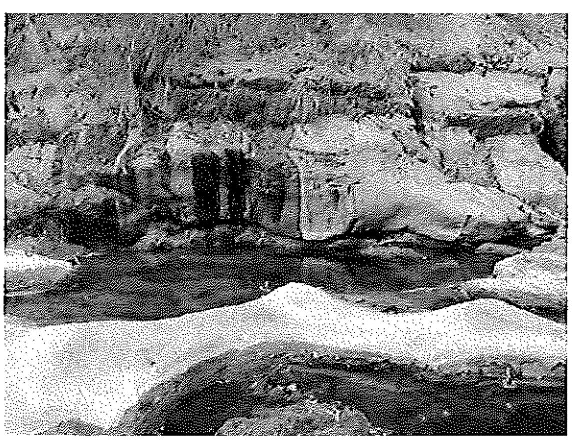

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12-20-05

HG 15 – Storm Falls

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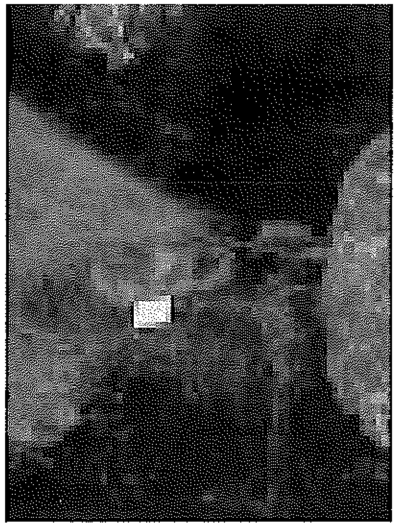

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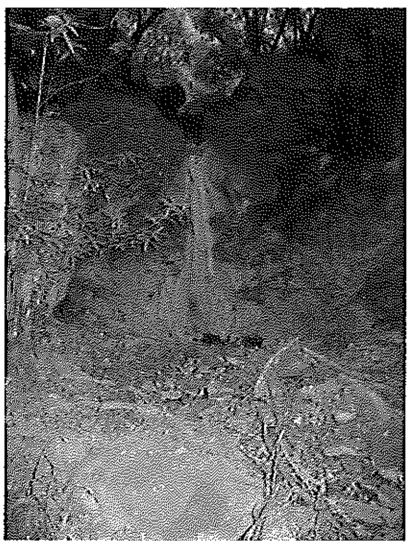

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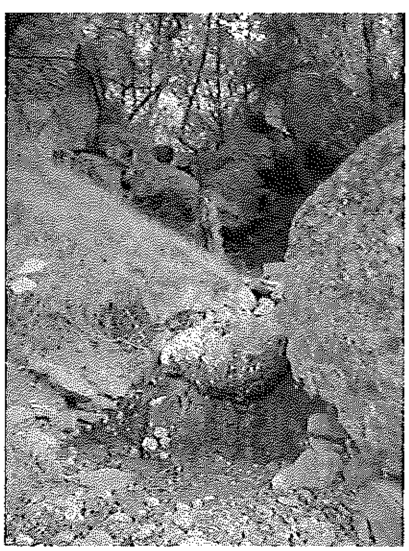

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12-20-05

HG 16 - Dead Alder Falls

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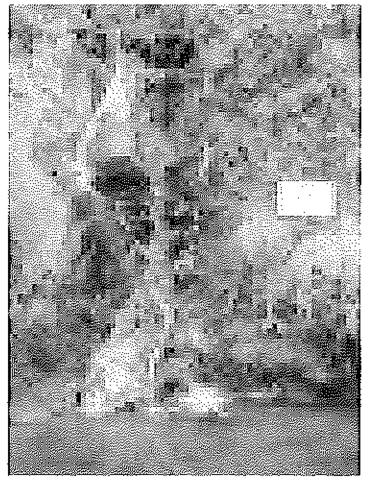

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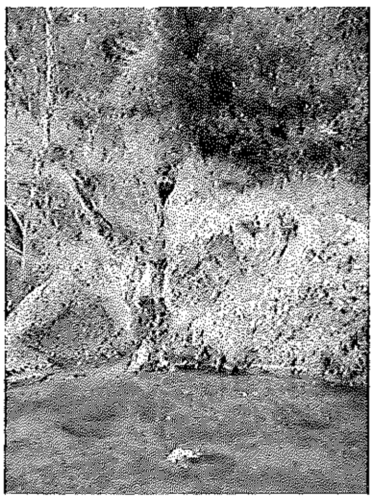

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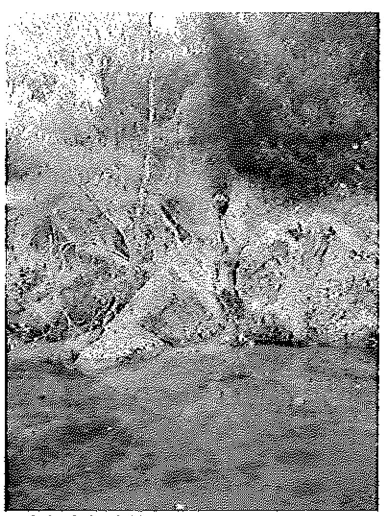

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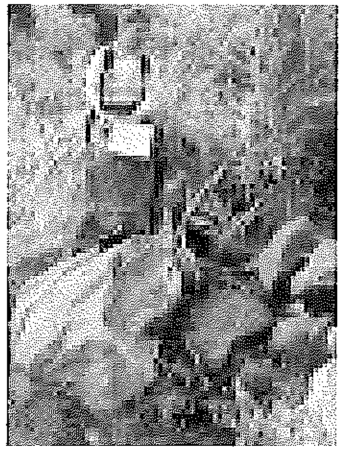
HG 17 - Elderberry Falls

6-15-05



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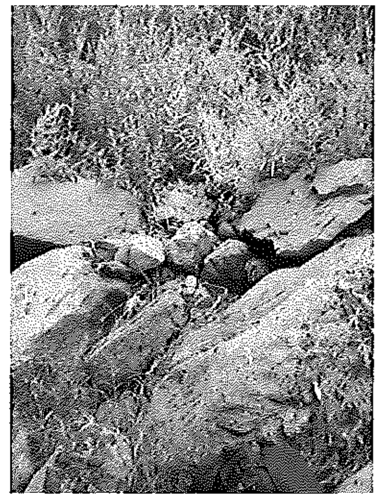

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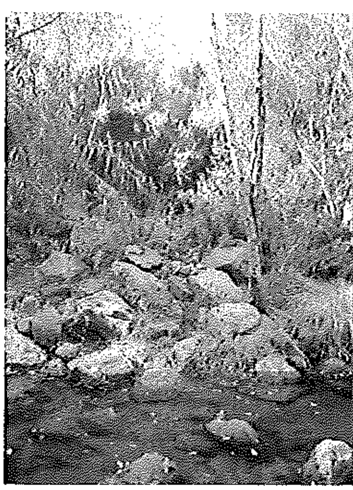

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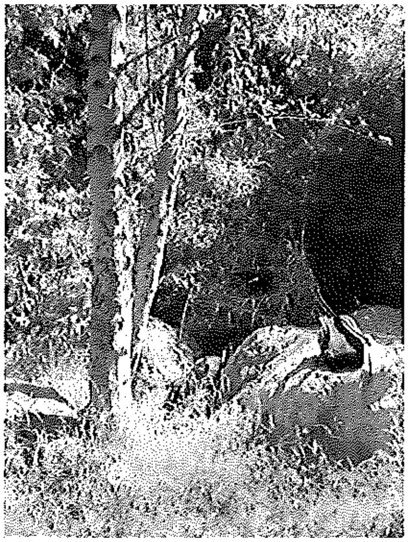
12-20-05

HG 18 – Tadpole Pool



6-14-05

7-14-05

8-16-05

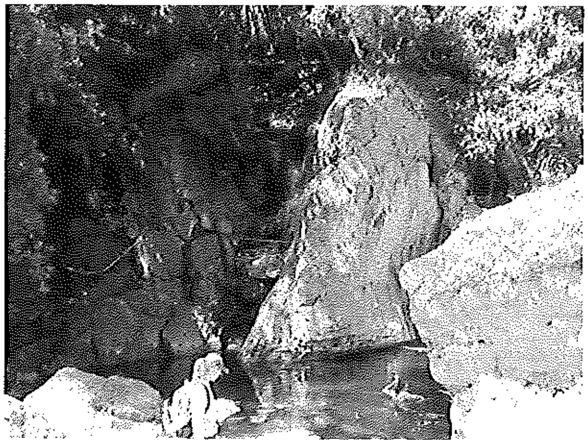
10-7-05

10-18-05

11-22-05

12-20-05

HG 19 - Pool of Many Drips



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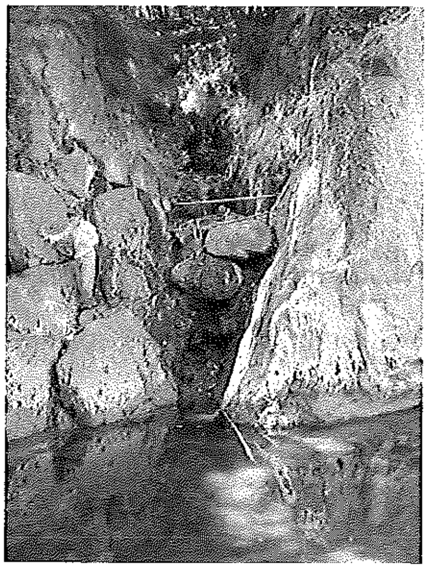

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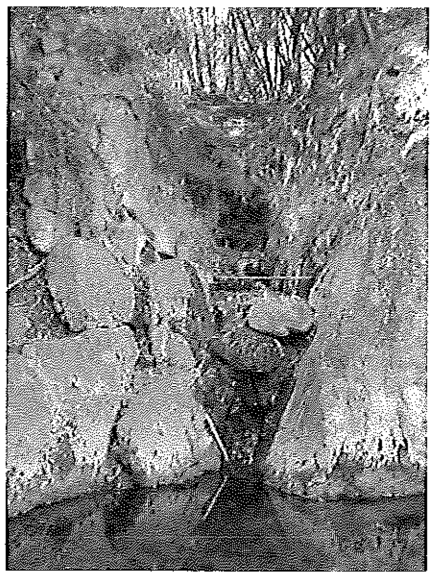

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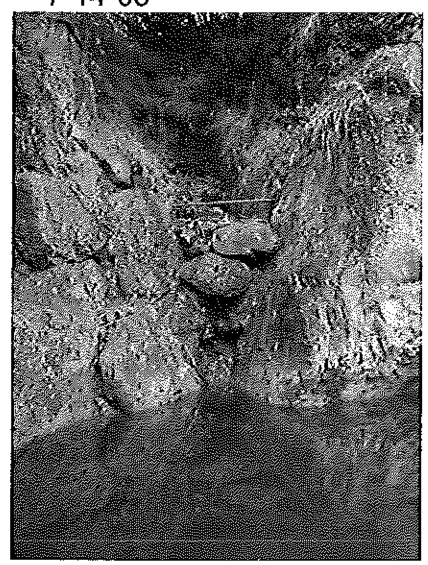

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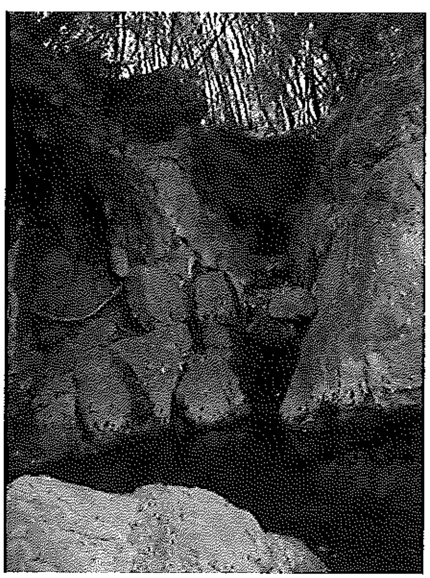

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12-20-05

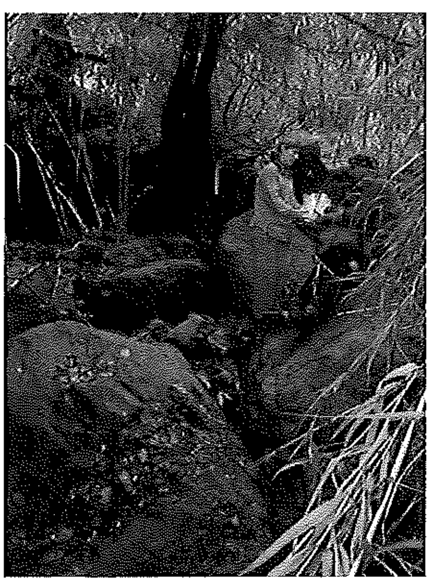
HG 20 - Big Leaf Maple

6-15-05

7-14-05

8-16-05

10-7-05



10-18-05

11-22-05

12-20-05

HG 21 – Up and Down Trib

6-15-05

8-16-05

10-18-05

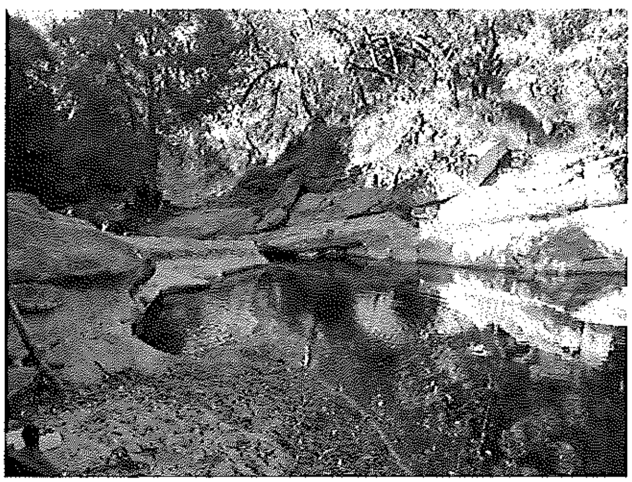
11-22-05

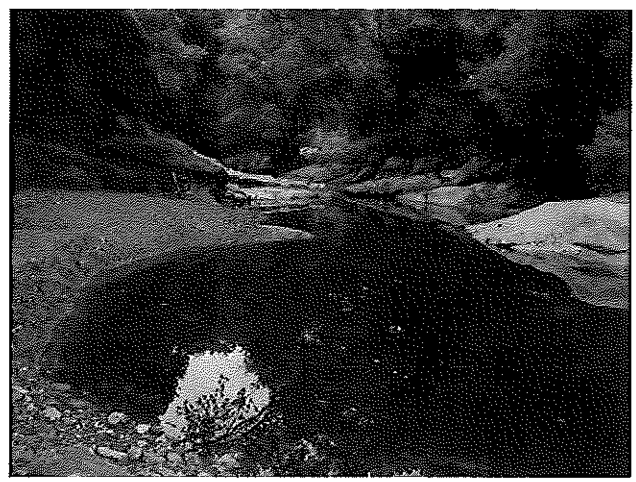
12-20-05

HG 22 – Rope Swing Pool

6-15-05

7-14-05





10-7-05

10-18-05

11-22-05

12-20-05

HG 23 – Time Tunnel

6-15-05

7-14-05

8-16-05

10-7-05

10-18-05

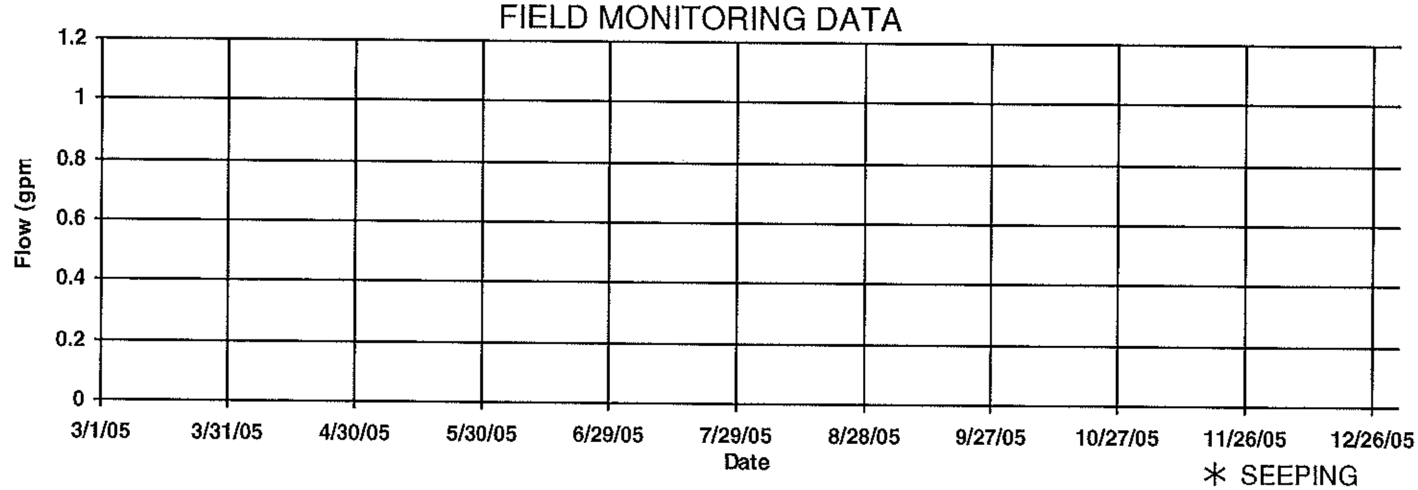
11-22-05

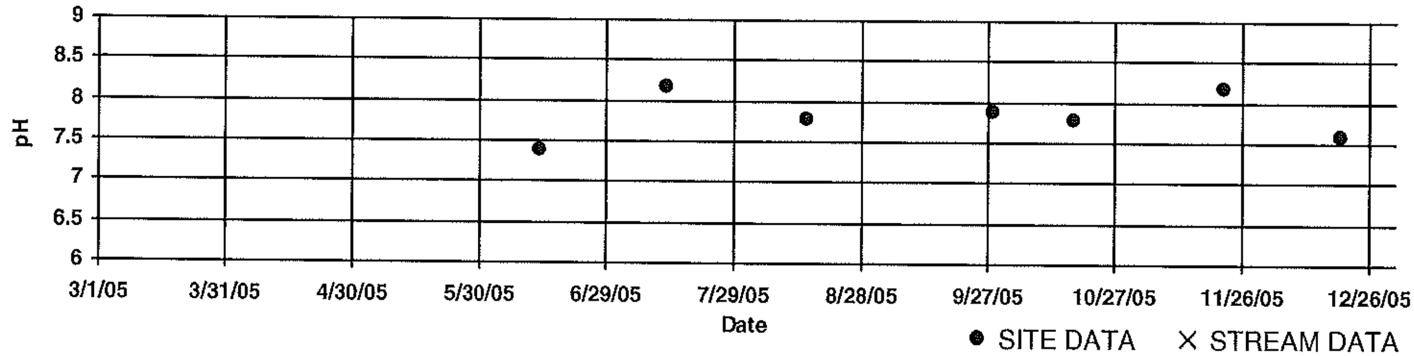
12-20-05

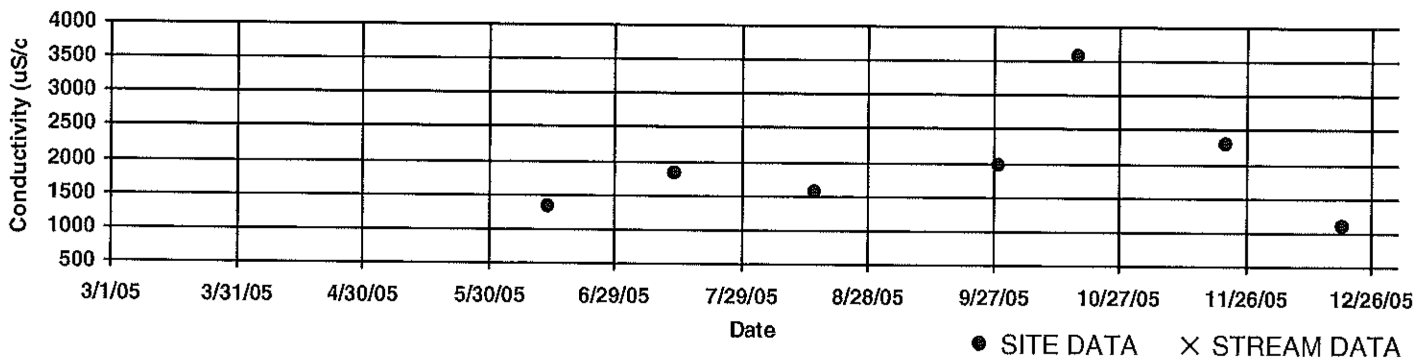
APPENDIX B
FIELD MONITORING DATA GRAPHS

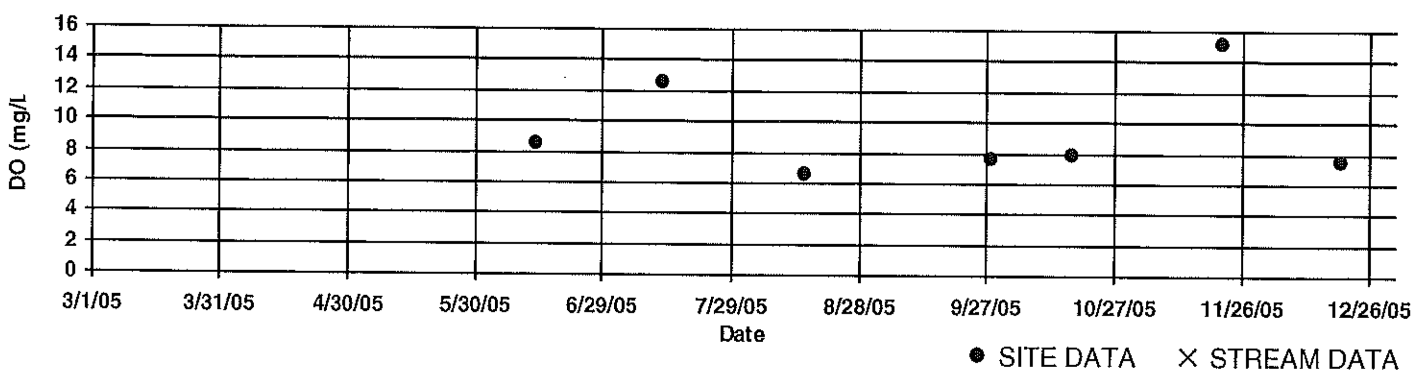
Study Site No. HG01 Topanga Lagoon Site No.: 301

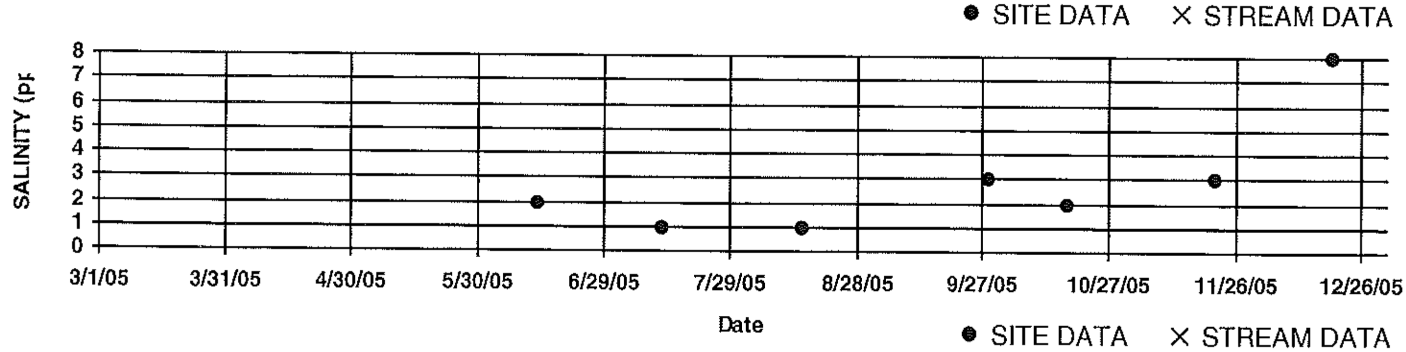
FIELD MONITORING DATA





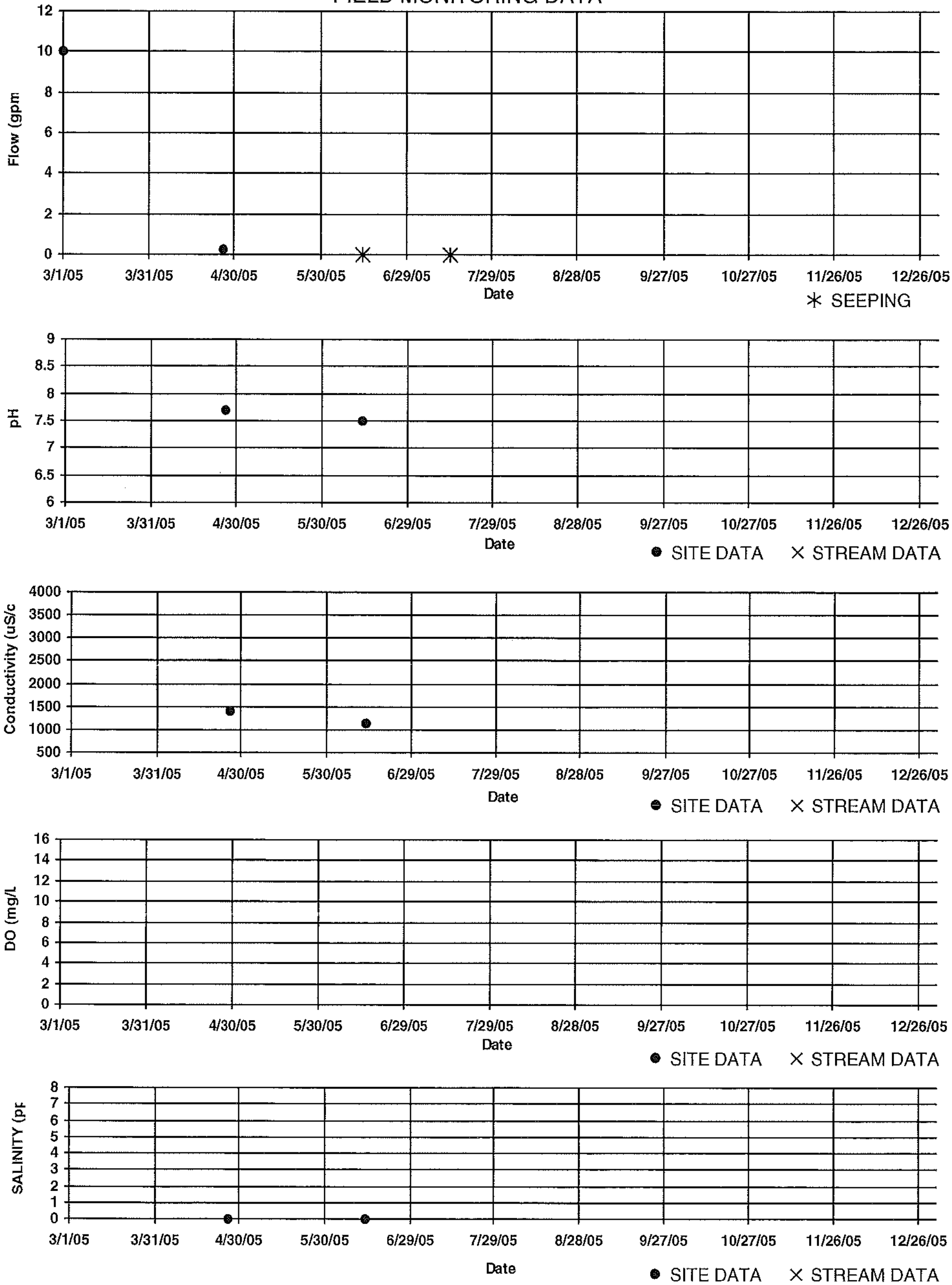






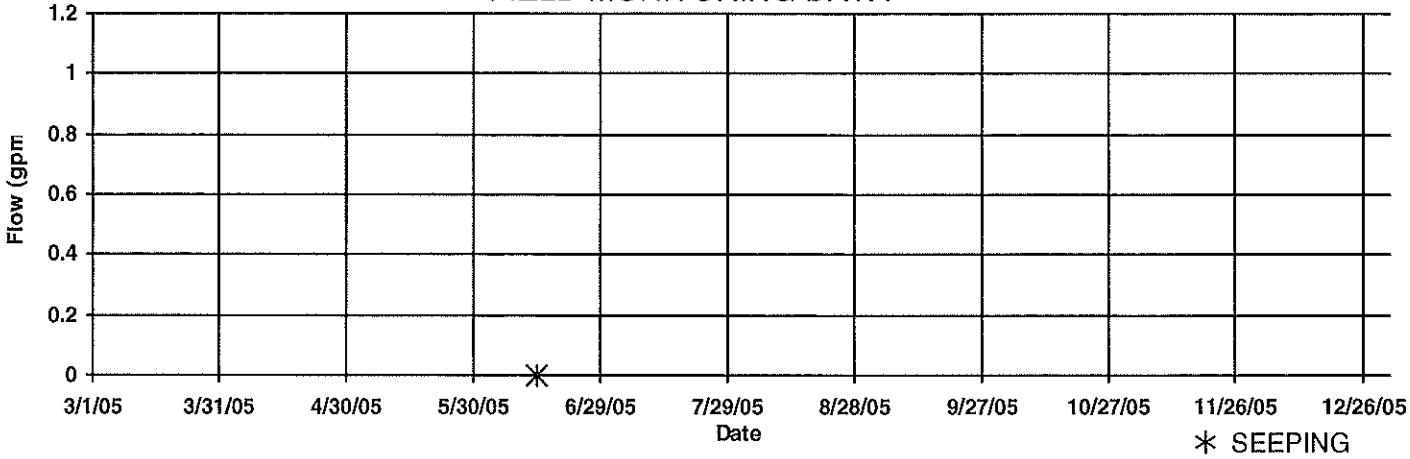
Study Site No. HG02 MM 0.05 TC Blvd. Site No.: 1

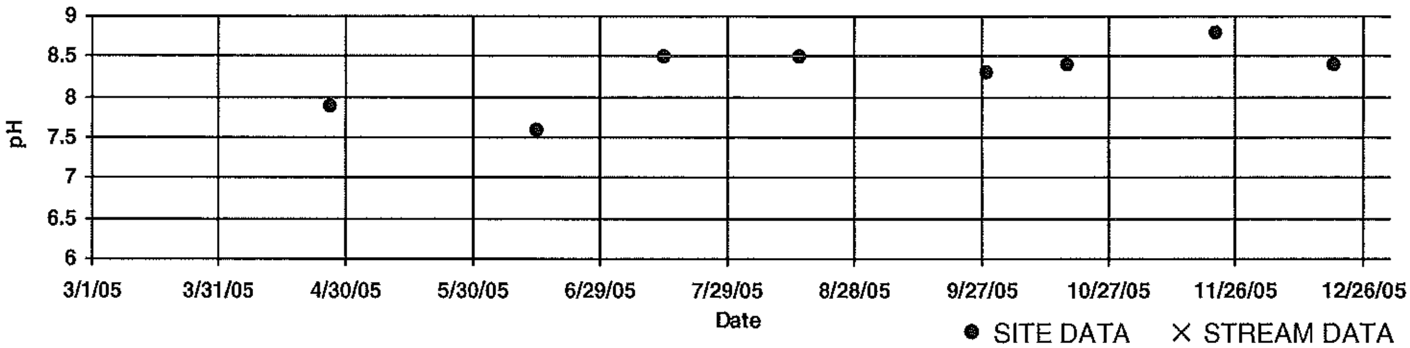
FIELD MONITORING DATA

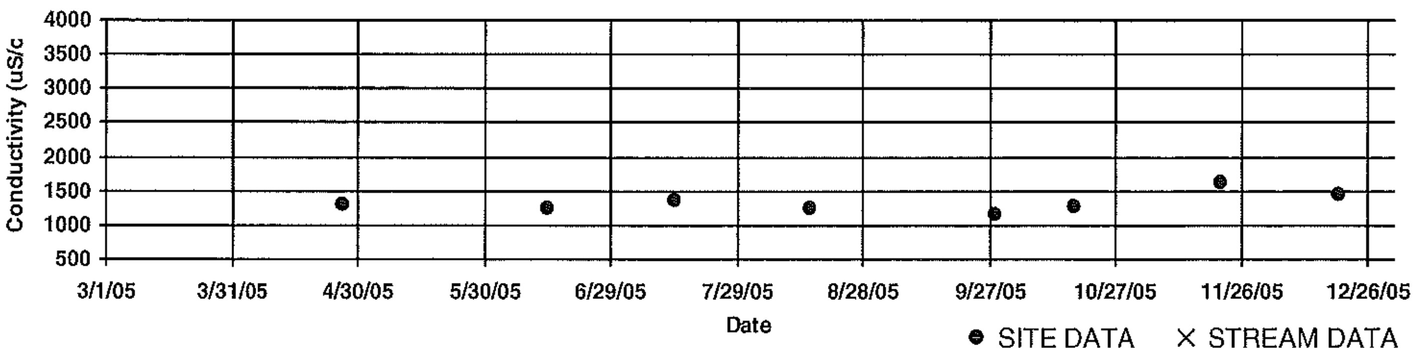


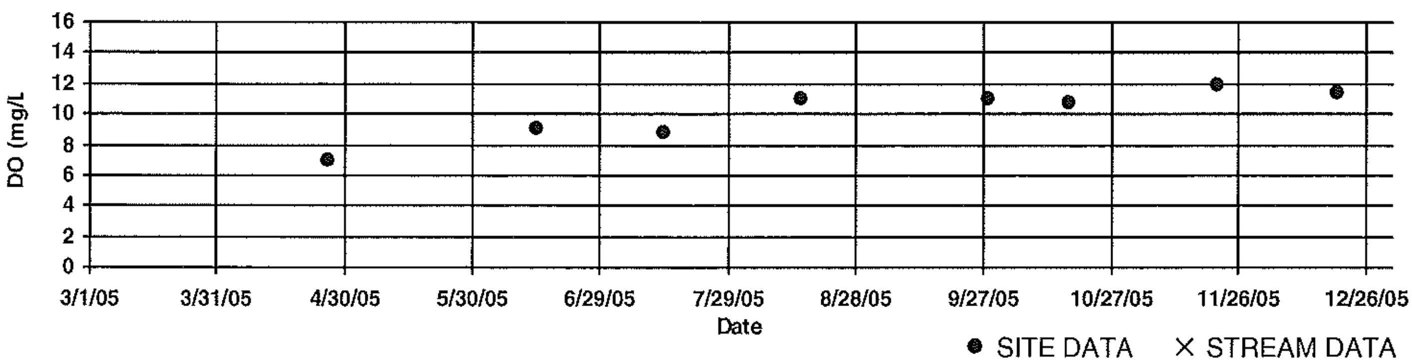
Study Site No. HG03 Transient Pool Site No.: 3

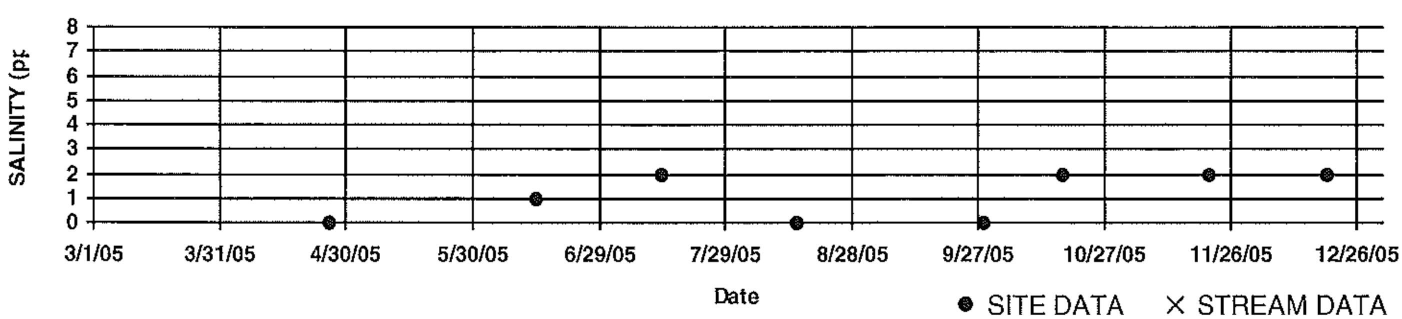
FIELD MONITORING DATA





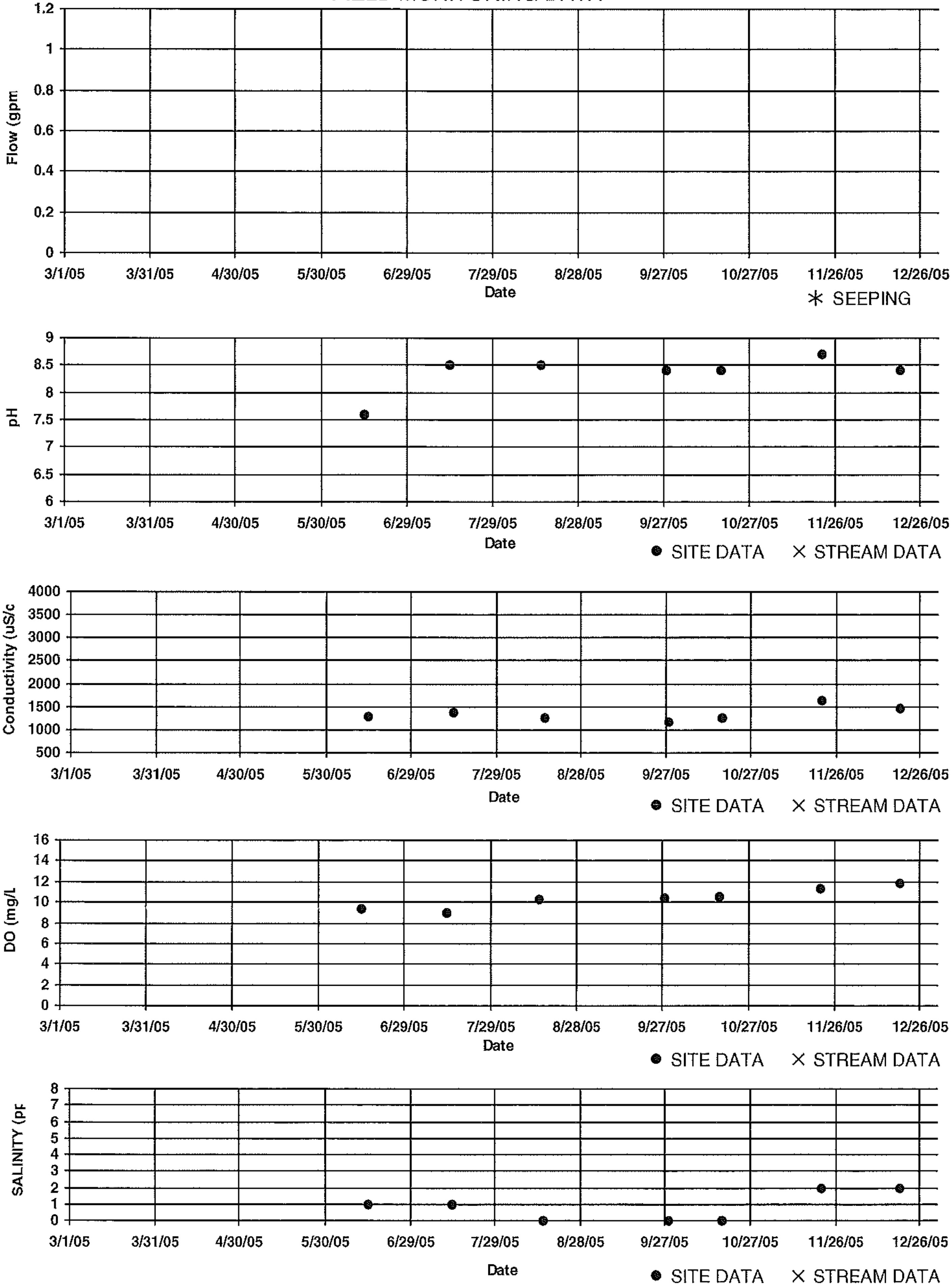






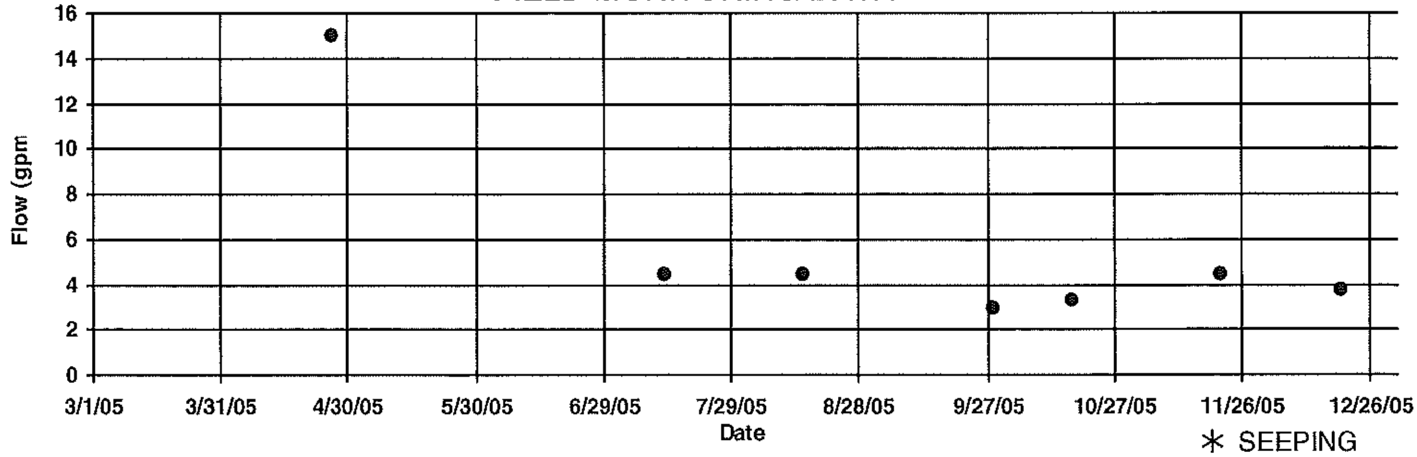
Study Site No. HG04 Ski Pole Pool Site No.: 2

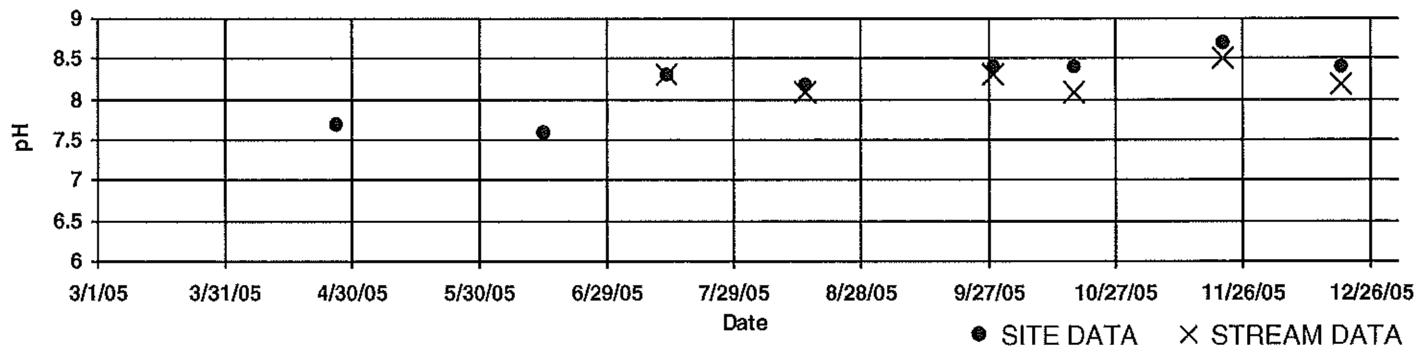
FIELD MONITORING DATA

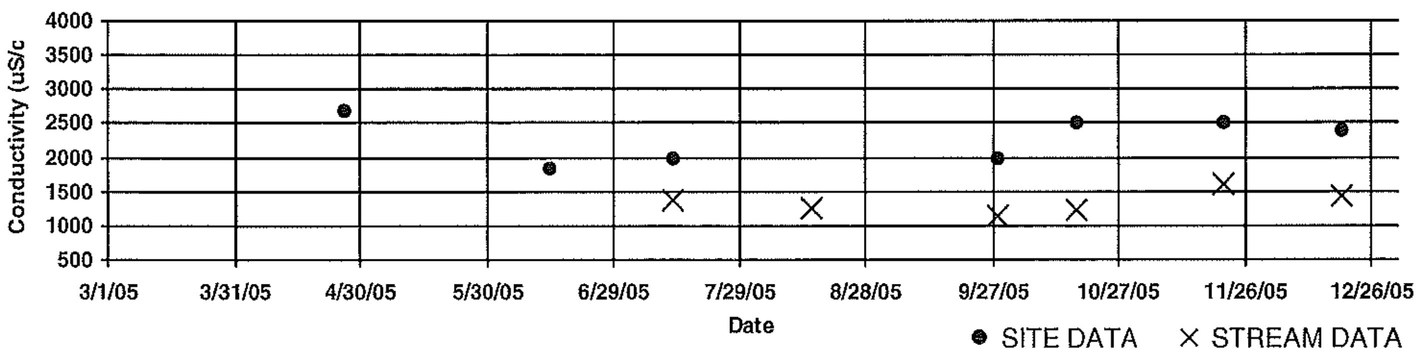


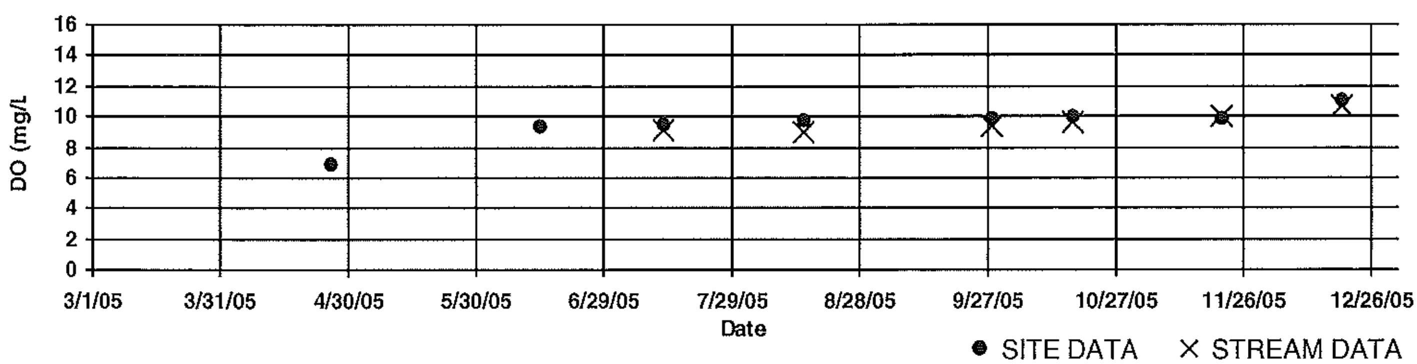
Study Site No. HG05 Green House Culvert Site No.: 4

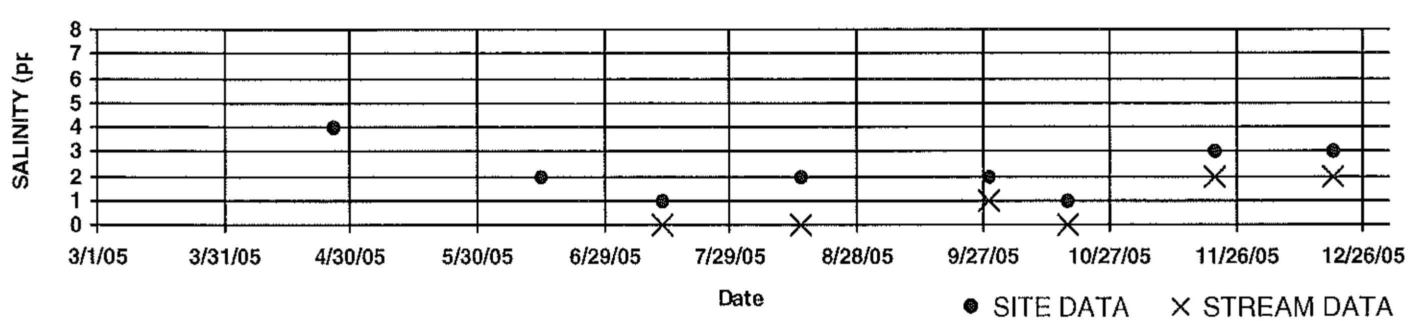
FIELD MONITORING DATA





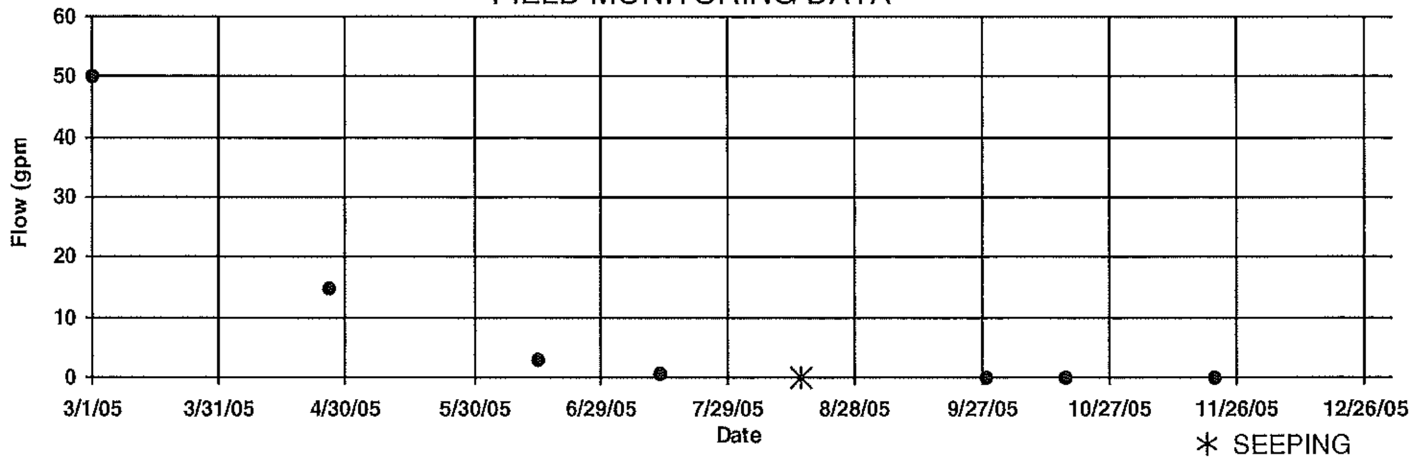


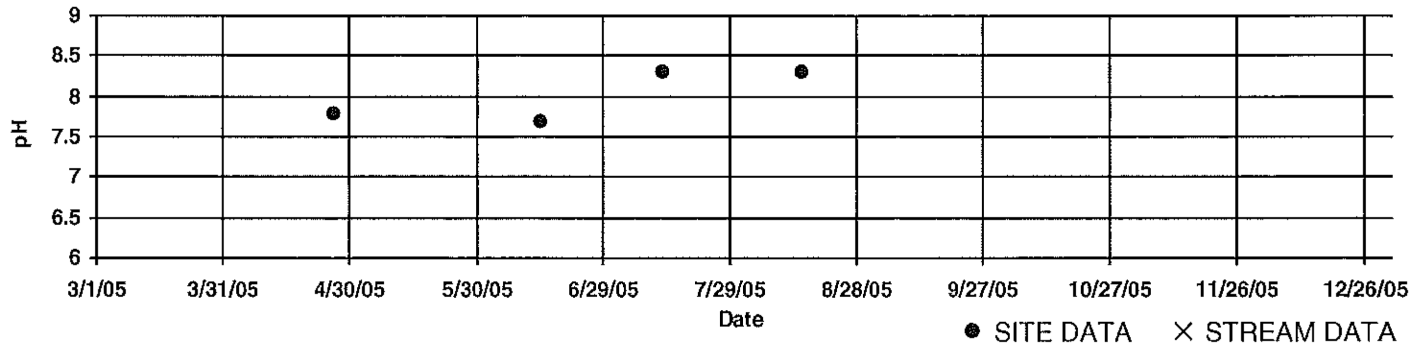


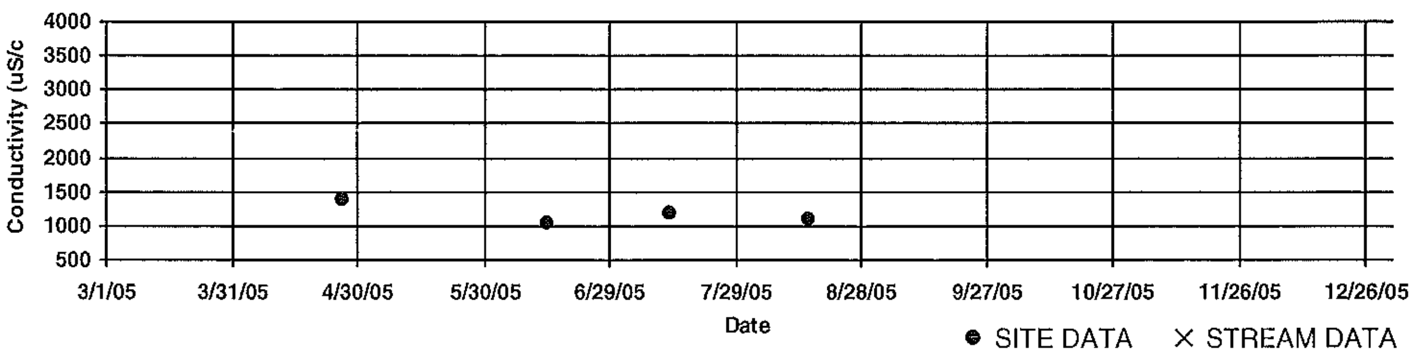


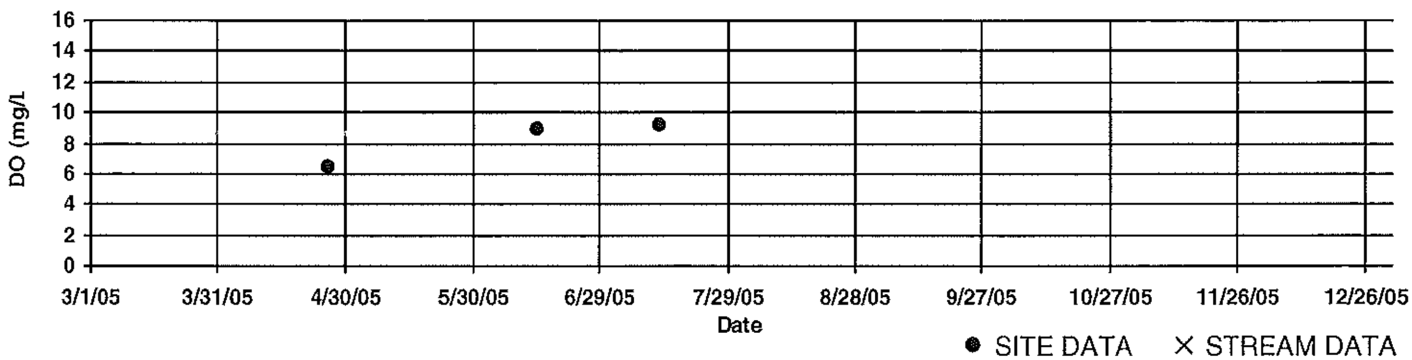
Study Site No. HG06 Culvert inlet E side Site No.: 8

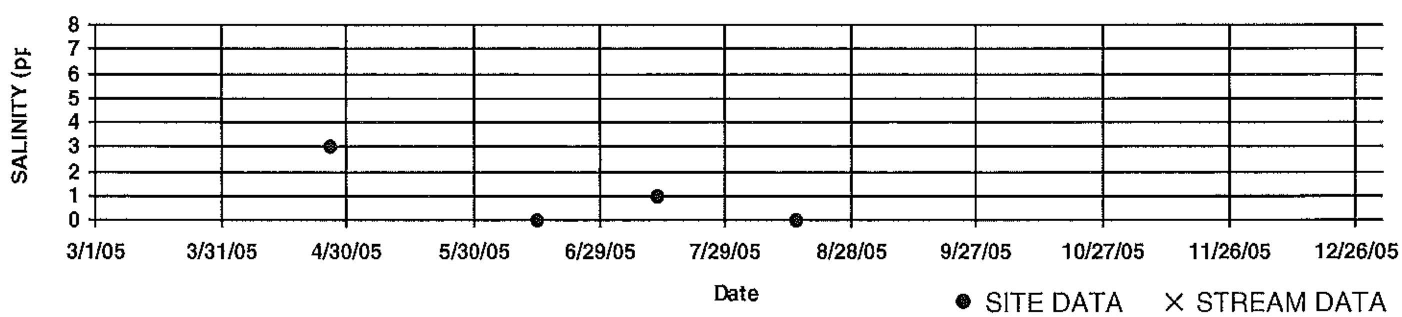
FIELD MONITORING DATA





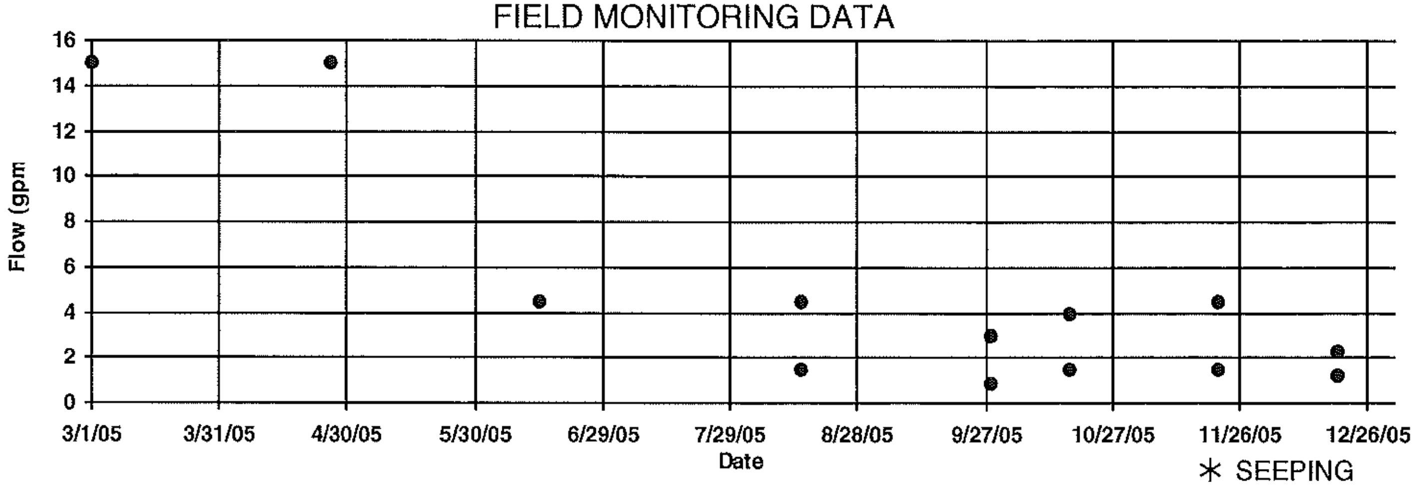


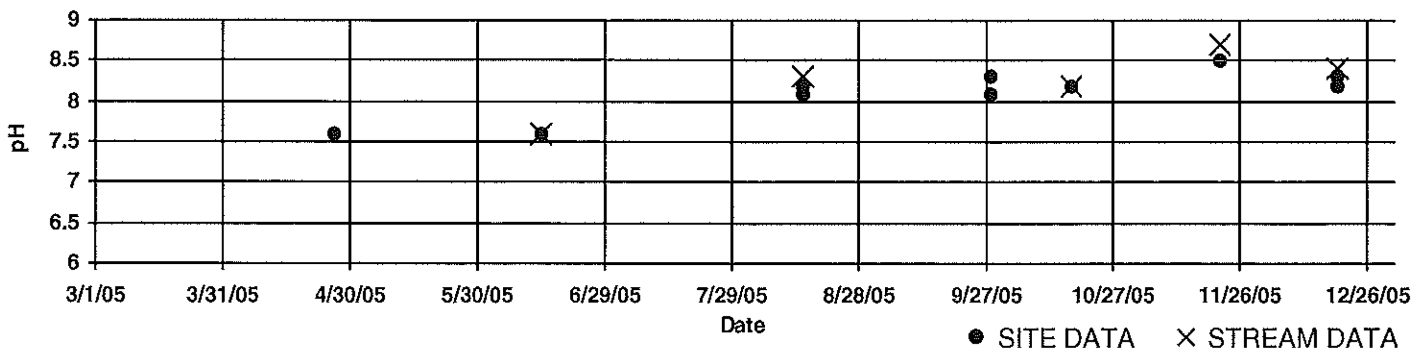


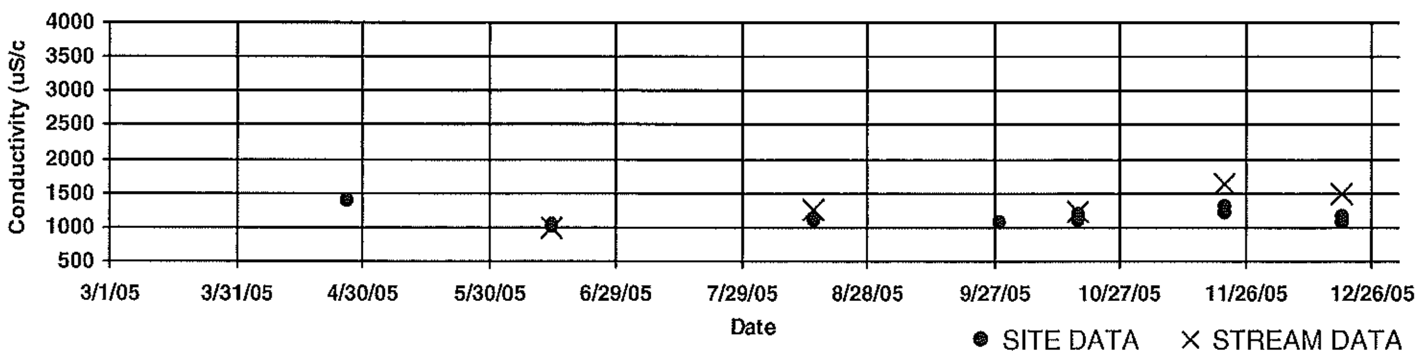


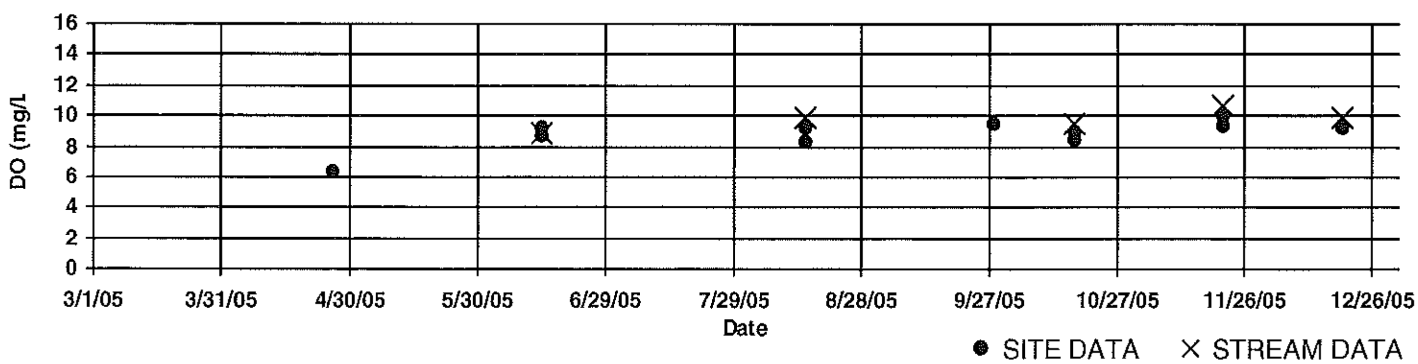
Study Site No. HG07 Ken2 Pool Site No.: 6

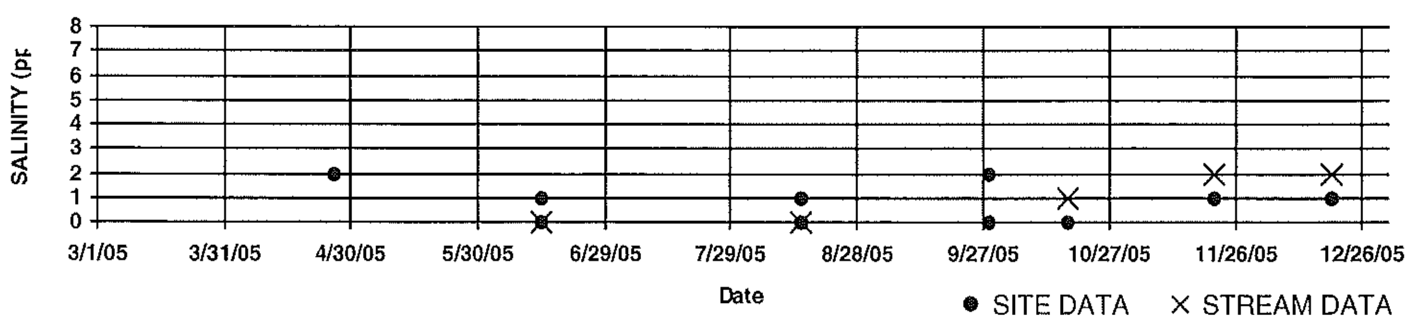
FIELD MONITORING DATA





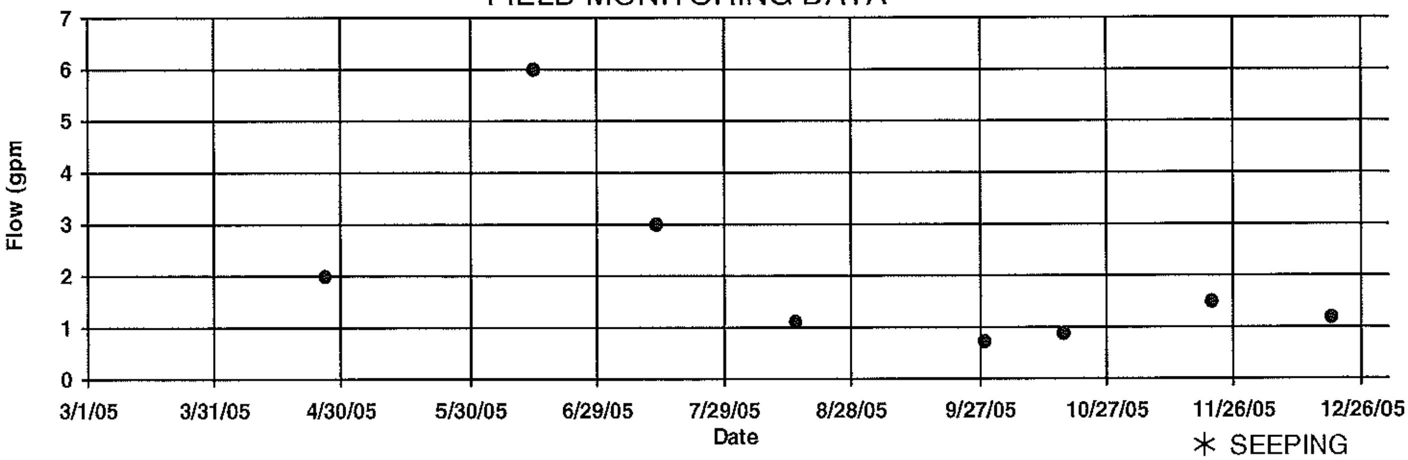


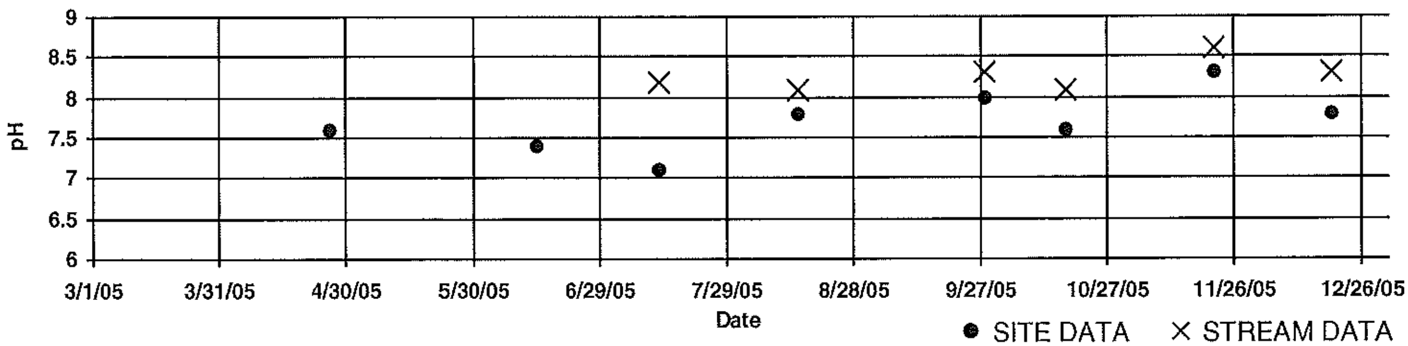


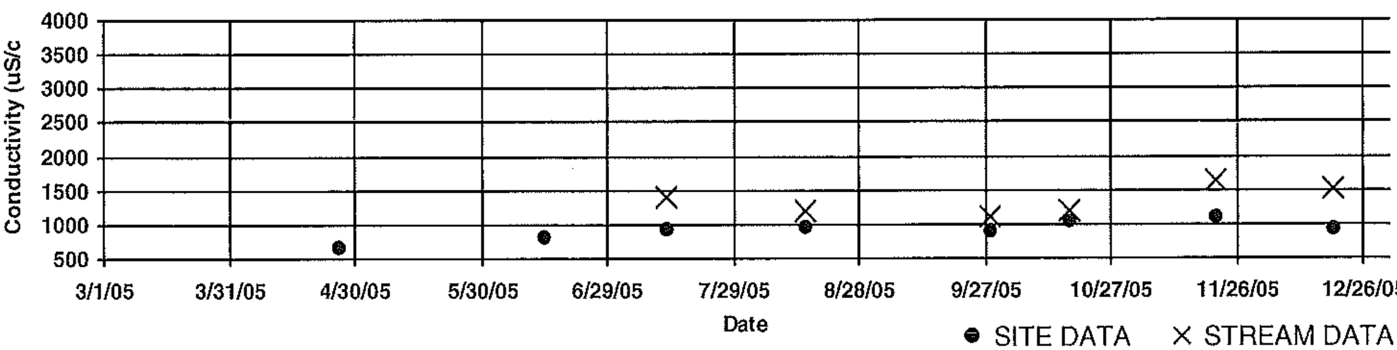


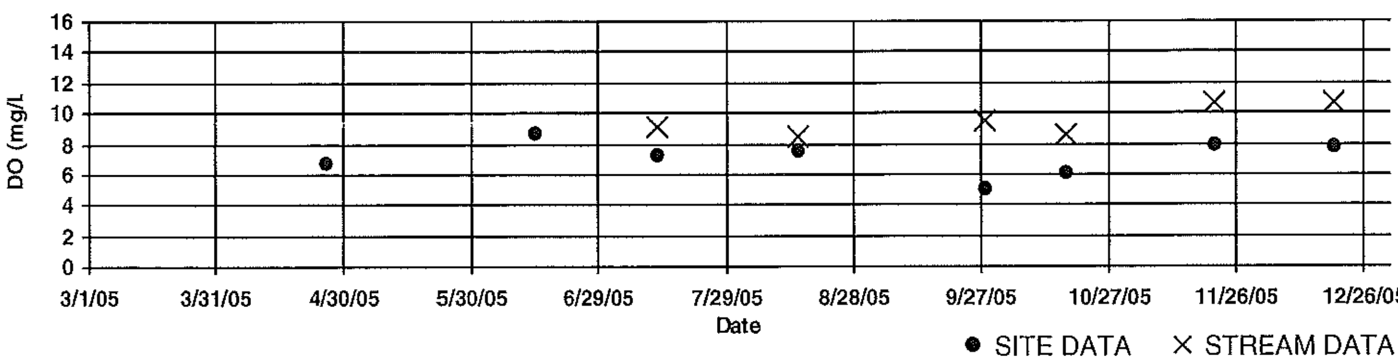
Study Site No. HG08 Alder Grove Site No.: 13

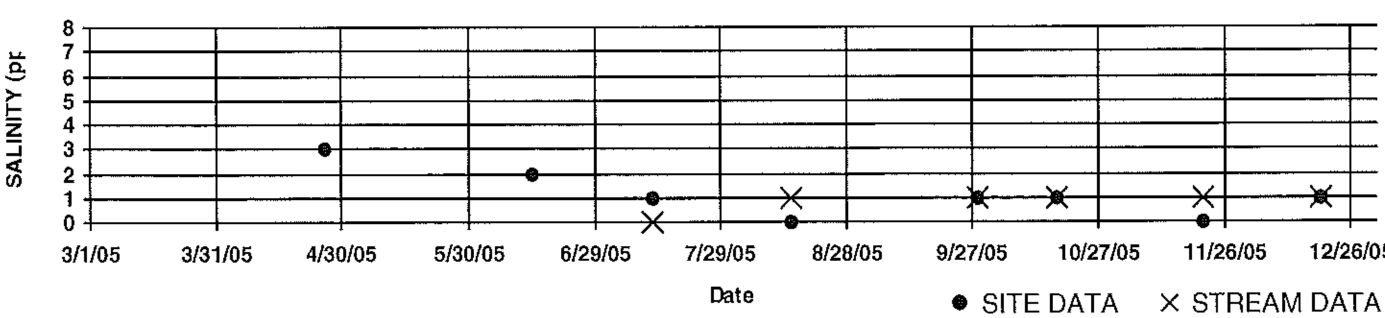
FIELD MONITORING DATA





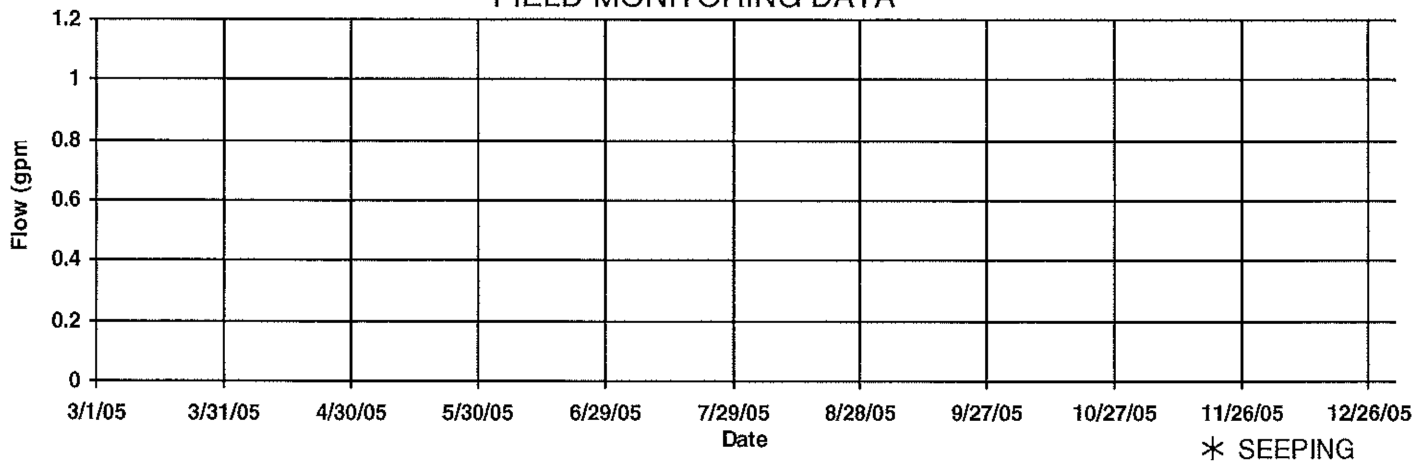


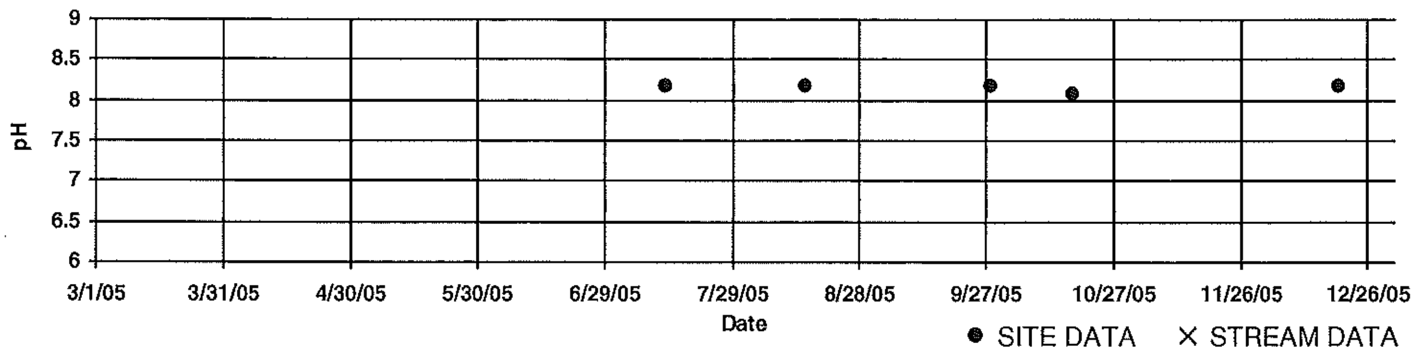


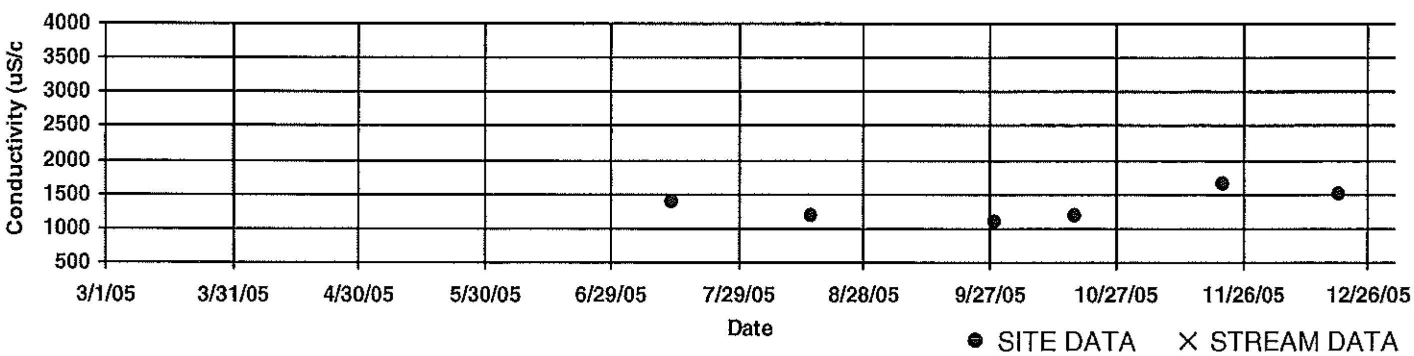


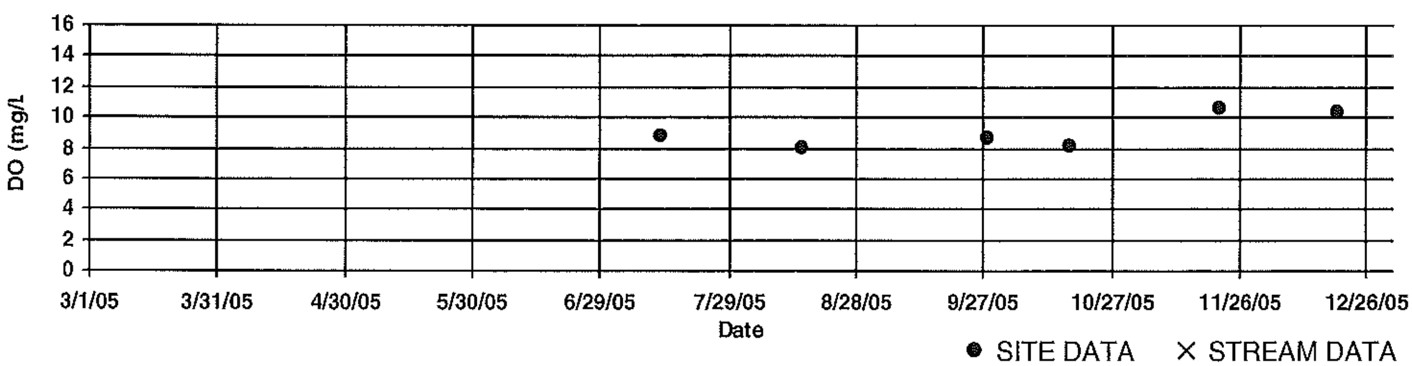
Study Site No. HG09 Bridge Site No.: 303

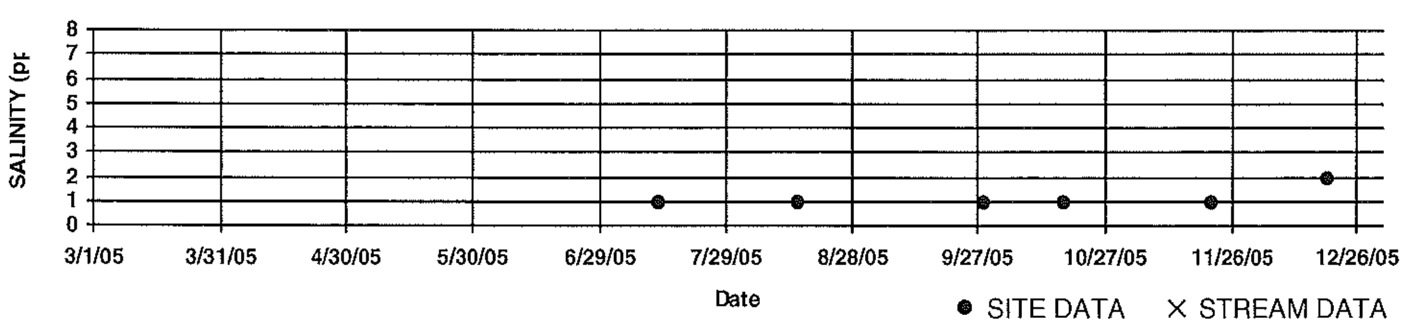
FIELD MONITORING DATA





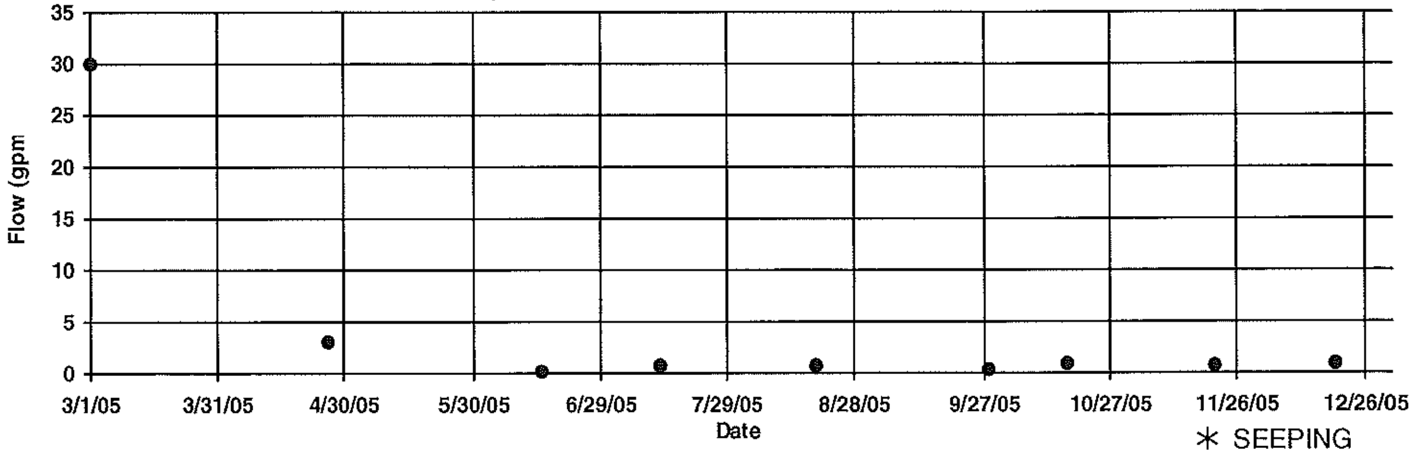


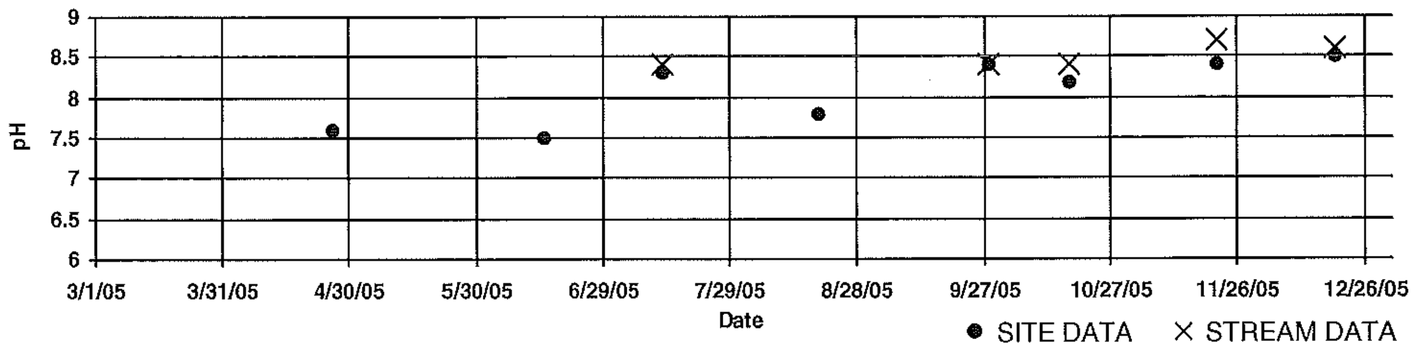


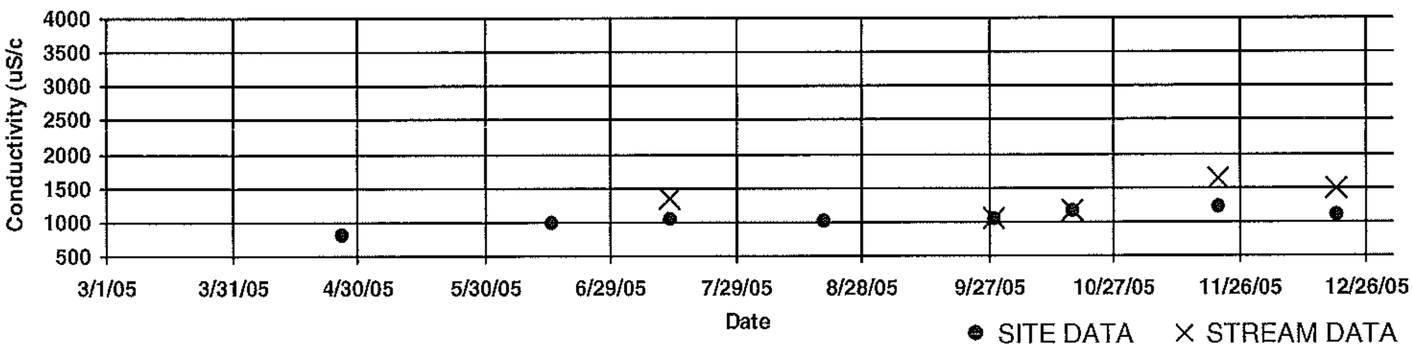


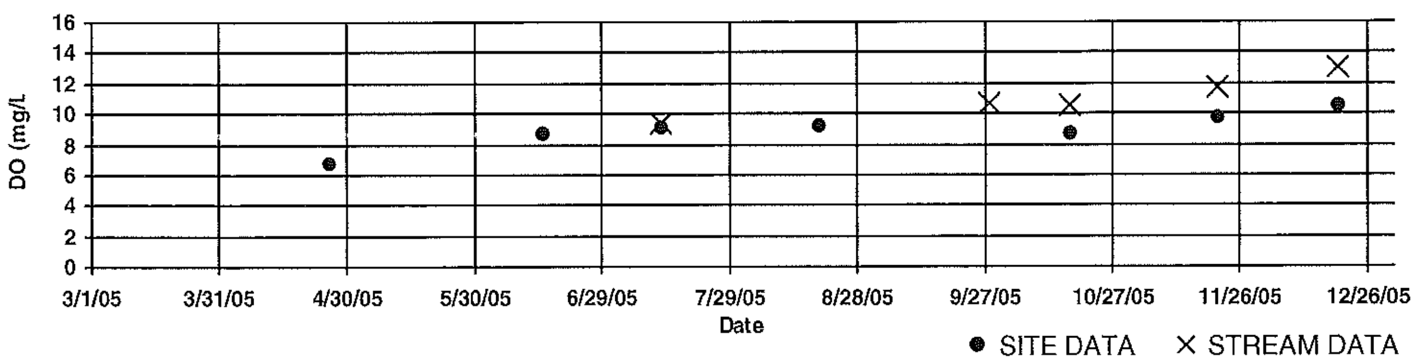
Study Site No. HG10 Sycamore Tree Site No.: 17

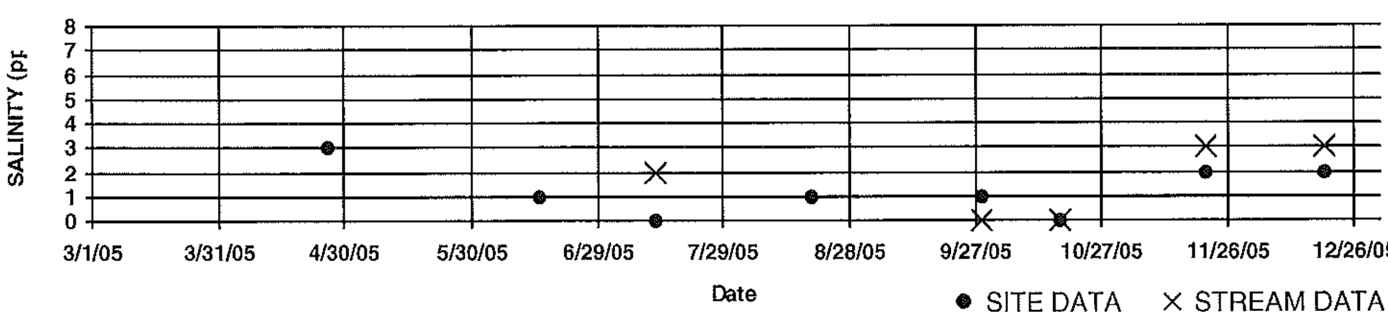
FIELD MONITORING DATA





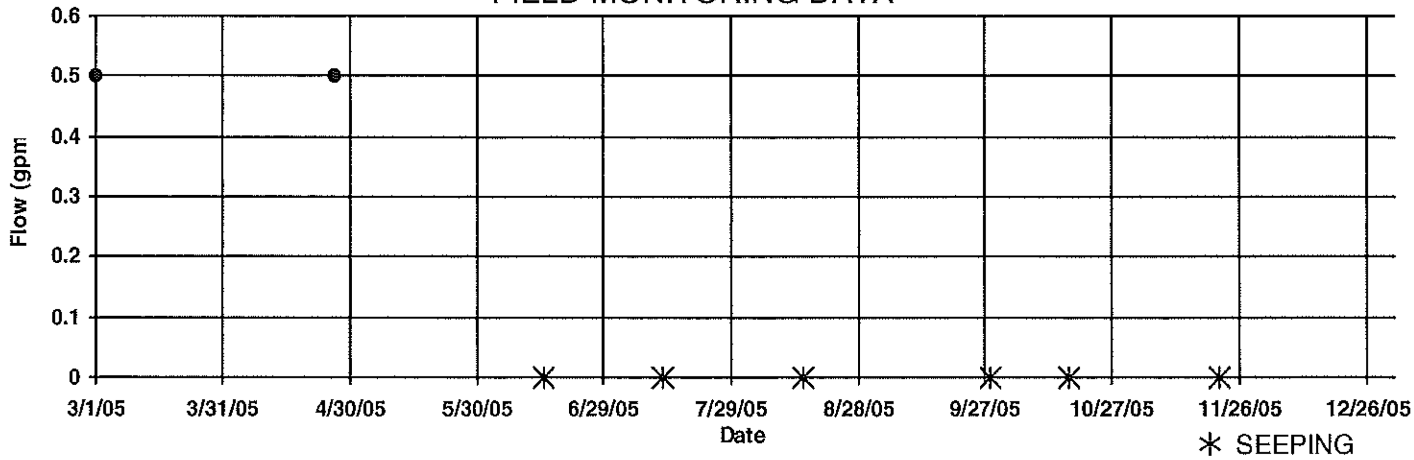


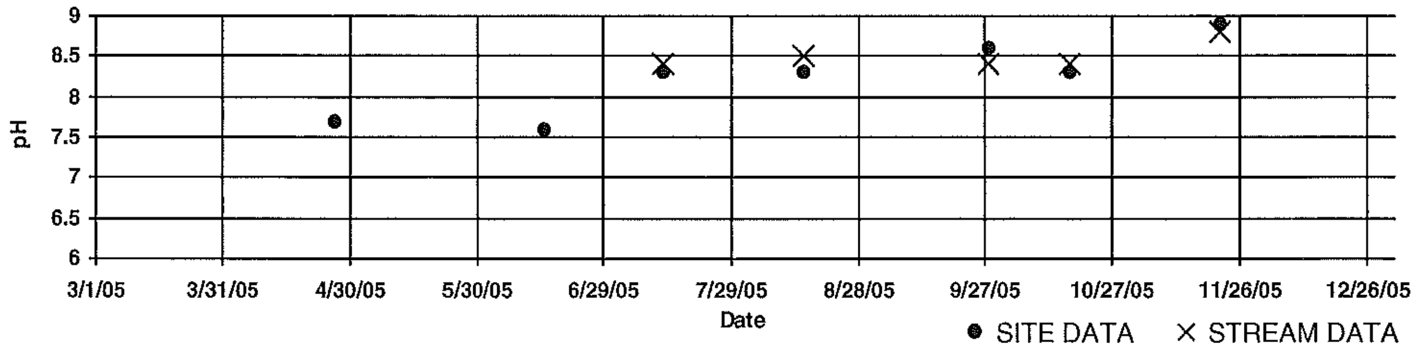


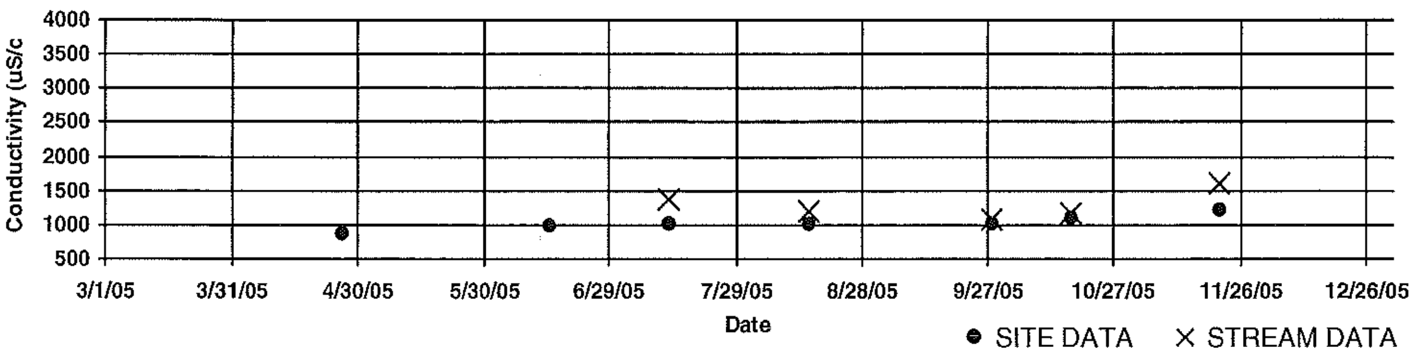


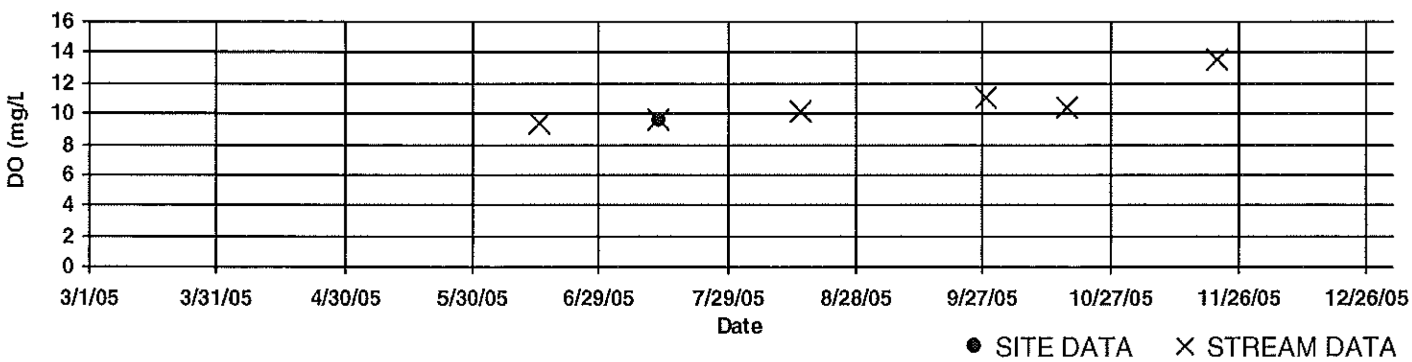
Study Site No. HG11 Maidenhair Fern Seep Site No.: 18

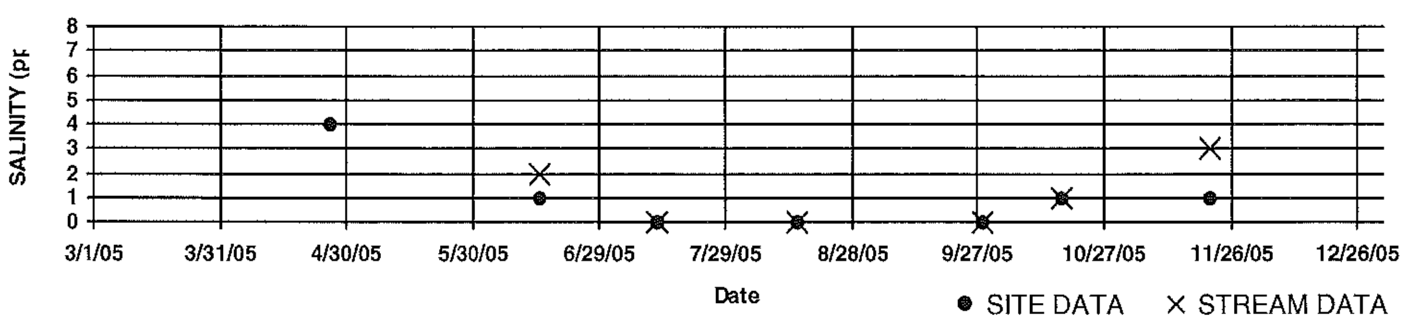
FIELD MONITORING DATA





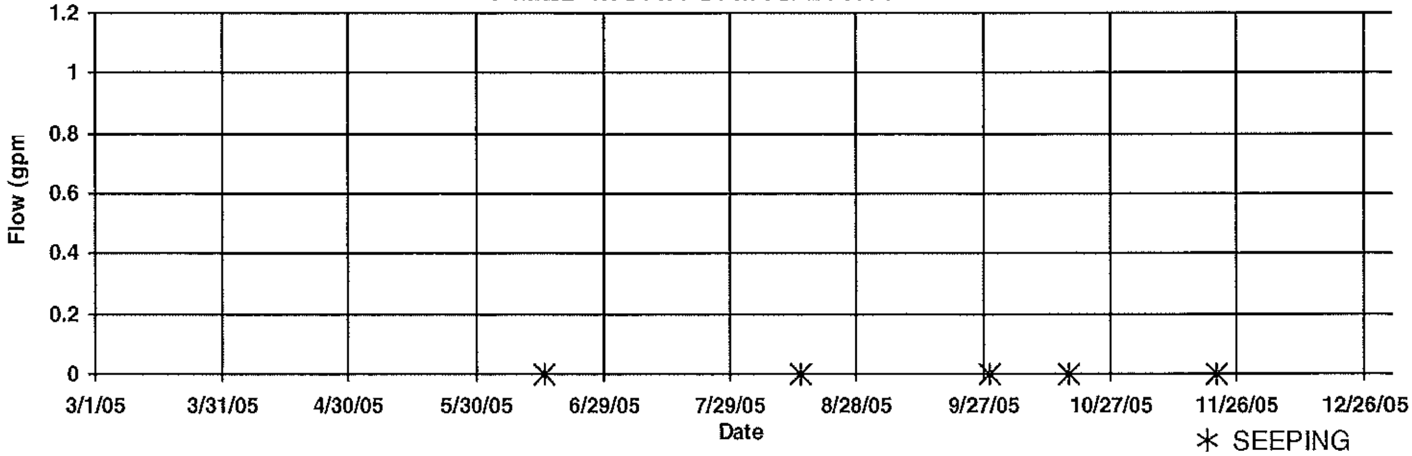


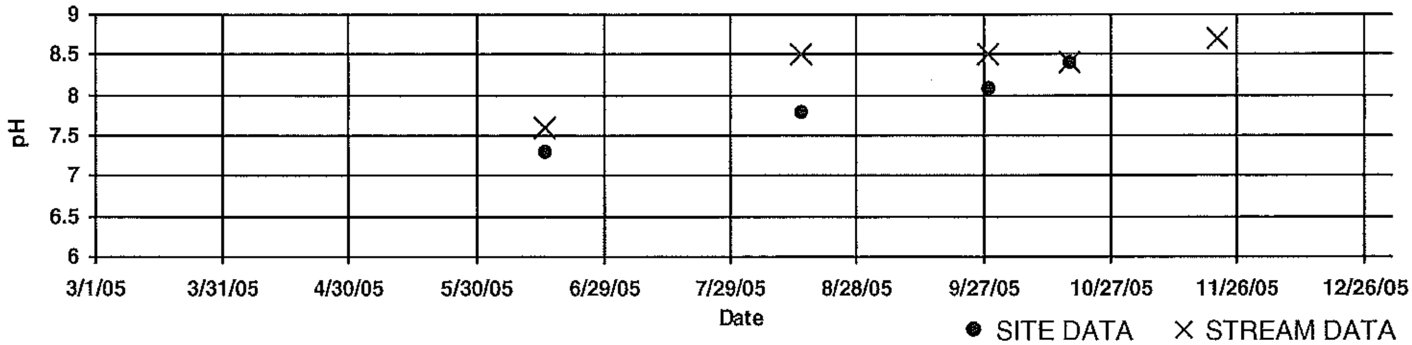


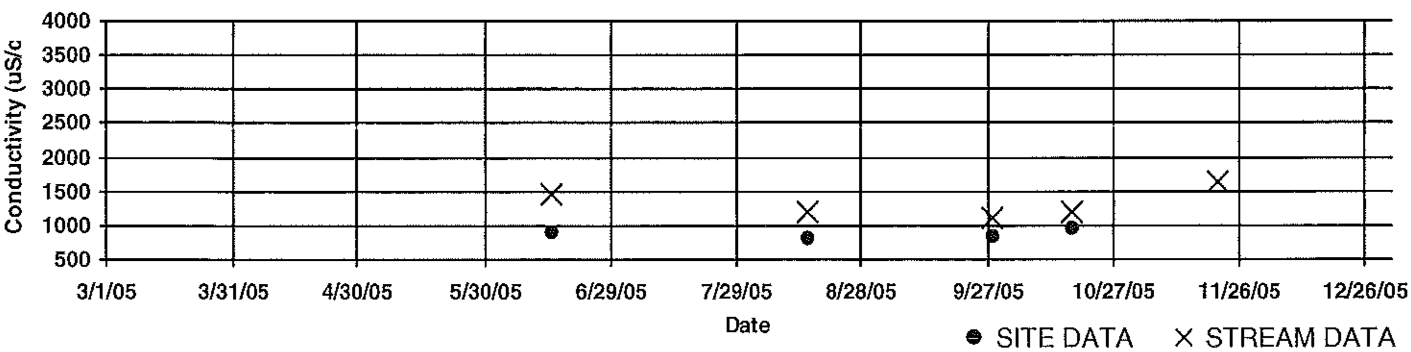


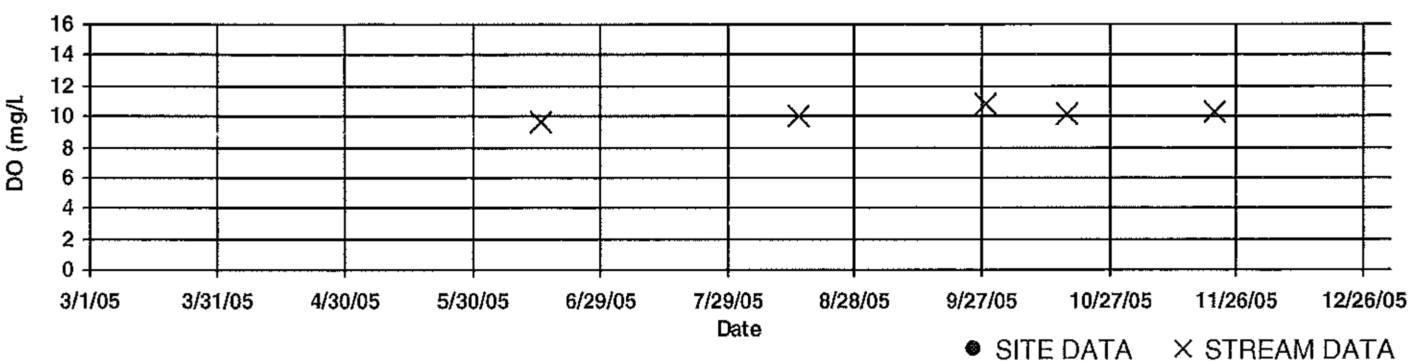
Study Site No. HG12 No Parking Alder Seep Site No.: 34

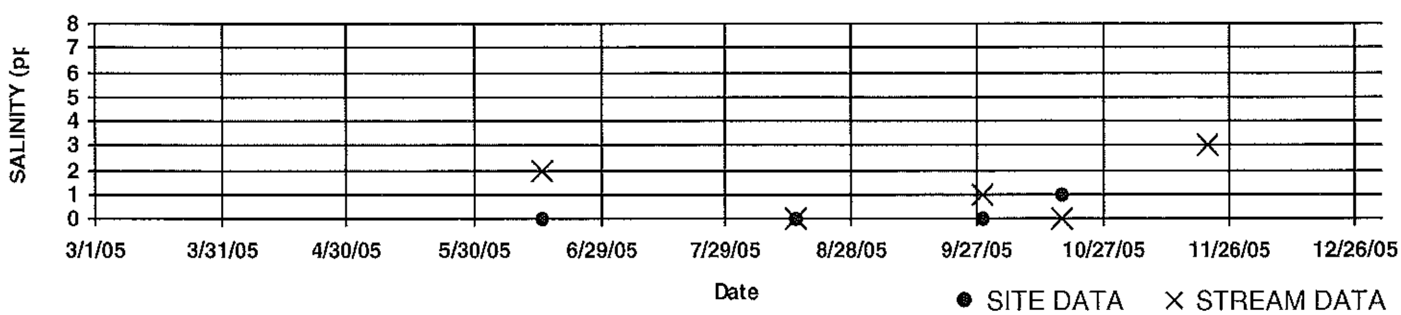
FIELD MONITORING DATA





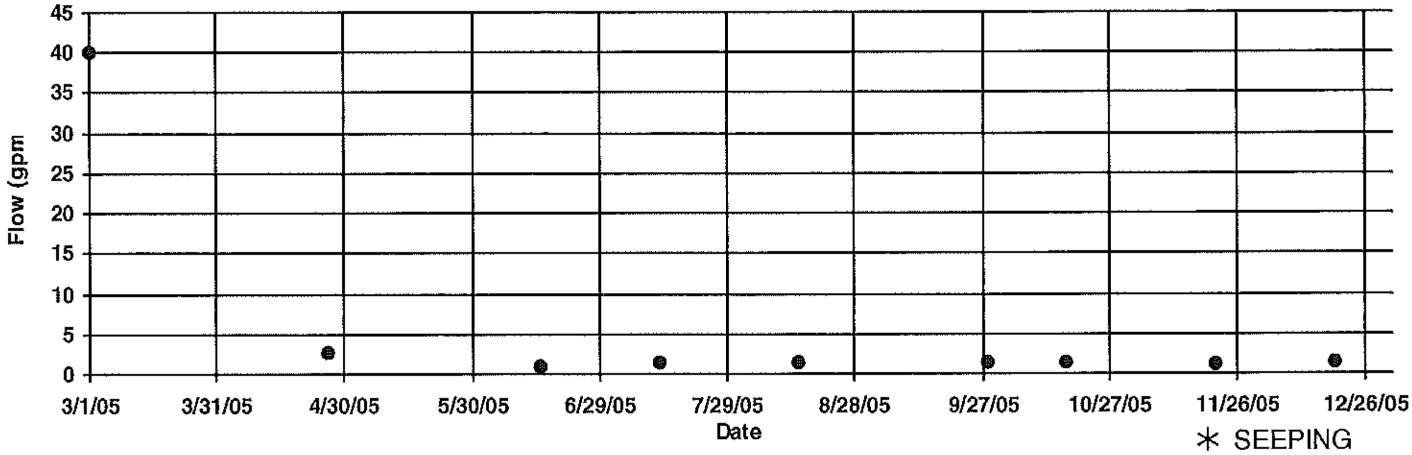


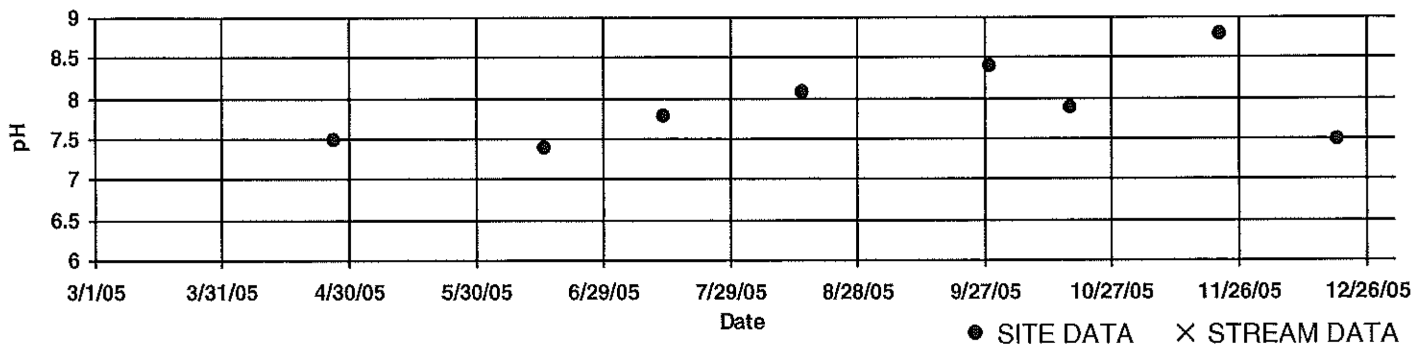


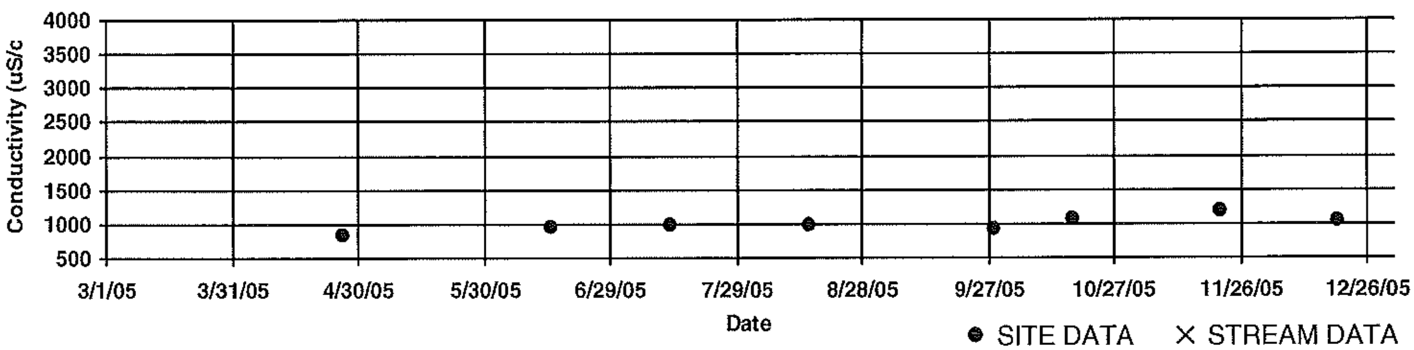


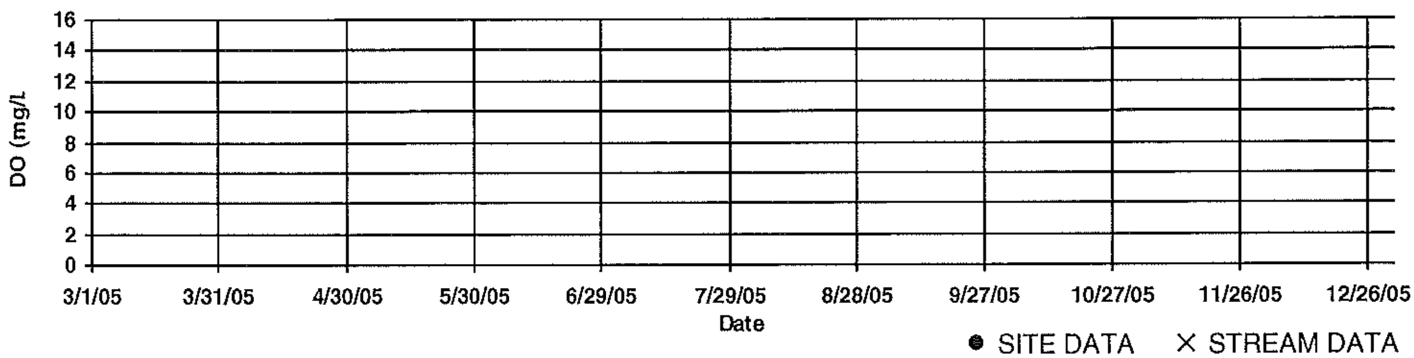
Study Site No. HG13 Narrows Seep Site No.: 19

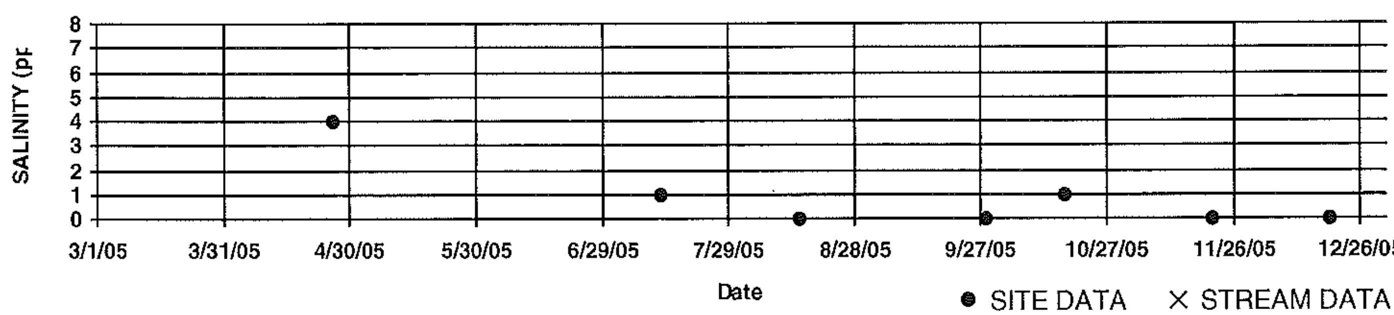
FIELD MONITORING DATA





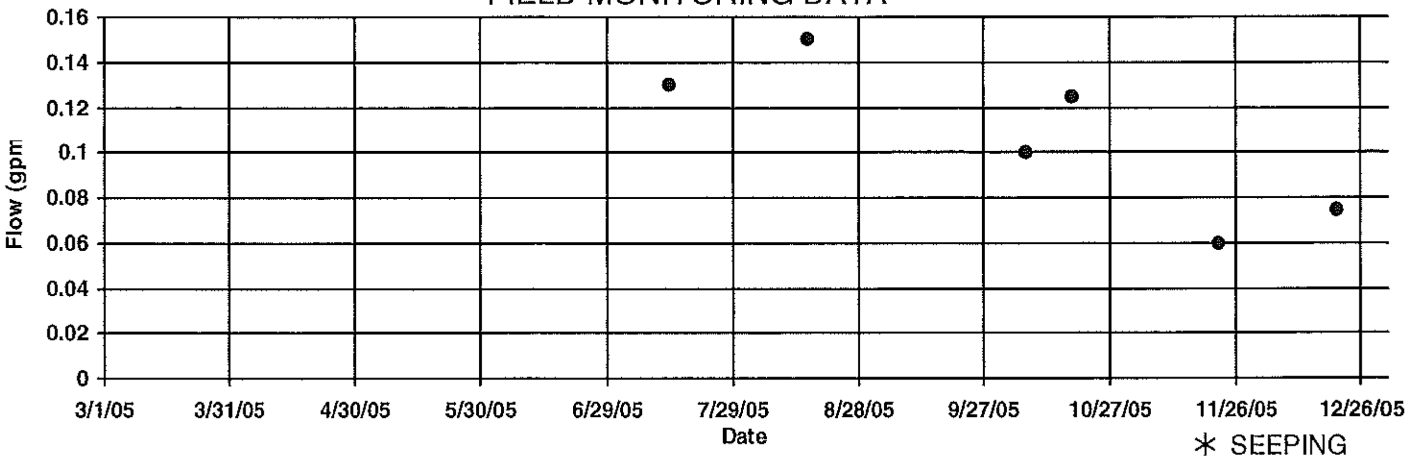


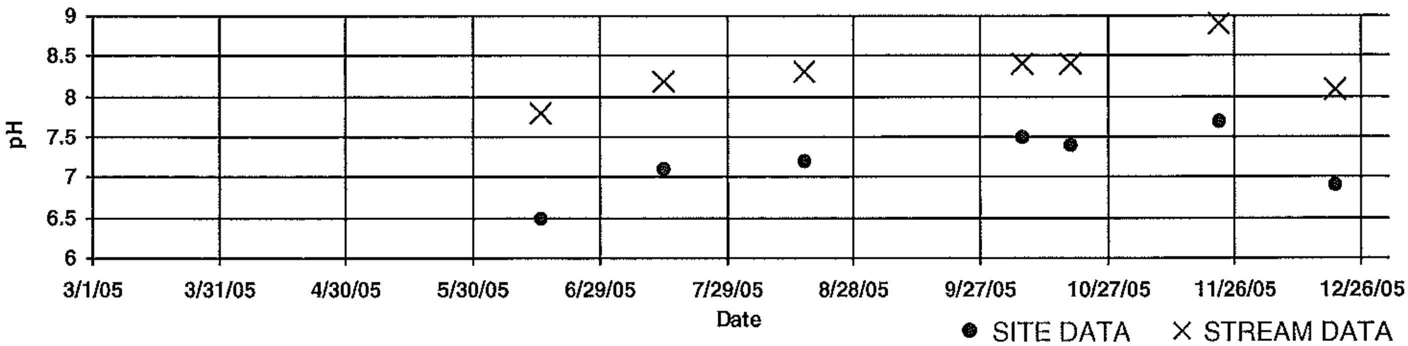


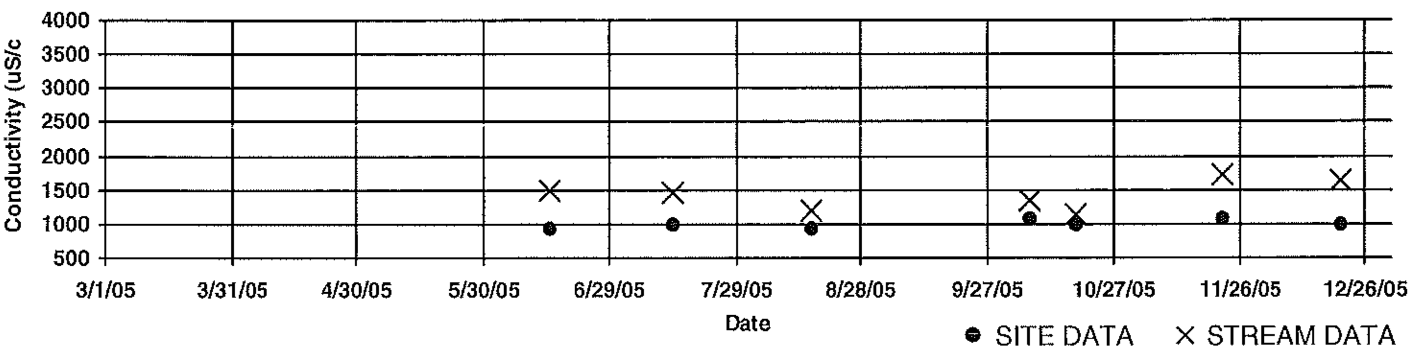


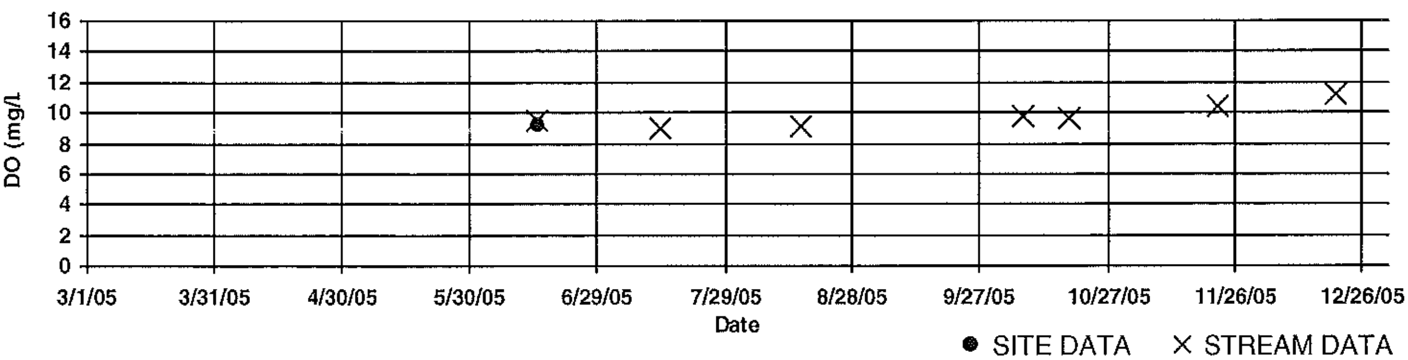
Study Site No. HG14 Duck Seep/Kevin Pool Site No.: 20

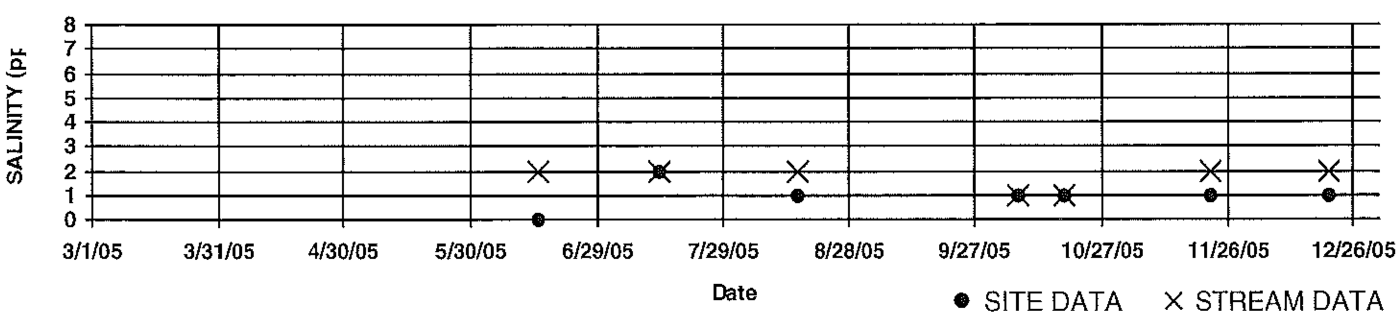
FIELD MONITORING DATA





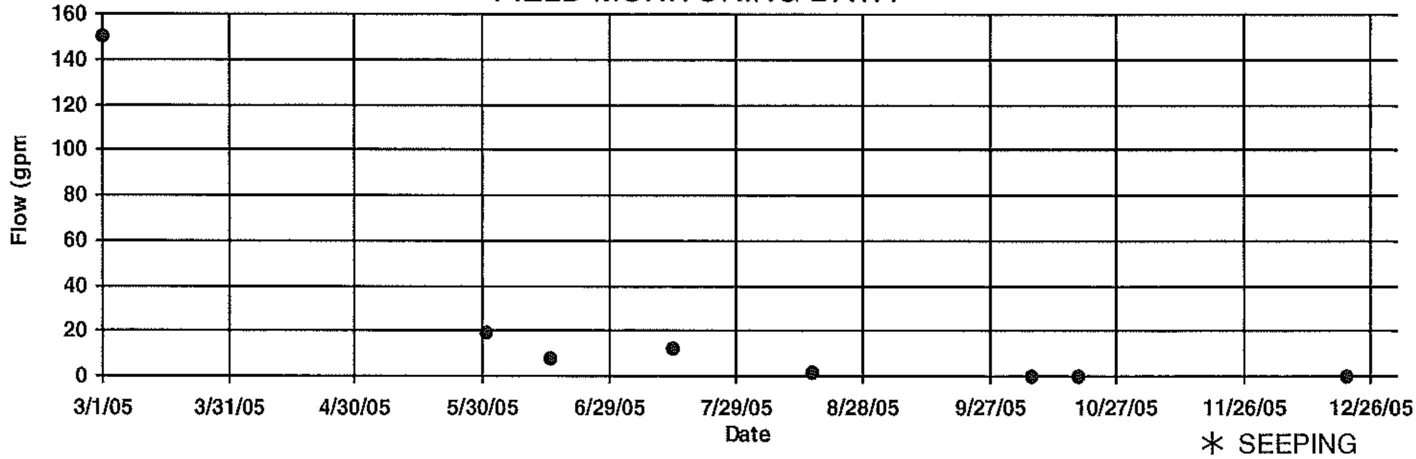


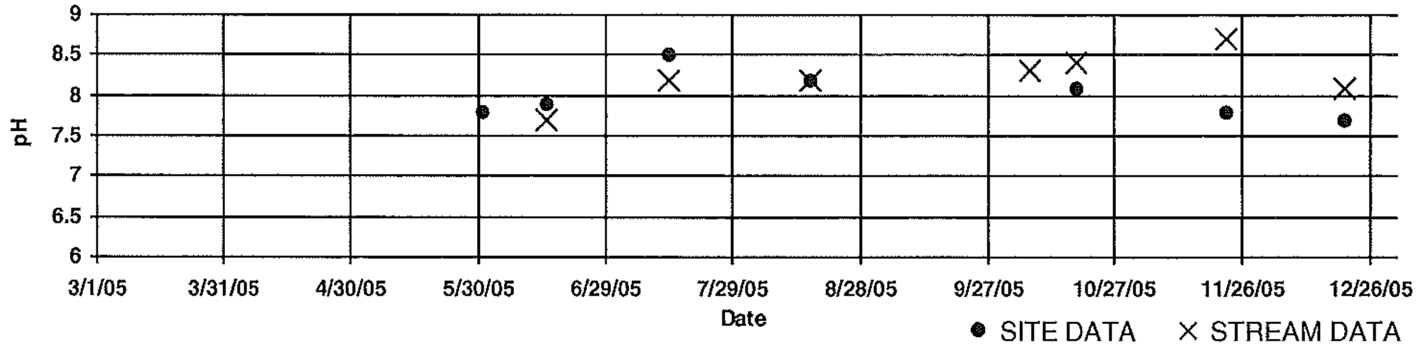


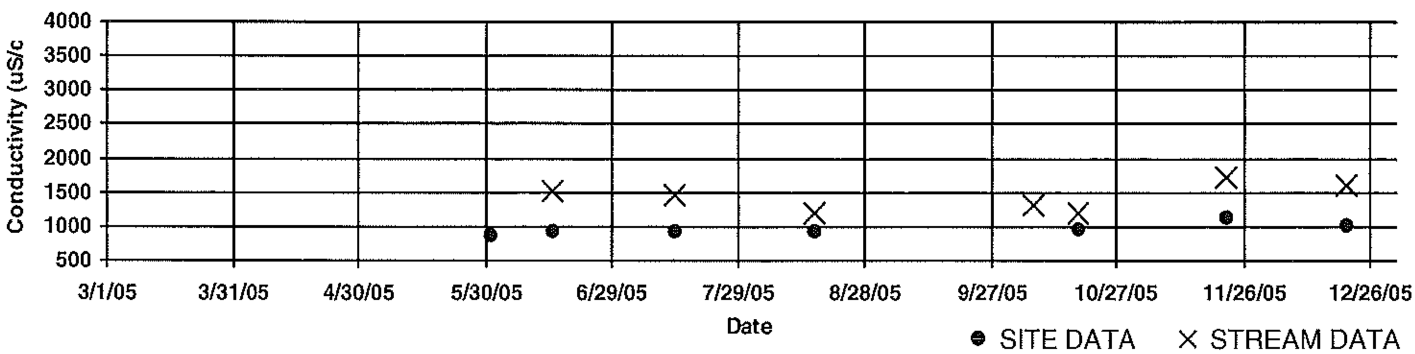


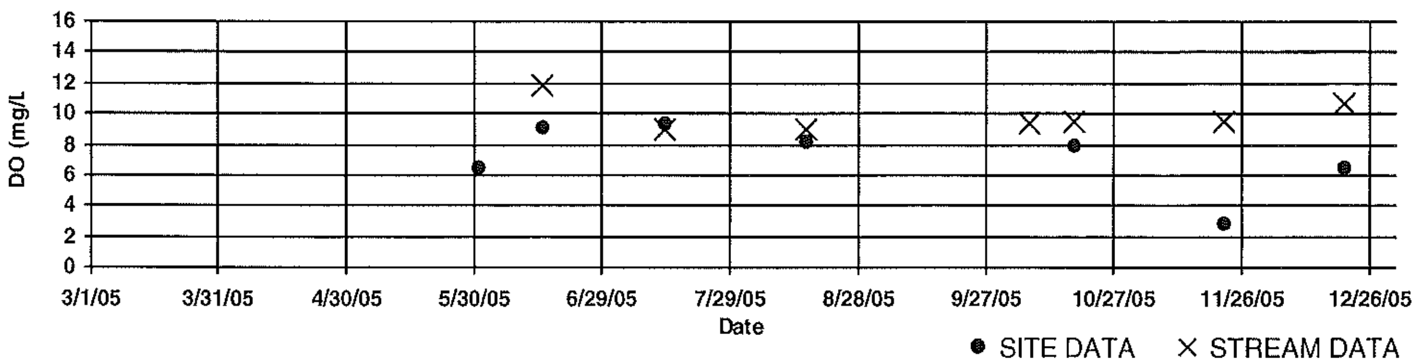
Study Site No. HG15 Storm Falls Site No.: 27

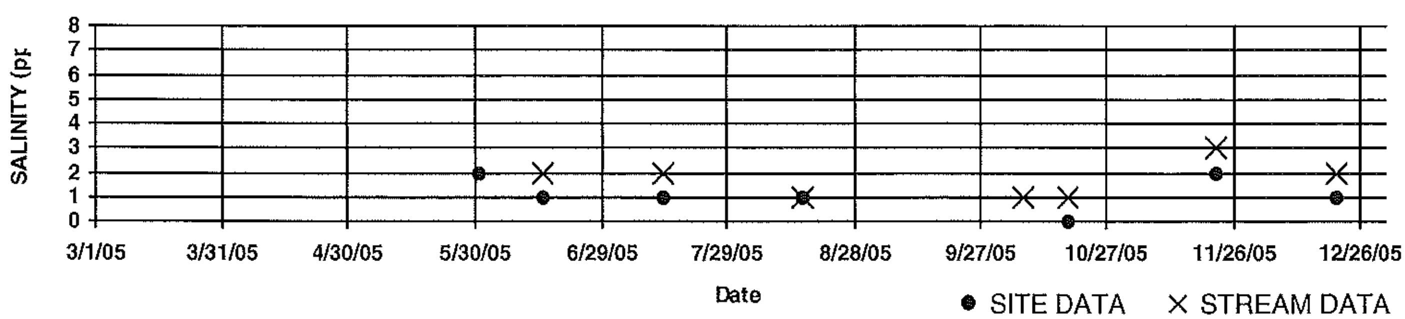
FIELD MONITORING DATA





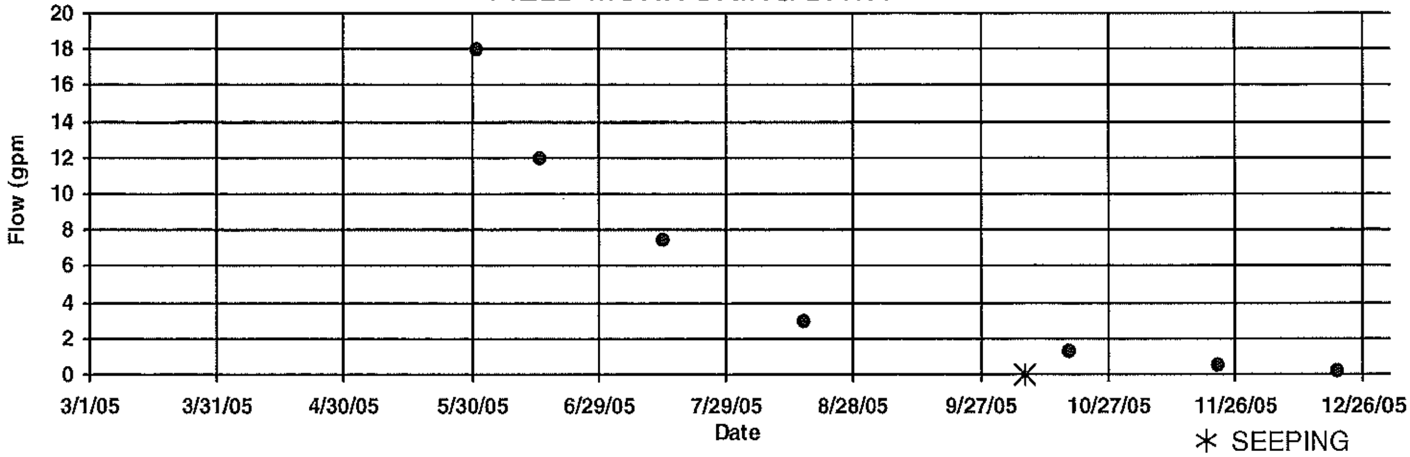


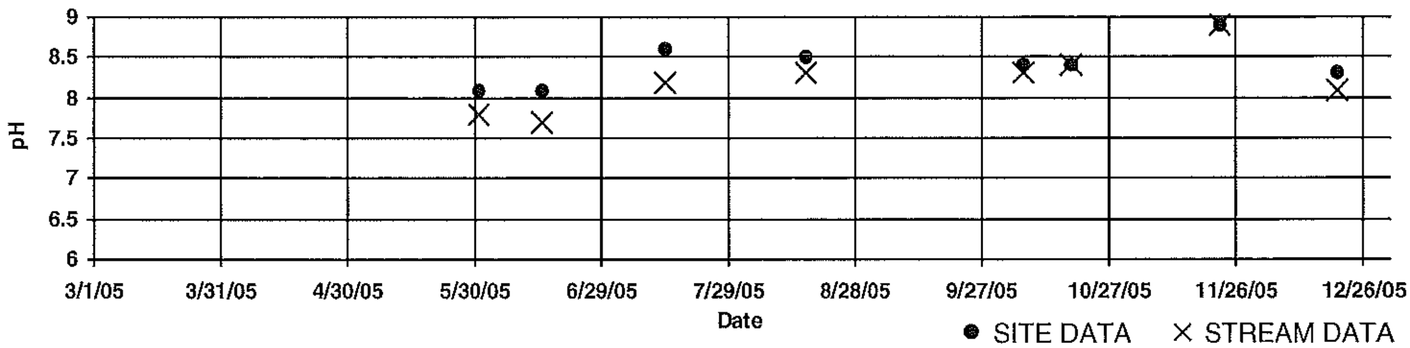


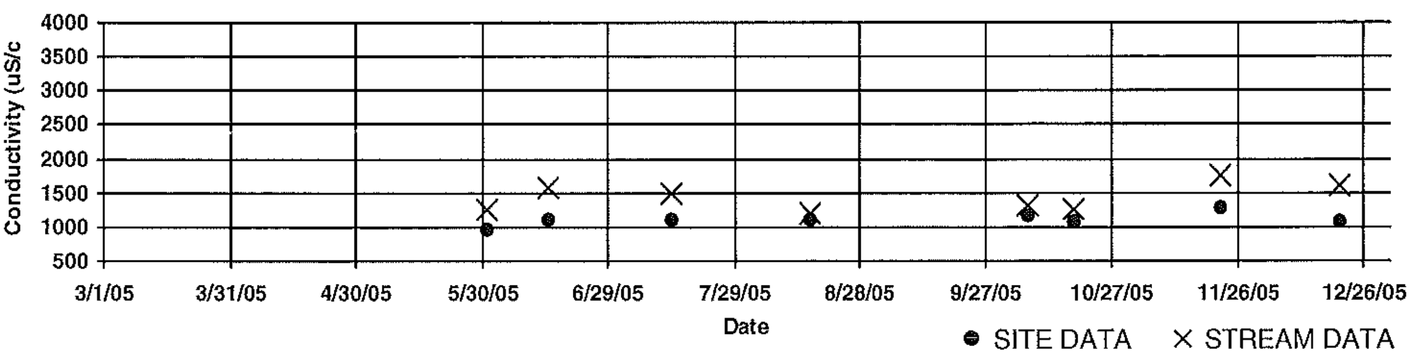


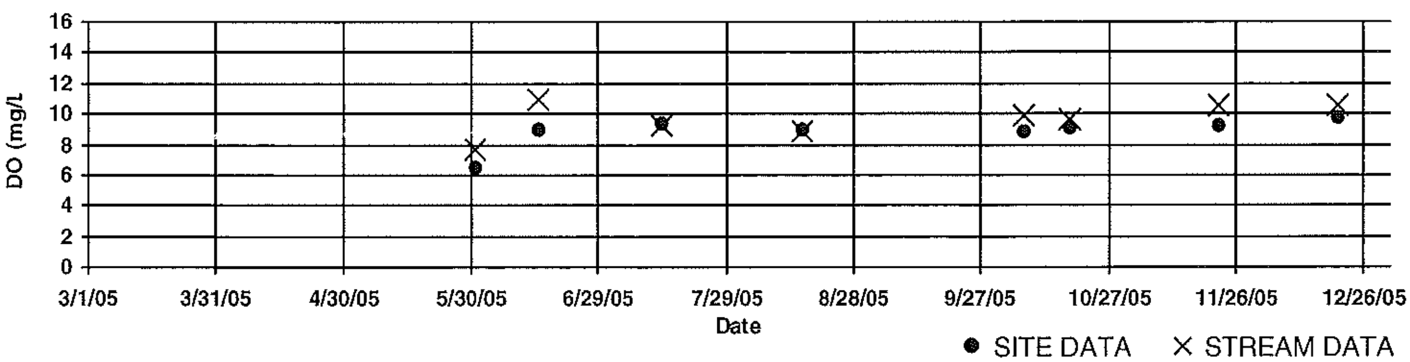
Study Site No. HG16 Dead Alder Falls Site No.: 31

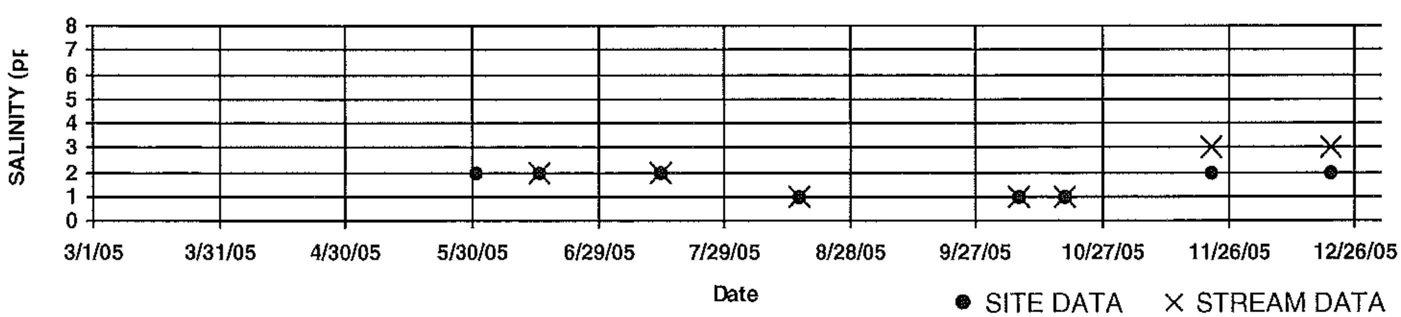
FIELD MONITORING DATA





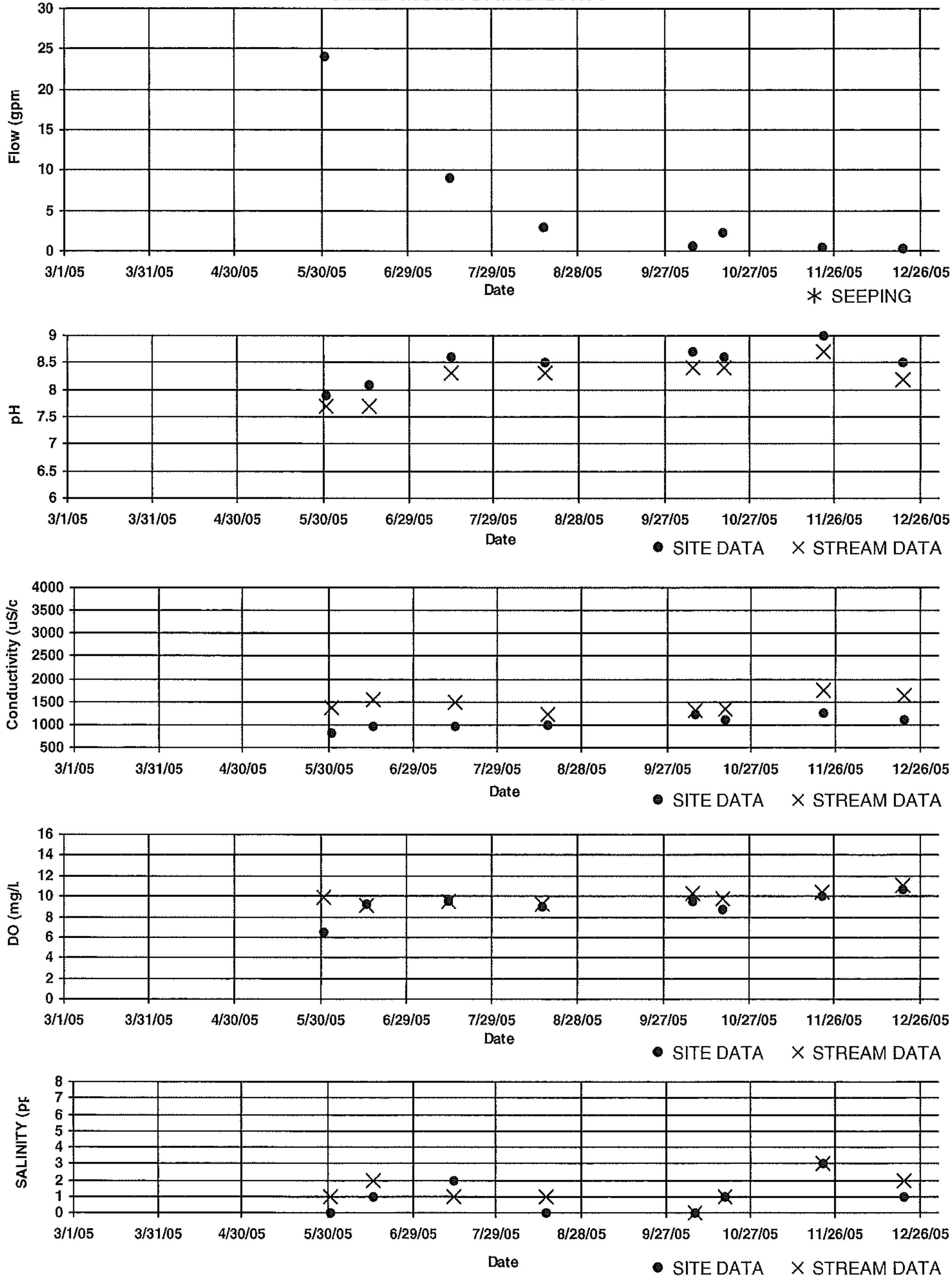






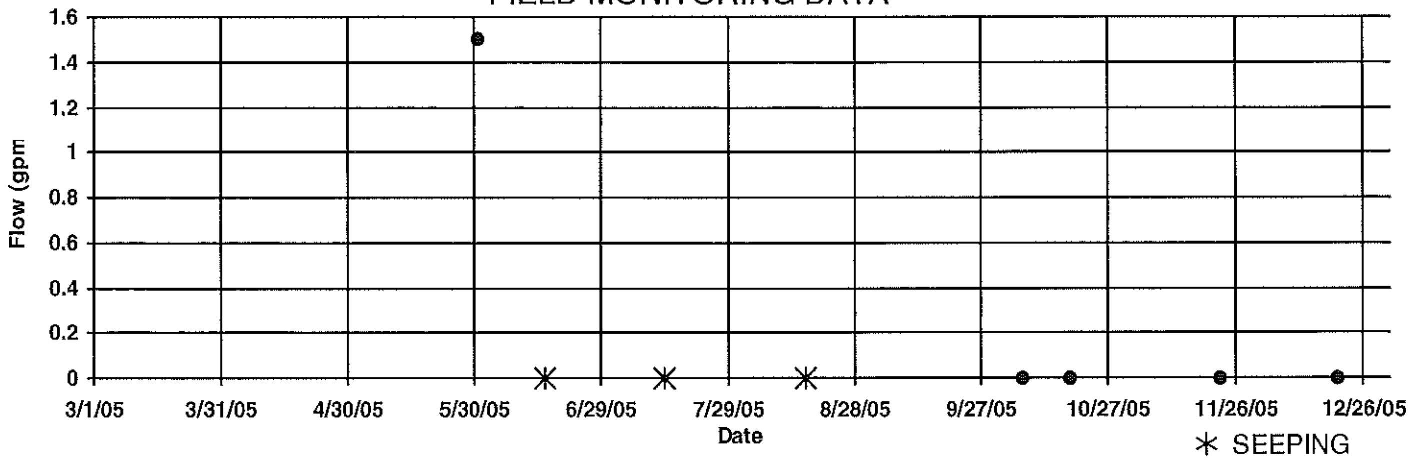
Study Site No. HG17 Elderberry Falls Site No.: 52

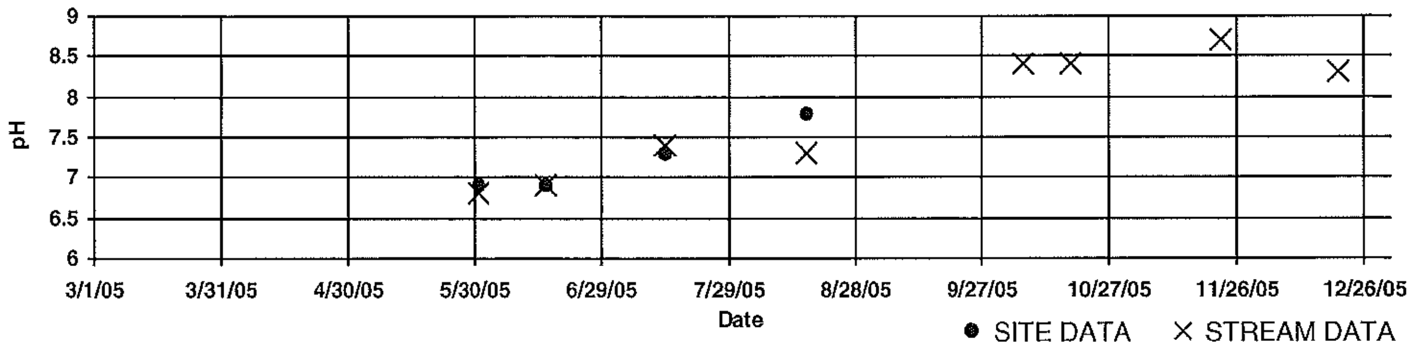
FIELD MONITORING DATA

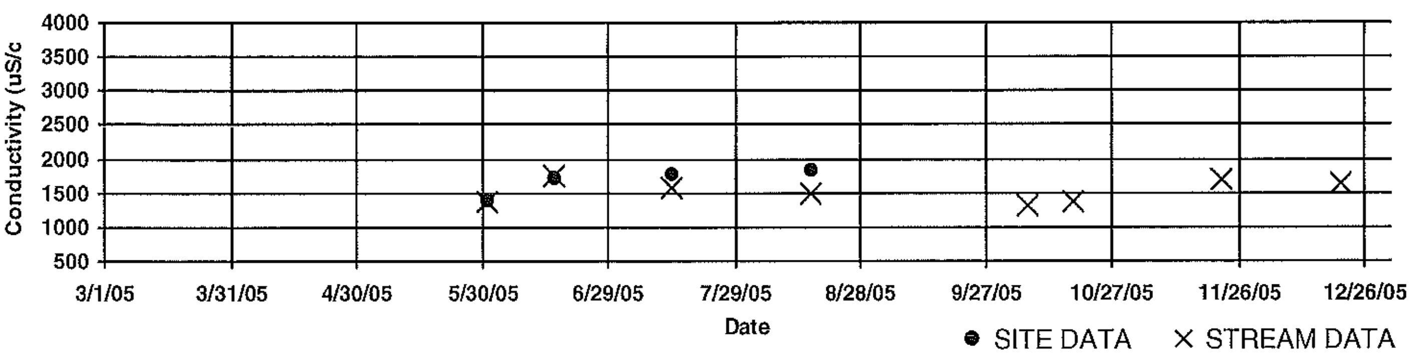


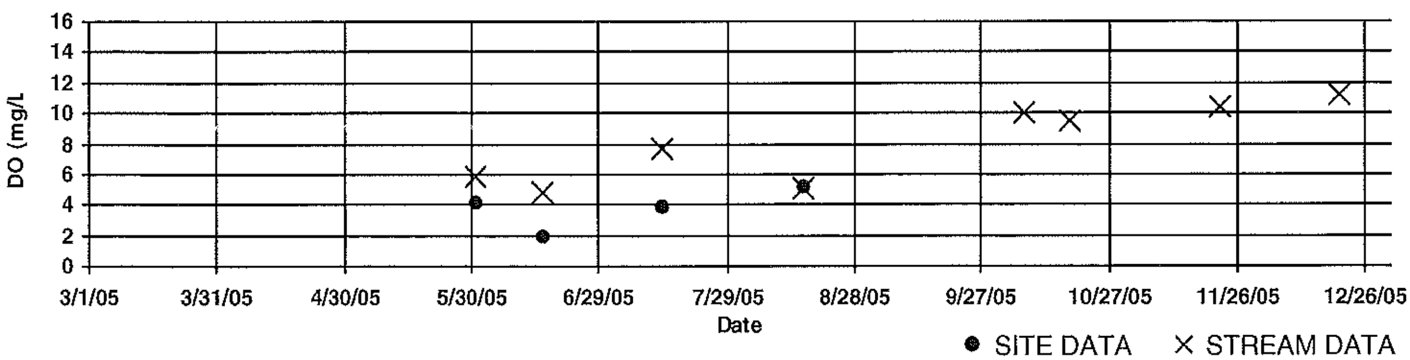
Study Site No. HG18 Tadpole Pool Site No.: 53

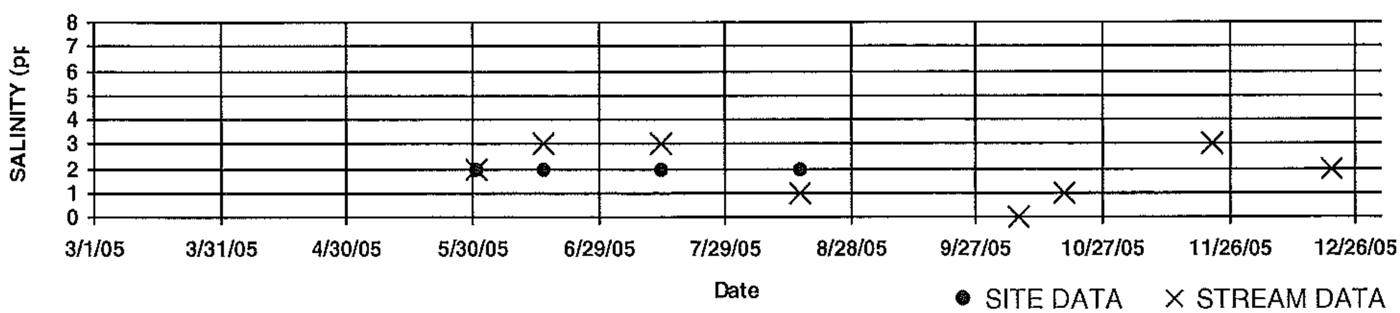
FIELD MONITORING DATA





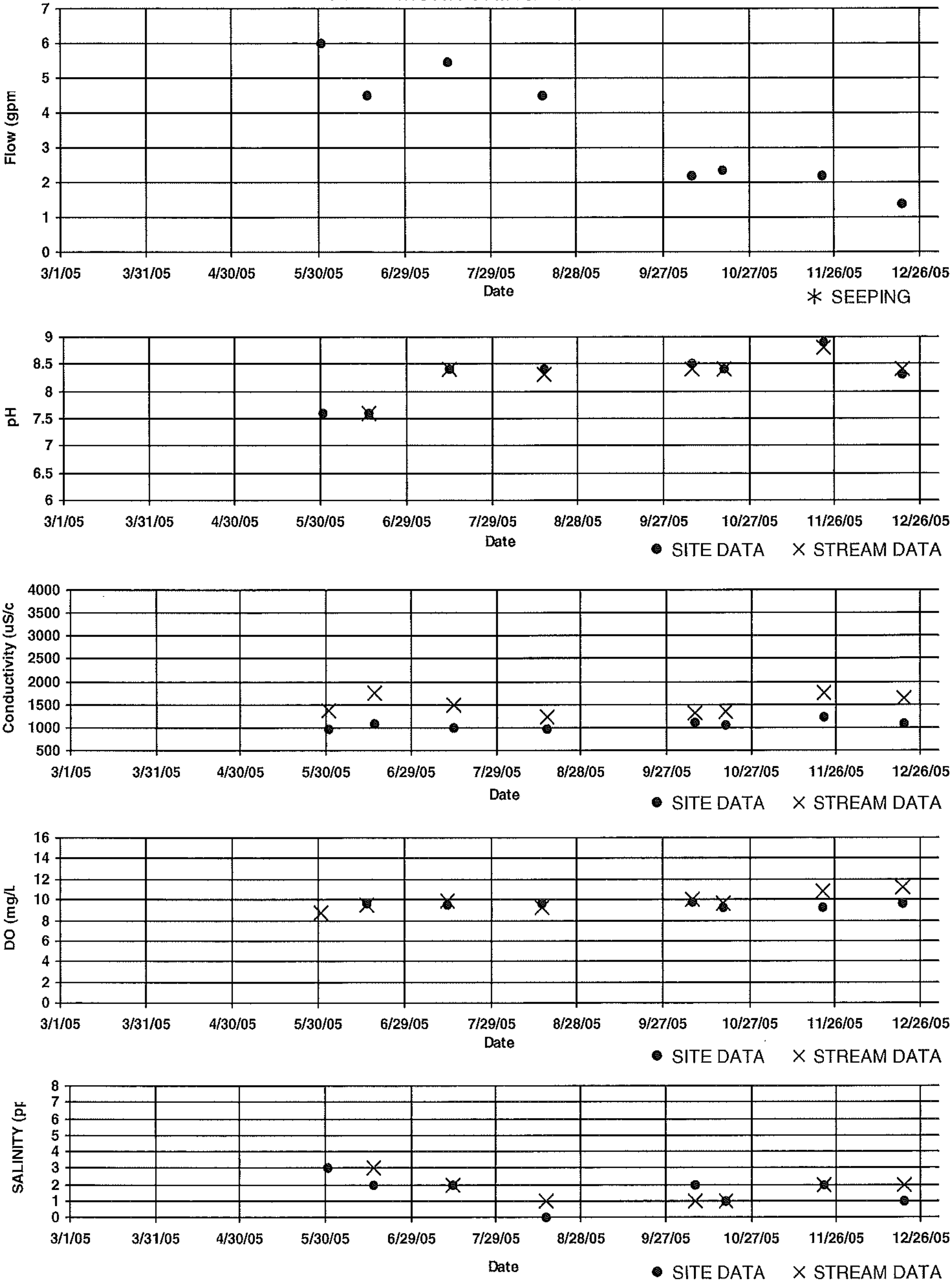






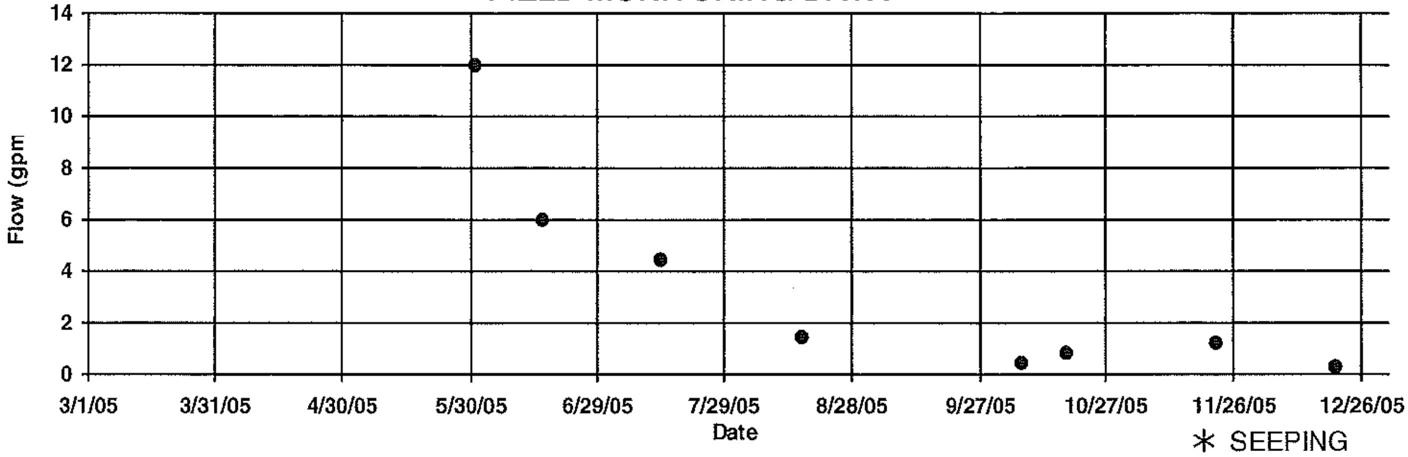
Study Site No. HG19 Pool of Many Drips Site No.: 54

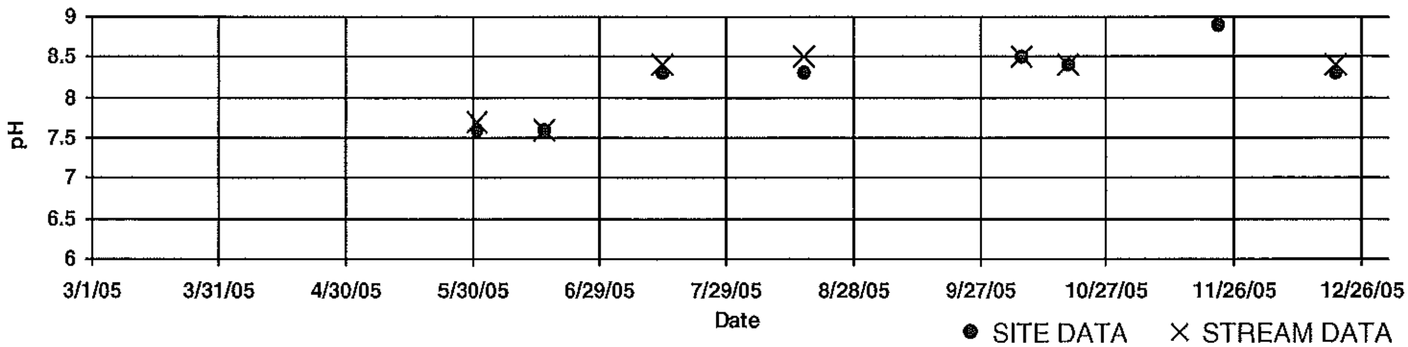
FIELD MONITORING DATA

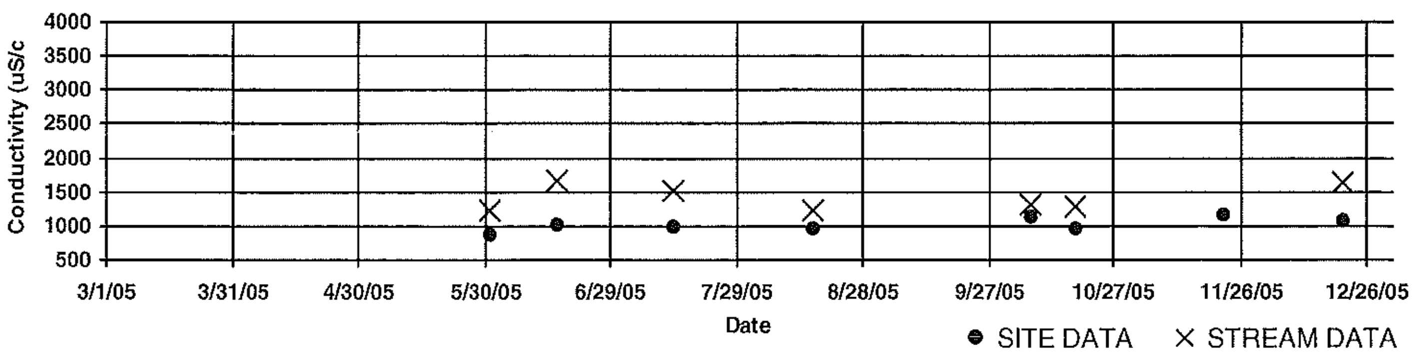


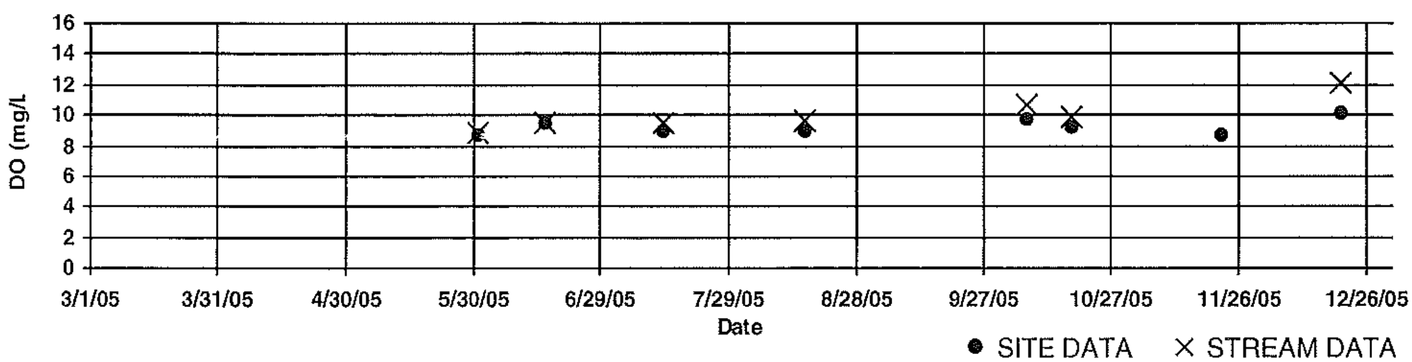
Study Site No. HG20 Bigleaf Maple Pool Site No.: 35

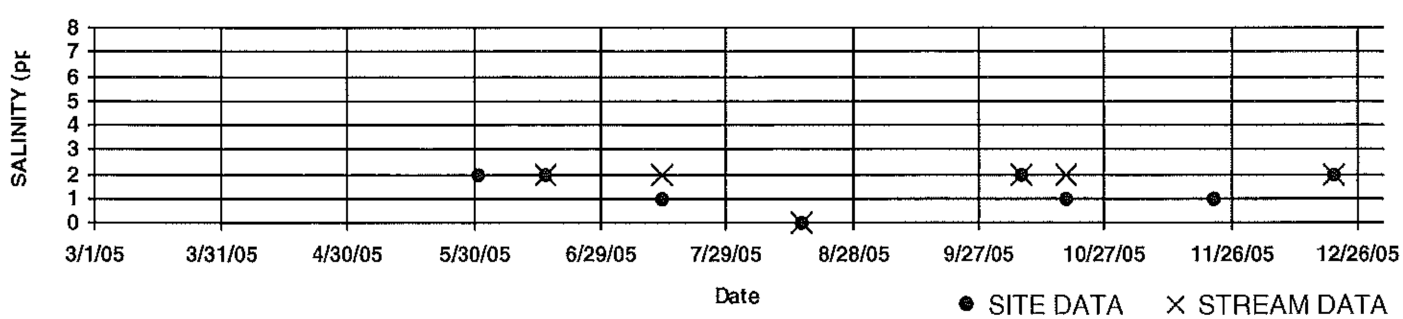
FIELD MONITORING DATA





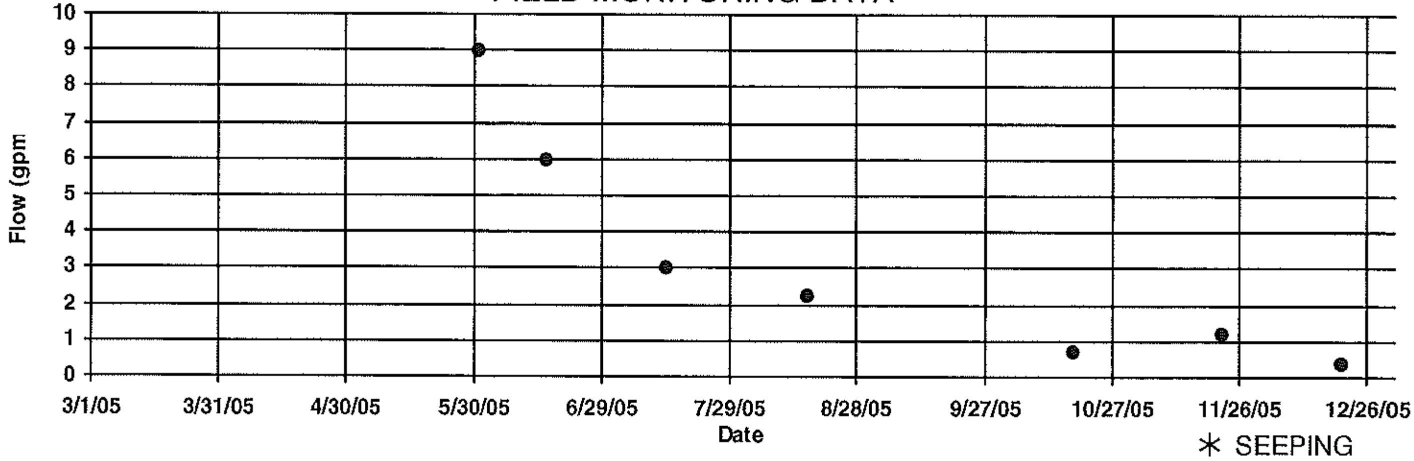


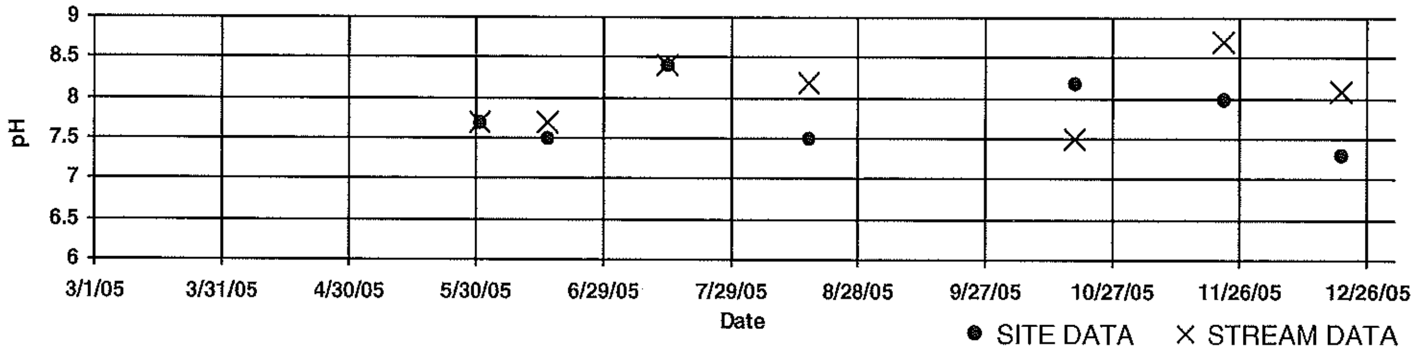


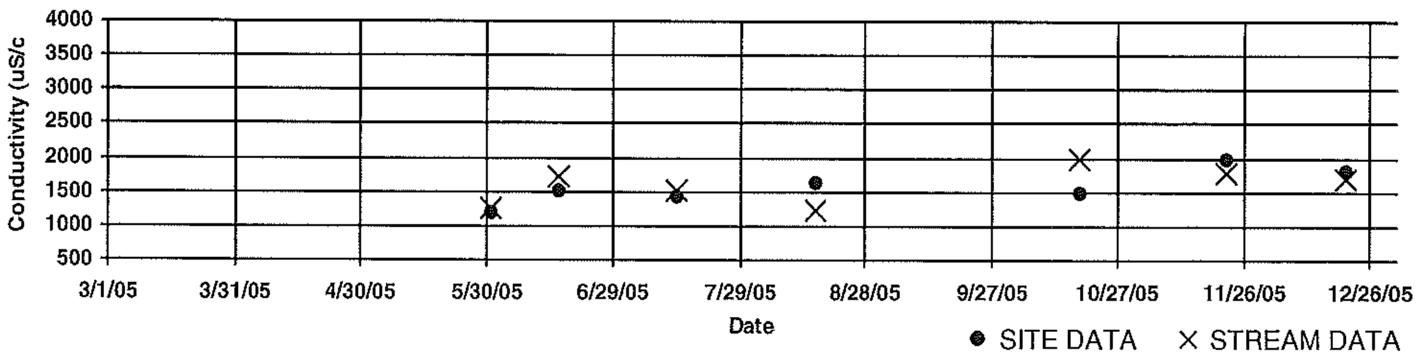


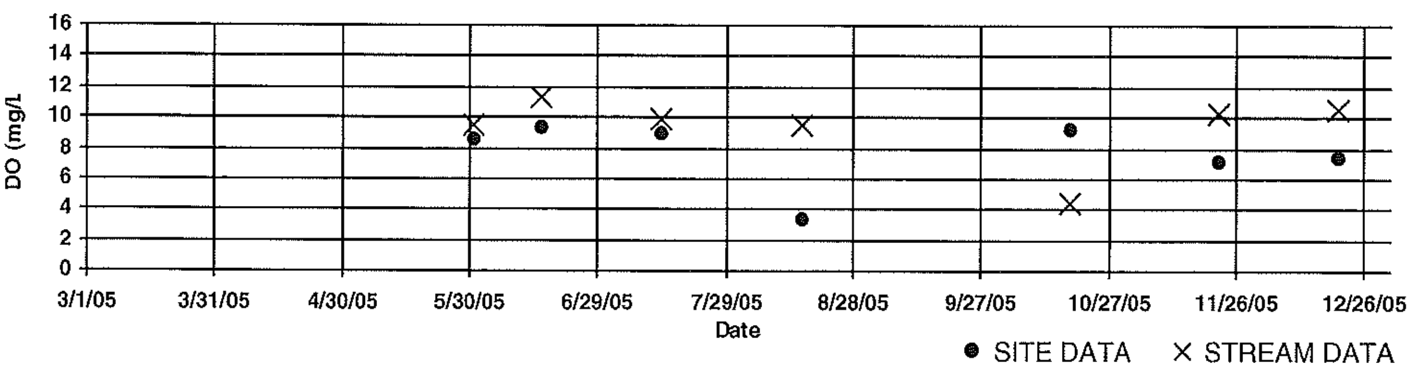
Study Site No. HG21 Up and Down Trib Site No.: 56

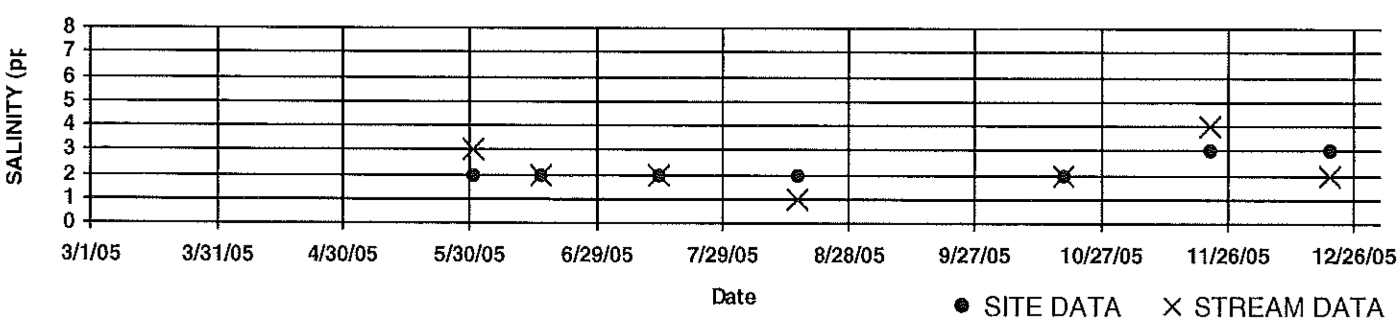
FIELD MONITORING DATA





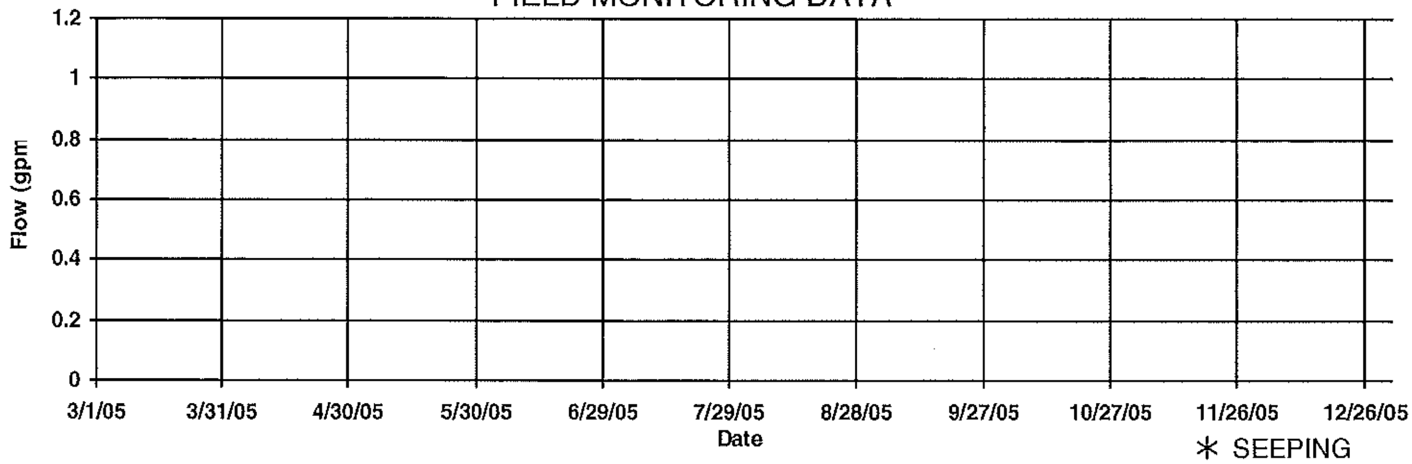


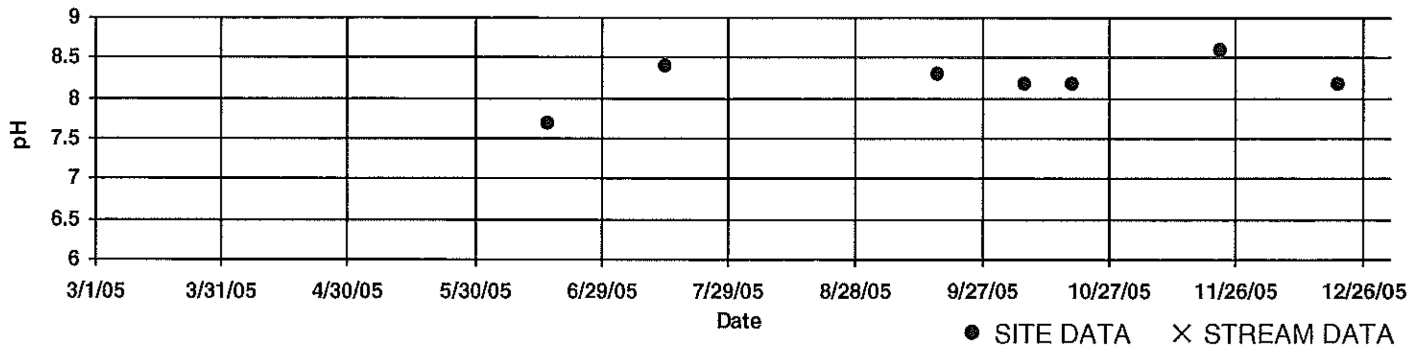


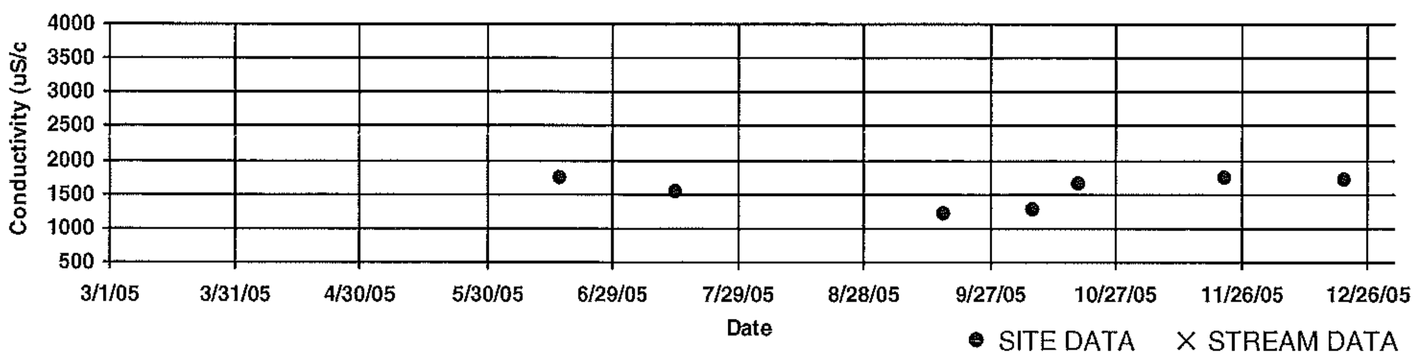


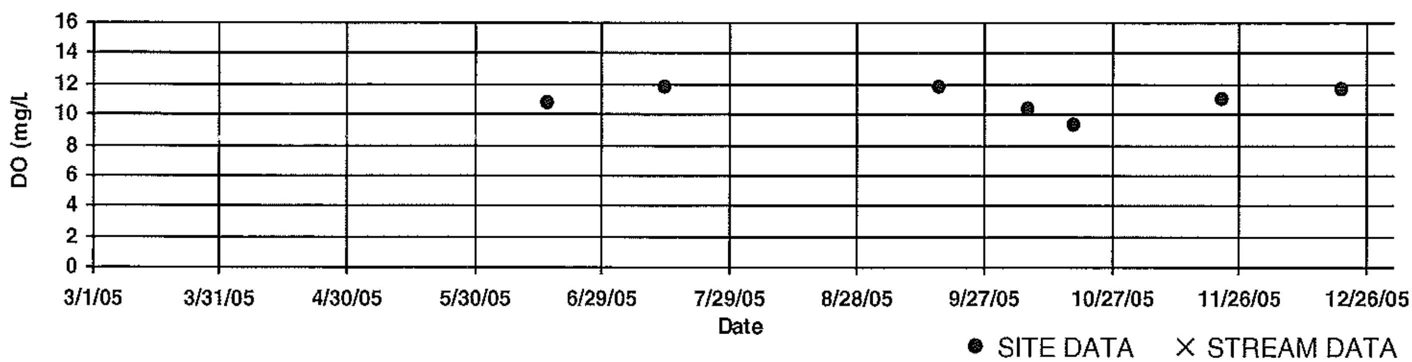
Study Site No. HG22 Rope Swing Pool Site No.: 304

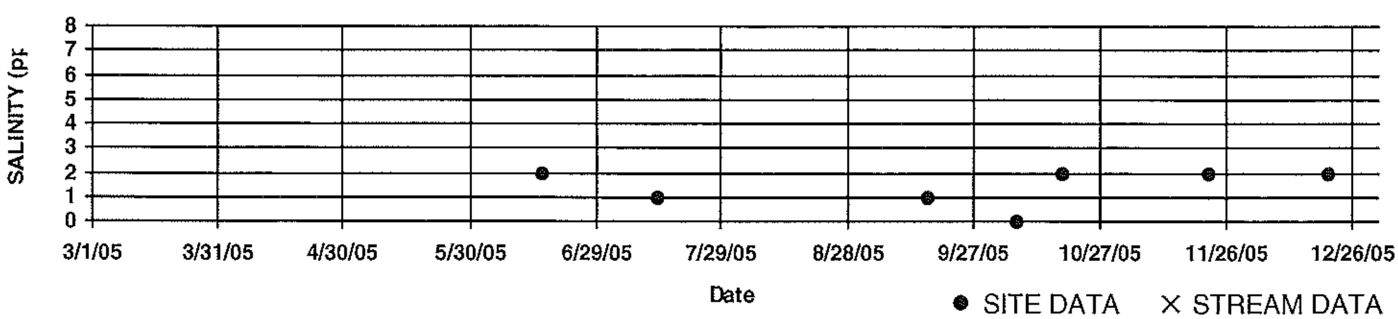
FIELD MONITORING DATA





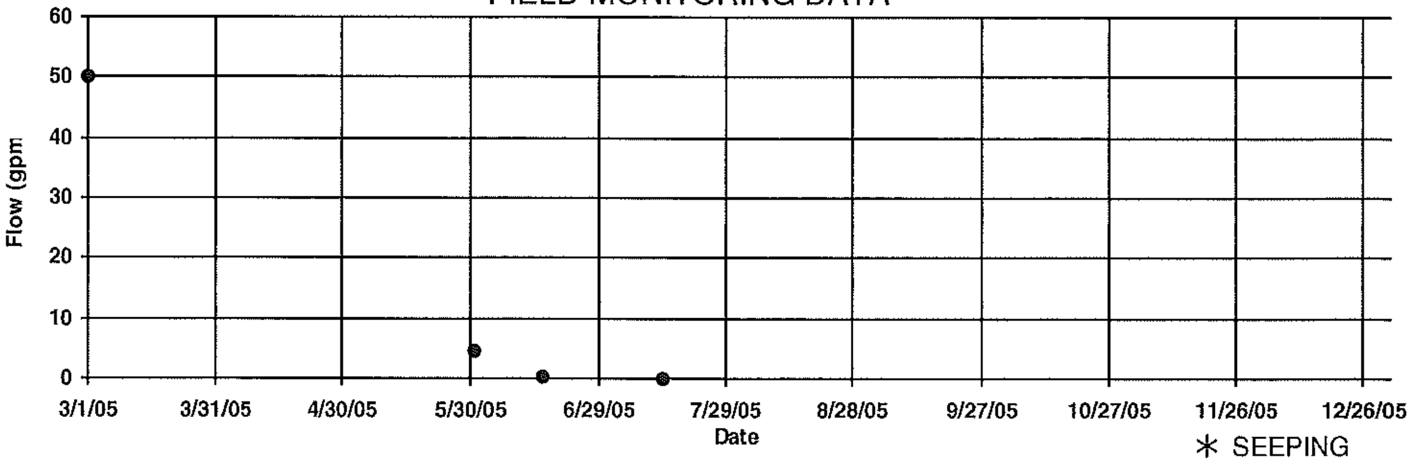


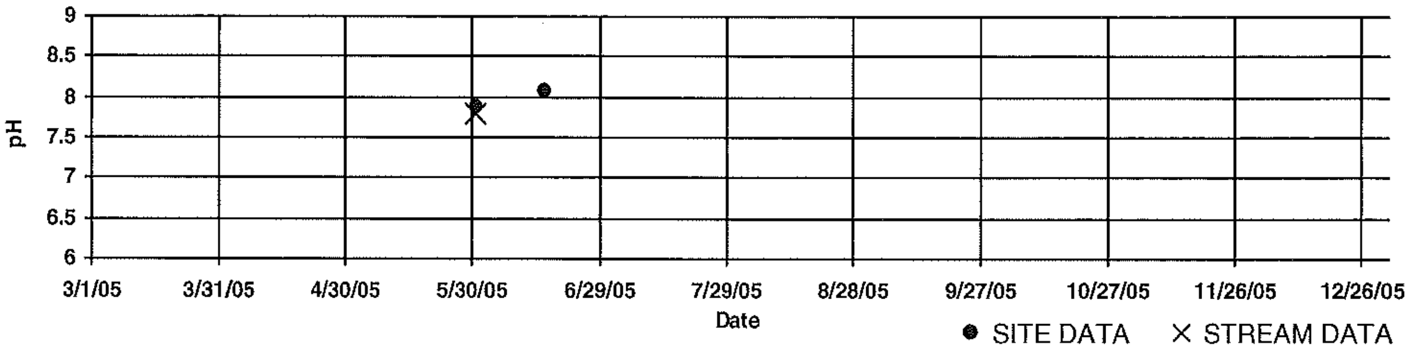


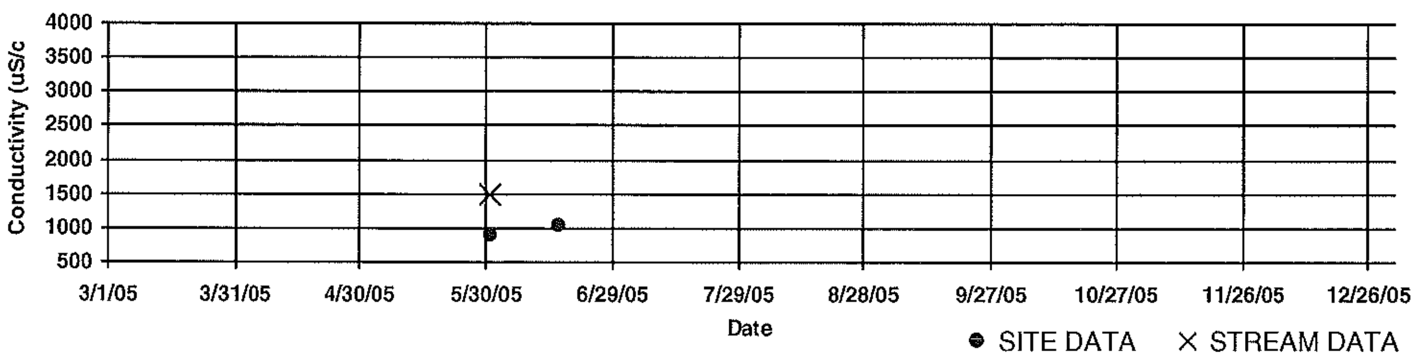


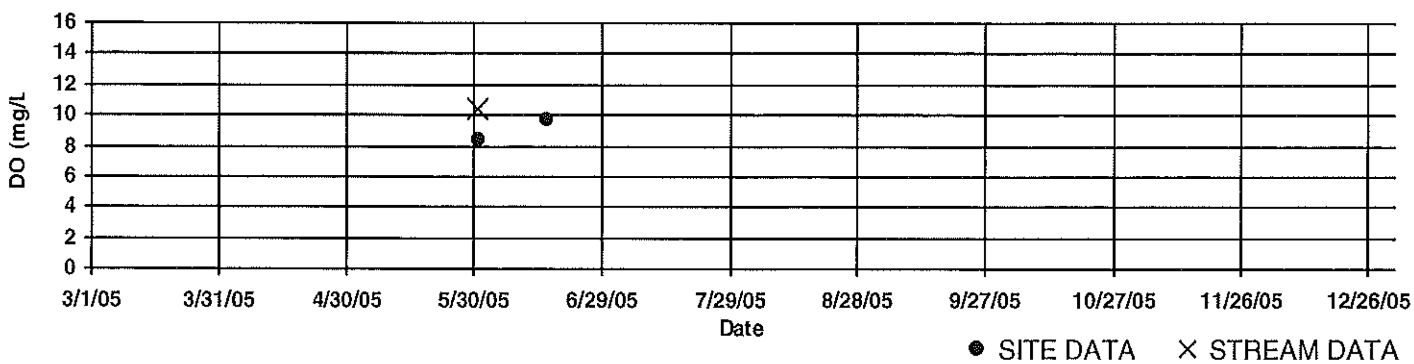
Study Site No. HG23 Time Tunnel Site No.: 39

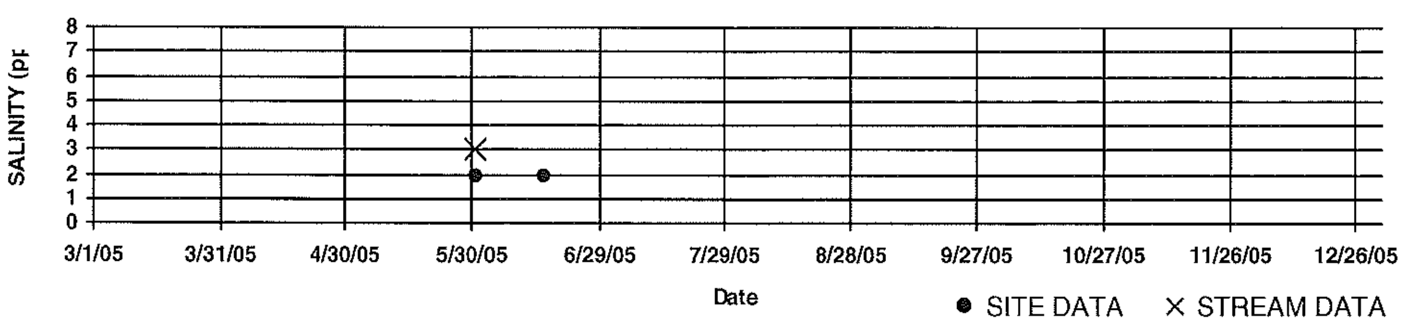
FIELD MONITORING DATA





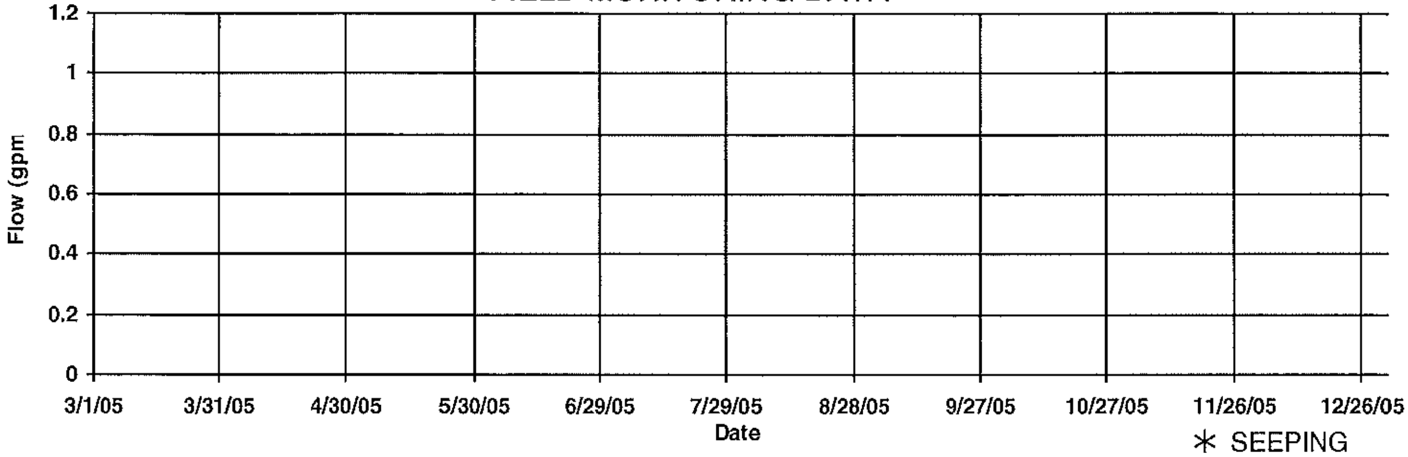


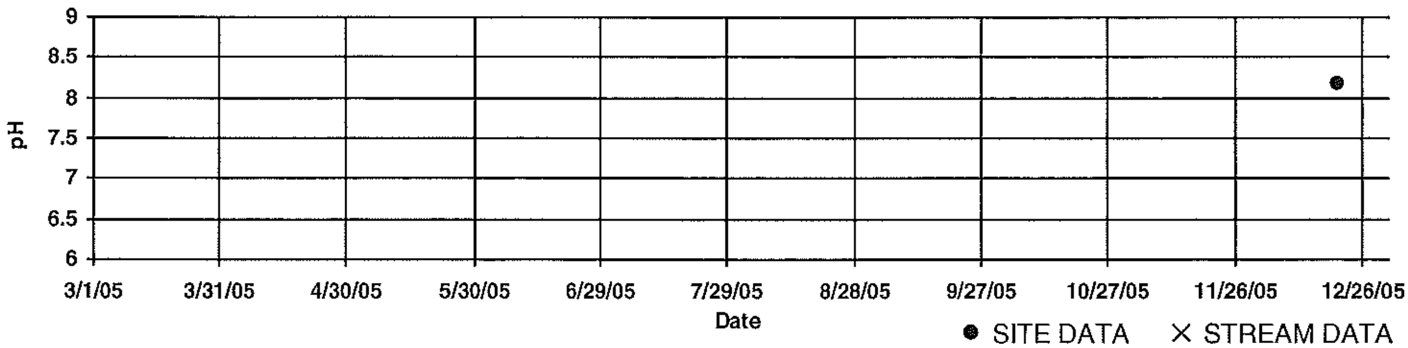


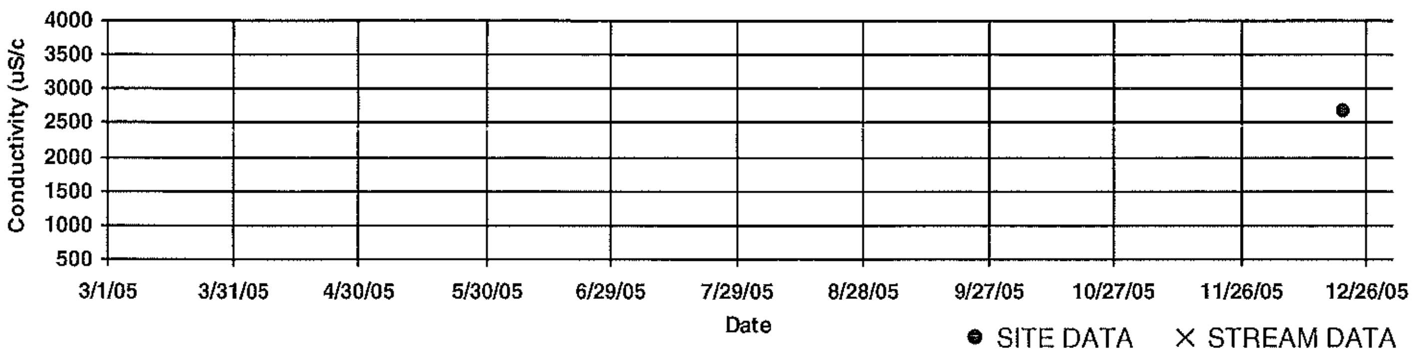


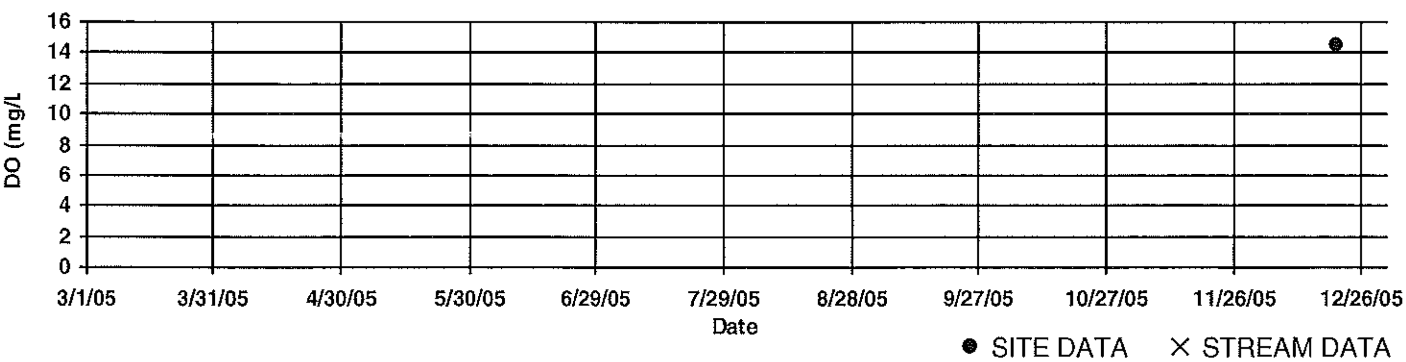
Study Site No. HG24 Abuelita's Site No.: 305

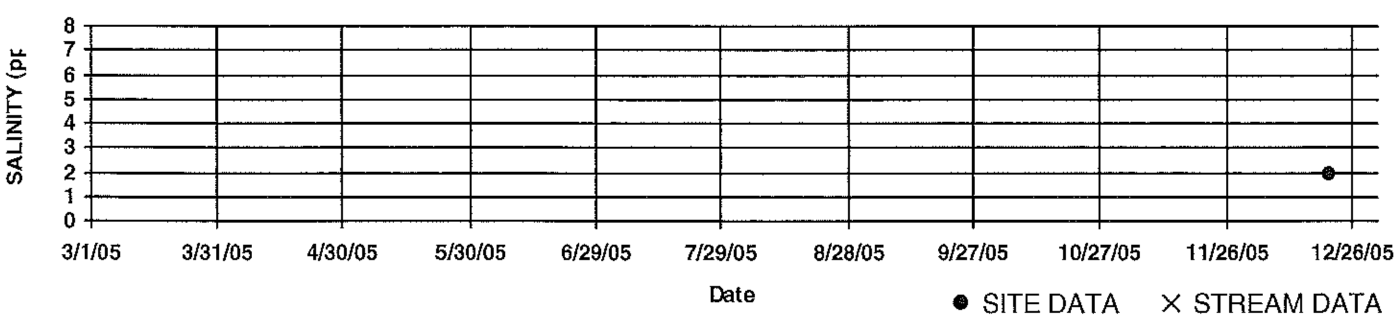
FIELD MONITORING DATA







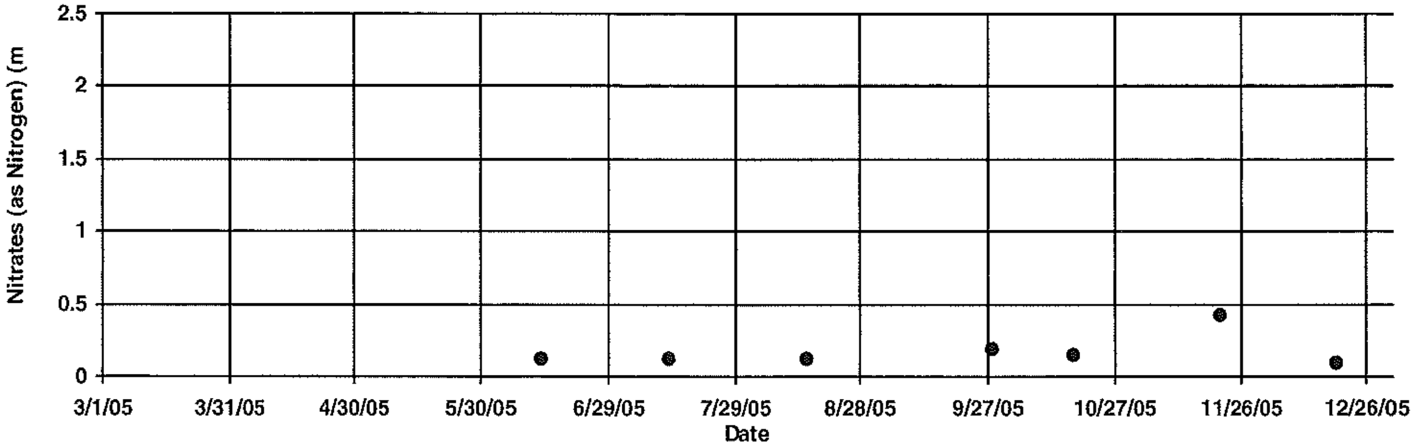


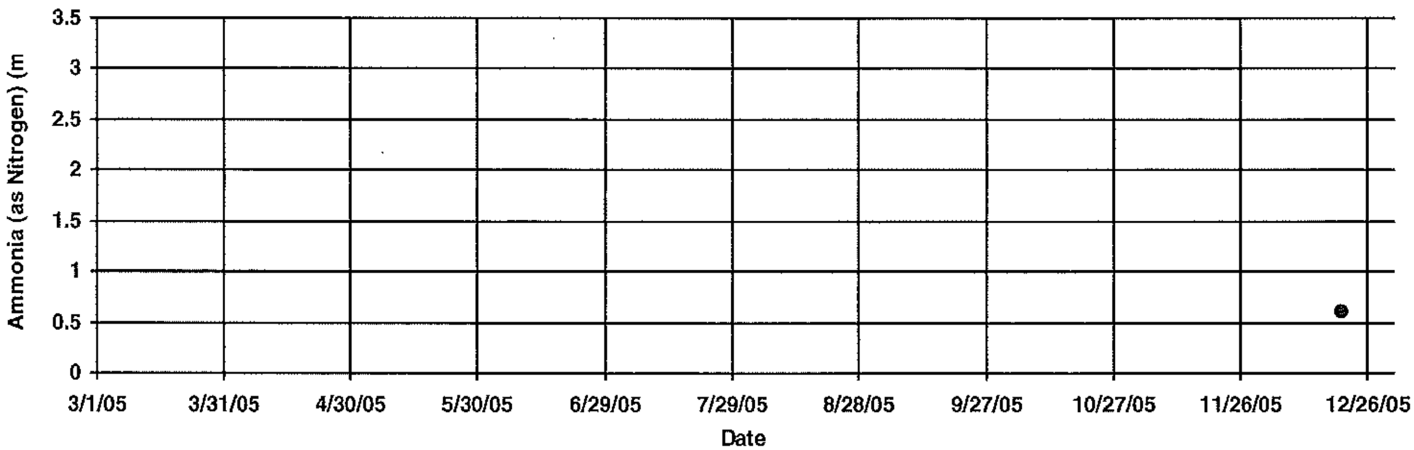


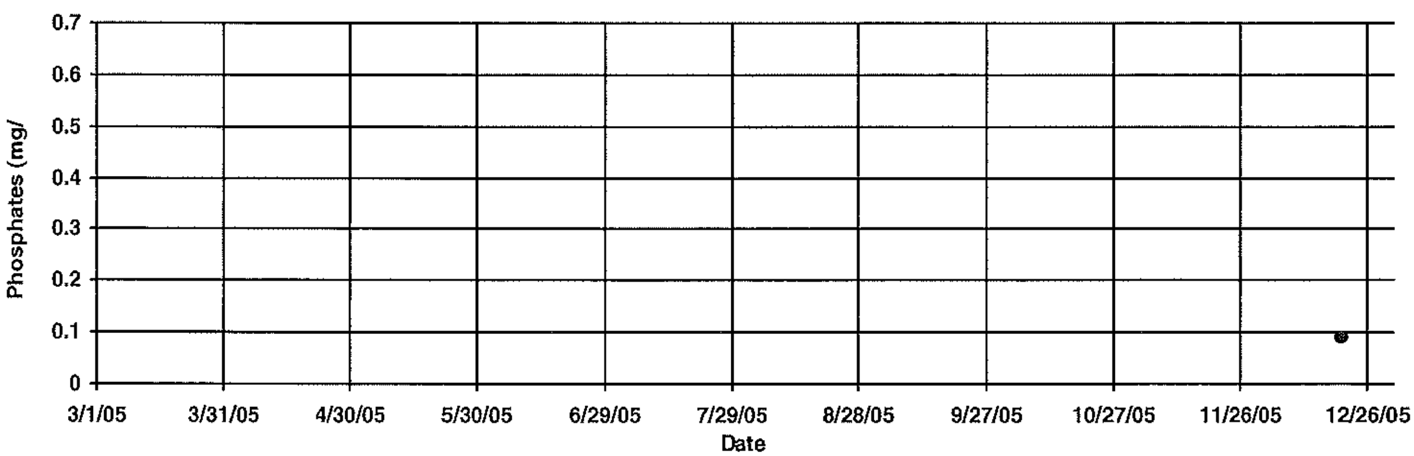
APPENDIX C
NUTRIENT TESTING DATA GRAPHS

Study Site No. HG01 Topanga Lagoon Site No.: 301

NUTRIENT DATA

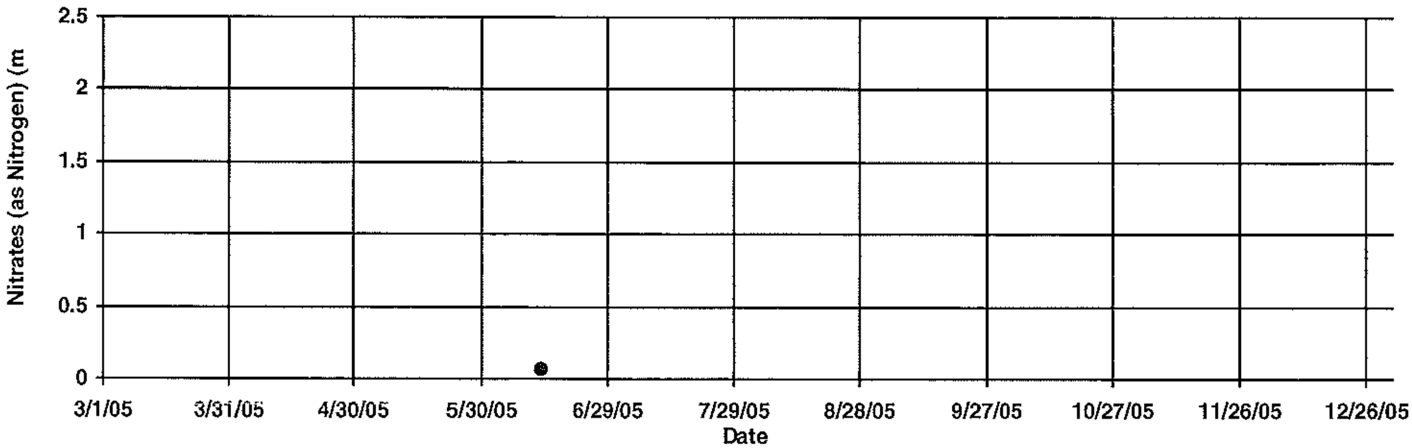


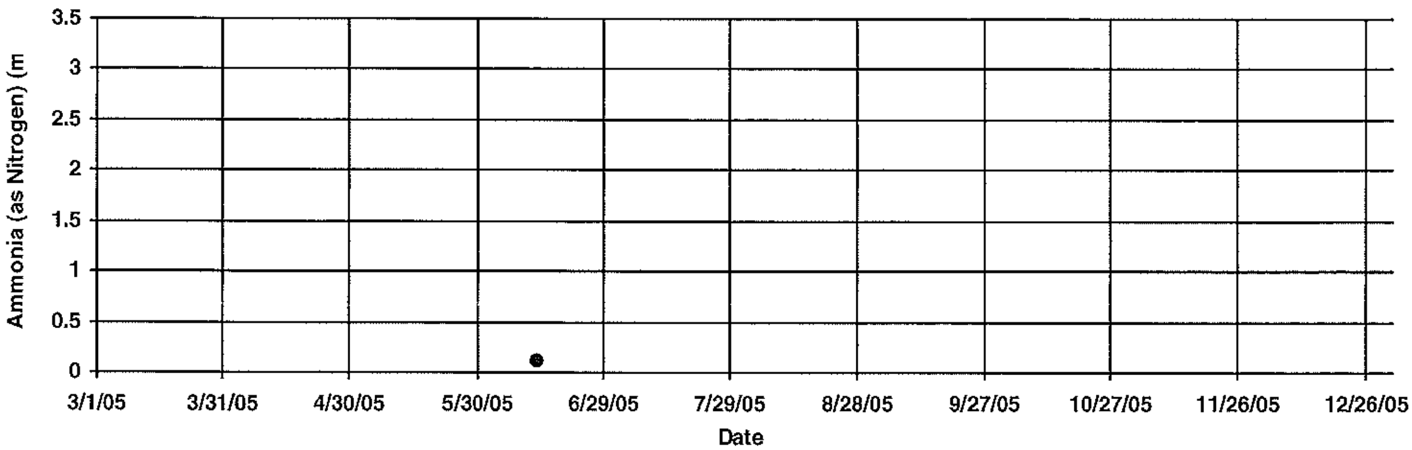


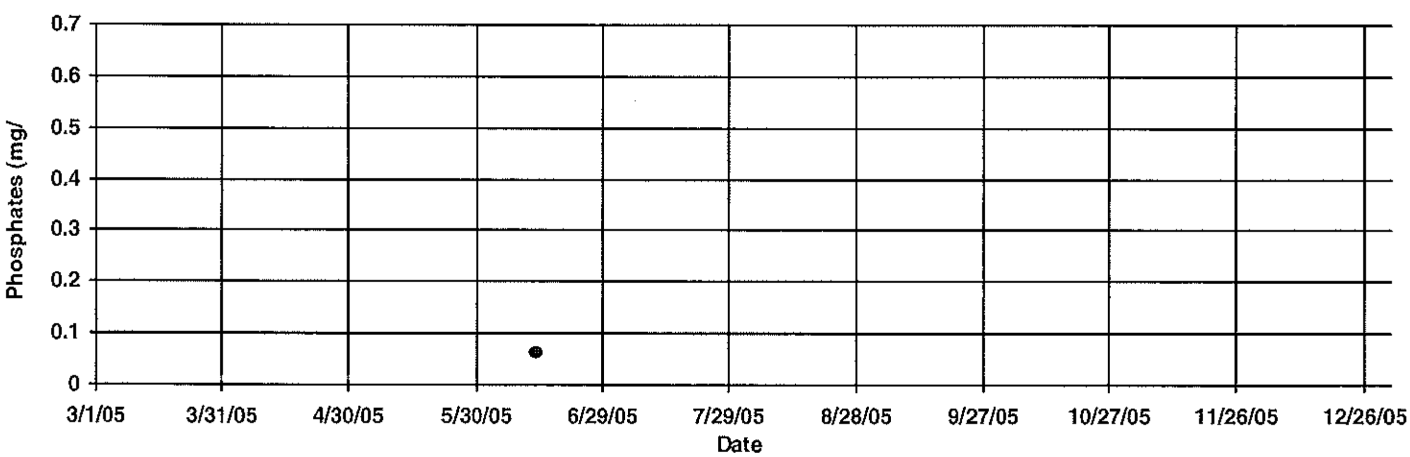


Study Site No. HG02 MM 0.05 TC Blvd. Site No.: 1

NUTRIENT DATA

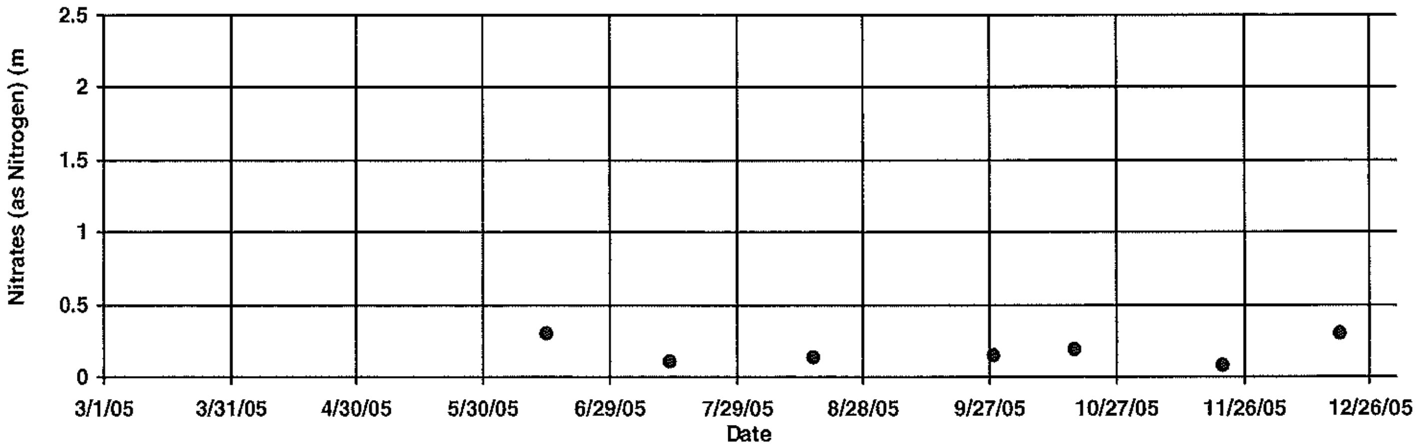


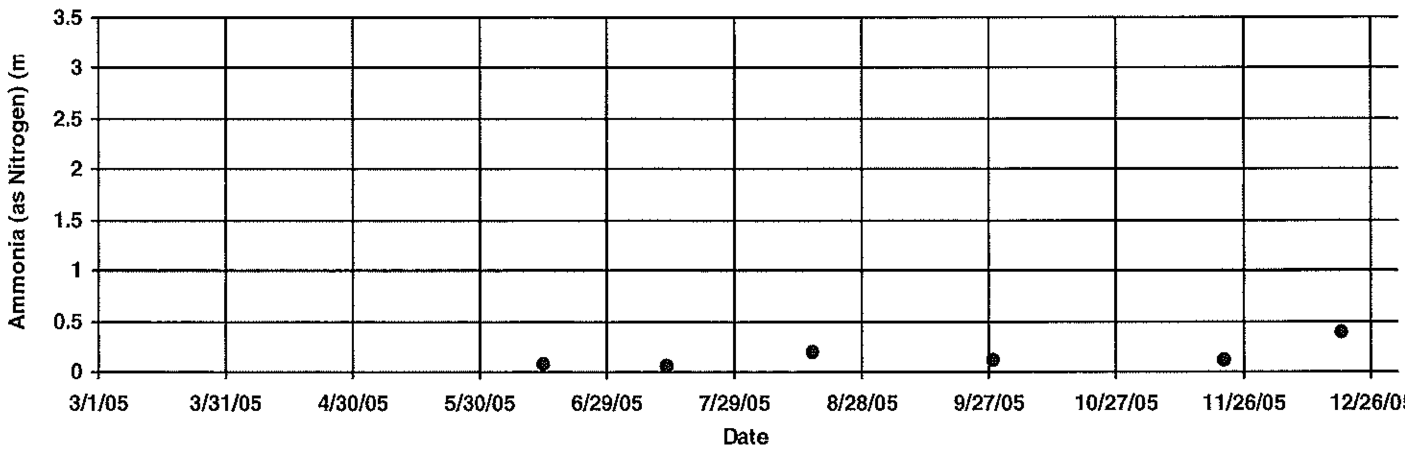


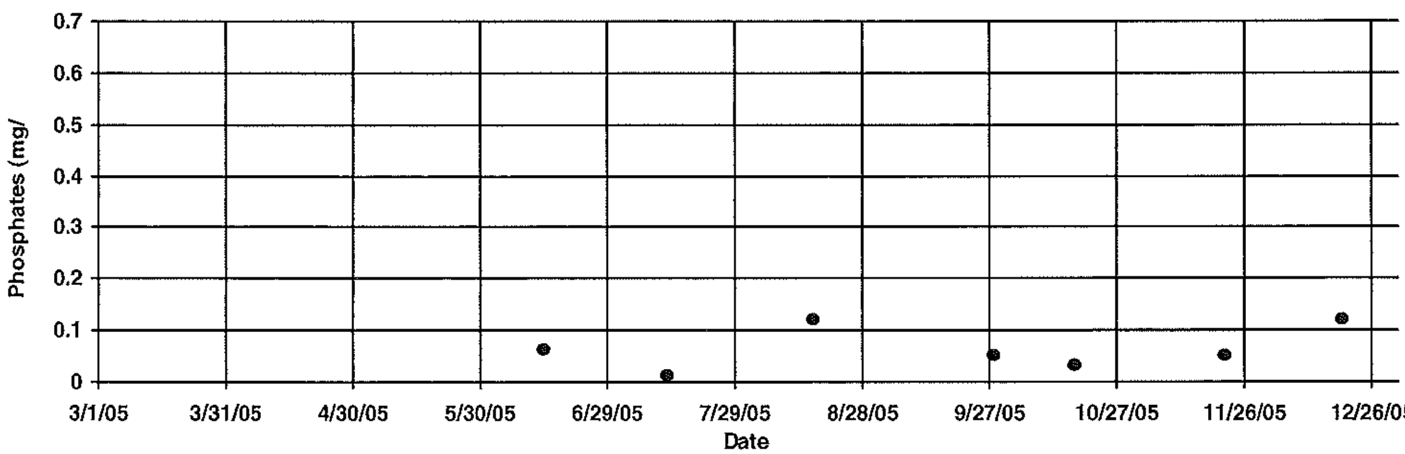


Study Site No. HG03 Transient Pool Site No.: 3

NUTRIENT DATA

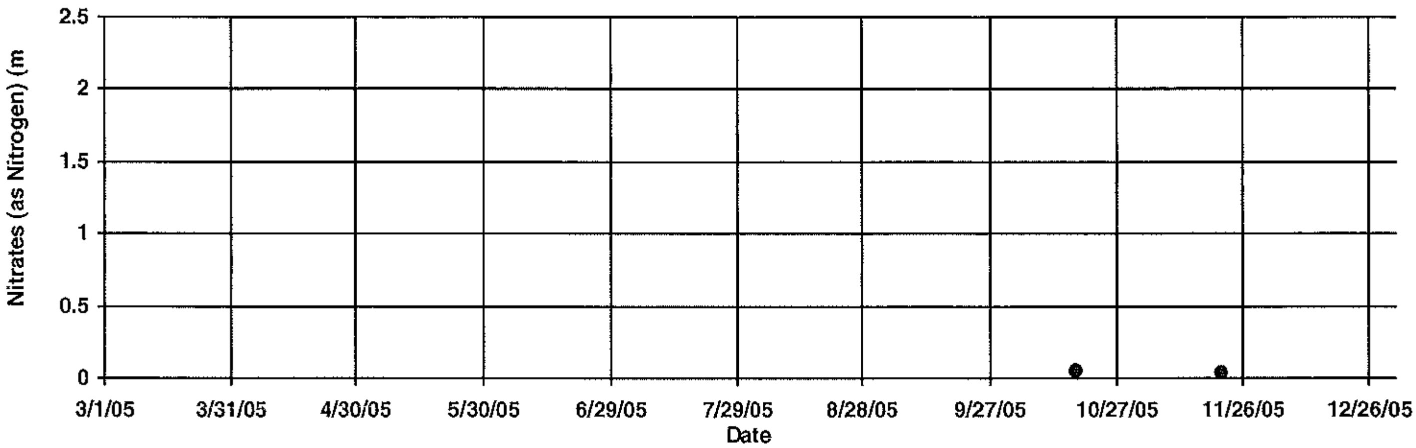


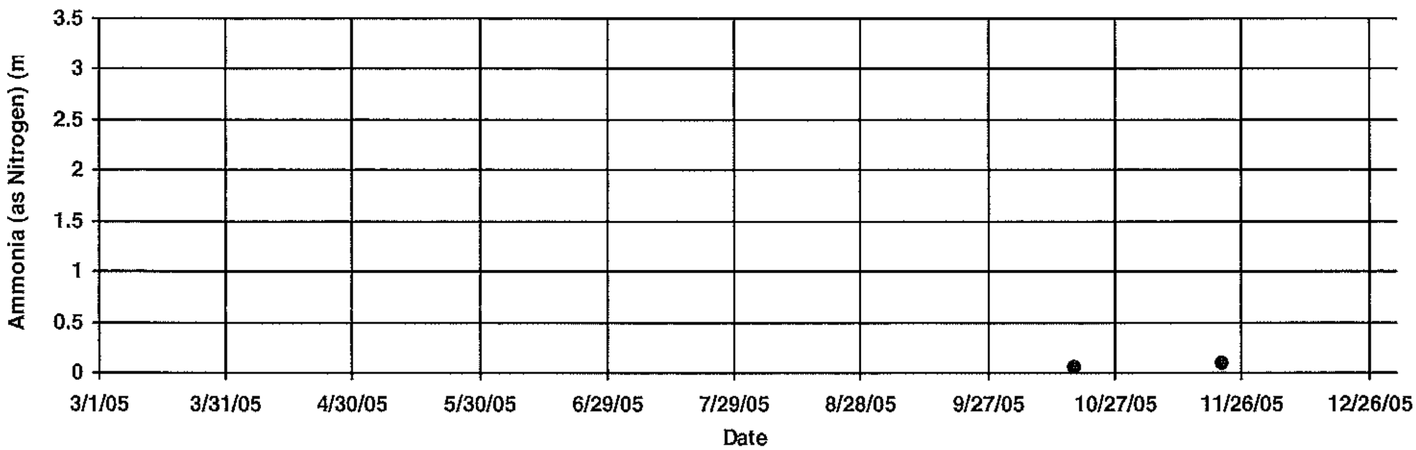


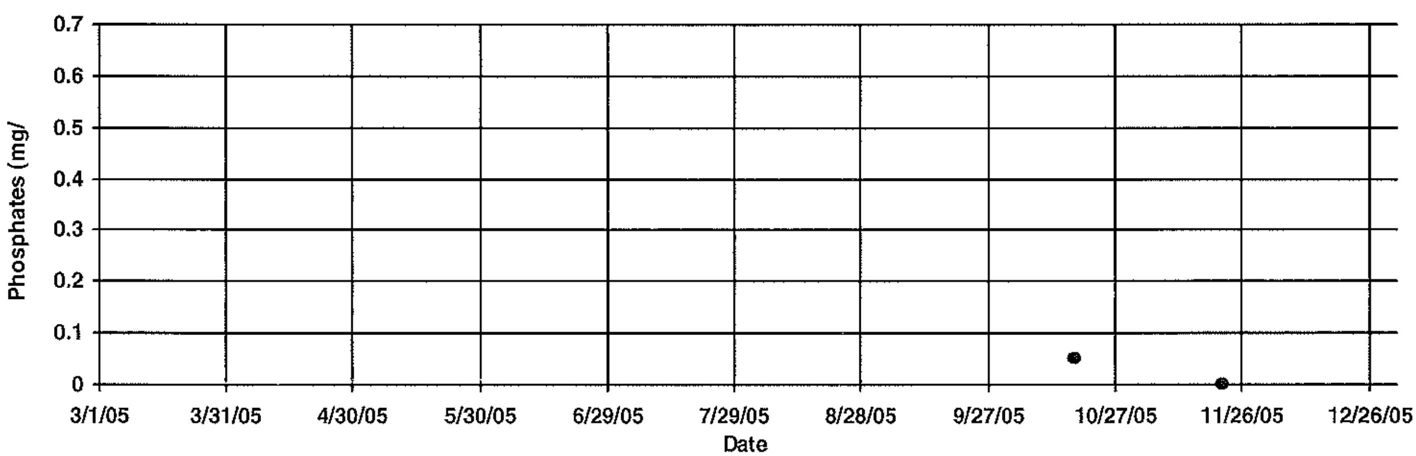


Study Site No. HG04 Ski Pole Pool Site No.: 2

NUTRIENT DATA

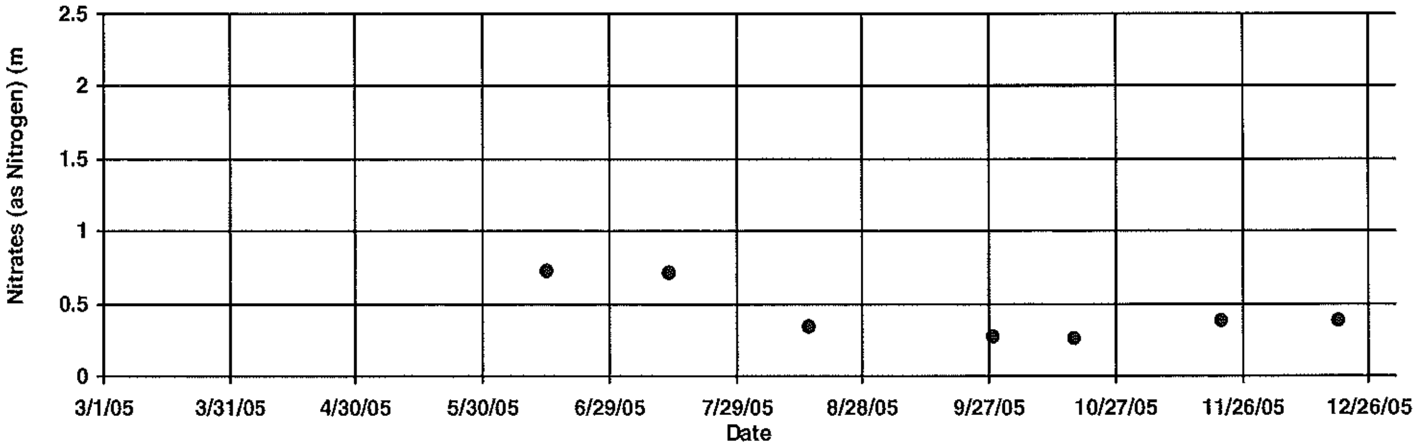


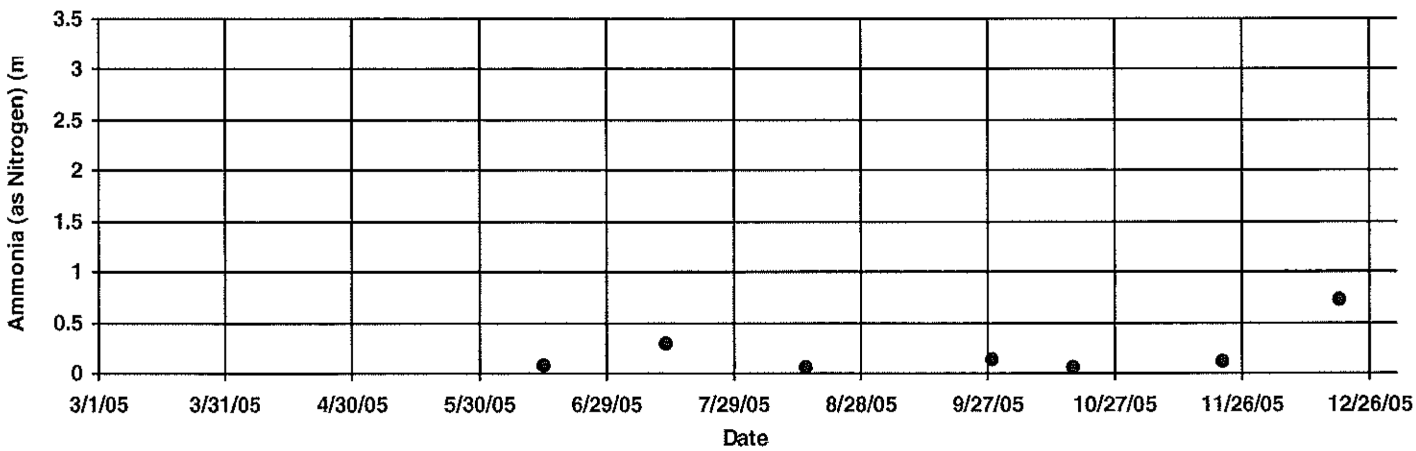


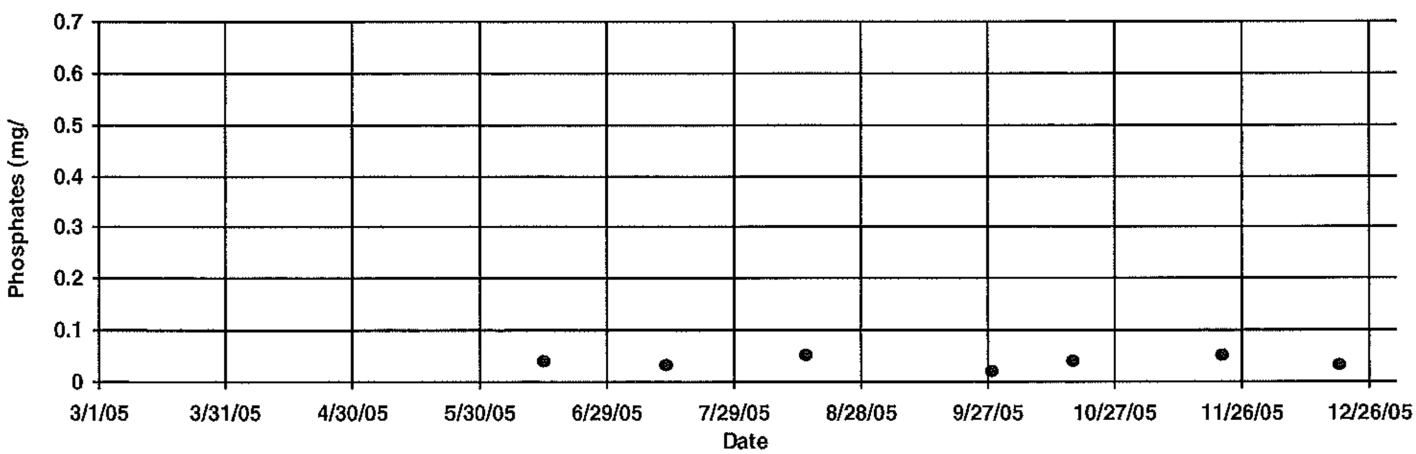


Study Site No. HG05 Green House Culvert Site No.: 4

NUTRIENT DATA

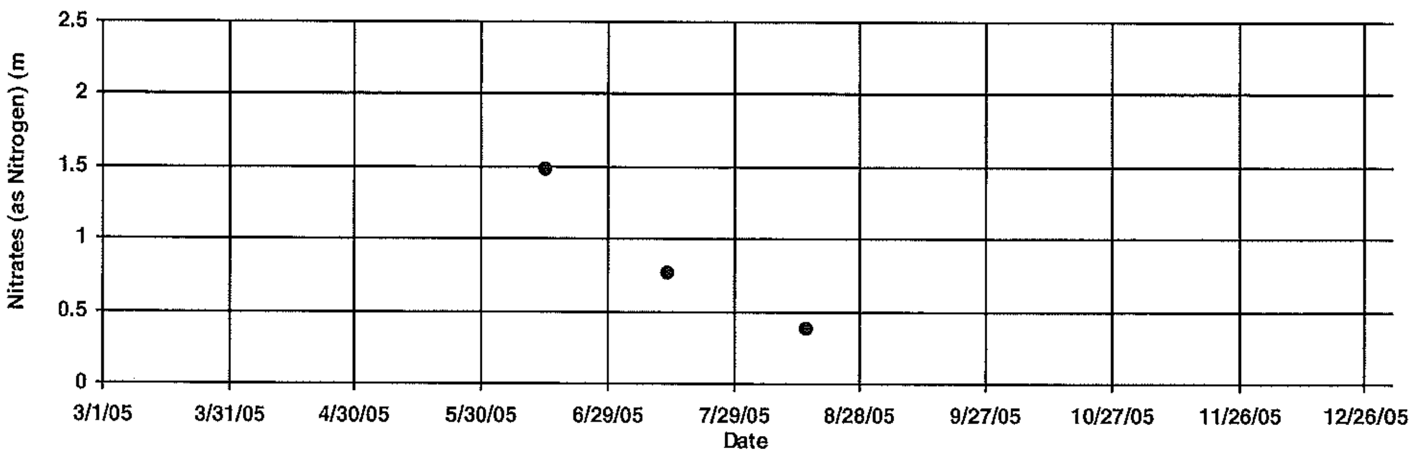


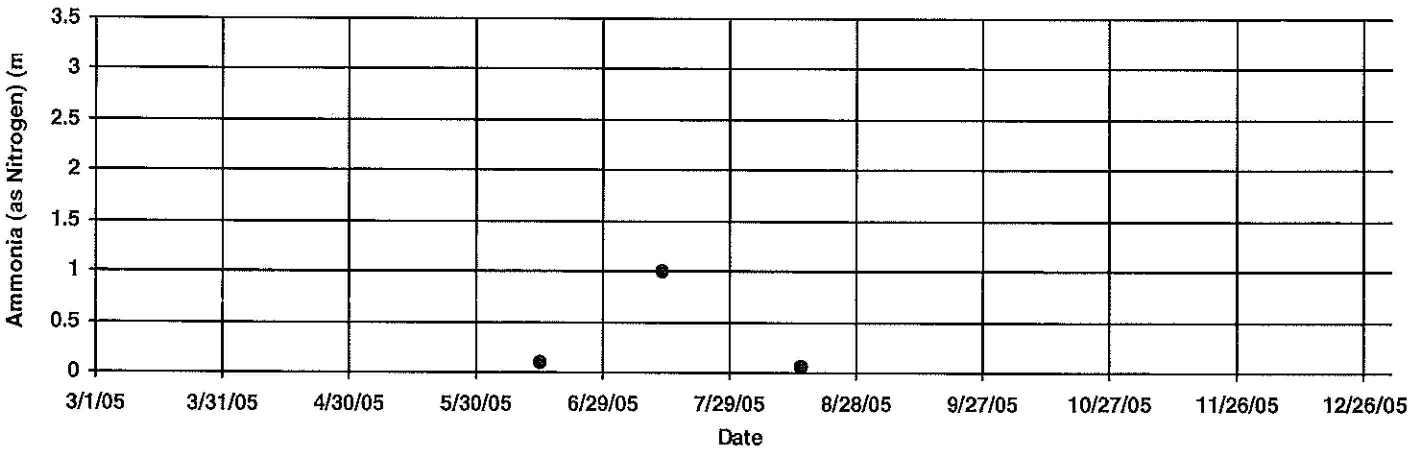


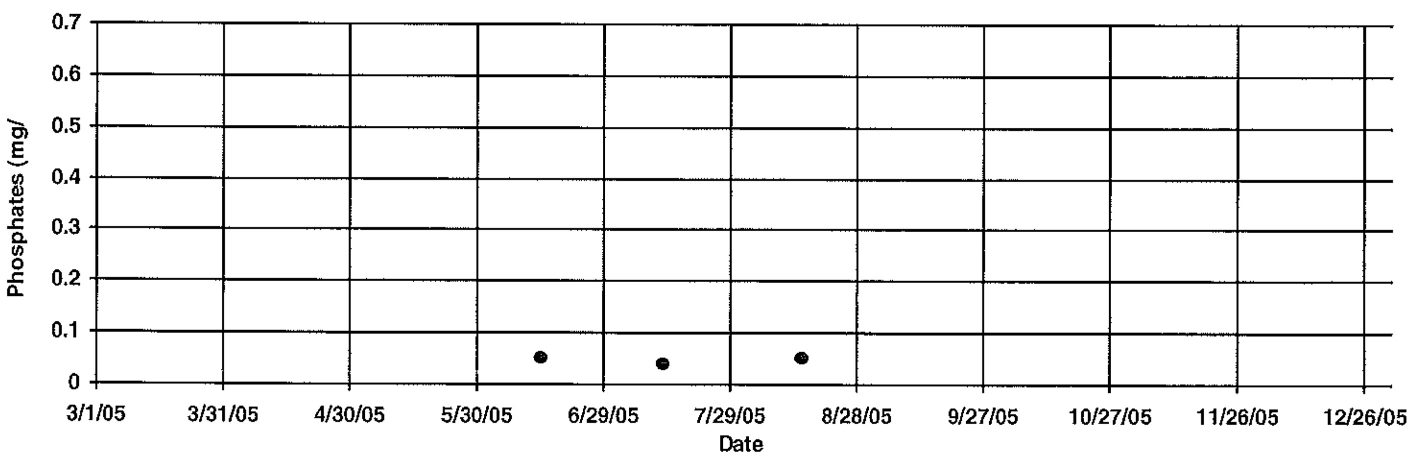


Study Site No. HG06 Culvert inlet E side Site No.: 8

NUTRIENT DATA

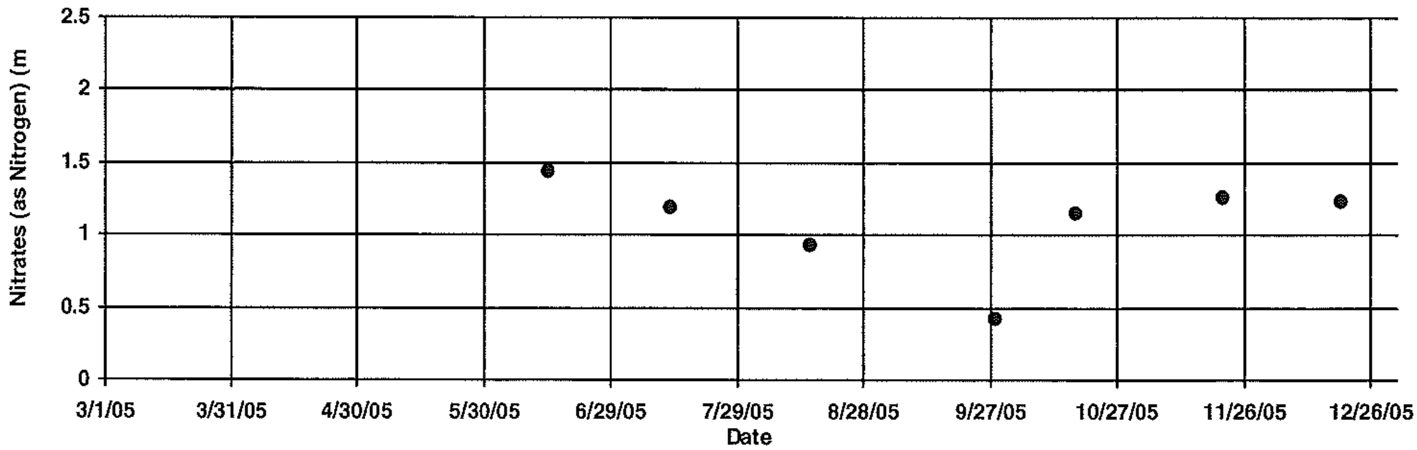


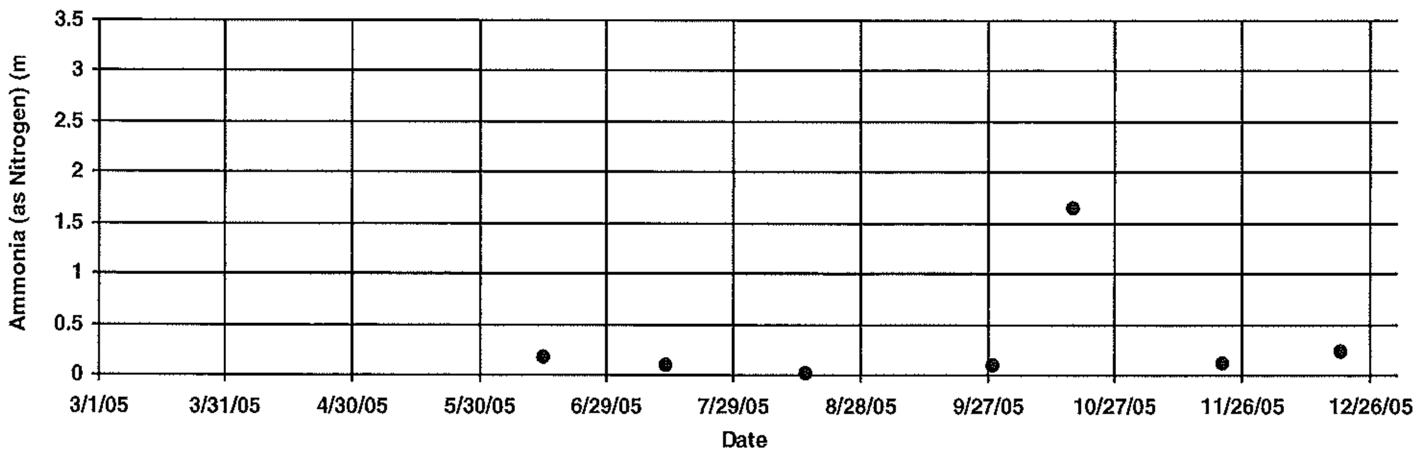


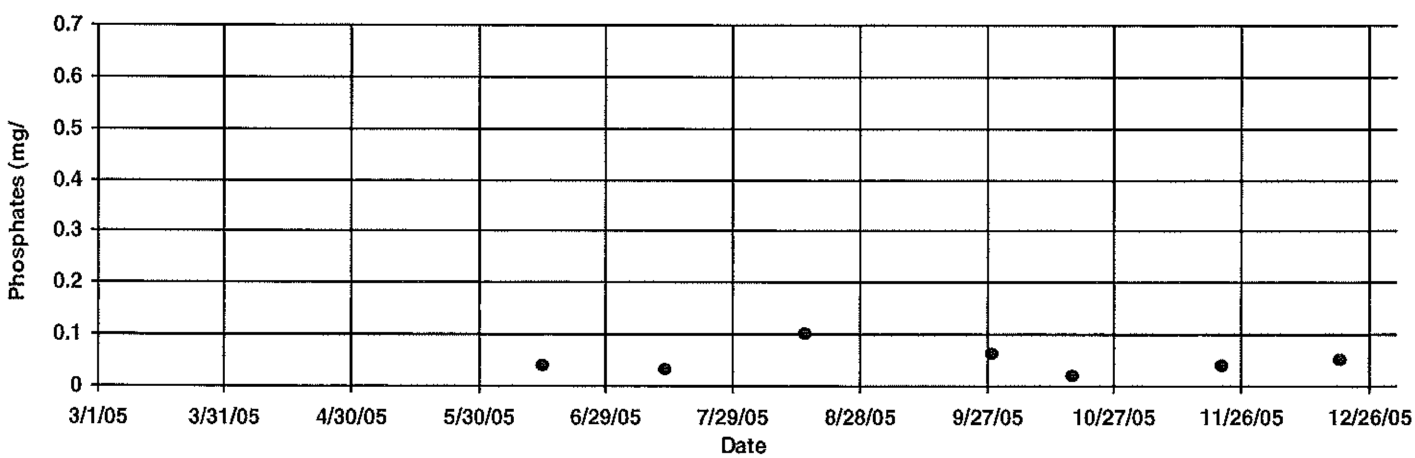


Study Site No. HG07 Ken2 Pool Site No.: 6

NUTRIENT DATA

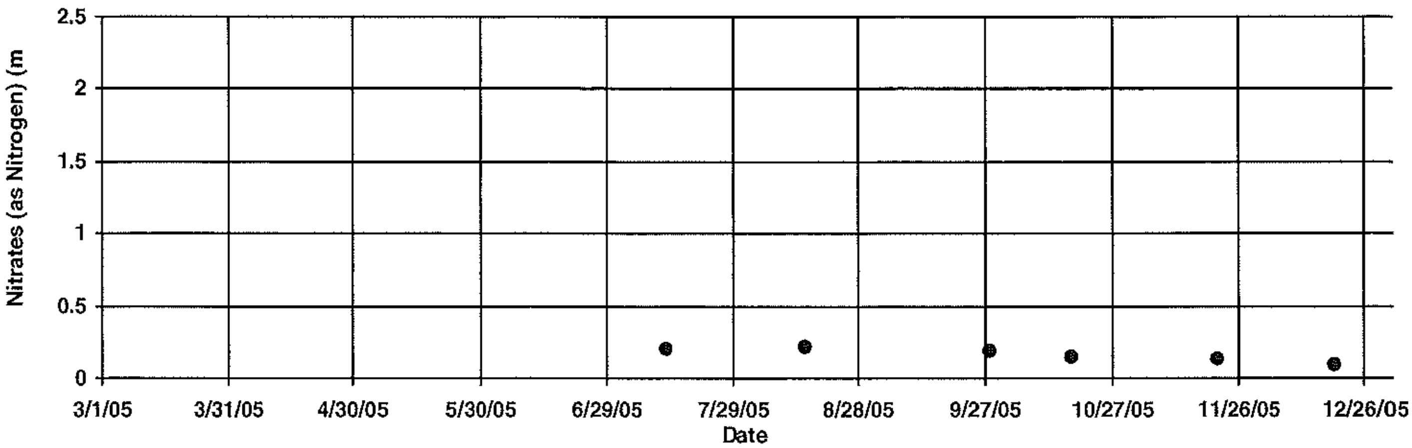


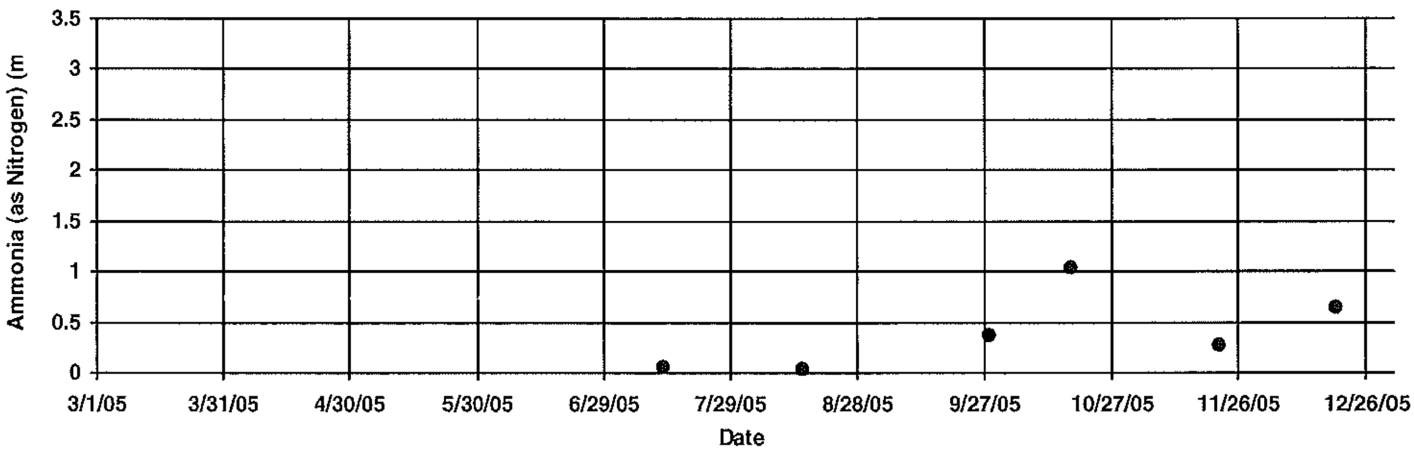


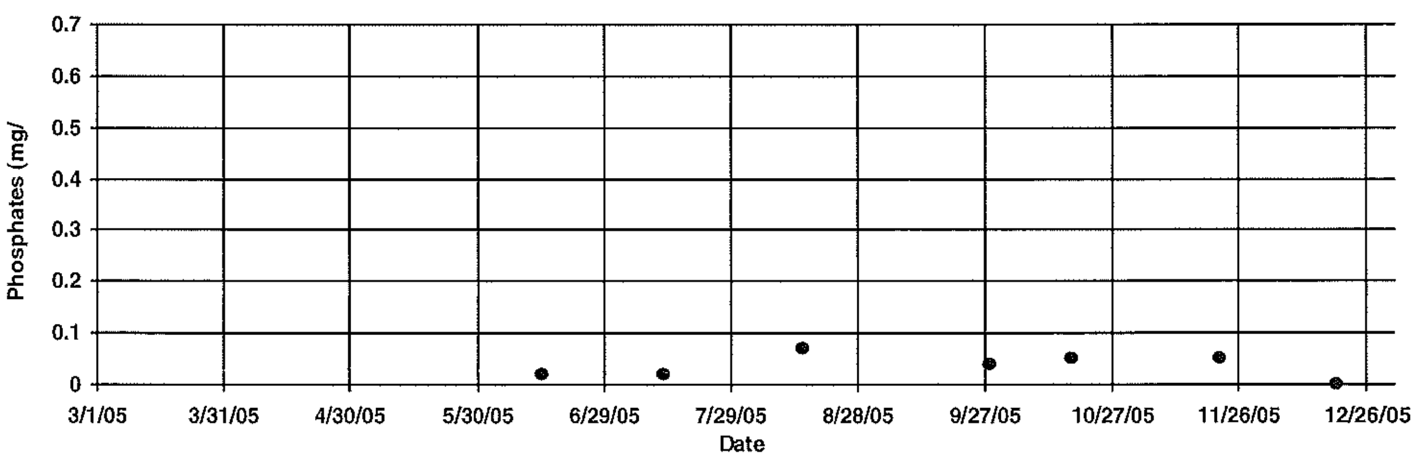


Study Site No. HG08 Alder Grove Site No.: 13

NUTRIENT DATA

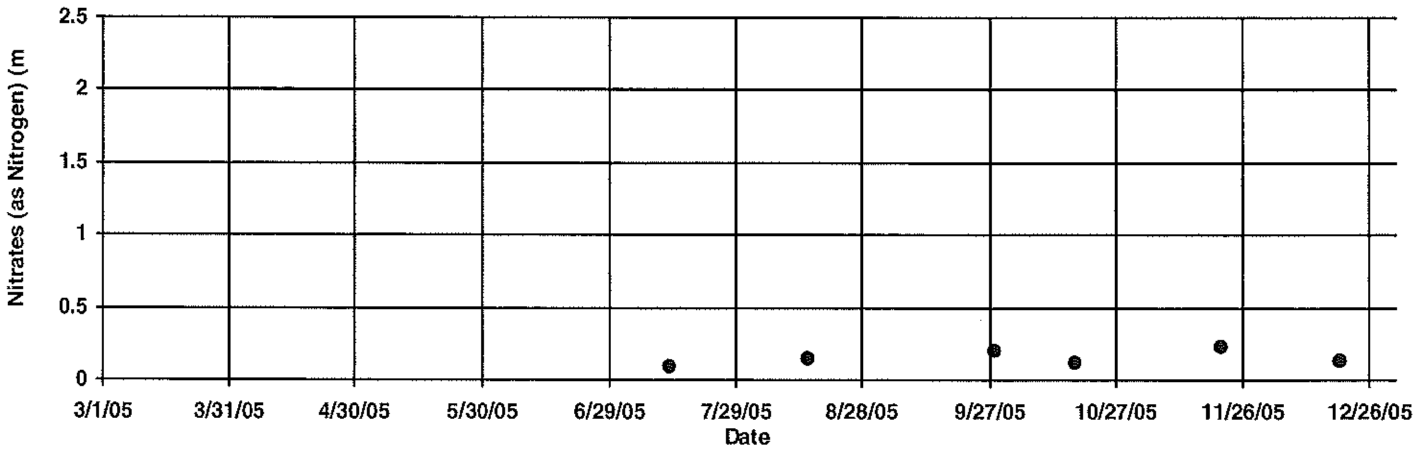


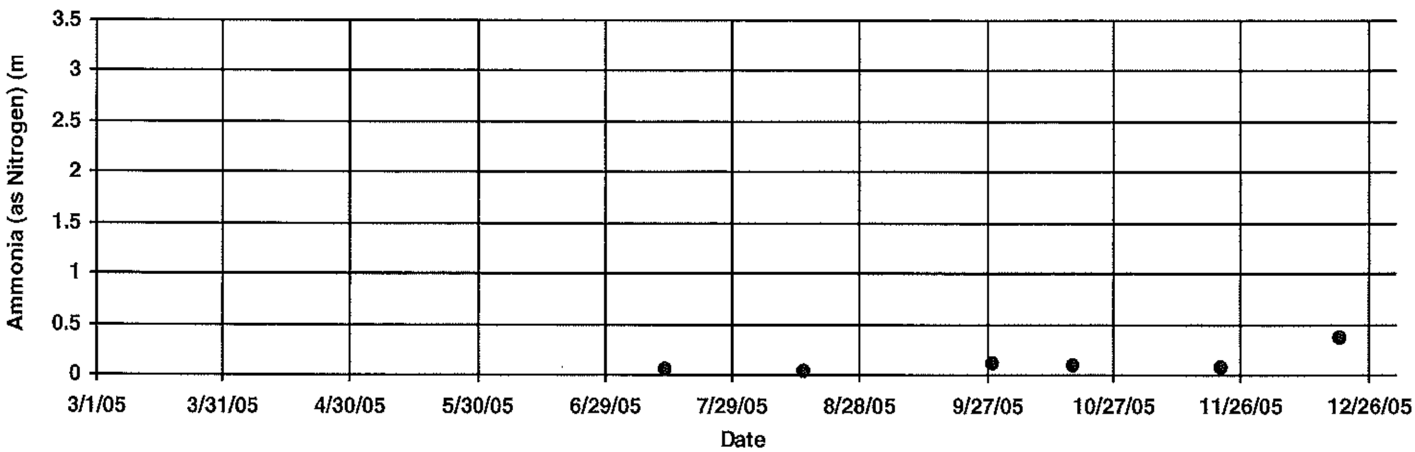


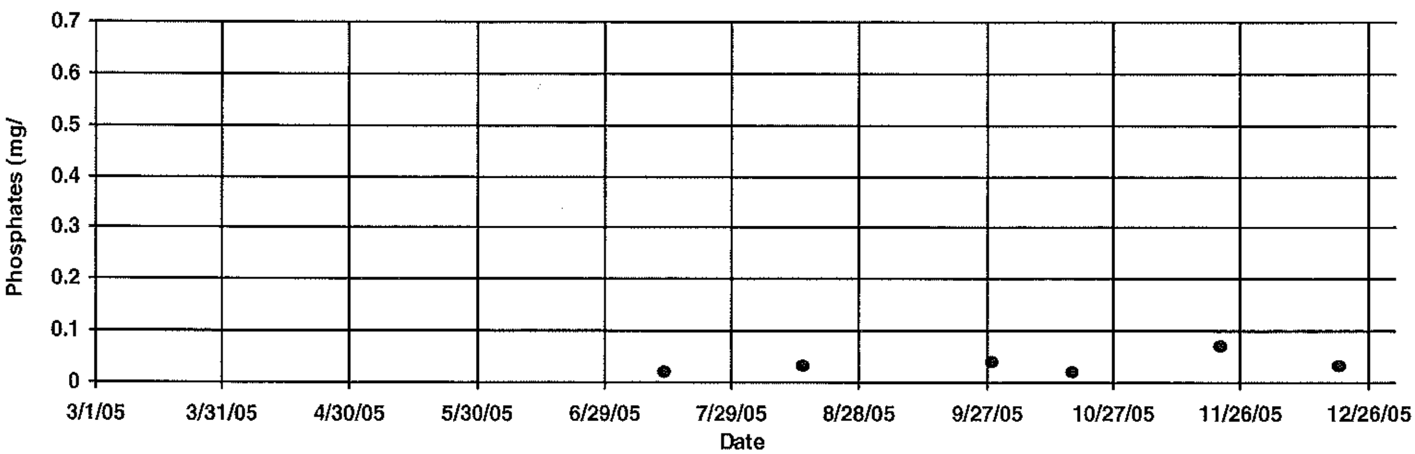


Study Site No. HG09 Bridge Site No.: 303

NUTRIENT DATA

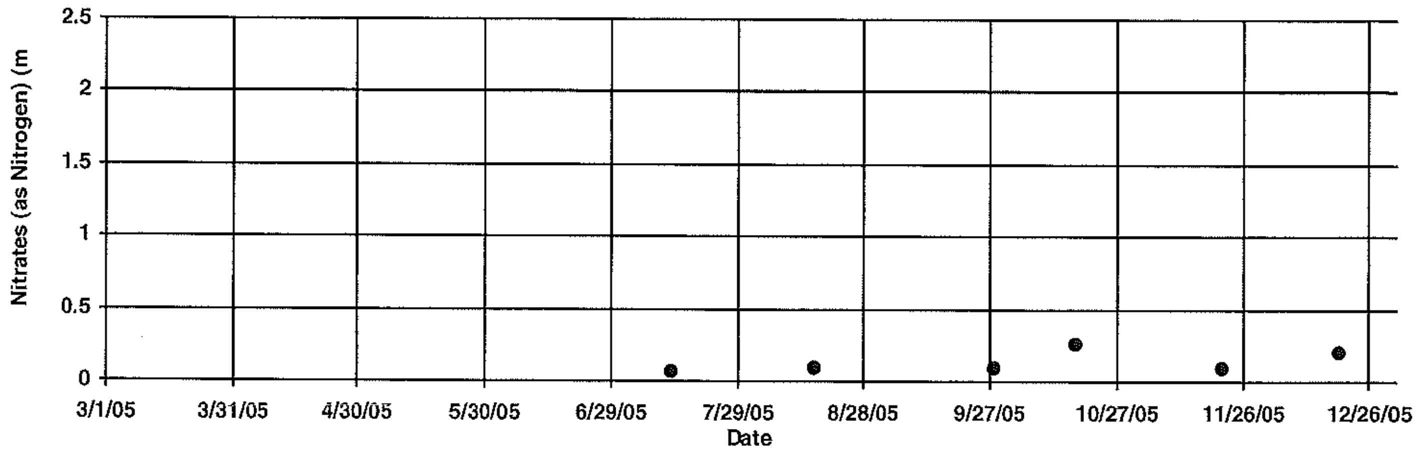


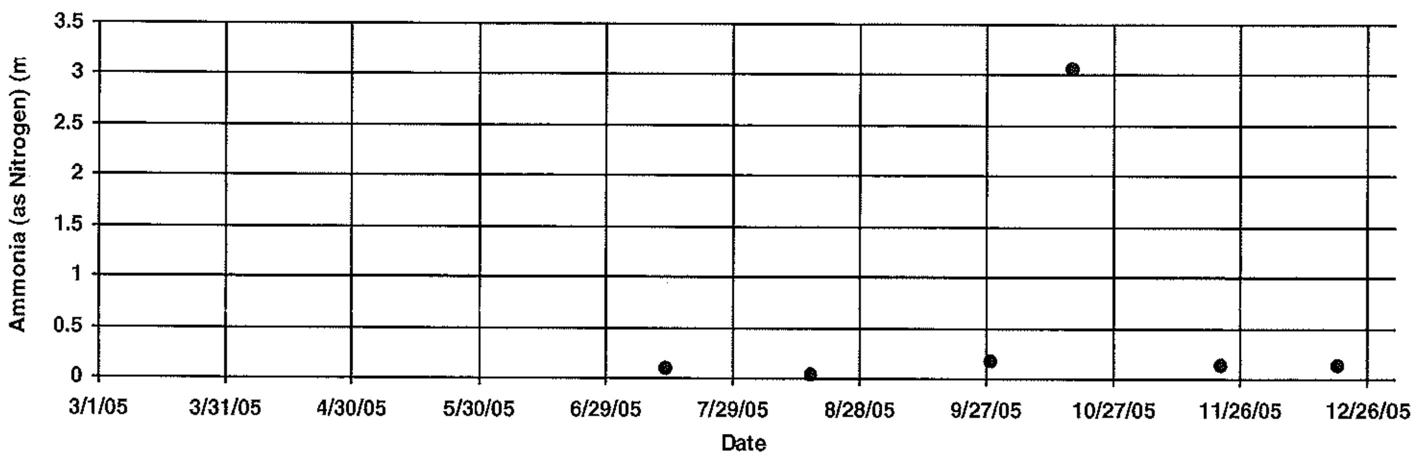


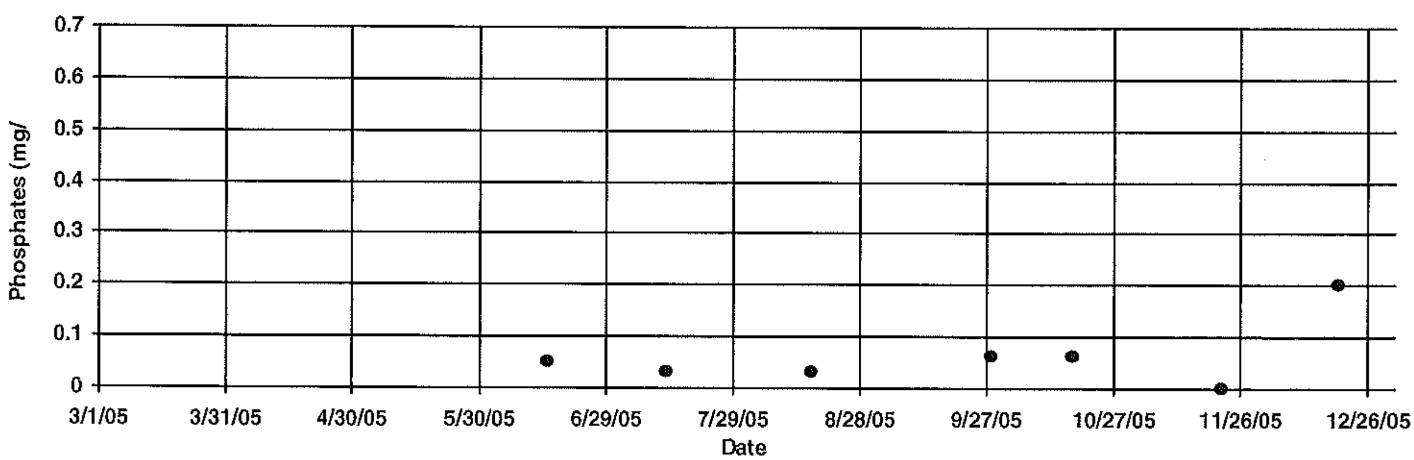


Study Site No. HG10 Sycamore Tree Site No.: 17

NUTRIENT DATA

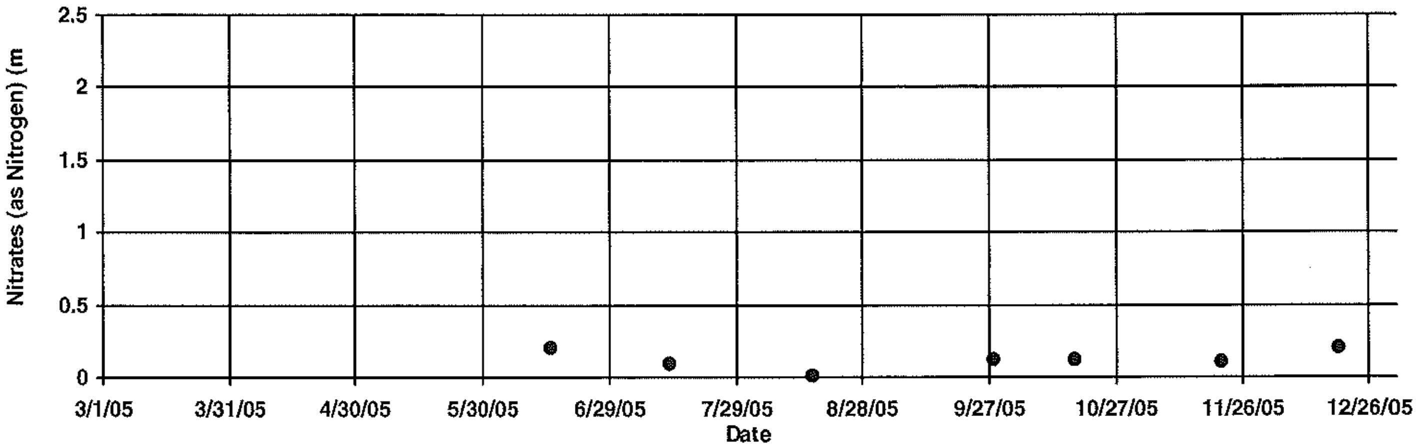


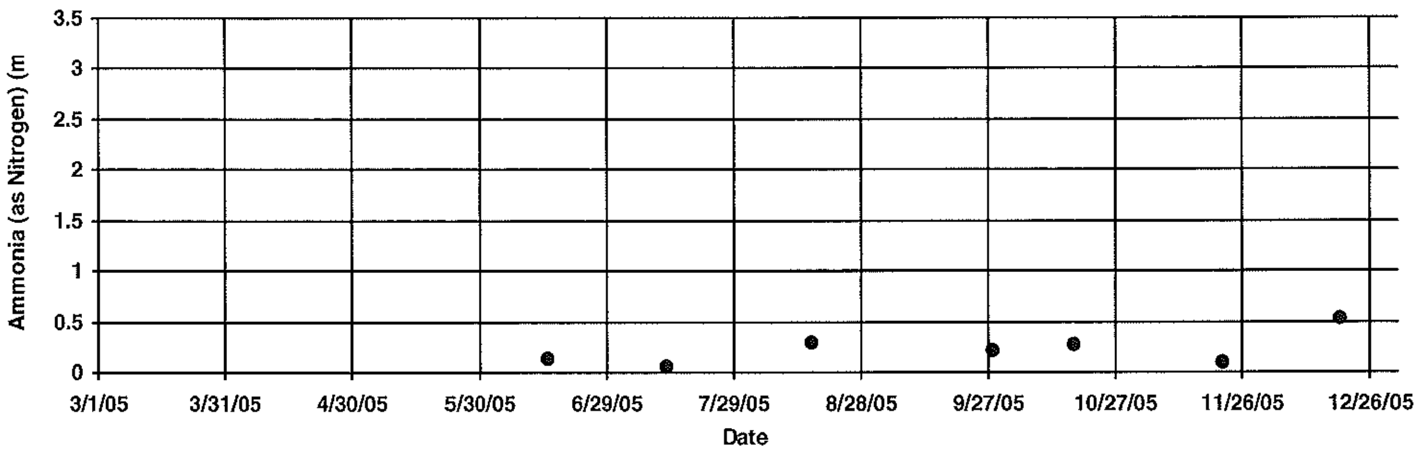


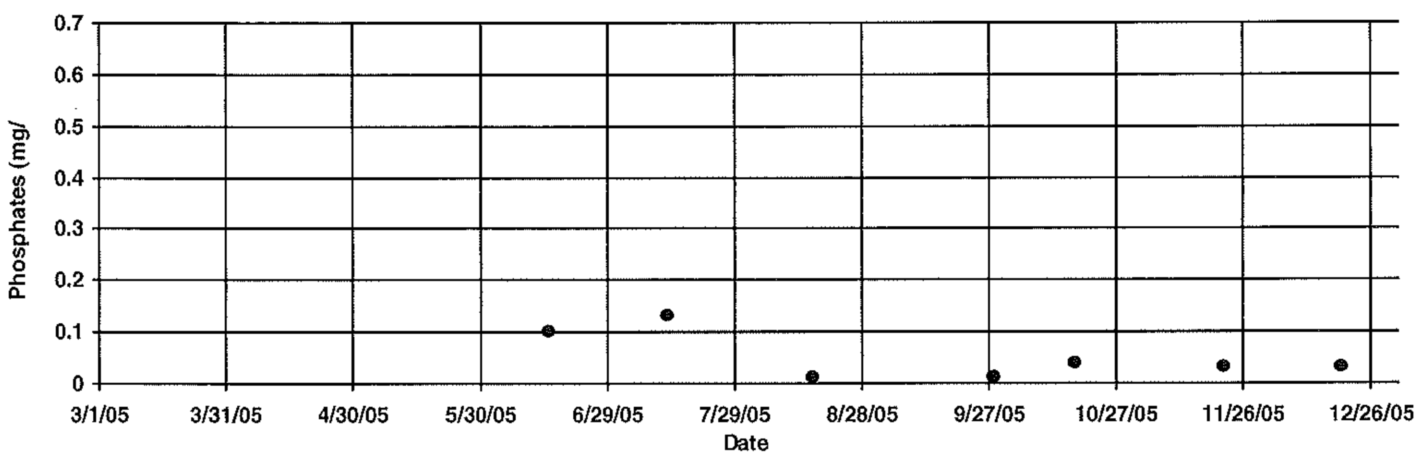


Study Site No. HG11 Maidenhair Fern Seep Site No.: 18

NUTRIENT DATA







Study Site No. HG12 No Parking Alder Seep Site No.: 34

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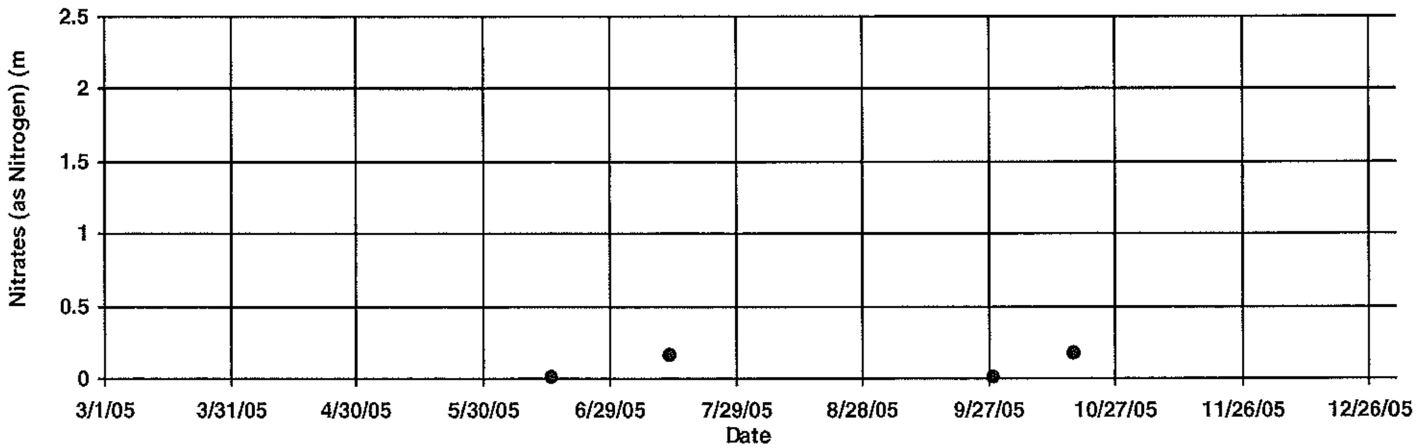

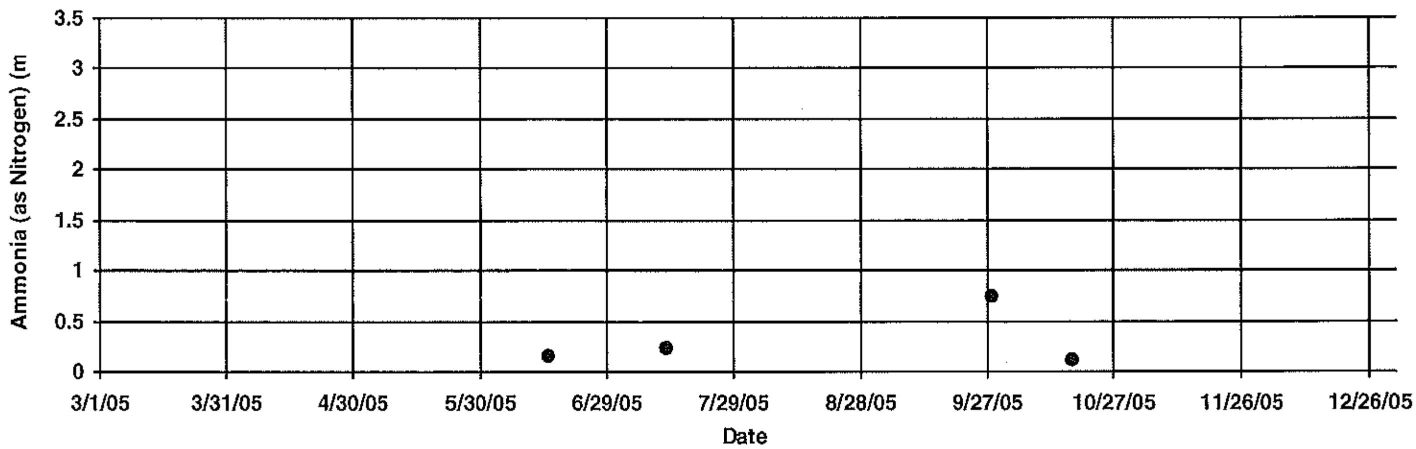

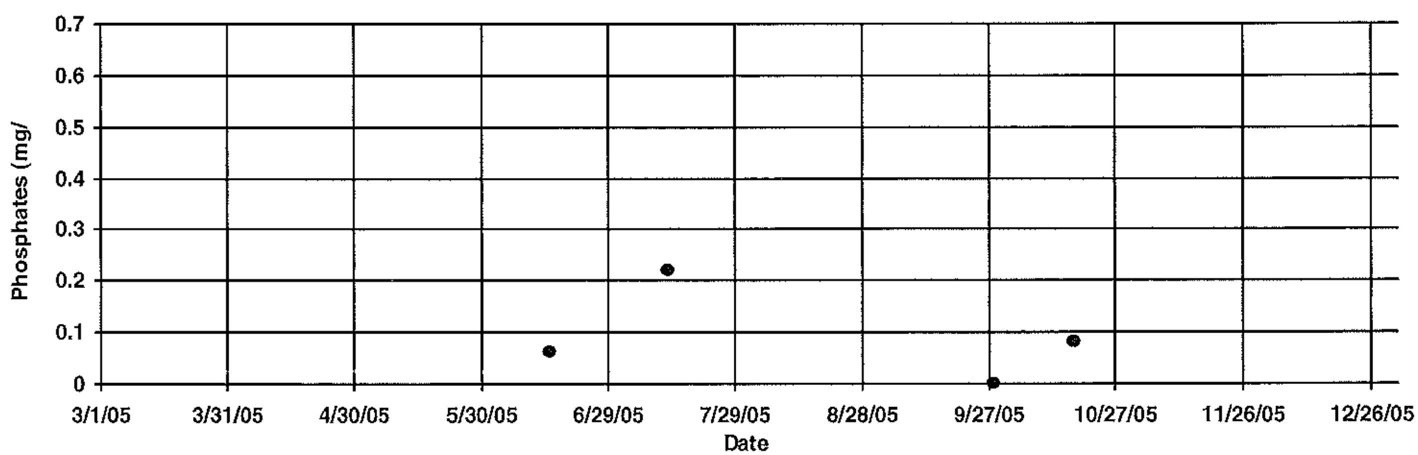

Study Site No. HG13 Narrows Seep Site No.: 19

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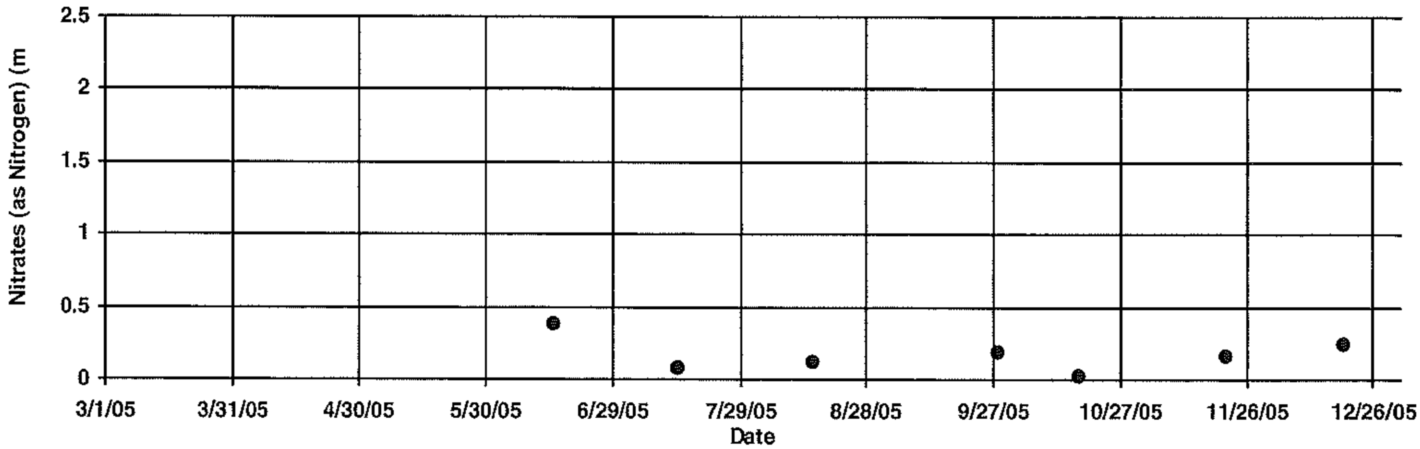

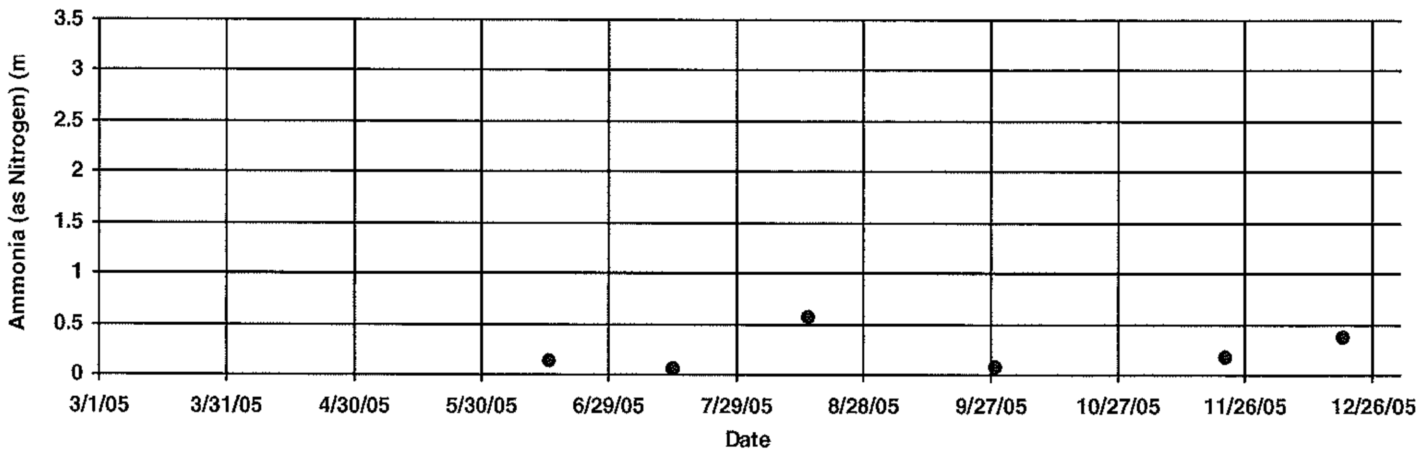

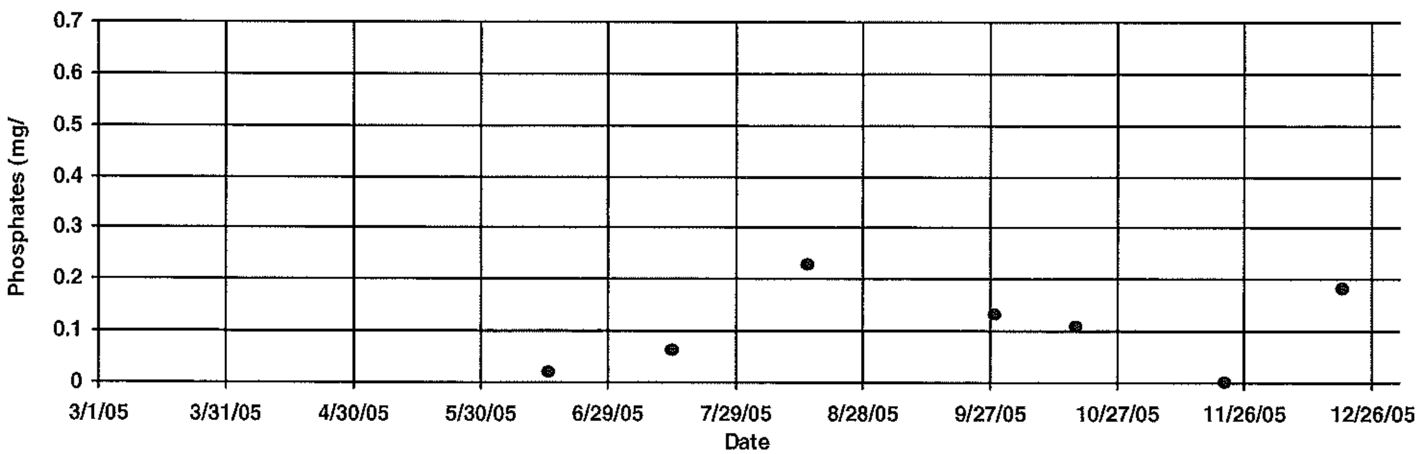

Study Site No. HG14 Duck Seep/Kevin Pool Site No.: 20

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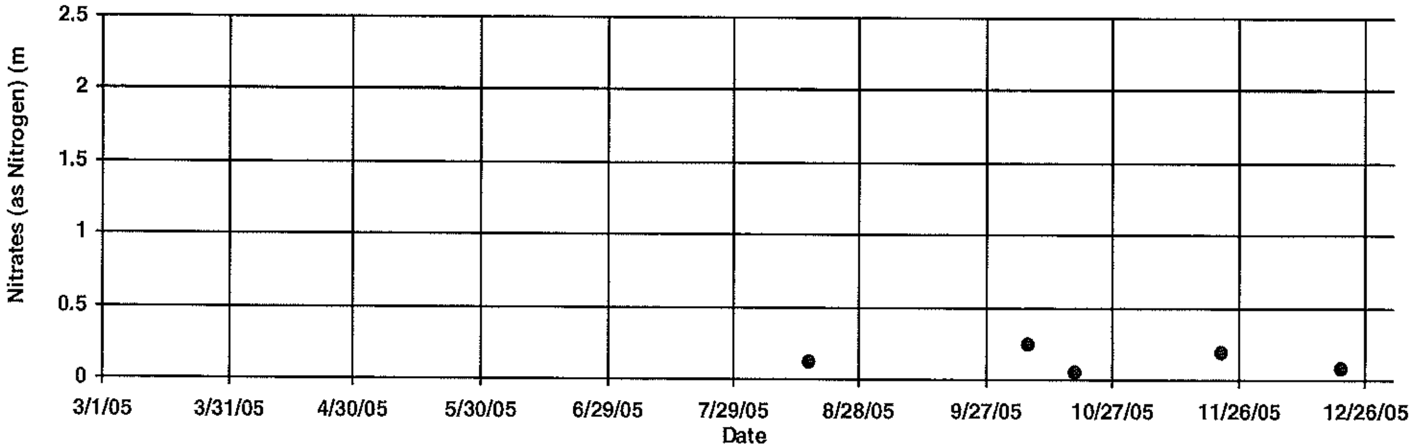

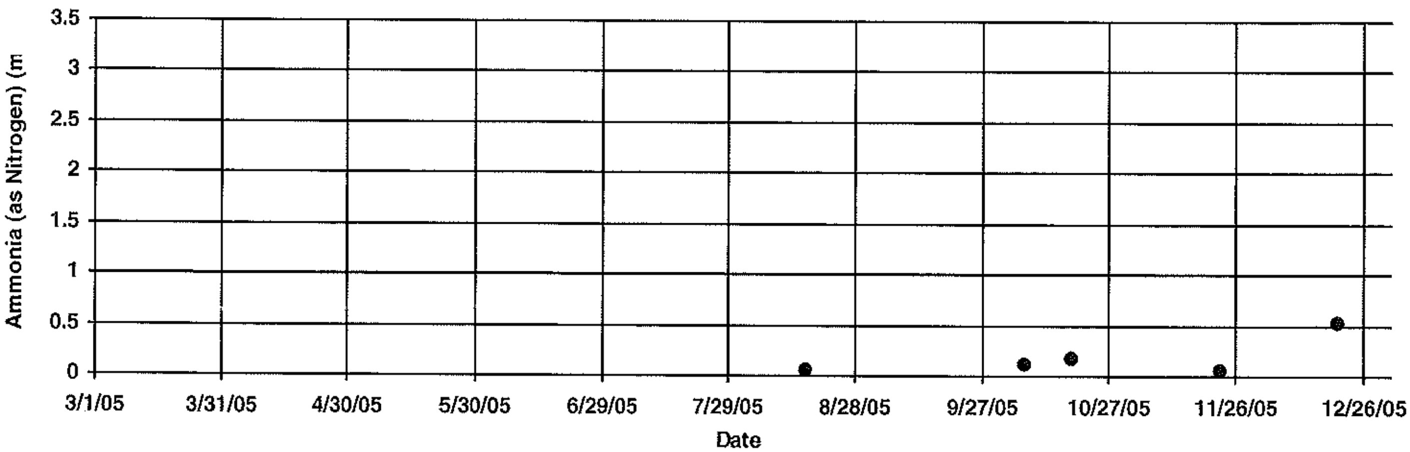

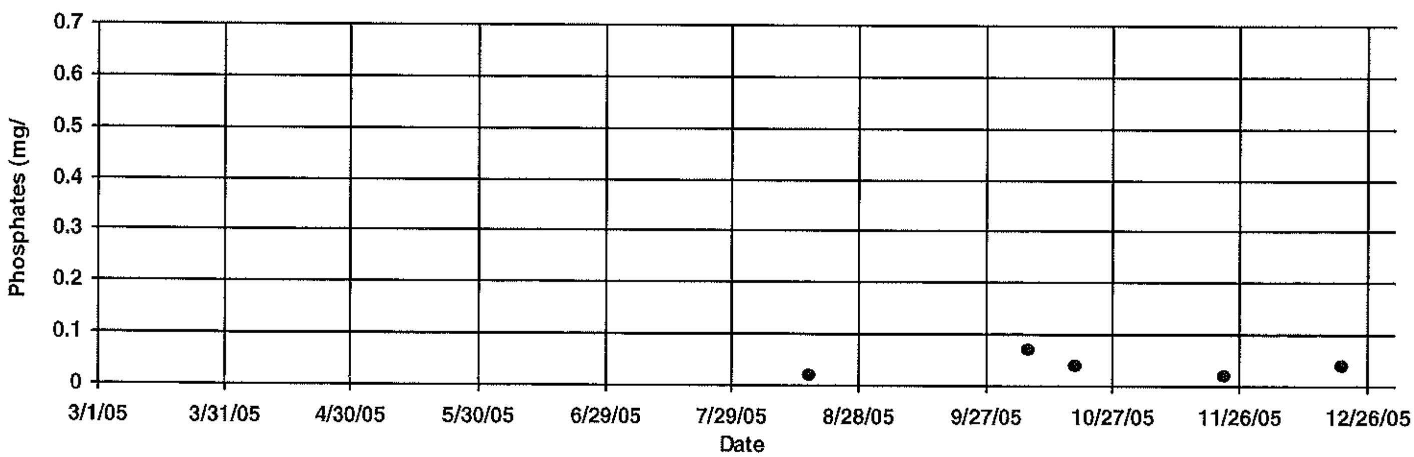

Study Site No. HG15 Storm Falls Site No.: 27

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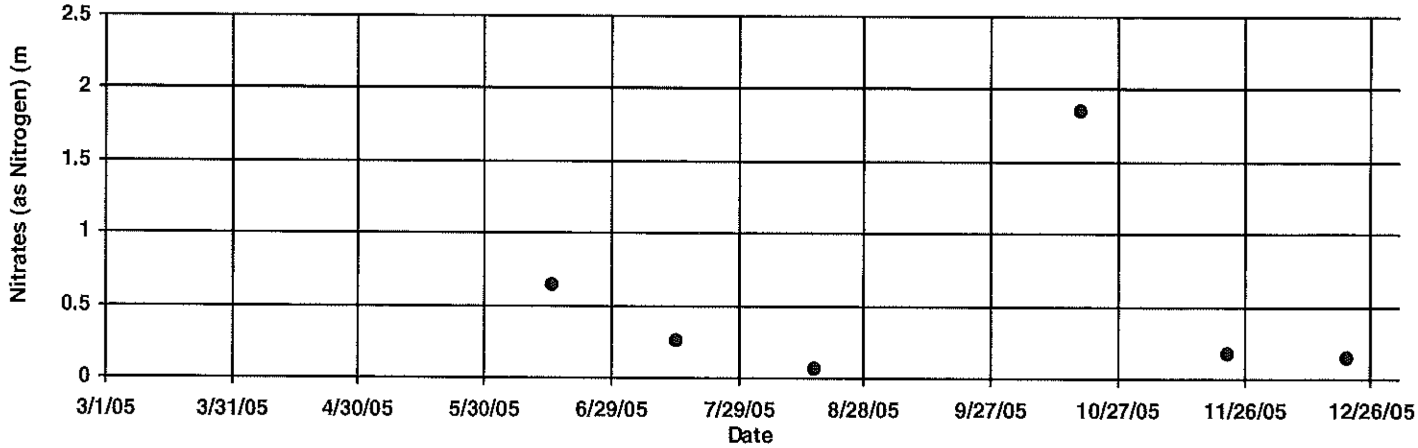
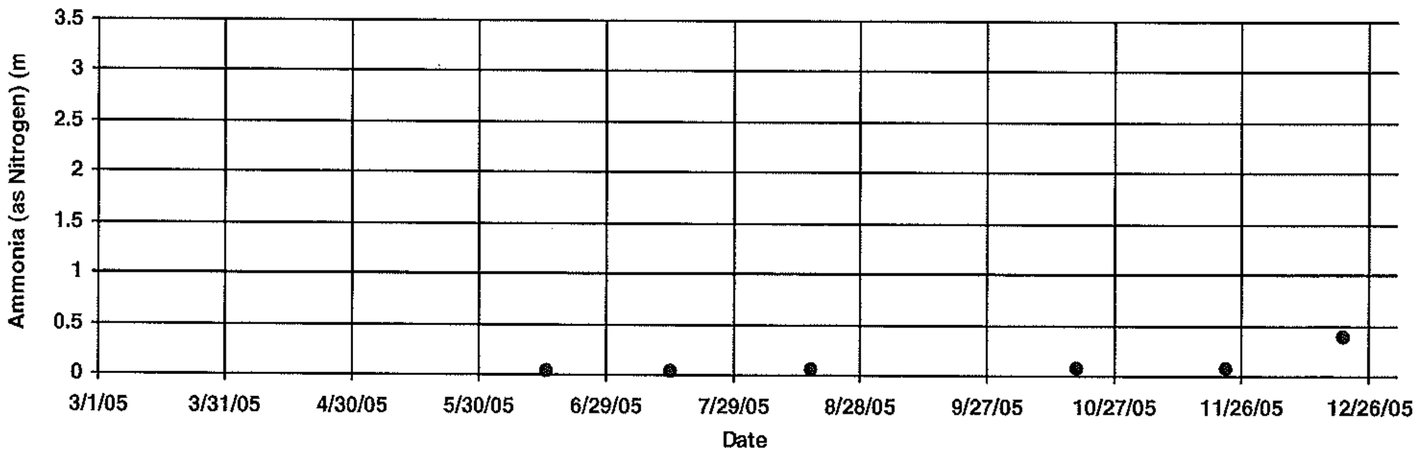
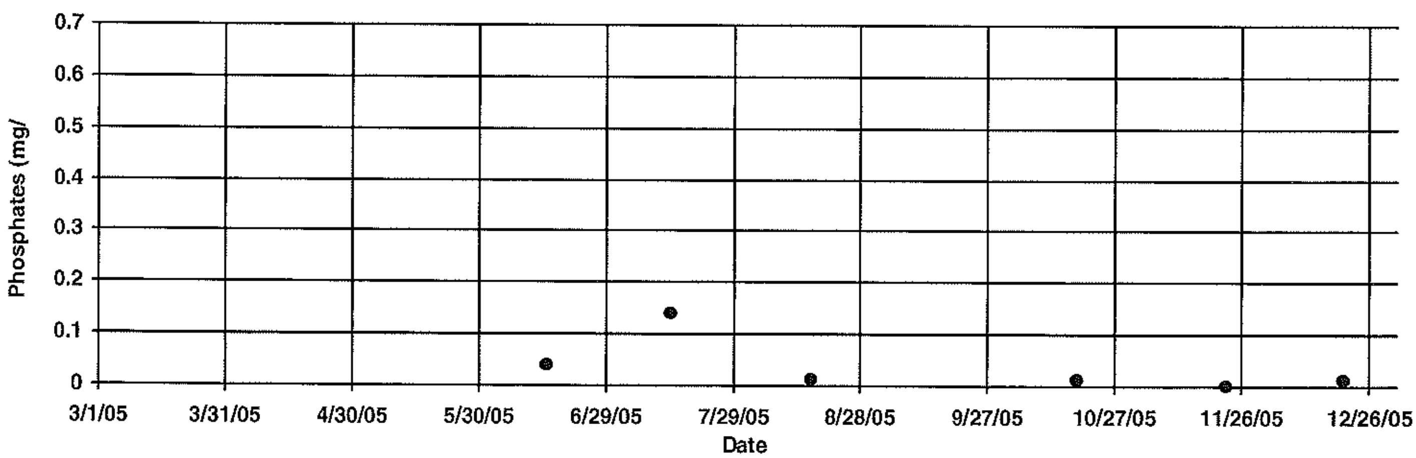
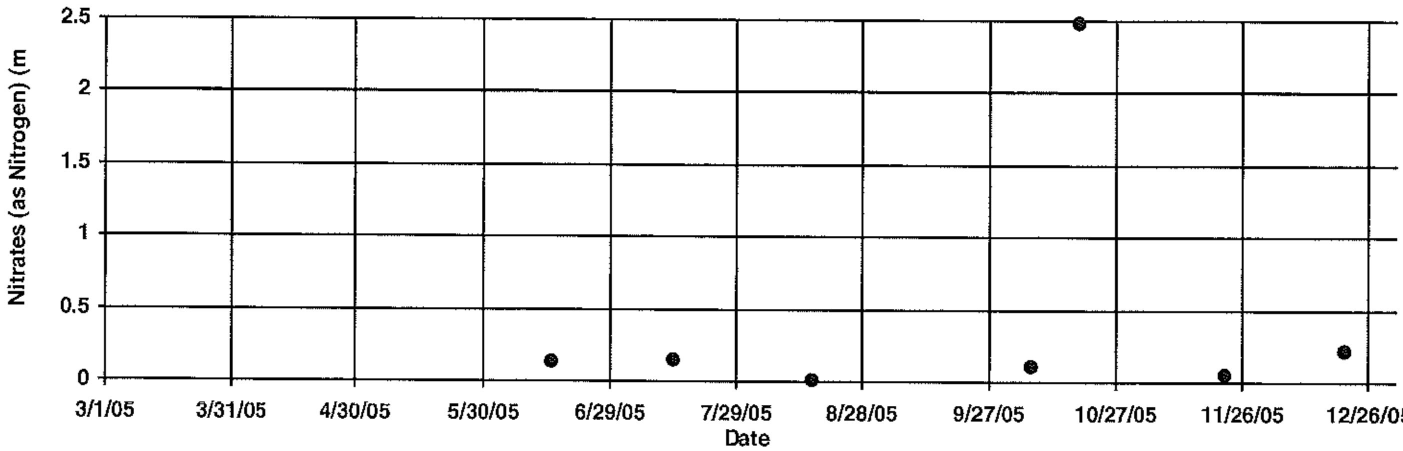


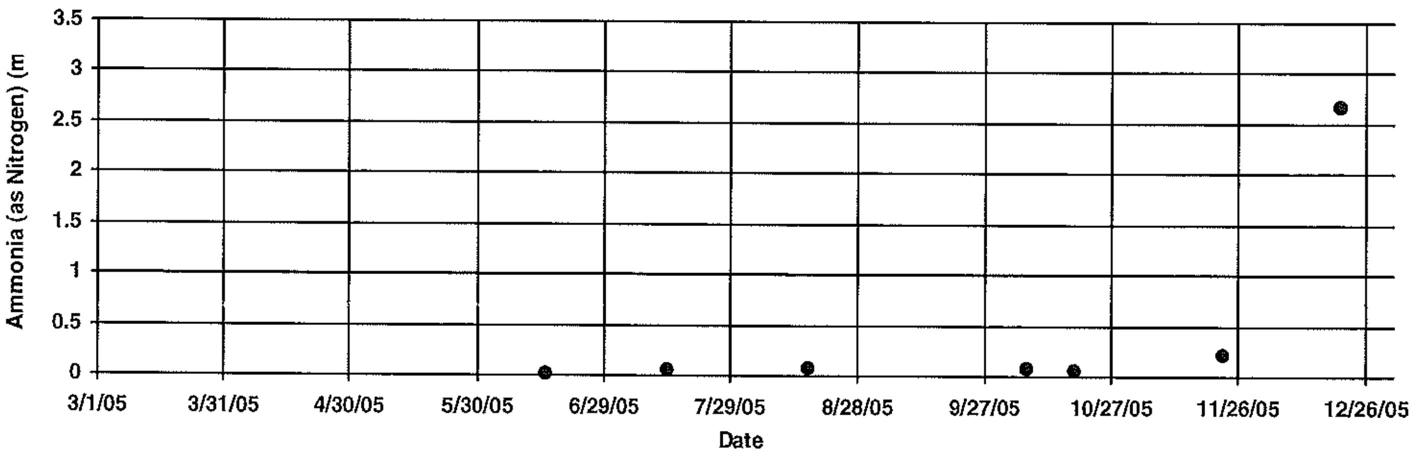


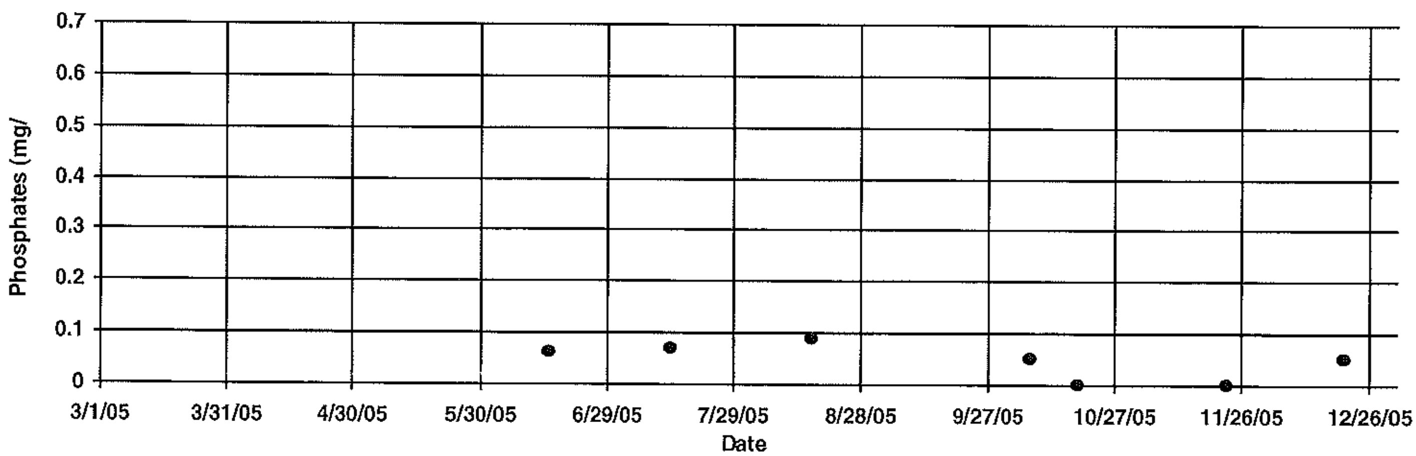


Study Site No. HG16 Dead Alder Falls Site No.: 31

NUTRIENT DATA







Study Site No. HG17 Elderberry Falls Site No.: 52

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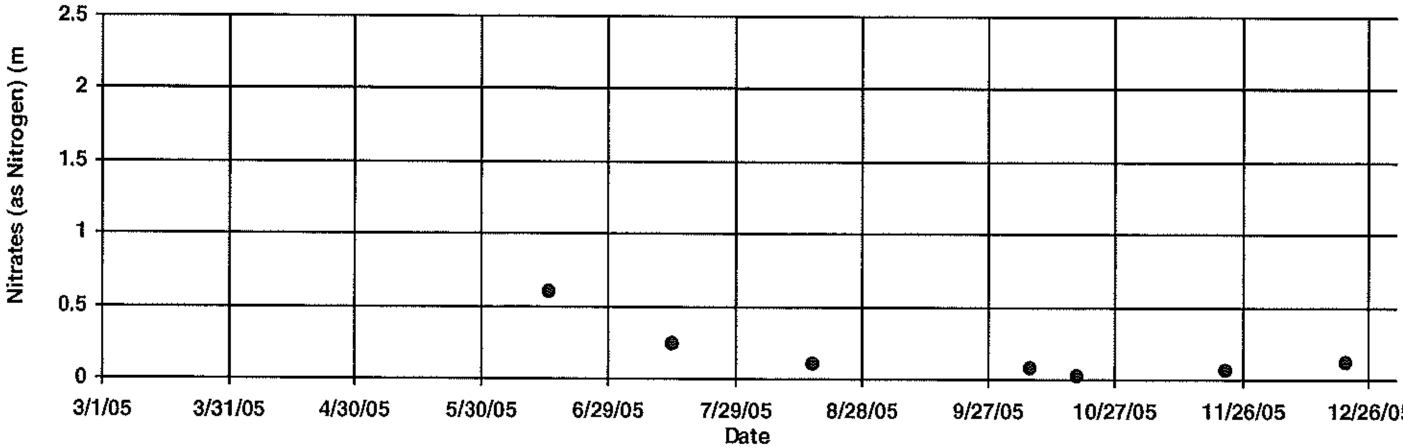
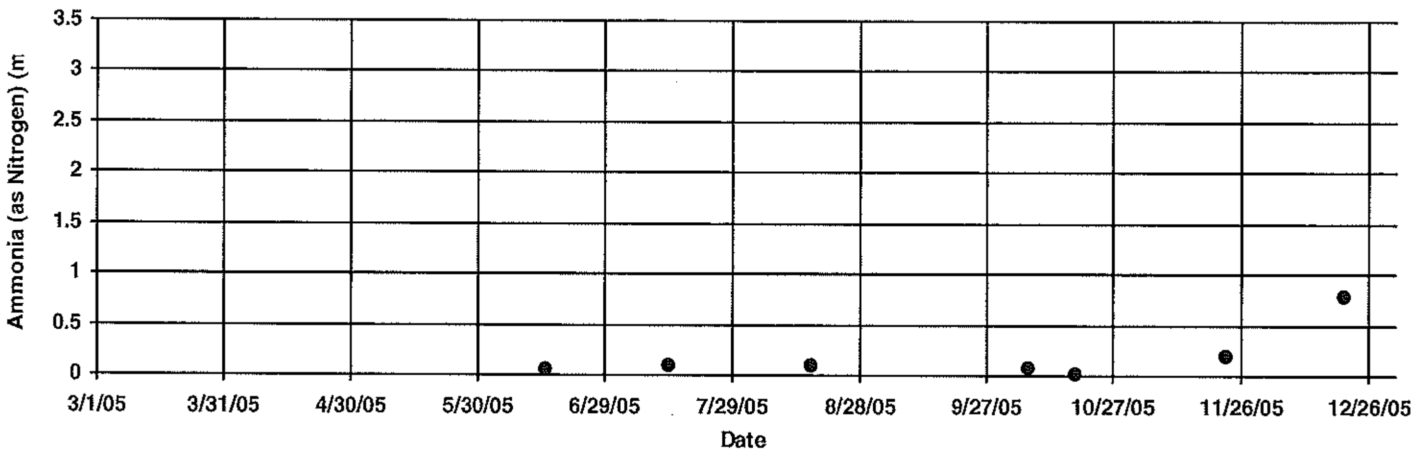
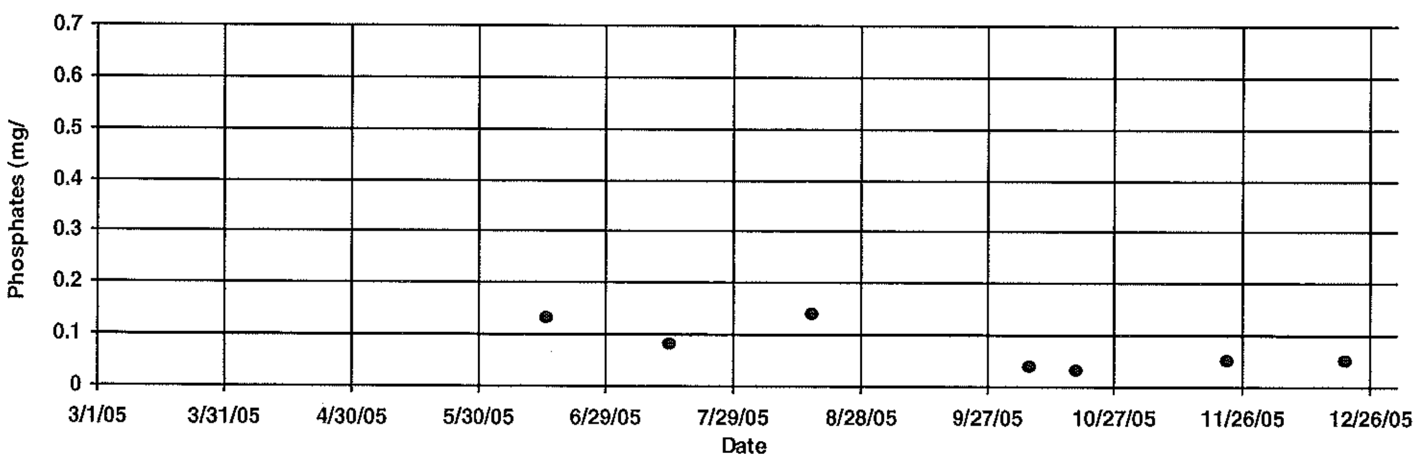
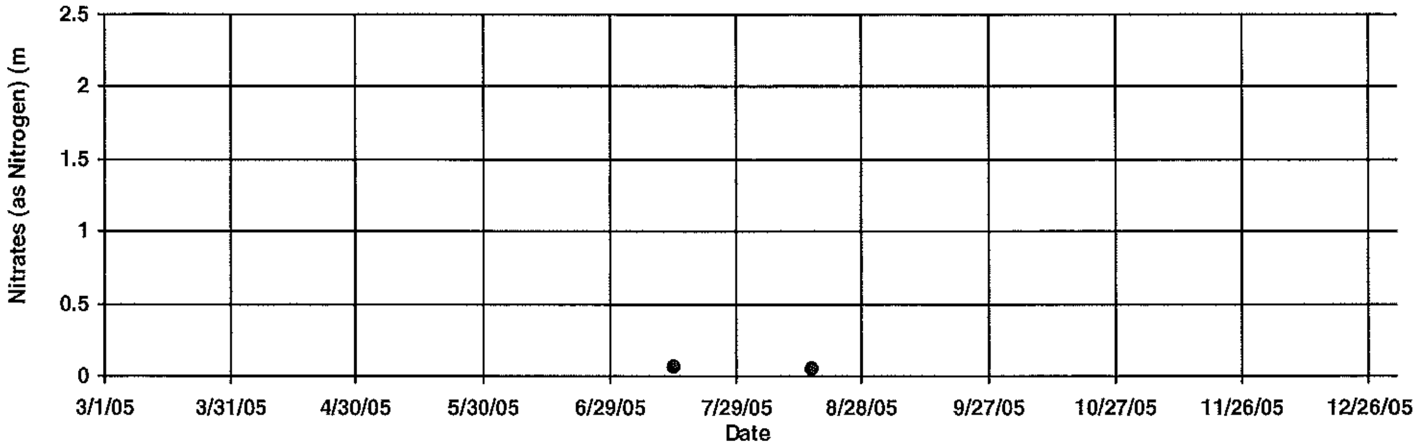


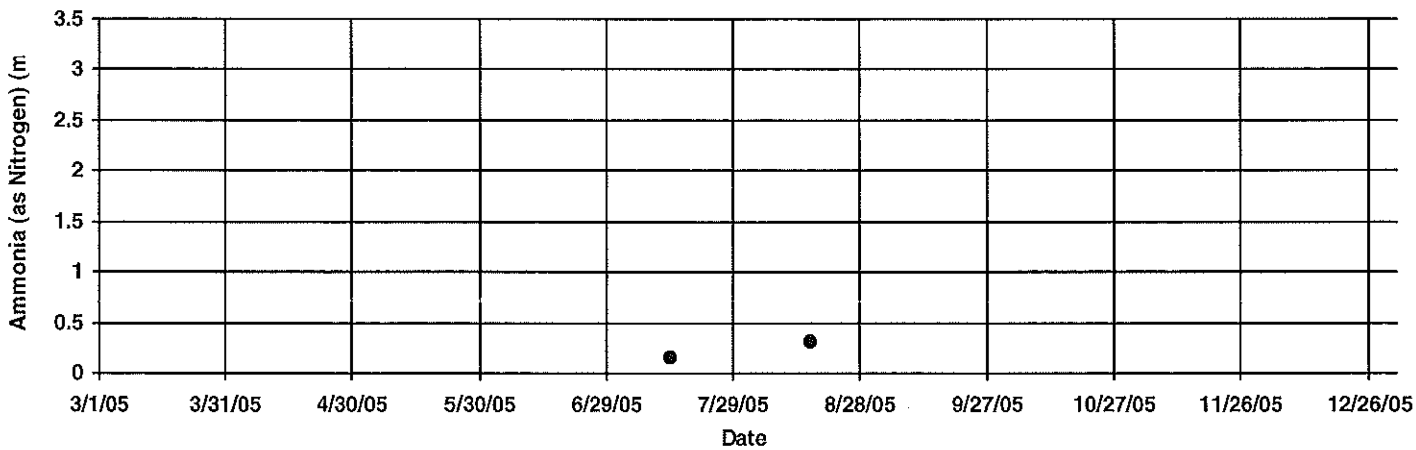


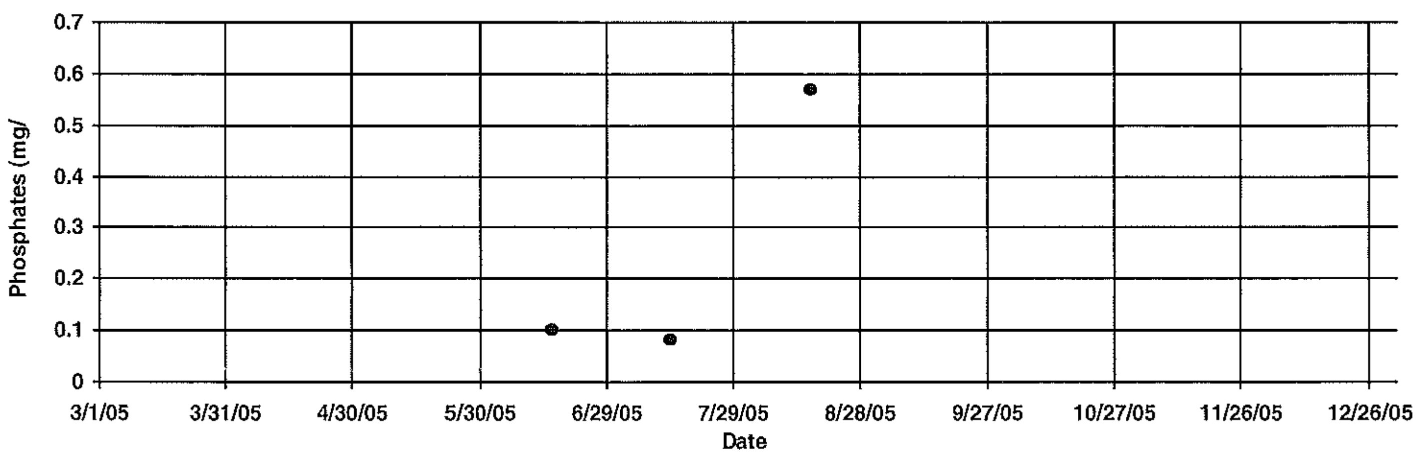


Study Site No. HG18 Tadpole Pool Site No.: 53

NUTRIENT DATA

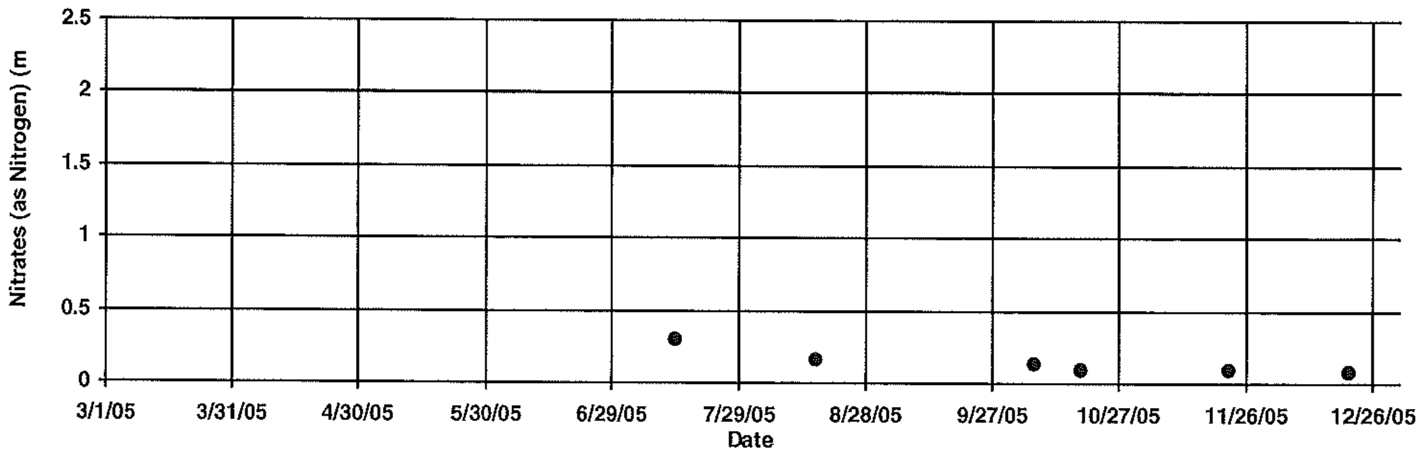


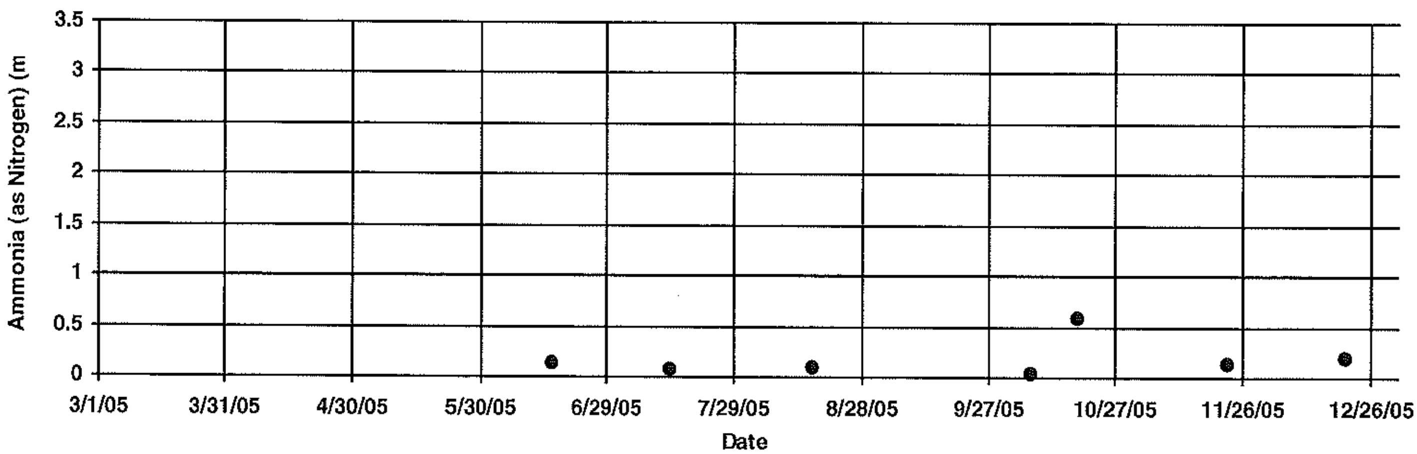


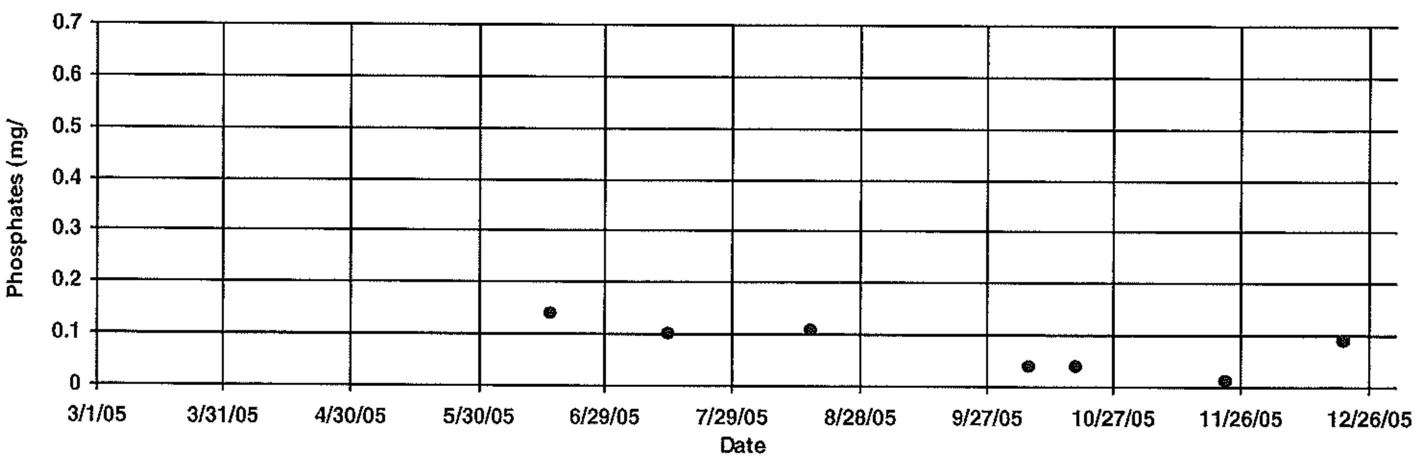


Study Site No. HG19 Pool of Many Drips Site No.: 54

NUTRIENT DATA

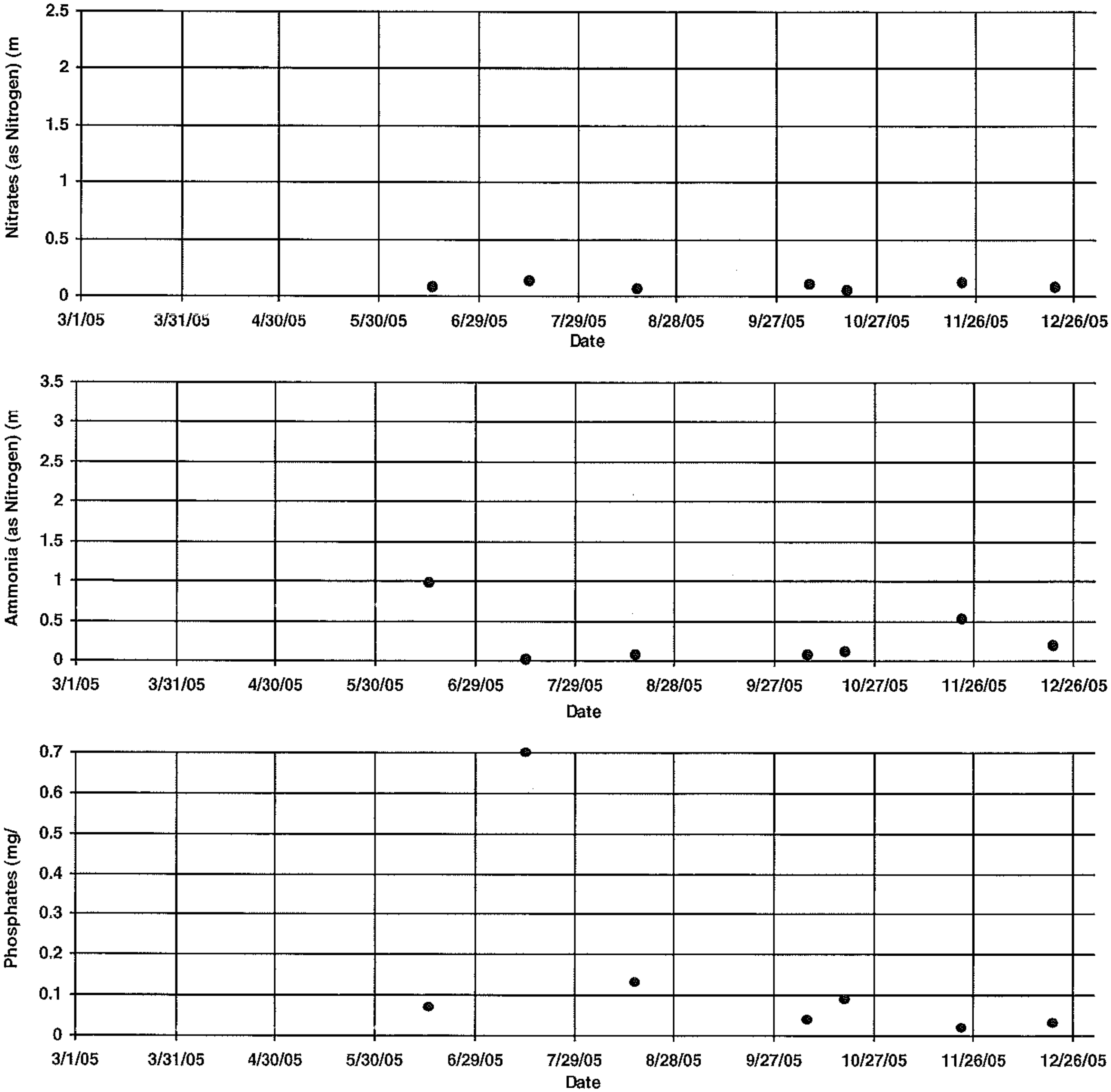






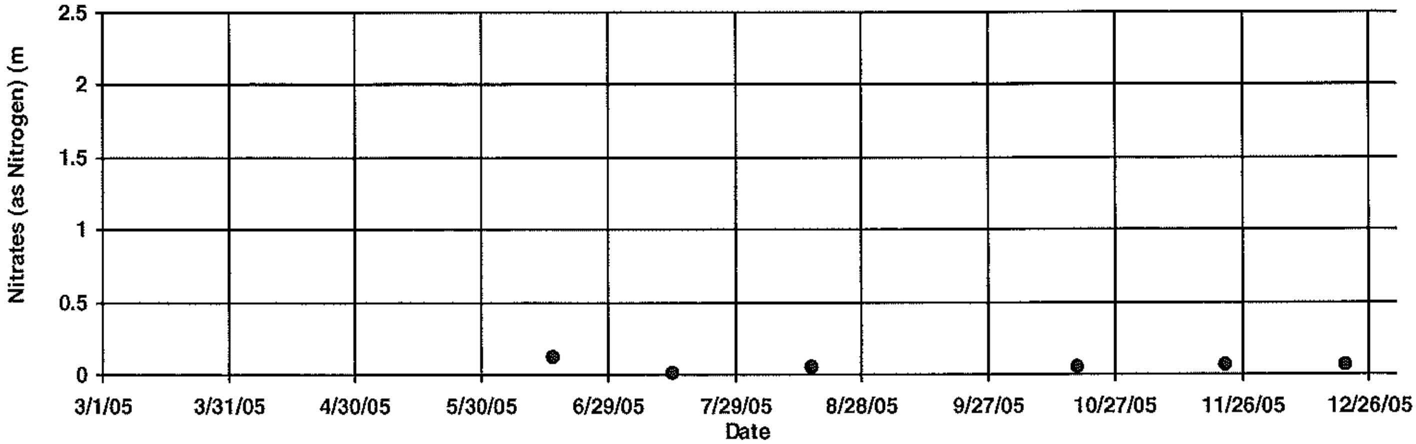
Study Site No. HG20 Bigleaf Maple Pool Site No.: 35

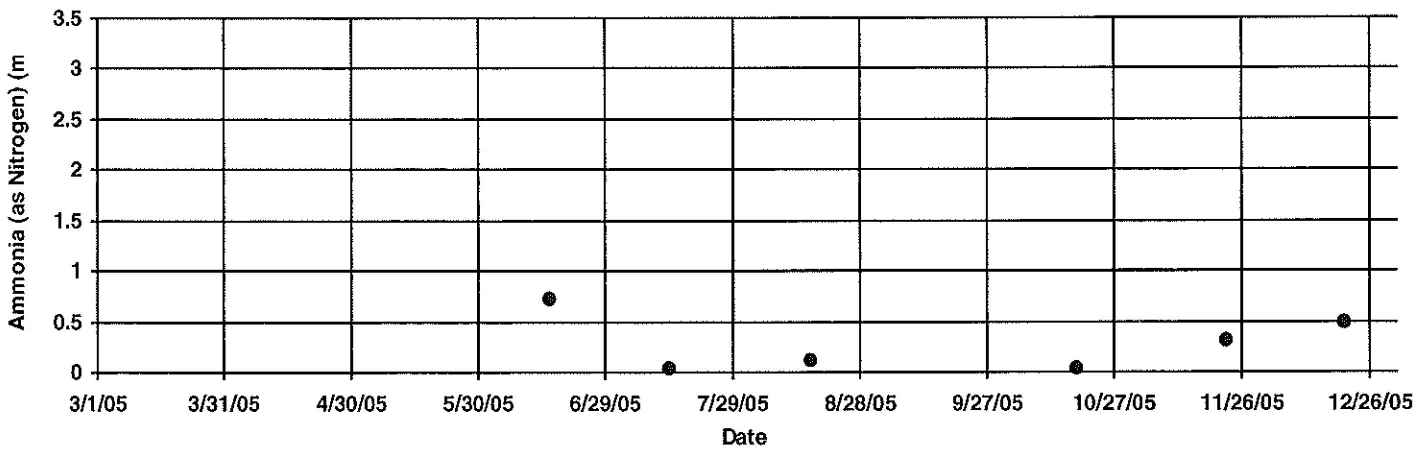
NUTRIENT DATA

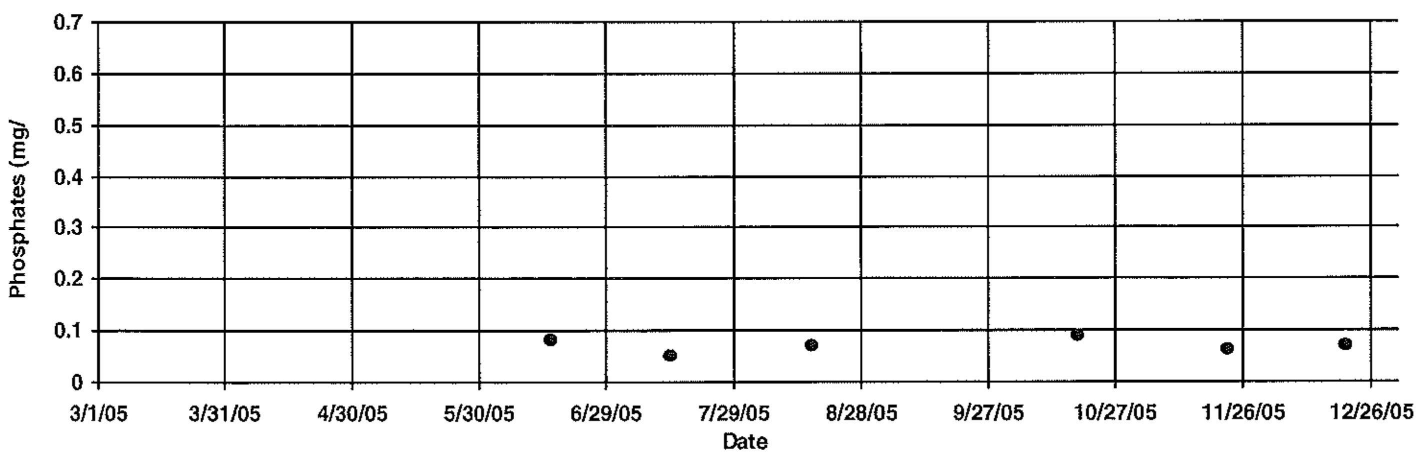


Study Site No. HG21 Up and Down Trib Site No.: 56

NUTRIENT DATA







Study Site No. HG22 Rope Swing Pool Site No.: 304

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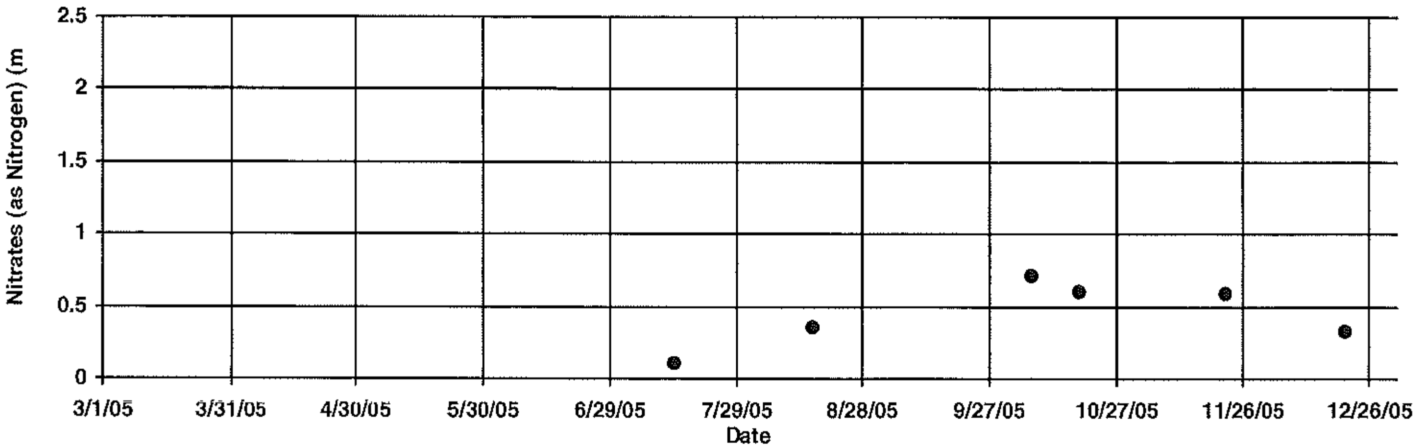

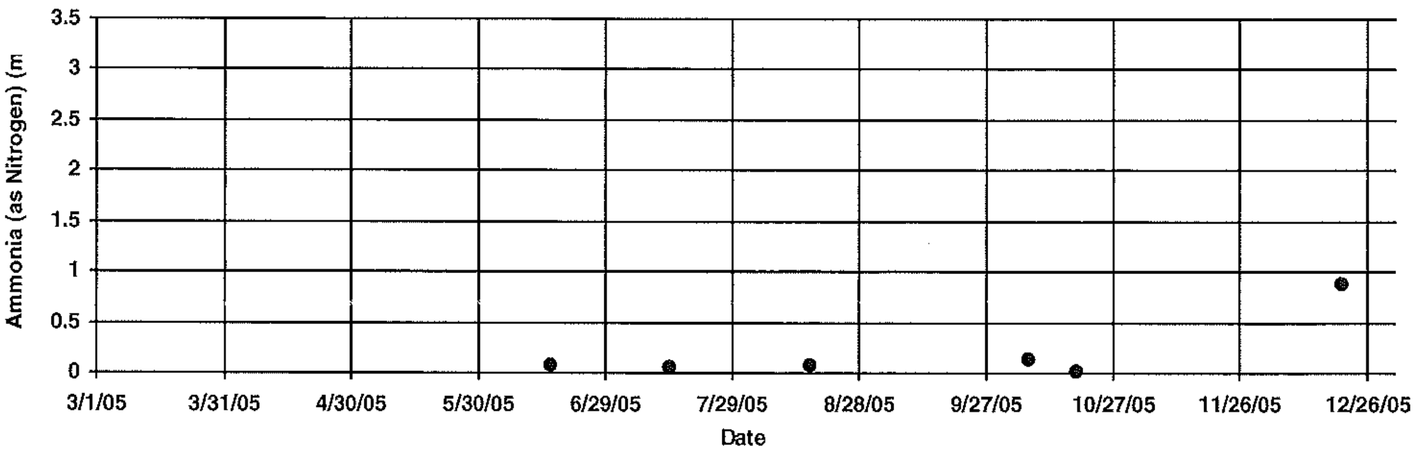

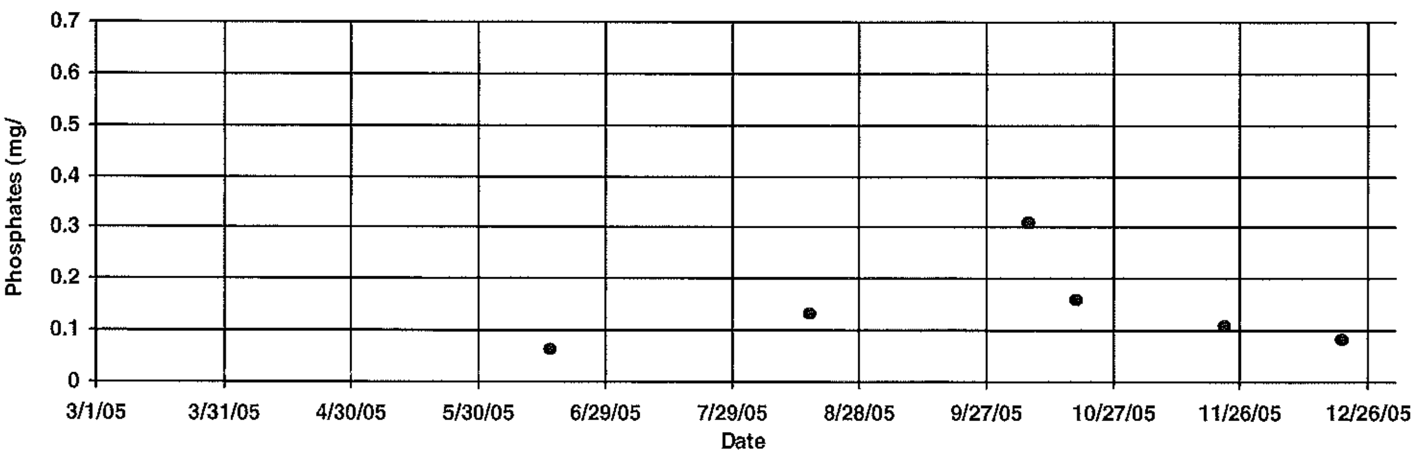

Study Site No. HG23 Time Tunnel Site No.: 39

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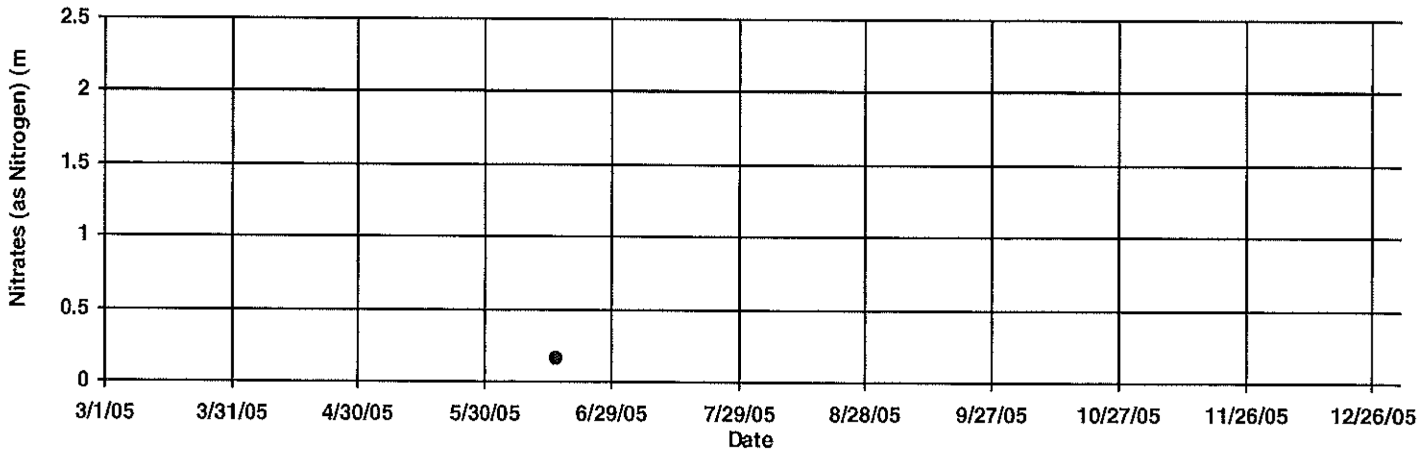
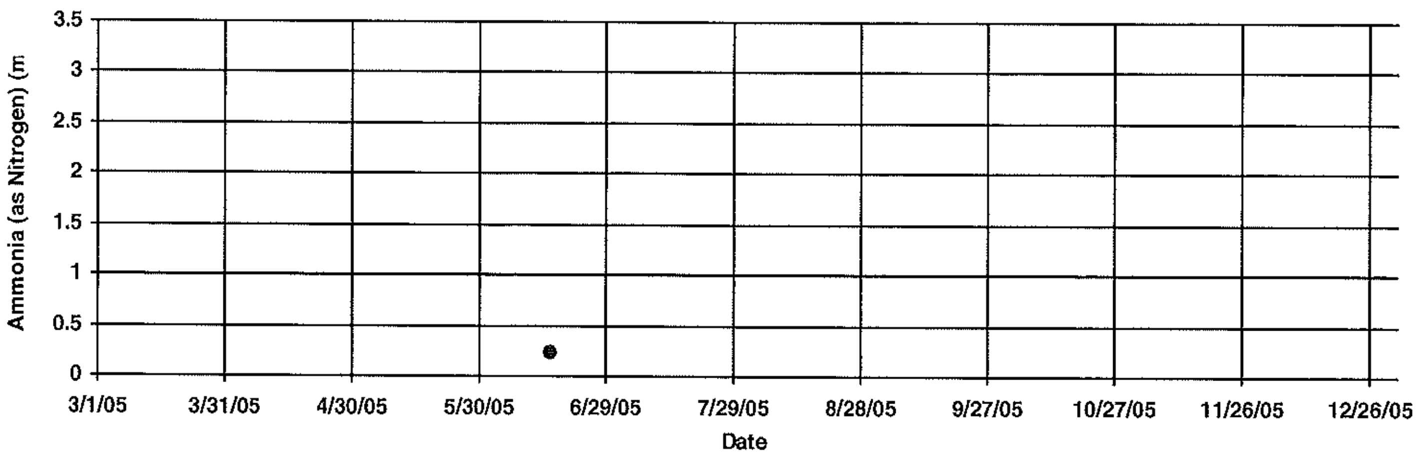
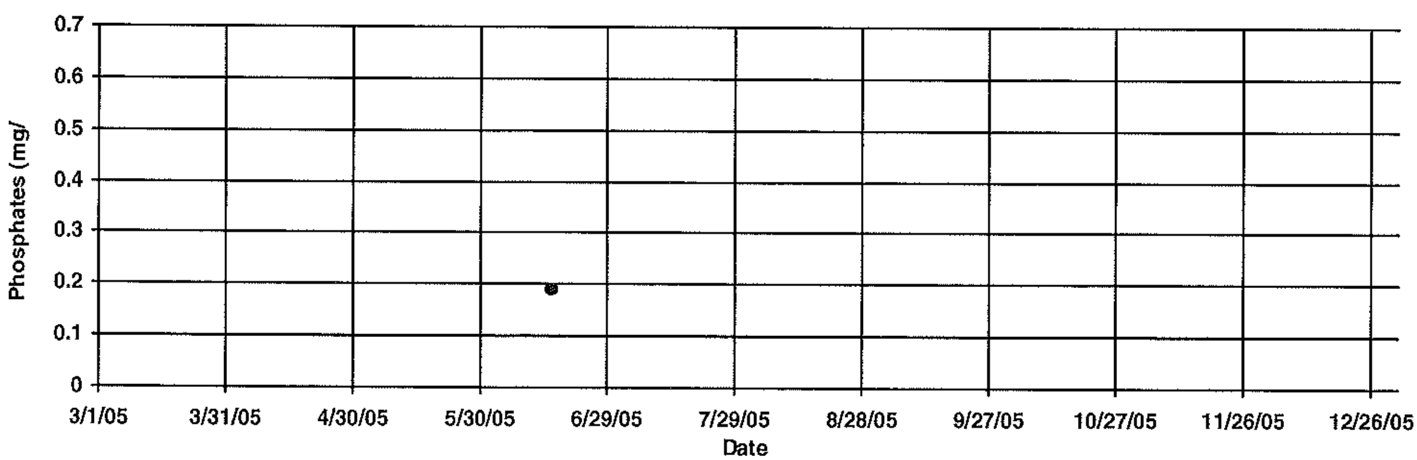
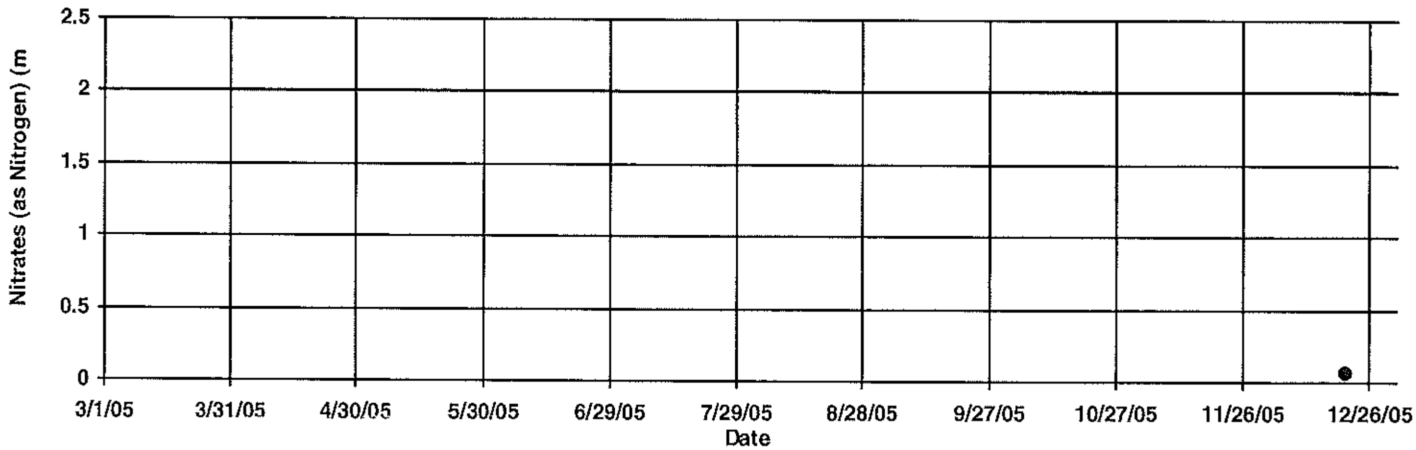


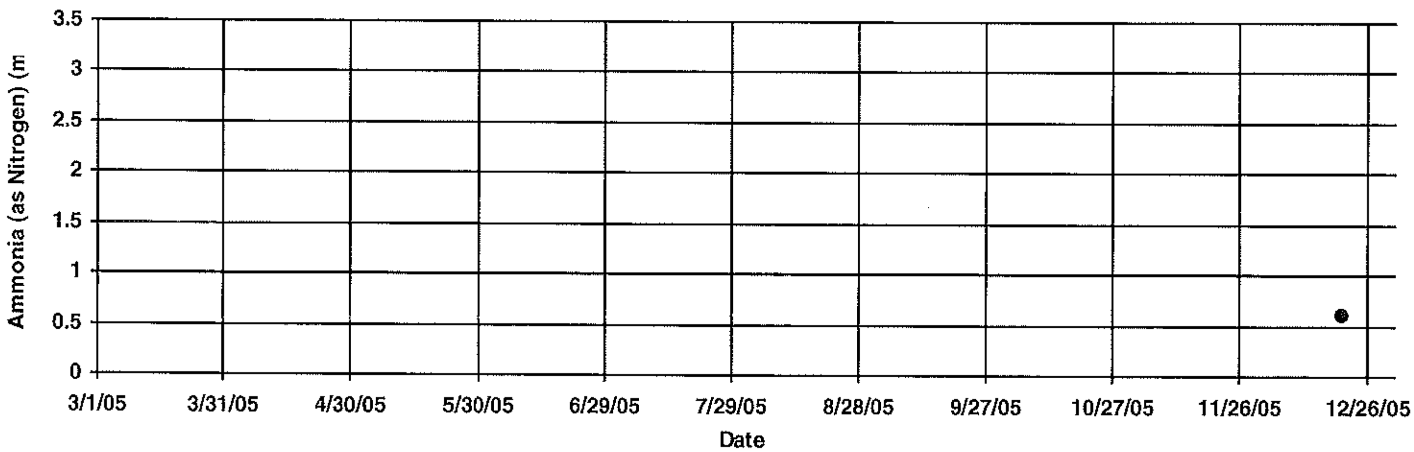


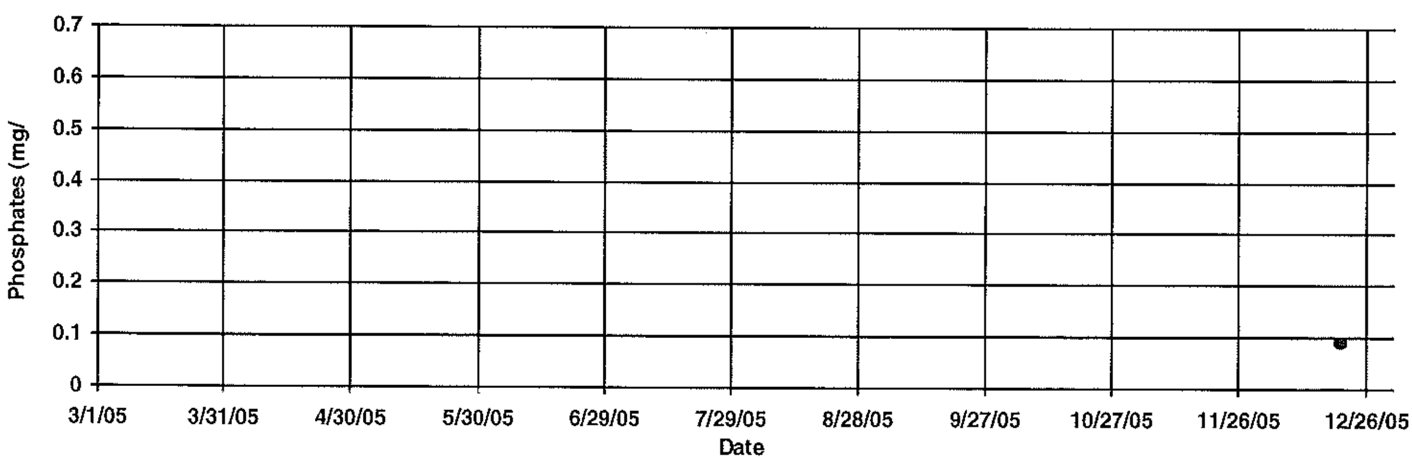


Study Site No. HG24 Abuelita's Site No.: 305

NUTRIENT DATA



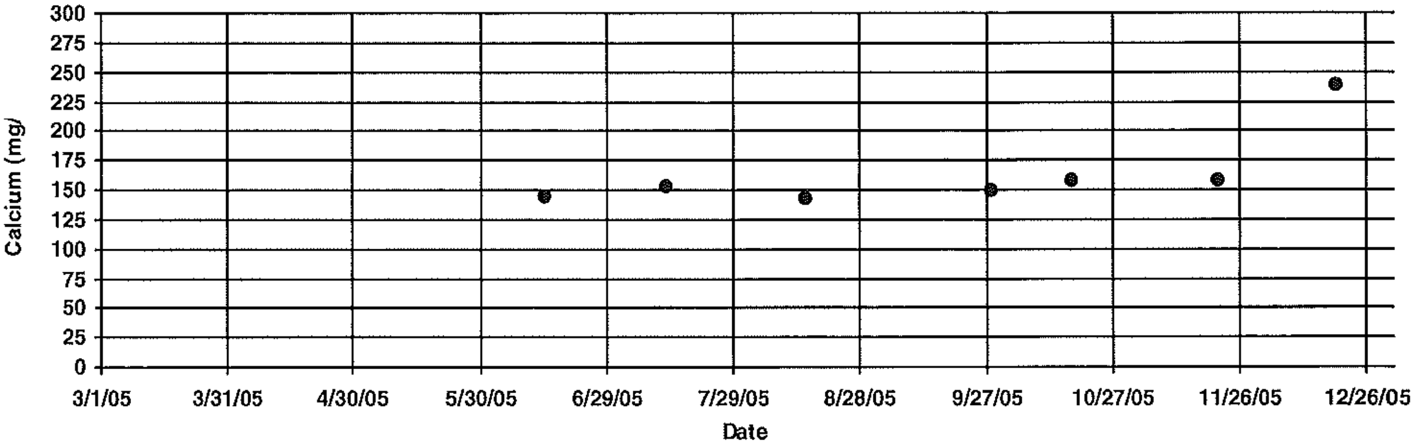


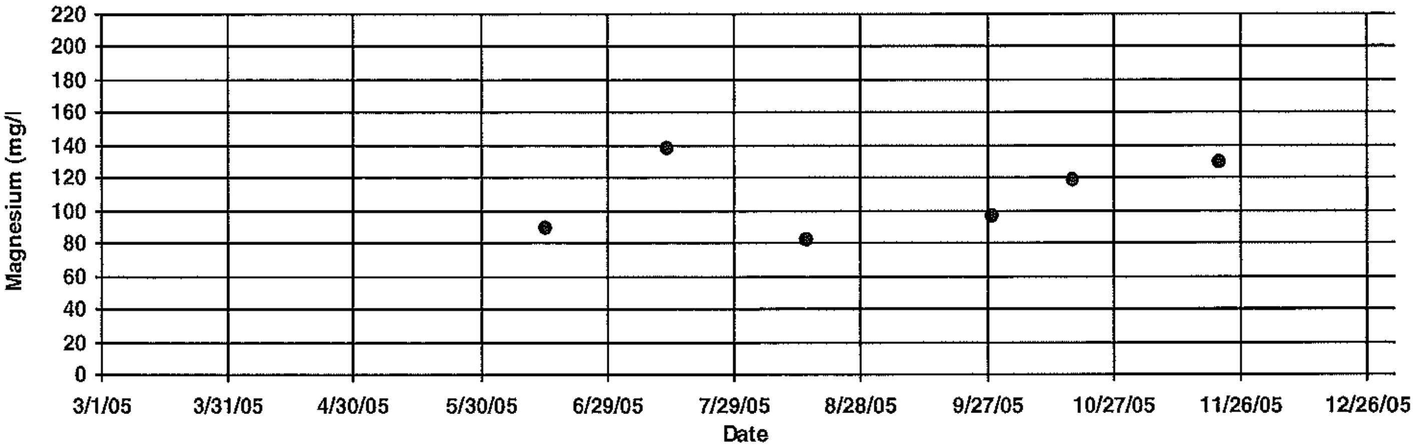


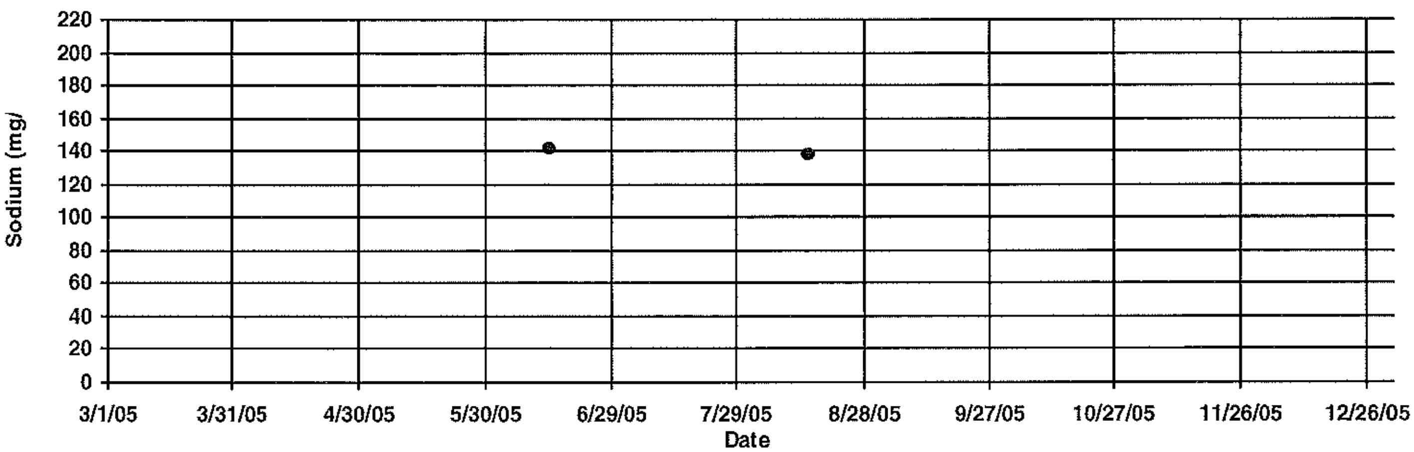
APPENDIX D
GENERAL MINERAL DATA GRAPHS

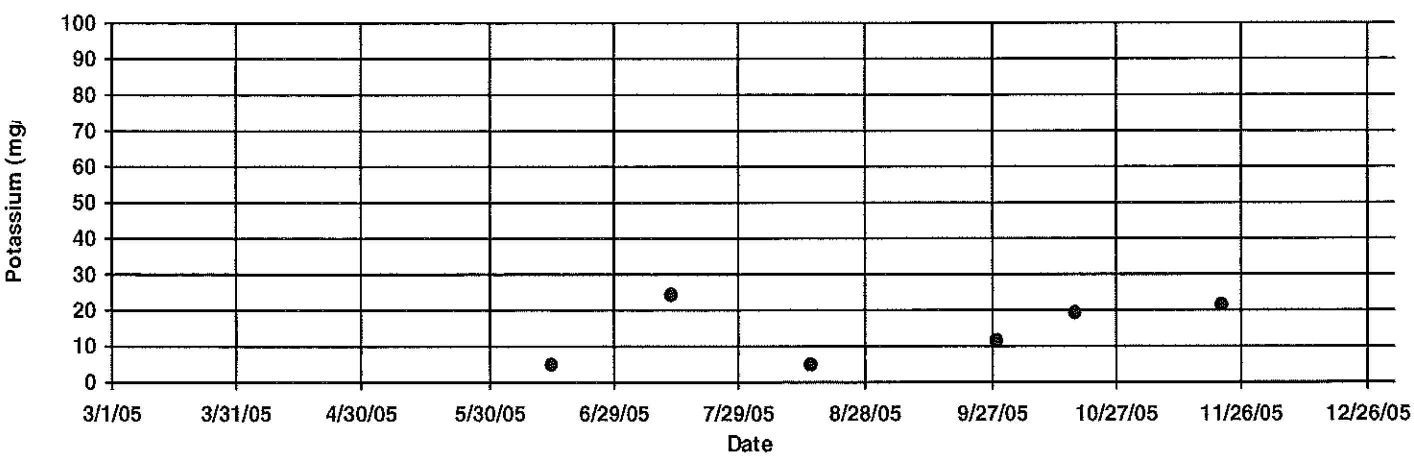
Study Site No. HG01 Topanga Lagoon Site No.: 301

GENERAL MINERAL DATA



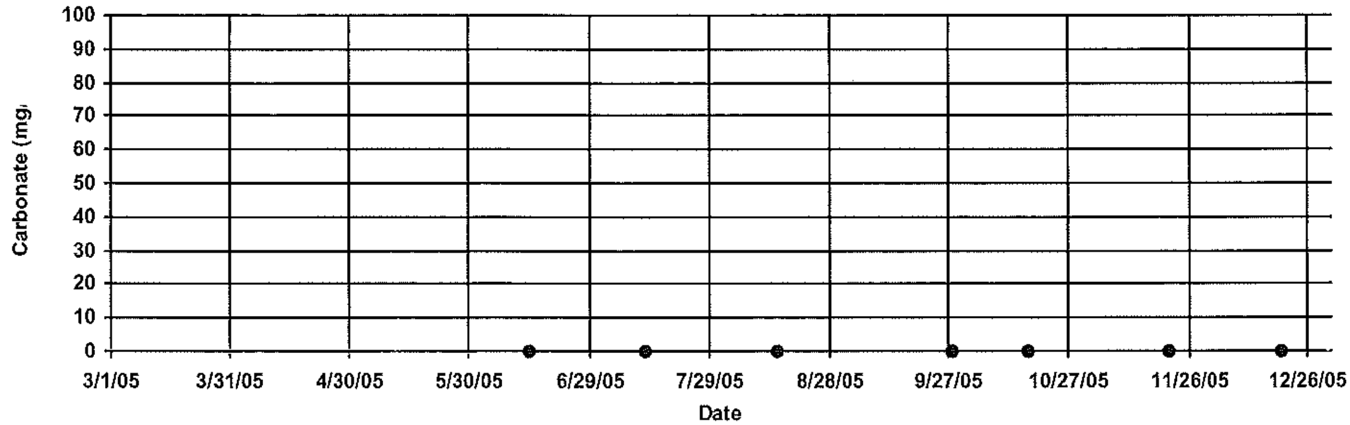


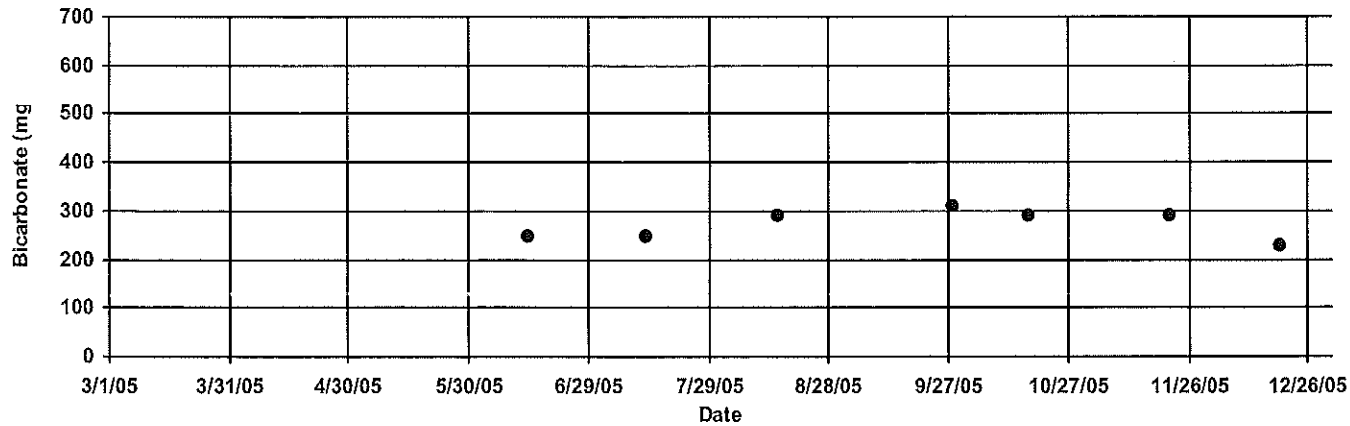


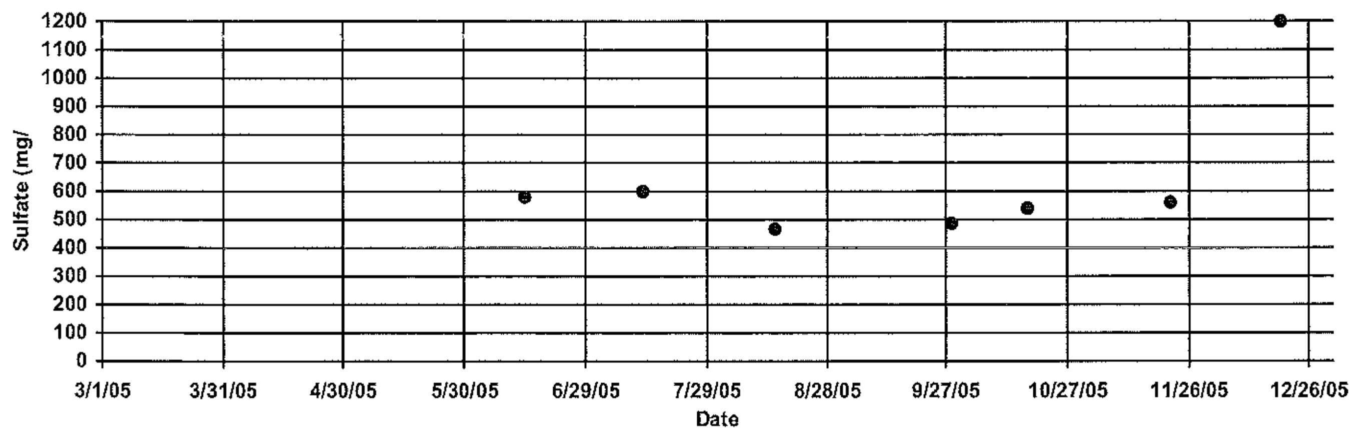


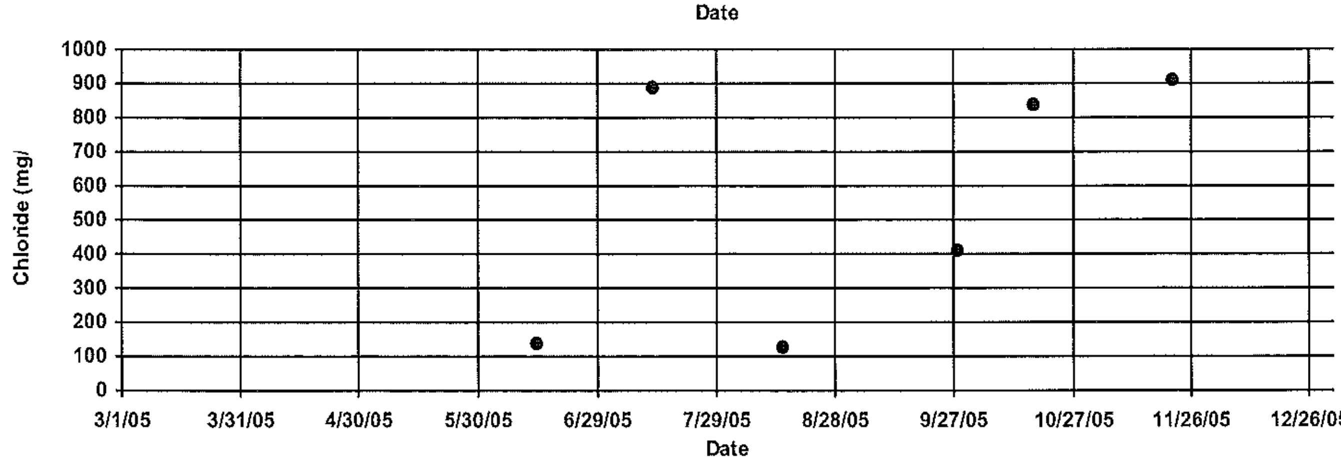
Study Site No. HG01 Topanga Lagoon Site No.: 301

GENERAL MINERAL DATA









Study Site No. HG01 Topanga Lagoon Site No.: 301

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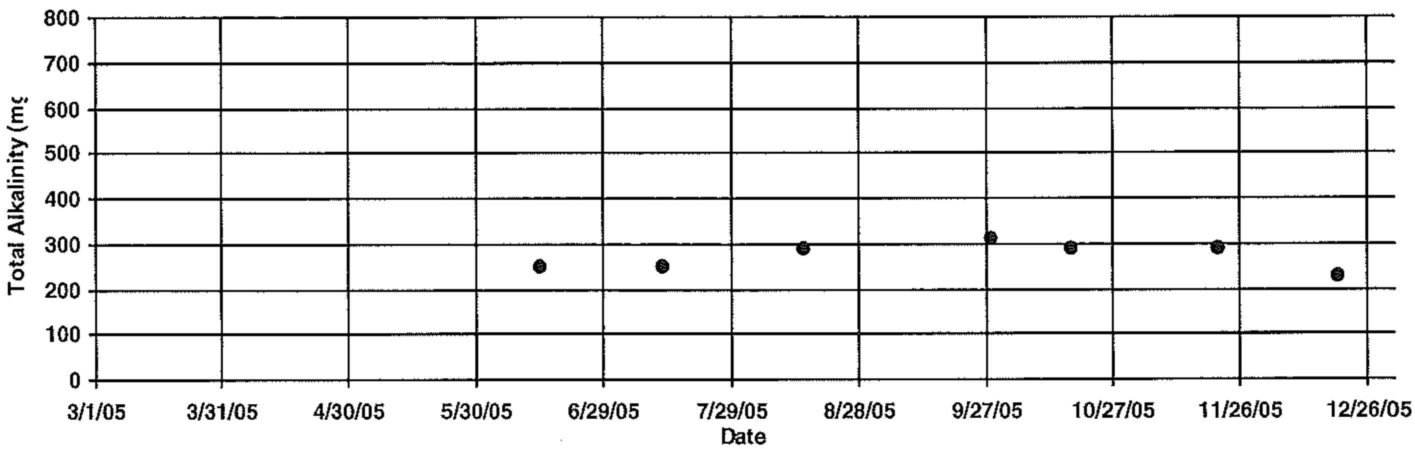
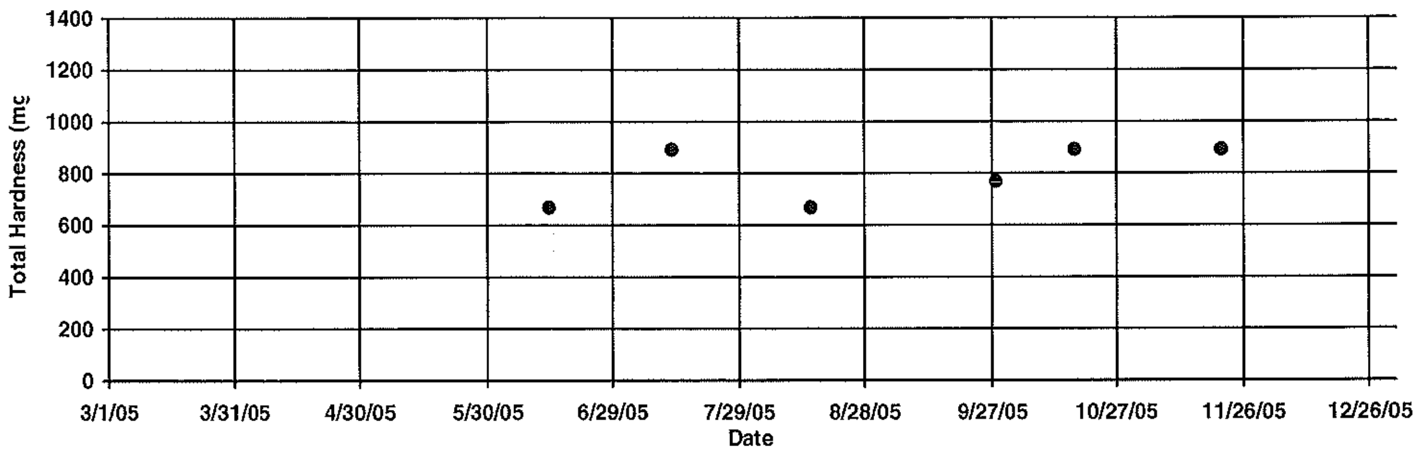
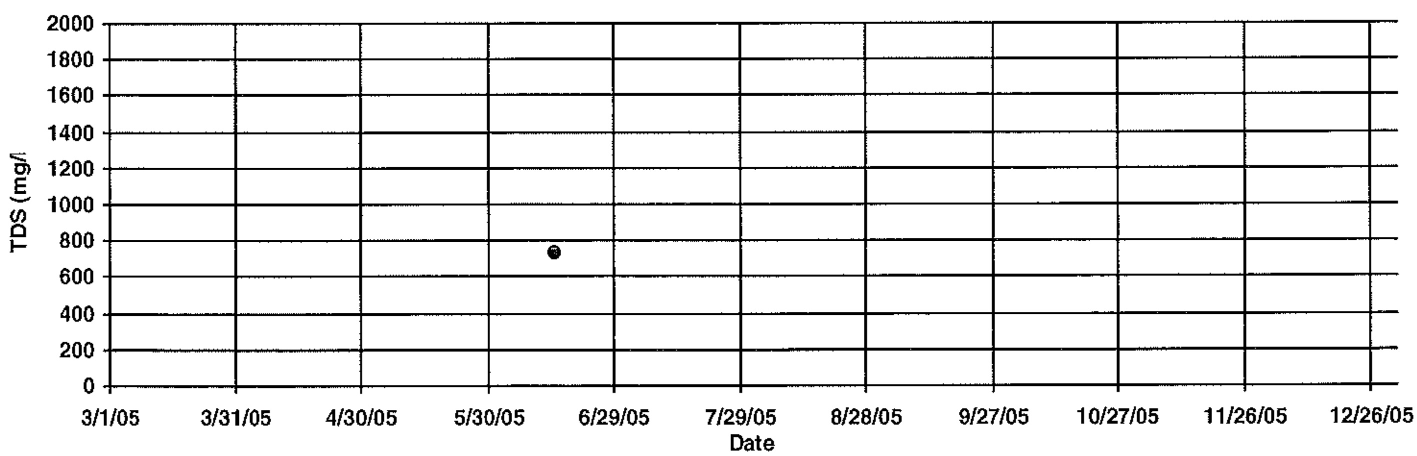
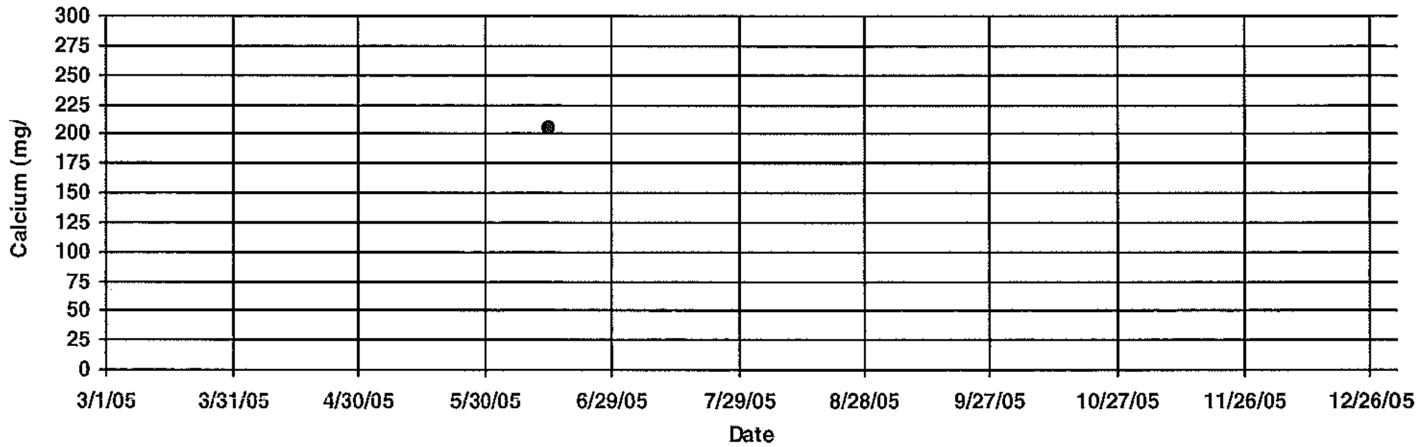


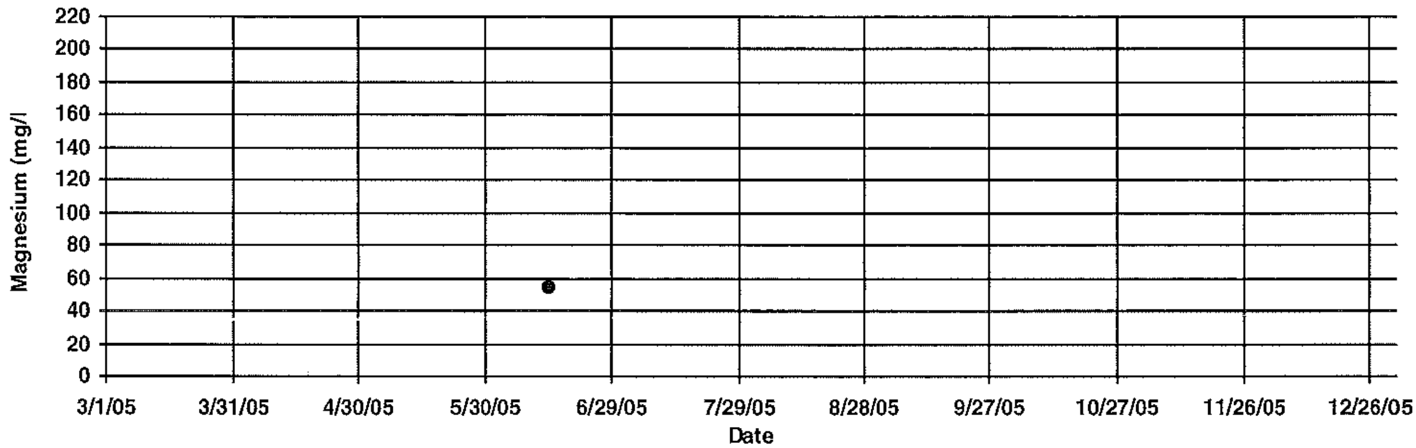


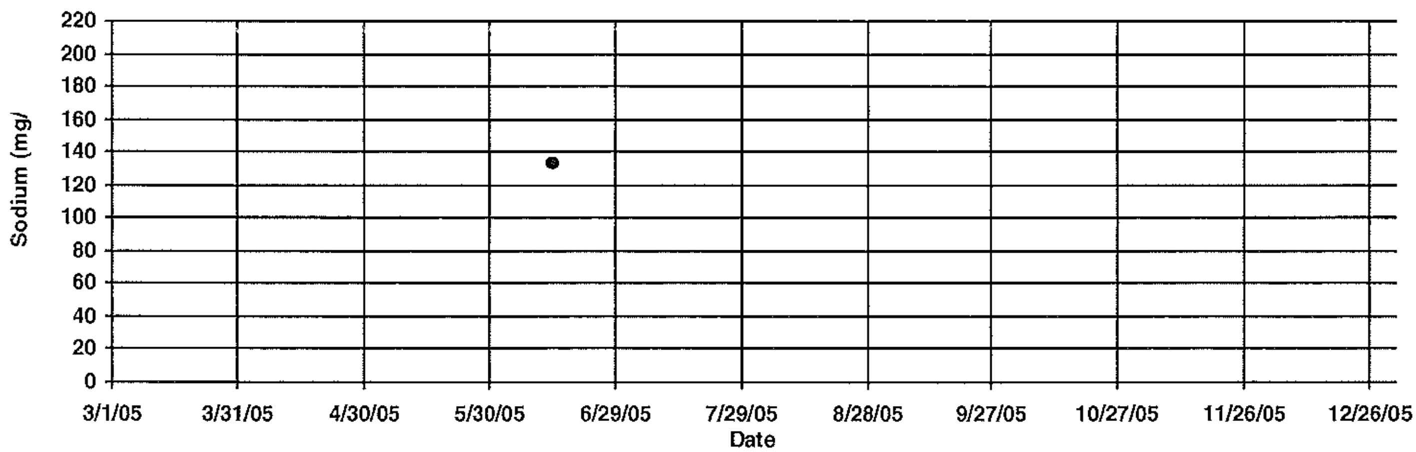


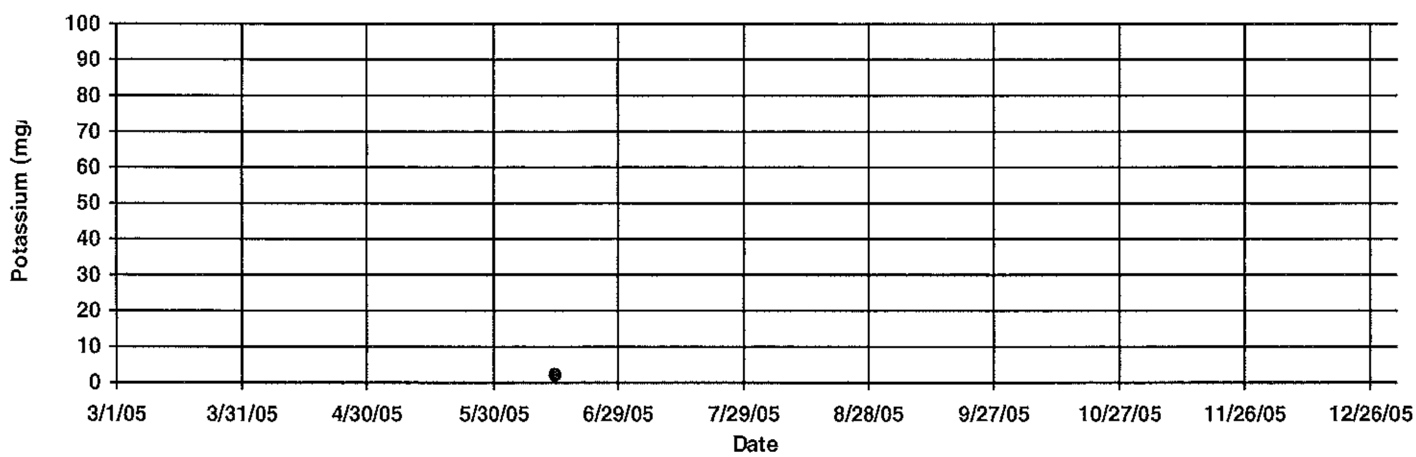
Study Site No. HG02 MM 0.05 TC Blvd. Site No.: 1

GENERAL MINERAL DATA









Study Site No. HG02 MM 0.05 TC Blvd. Site No.: 1

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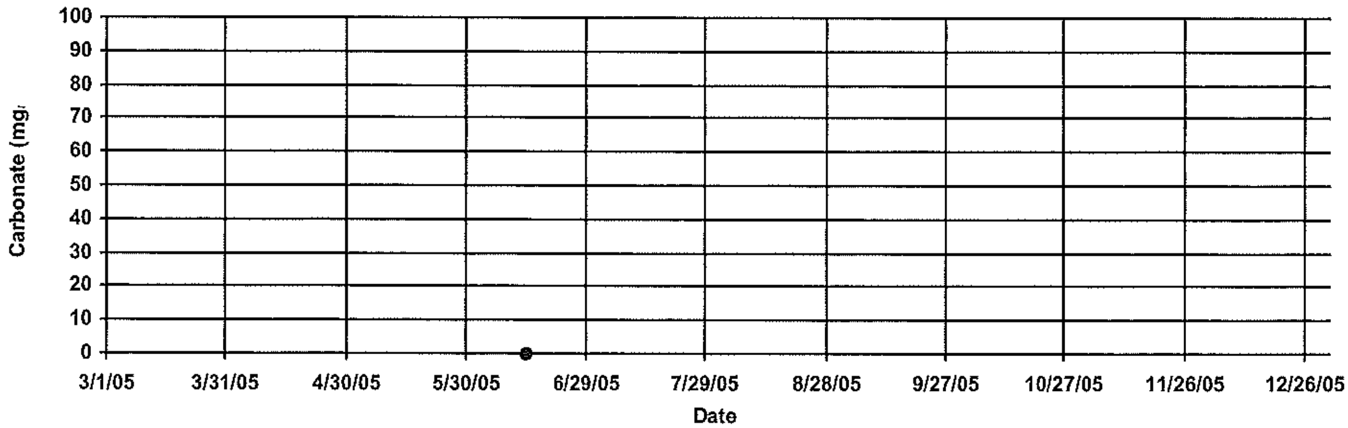

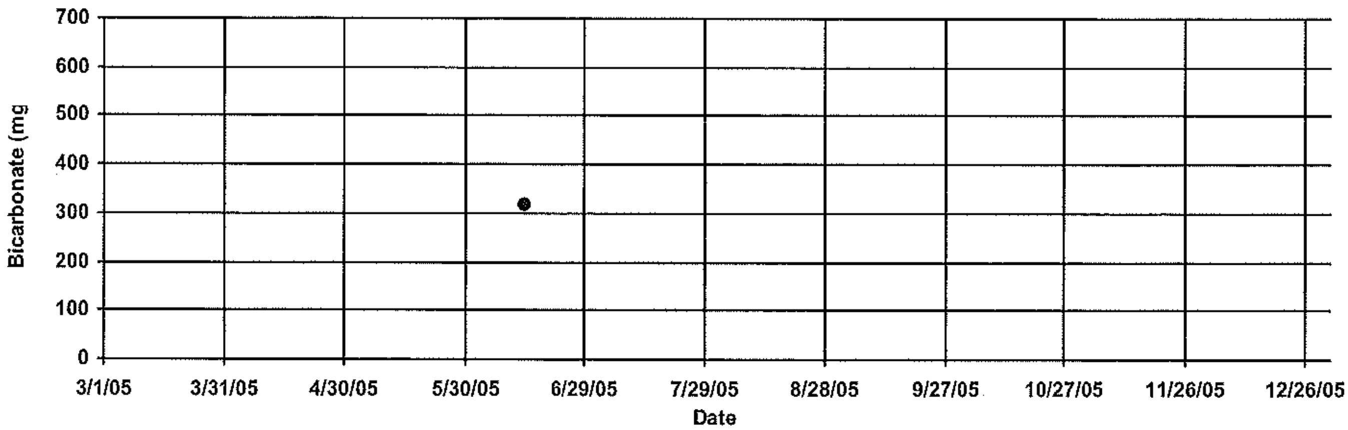

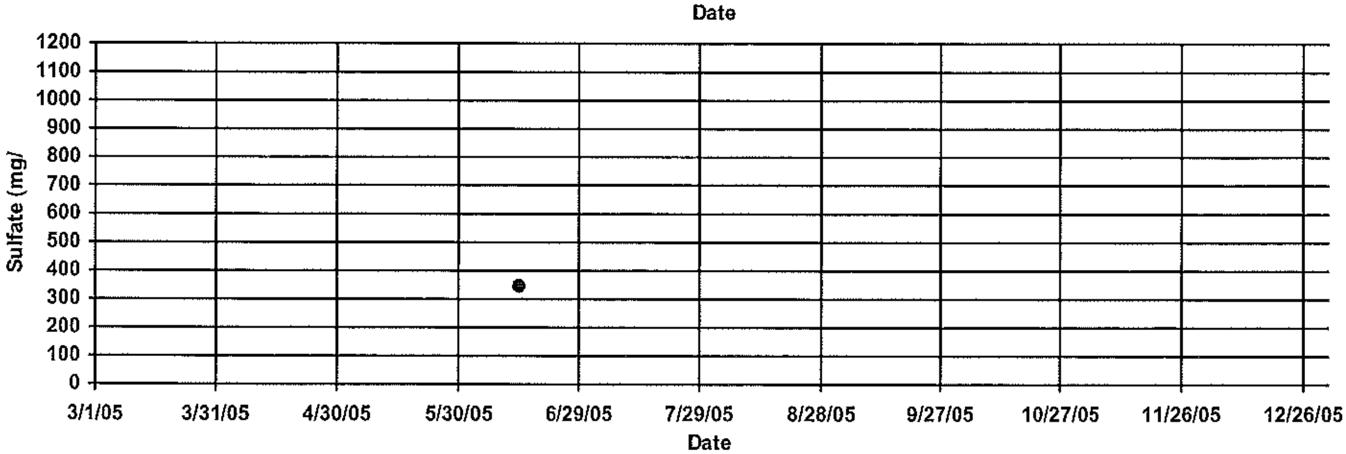

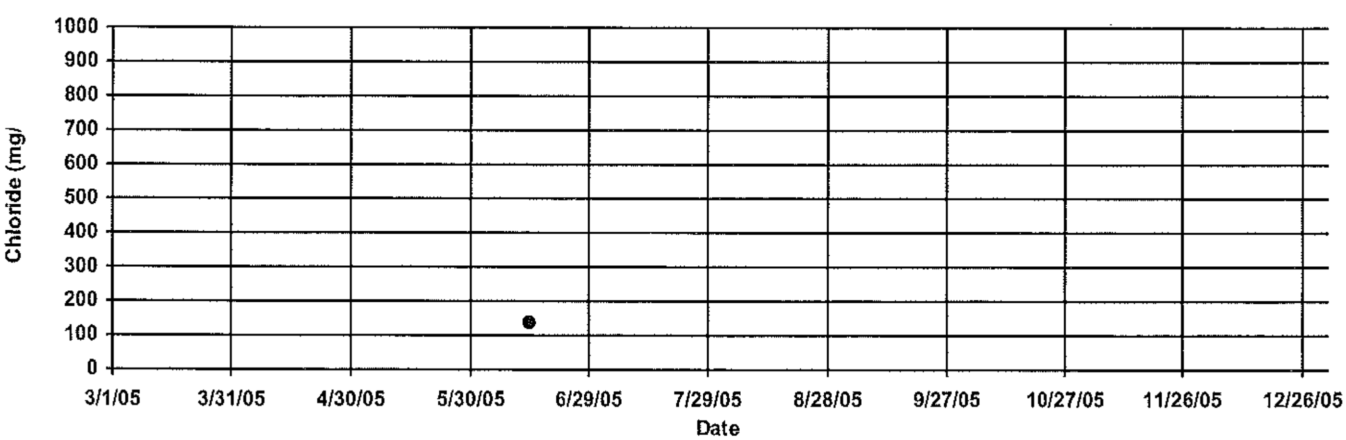

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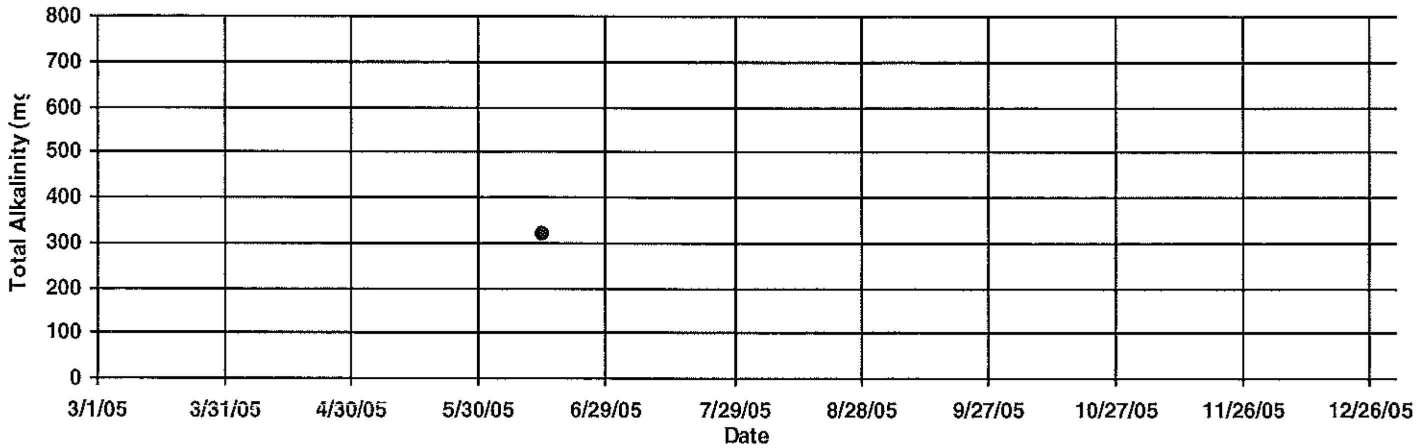
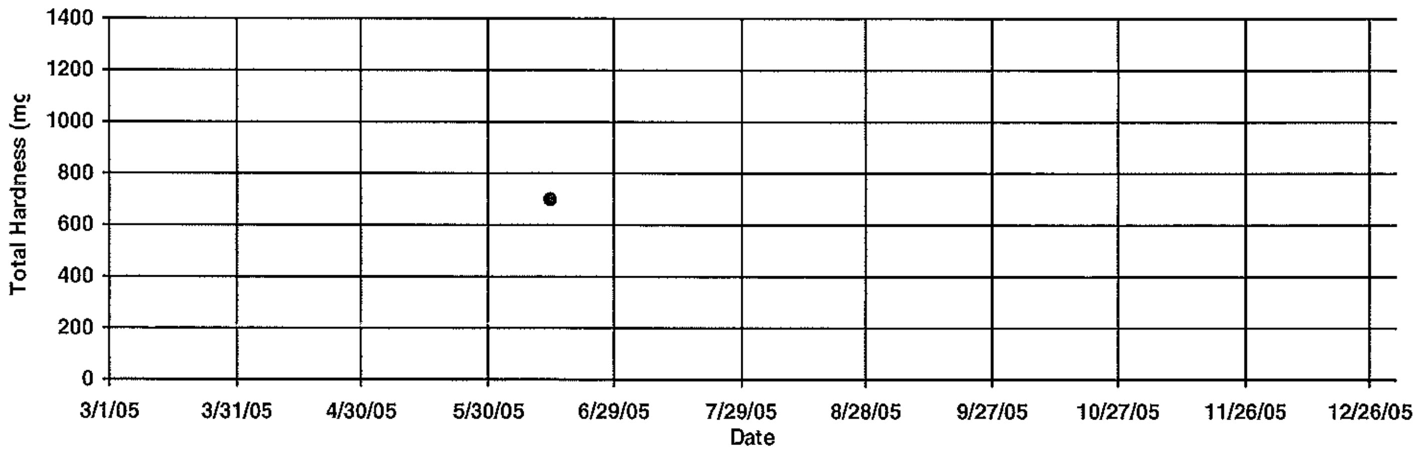
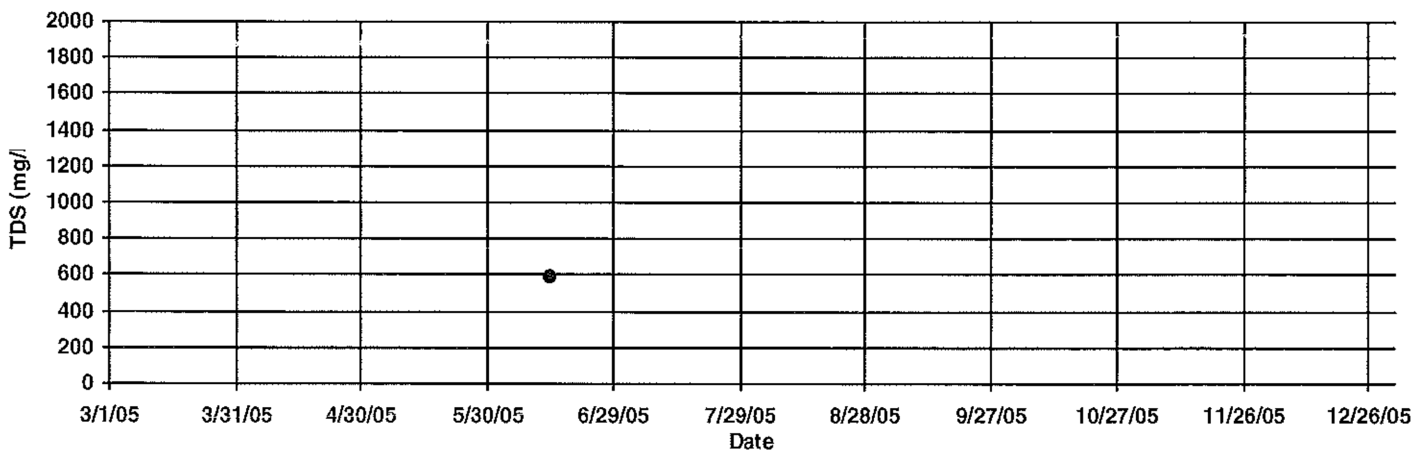
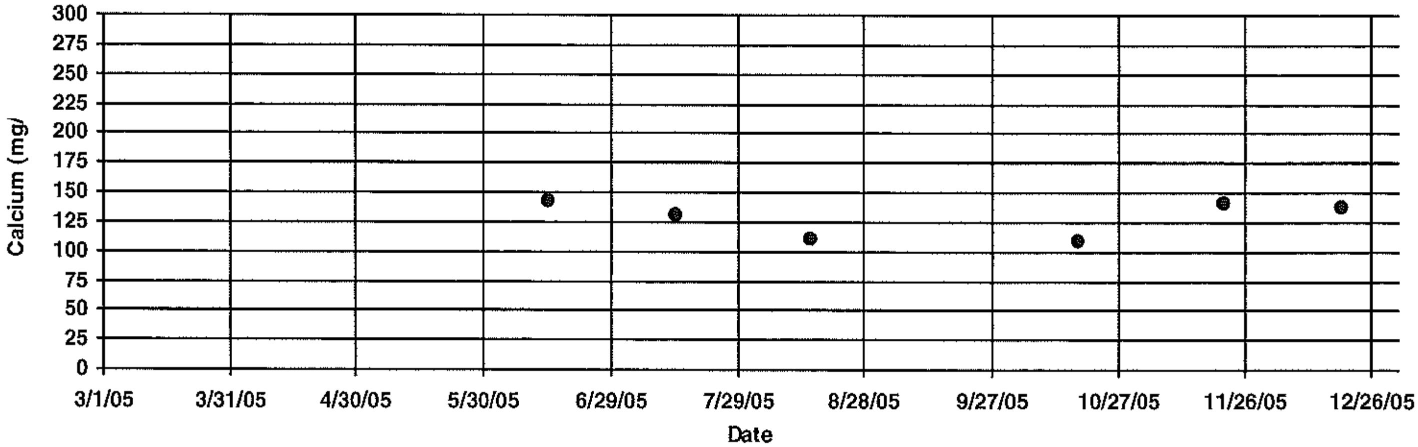


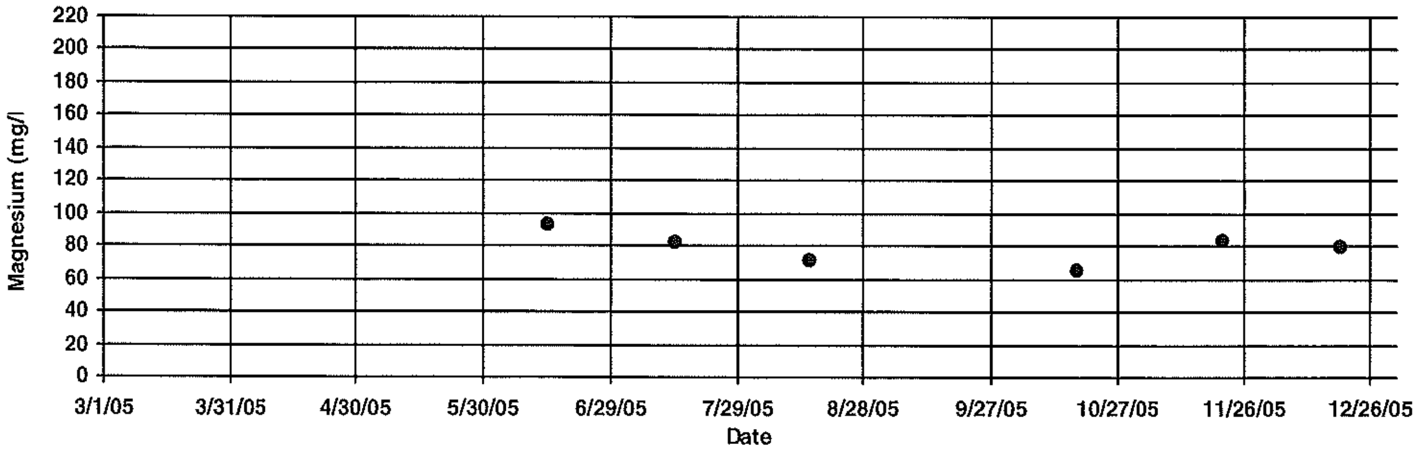


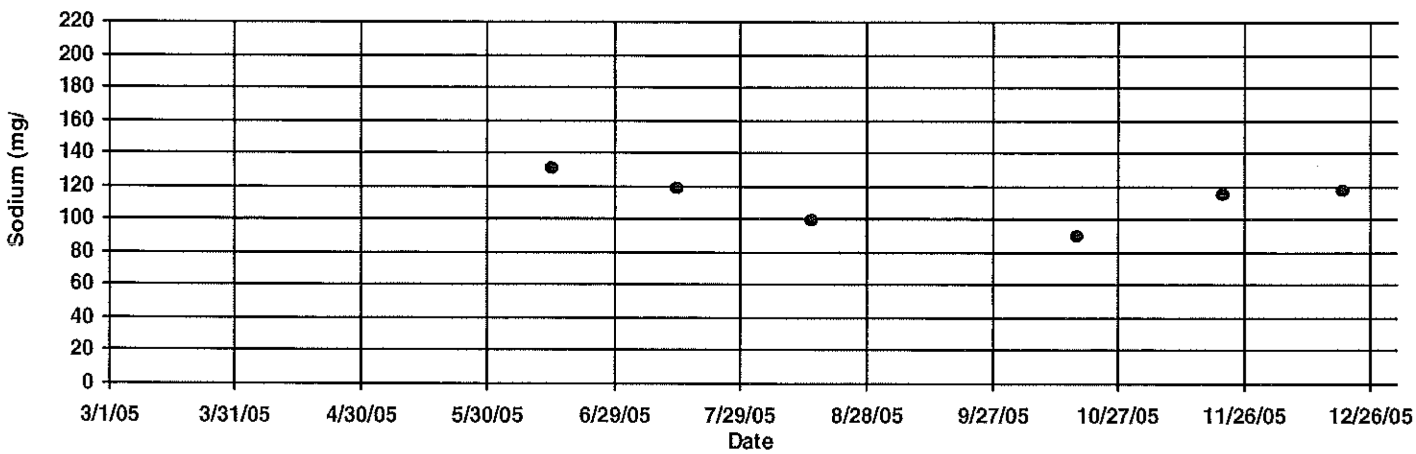


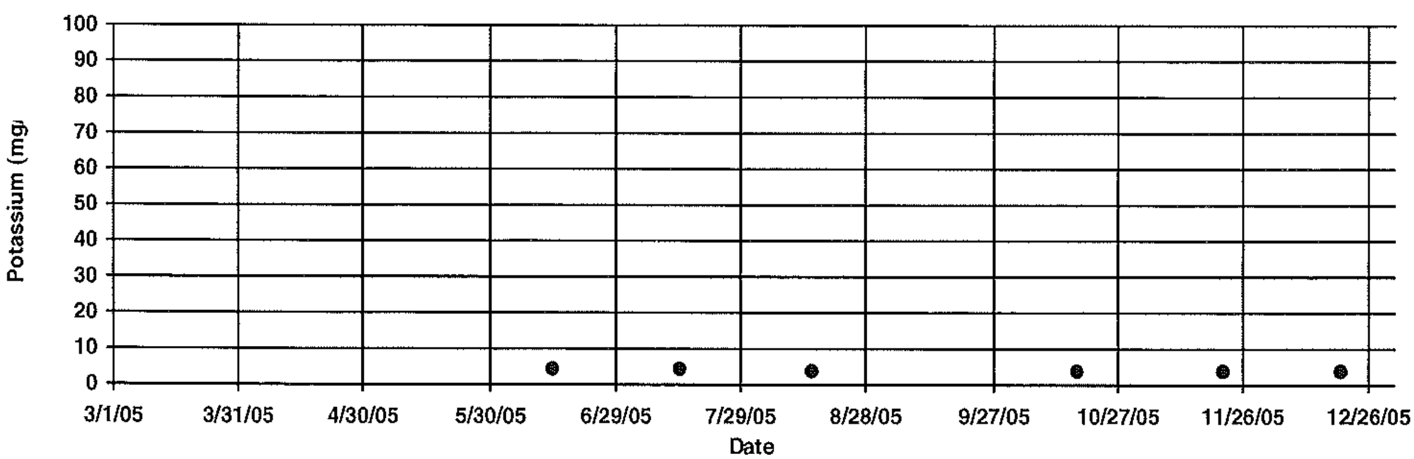
Study Site No. HG03 Transient Pool Site No.: 3

GENERAL MINERAL DATA









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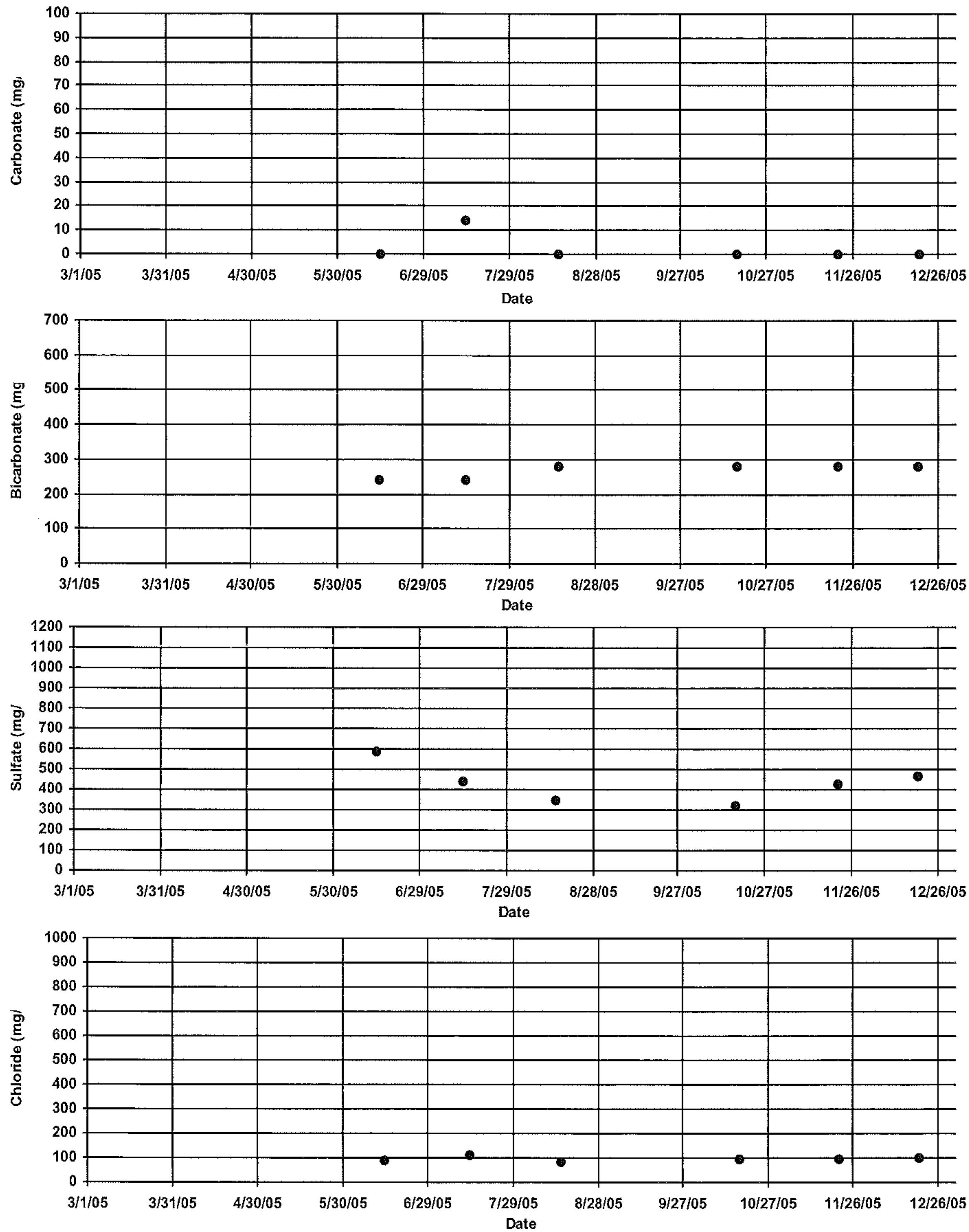

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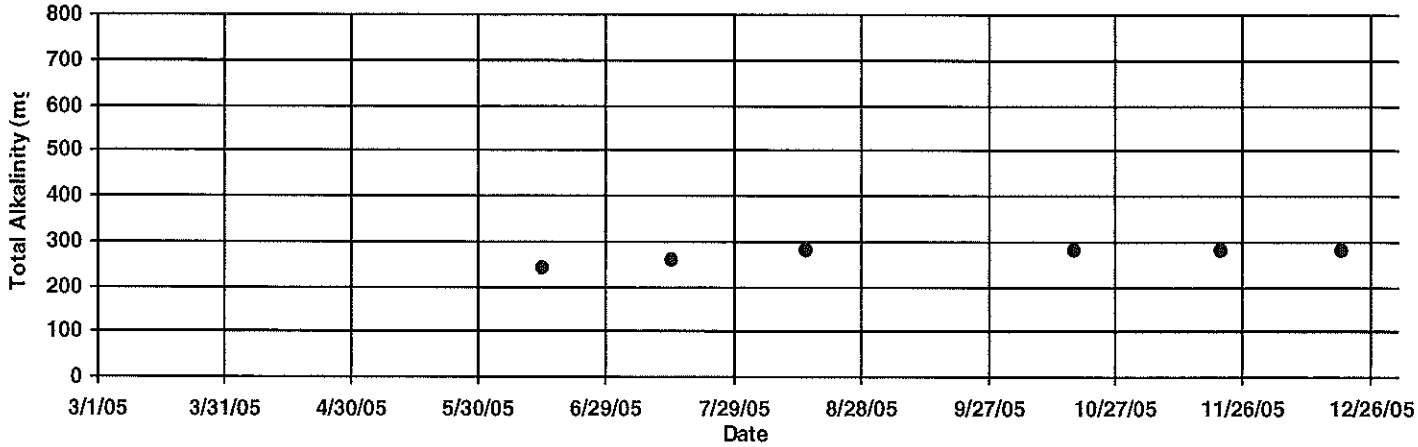
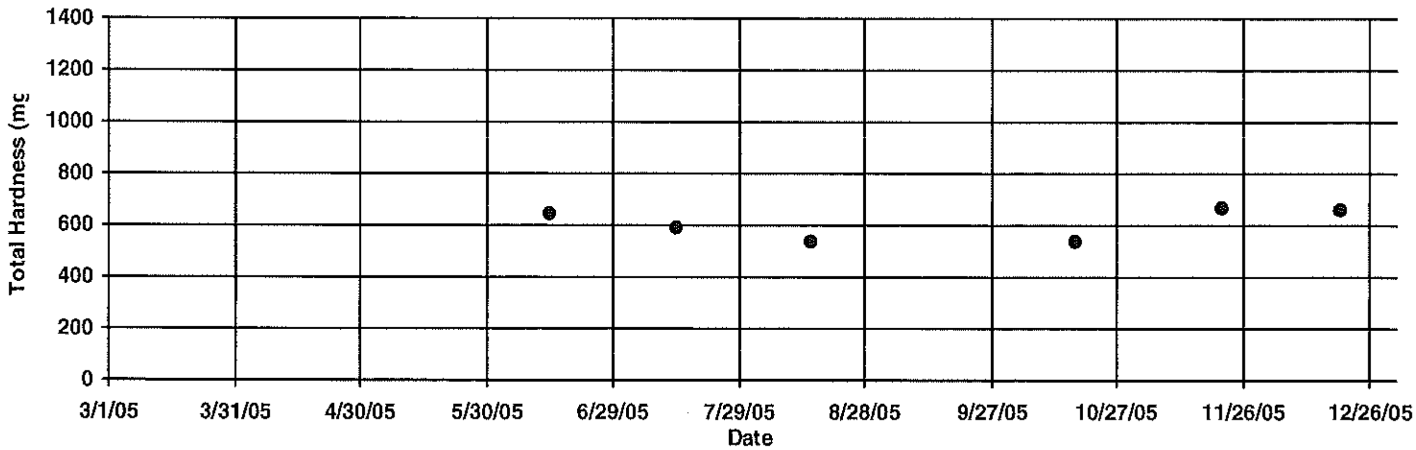
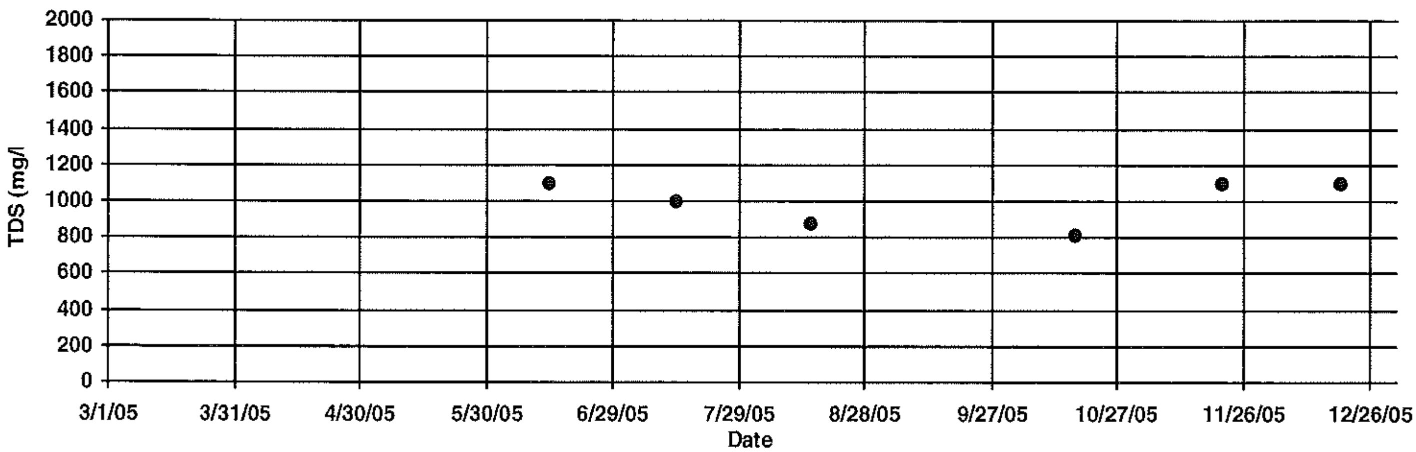
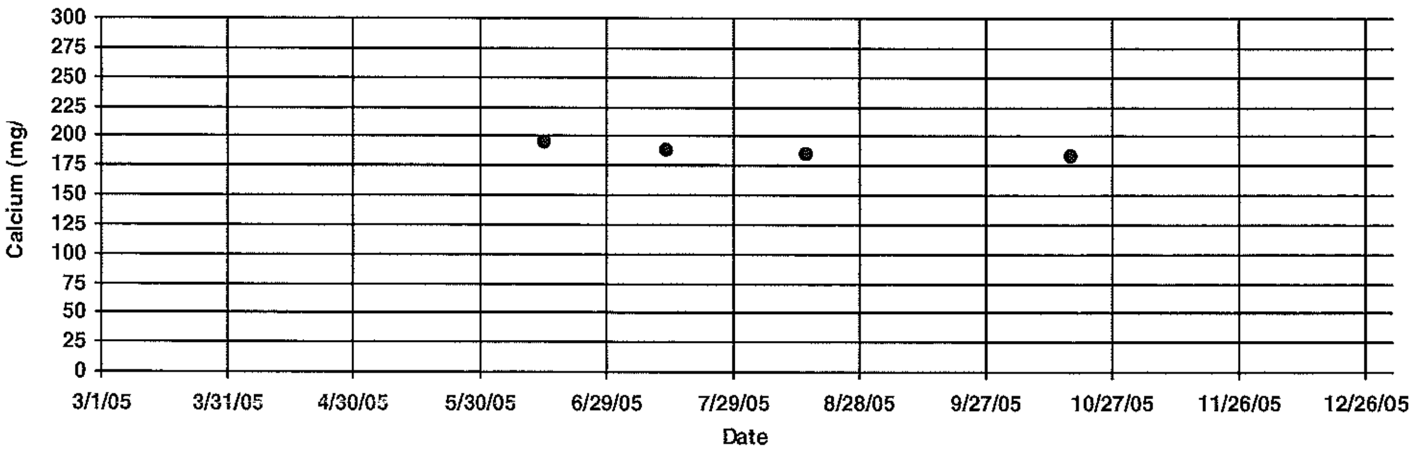


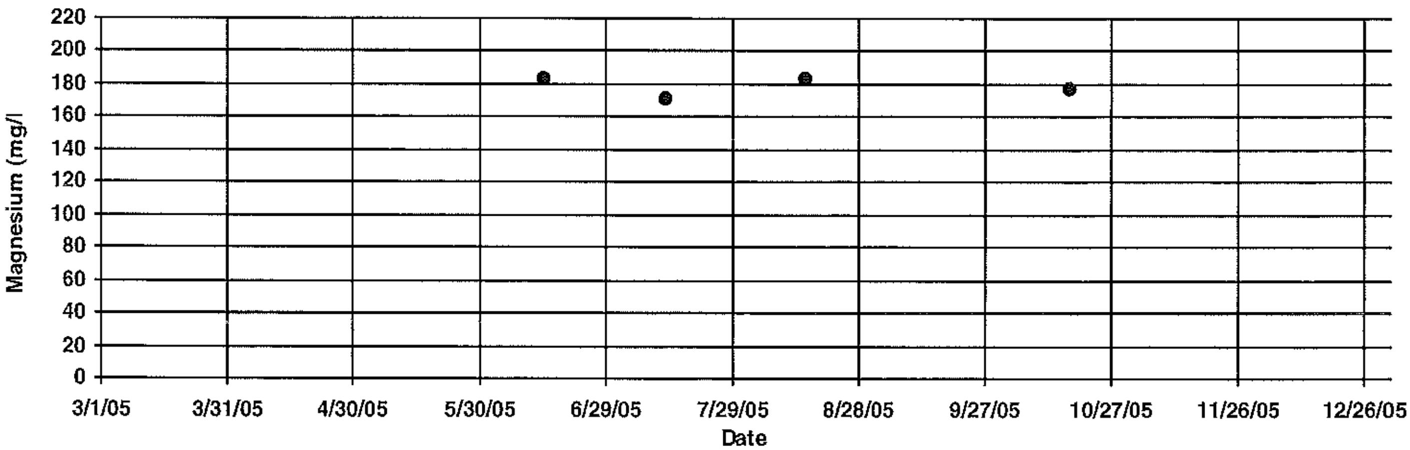


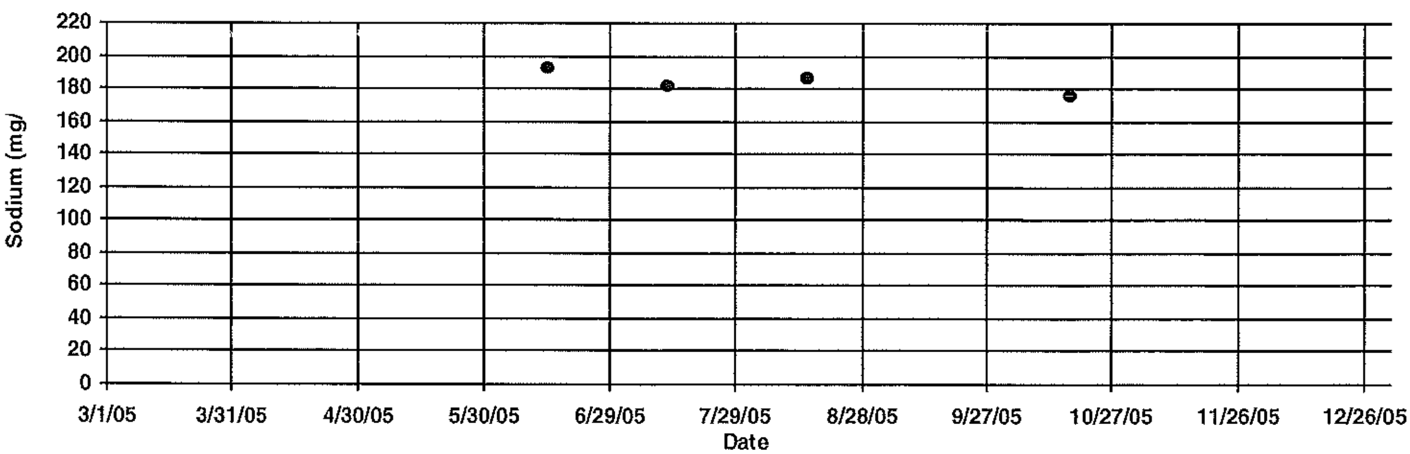


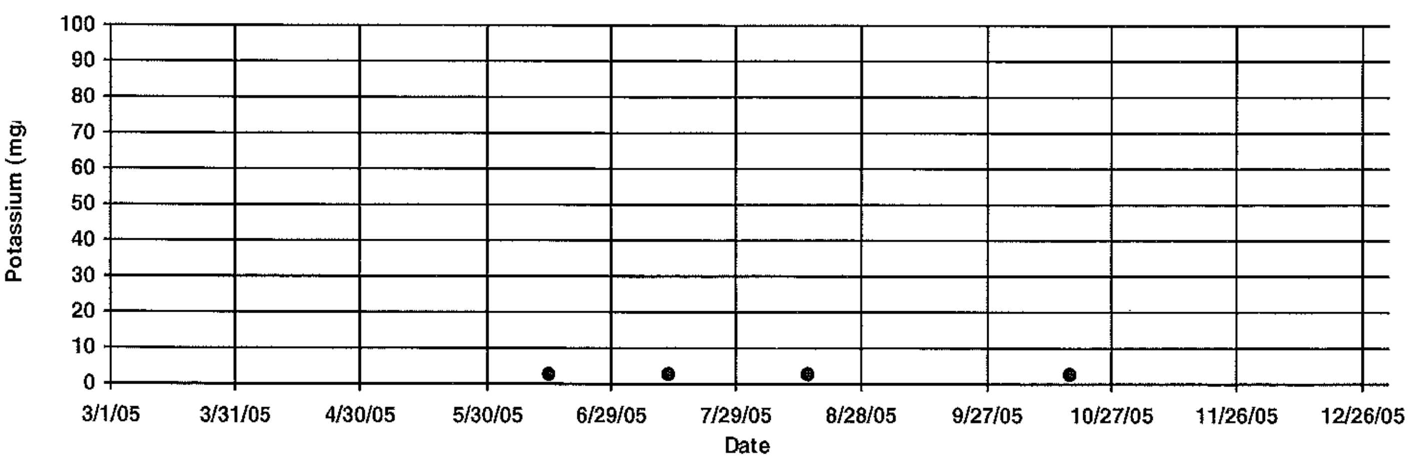
Study Site No. HG05 Green House Culvert Site No.: 4

GENERAL MINERAL DATA









Study Site No. HG05 Green House Culvert Site No.: 4

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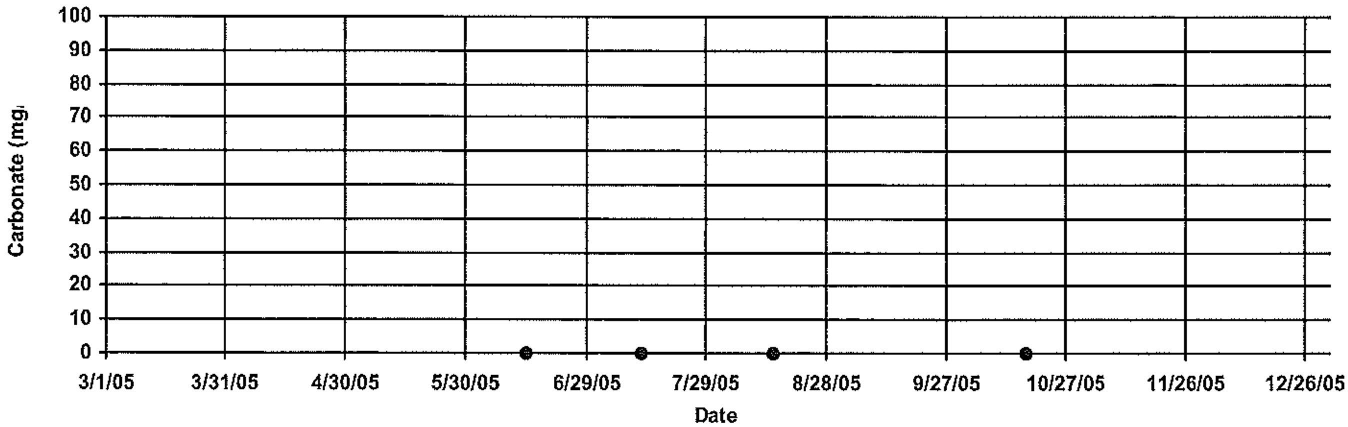
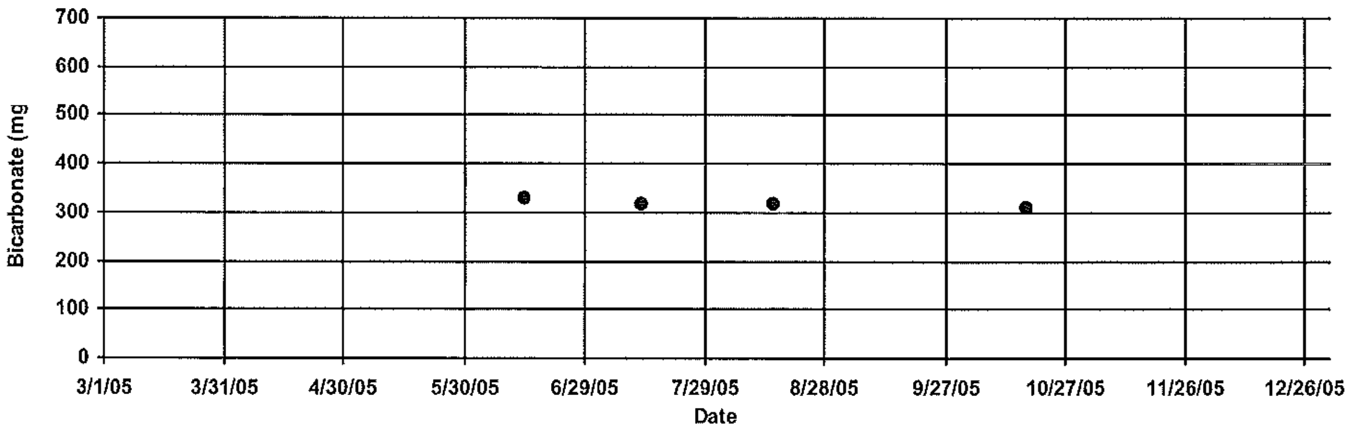
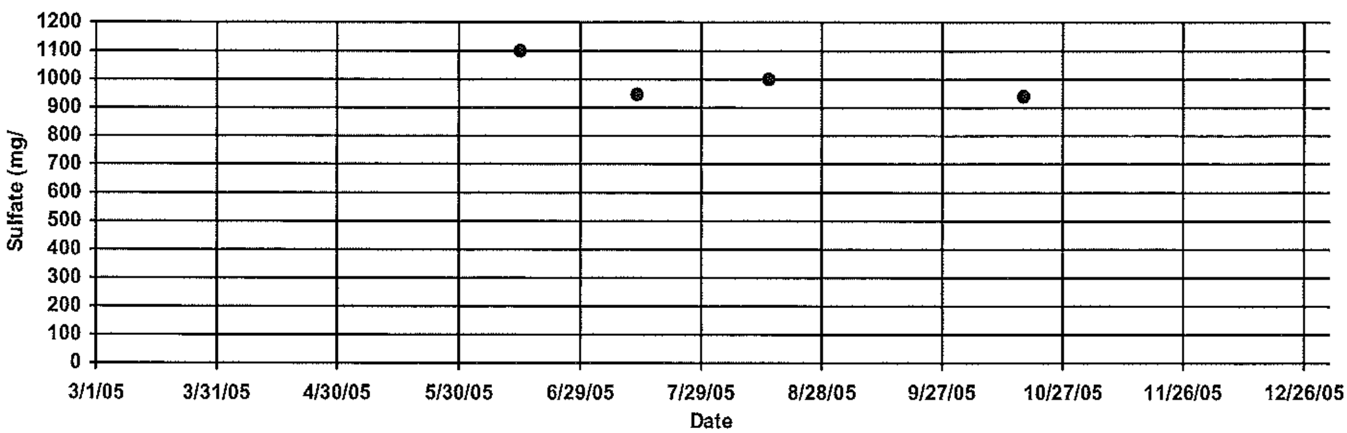
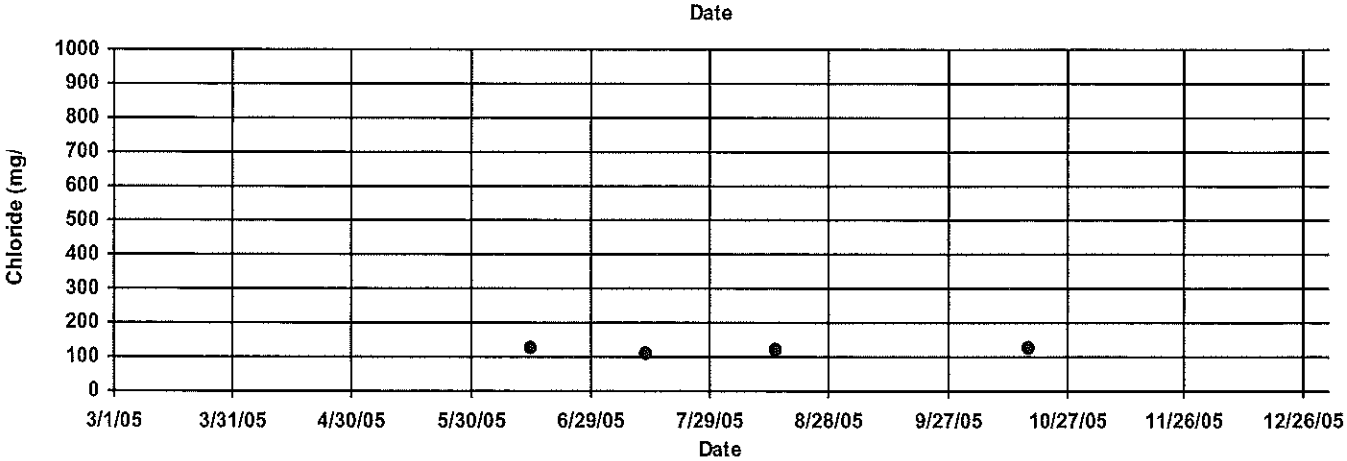


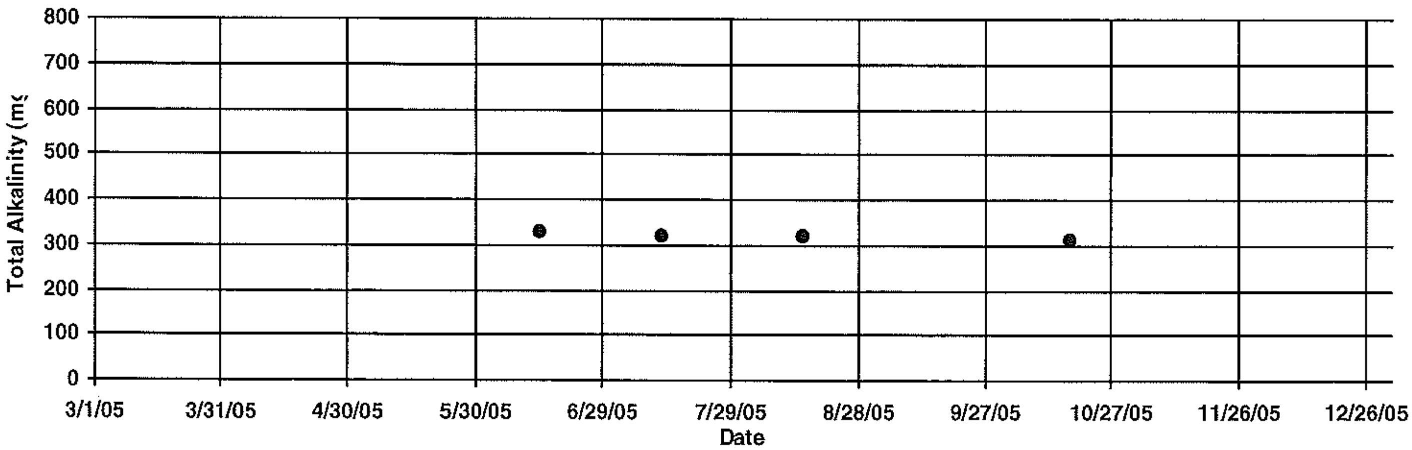


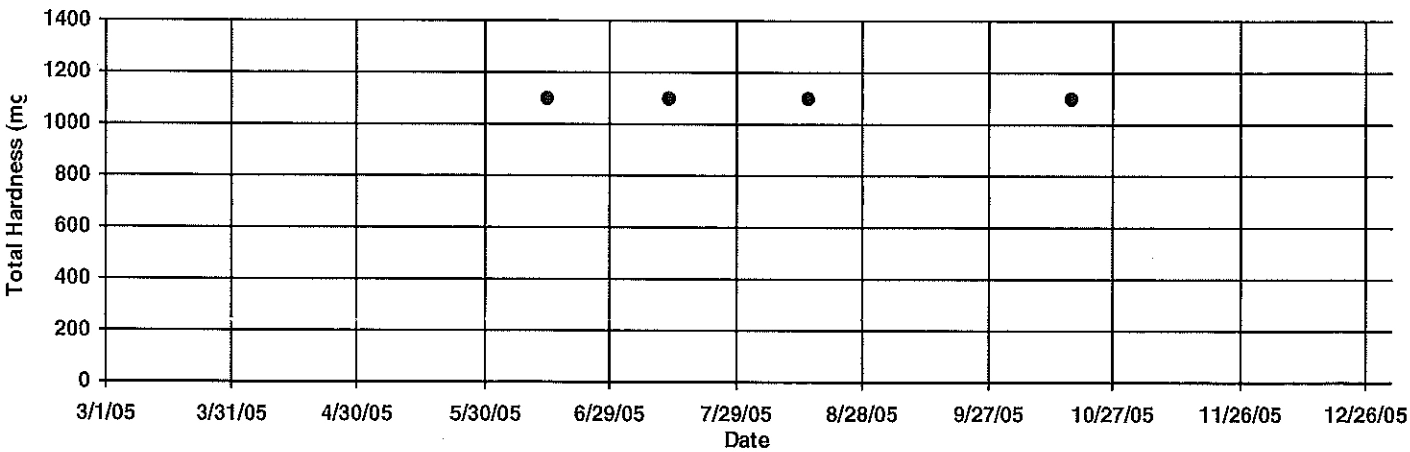


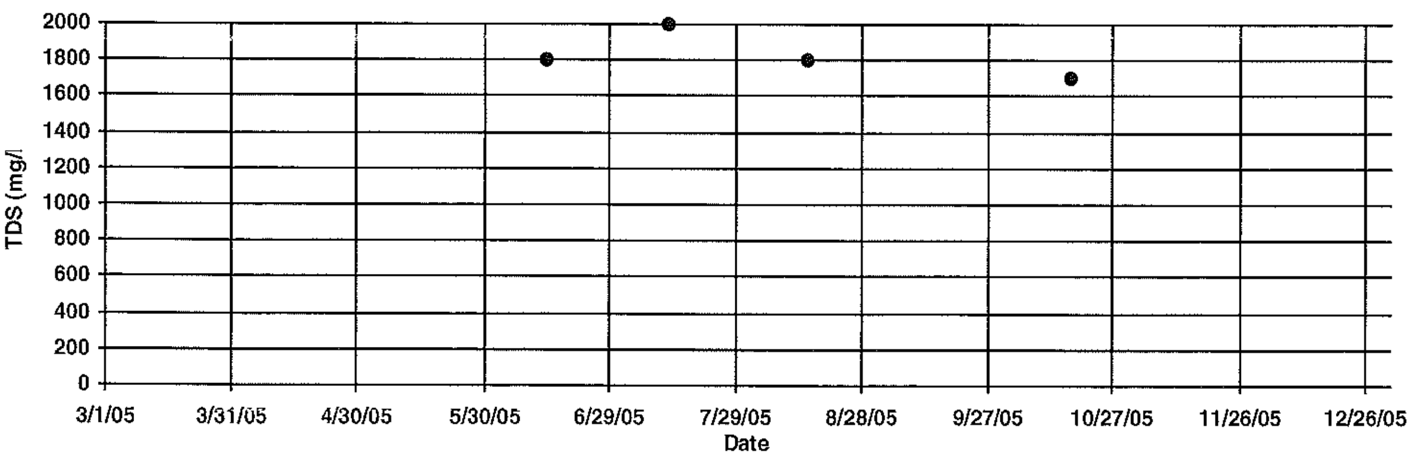


Study Site No. HG05 Green House Culvert Site No.: 4

GENERAL MINERAL DATA







Study Site No. HG06 Culvert inlet E side Site No.: 8

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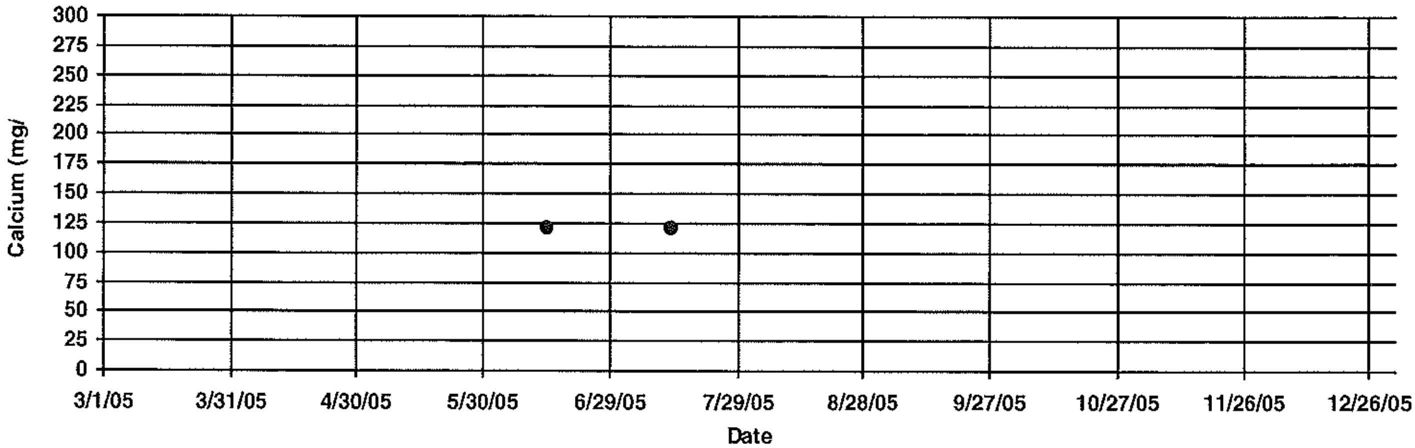

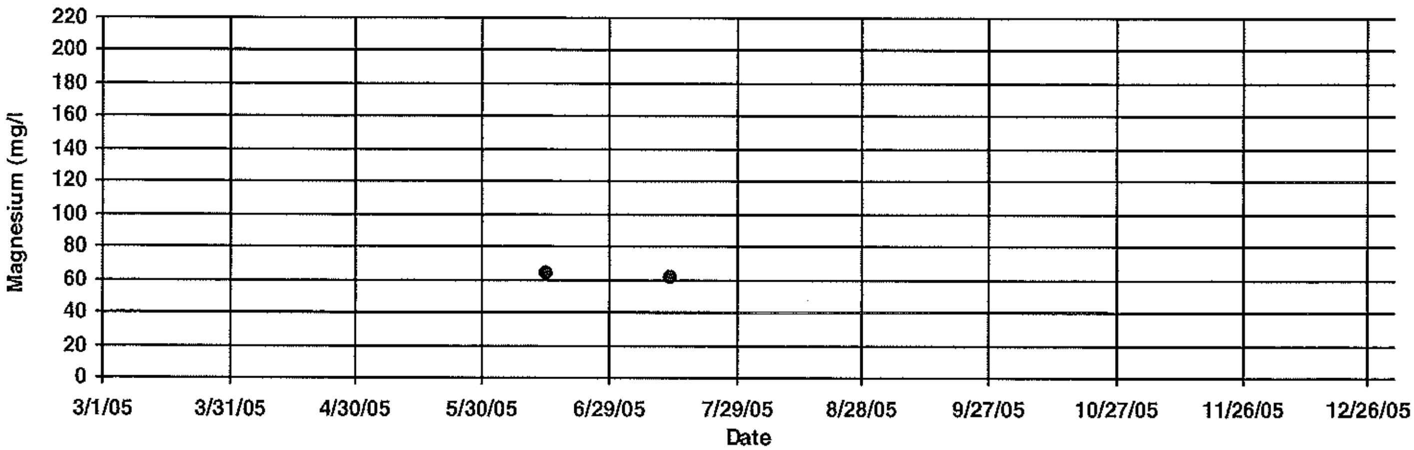

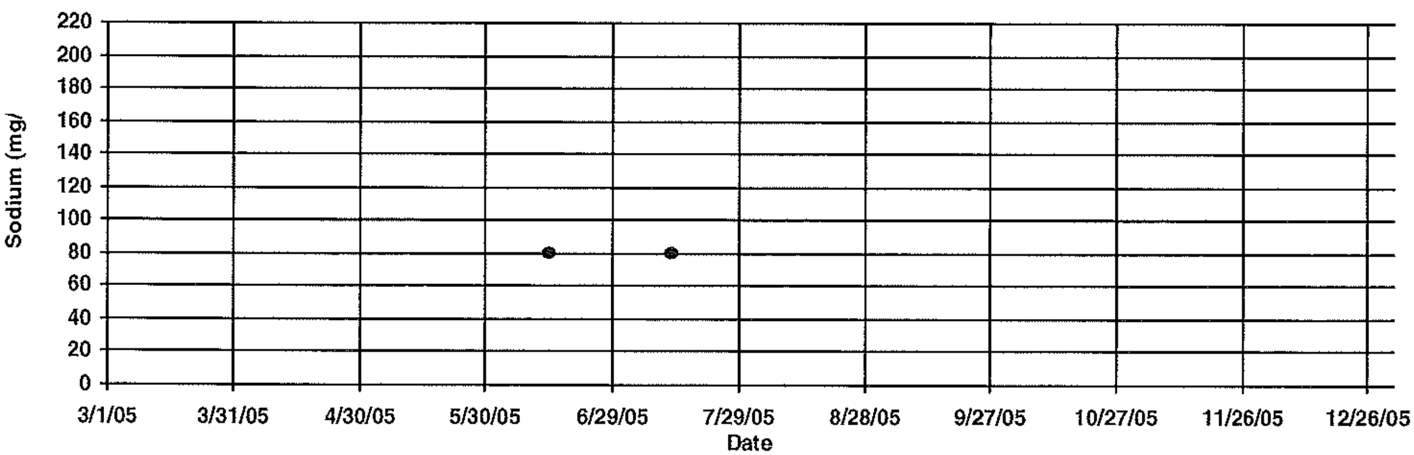

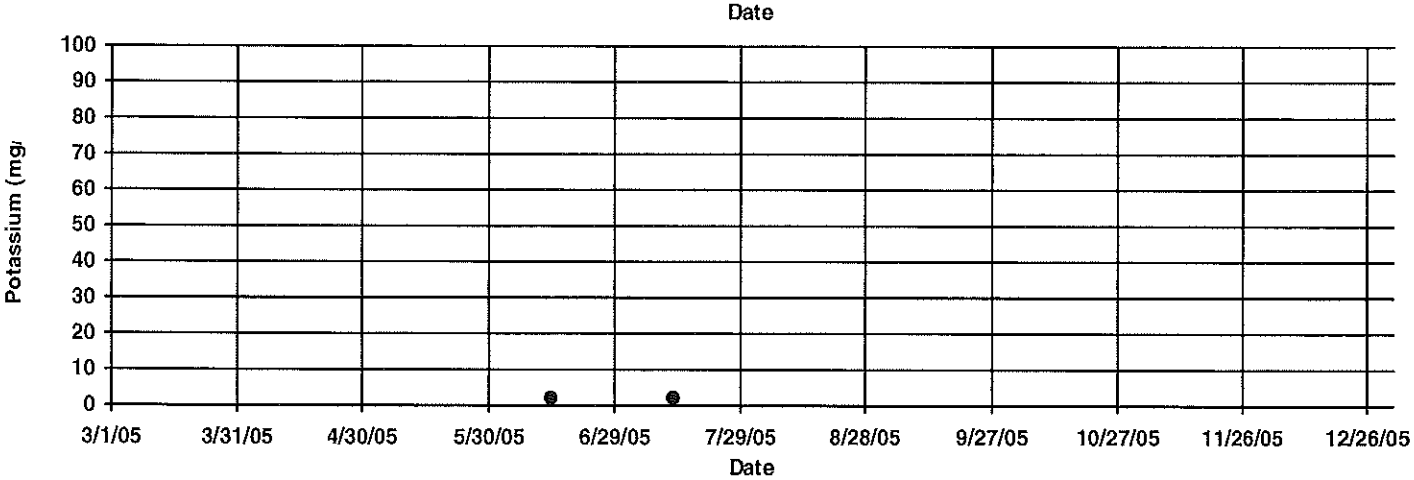

Study Site No. HG06 Culvert inlet E side Site No.: 8

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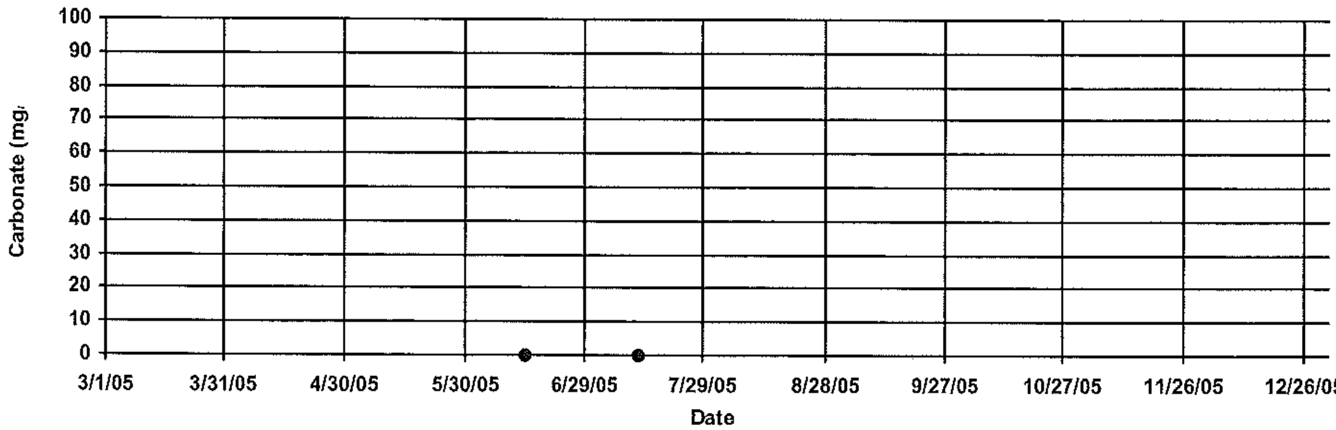

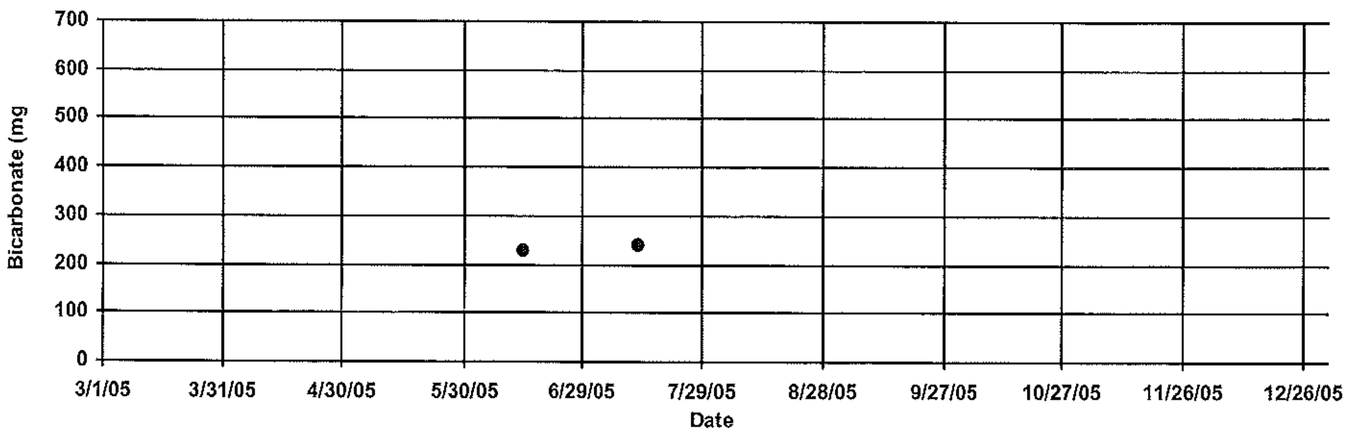

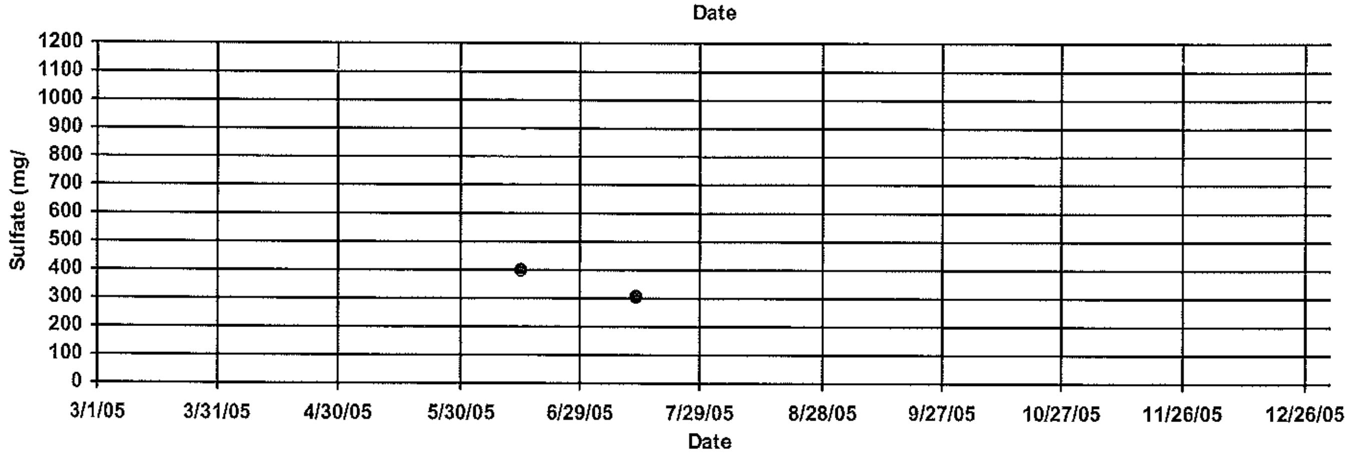

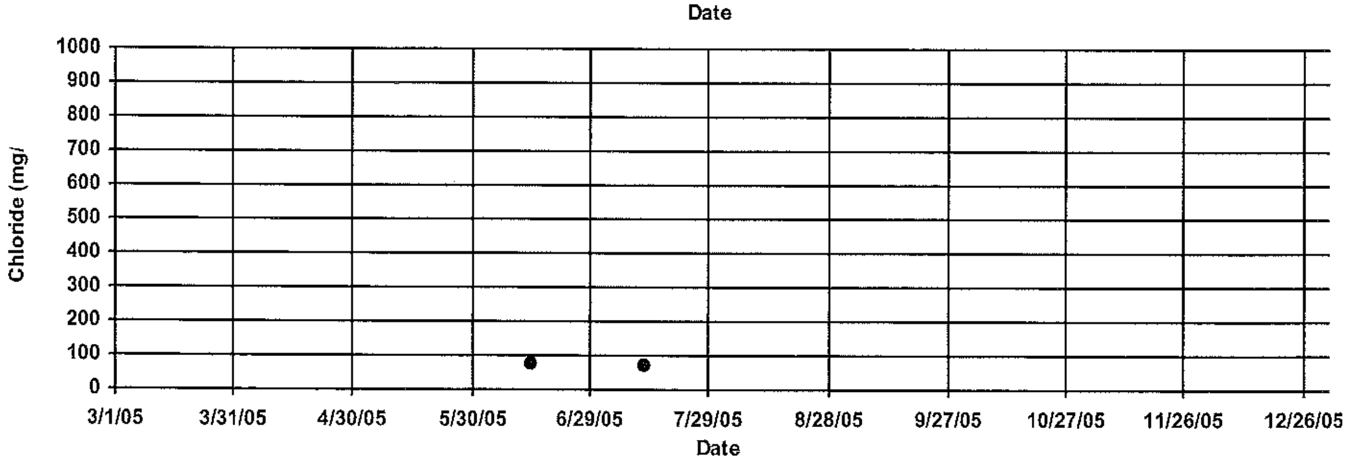

Study Site No. HG06 Culvert inlet E side Site No.: 8

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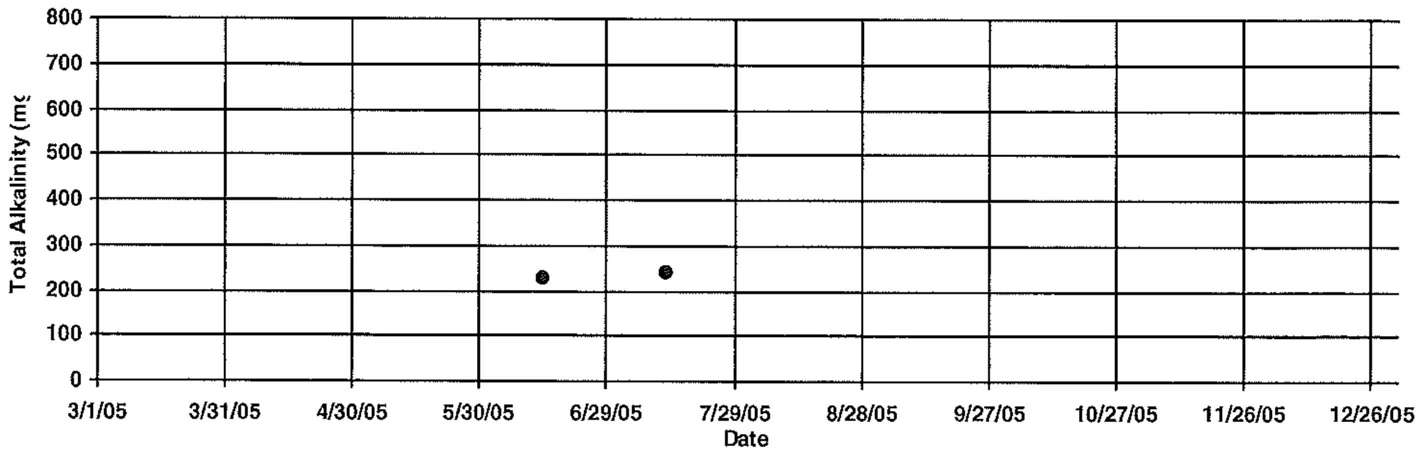
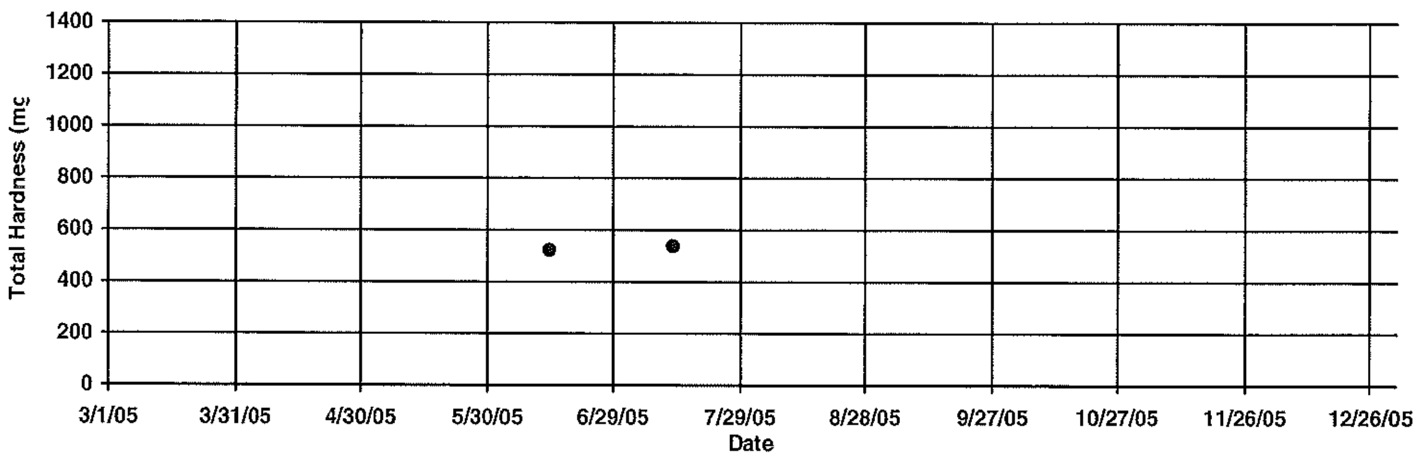
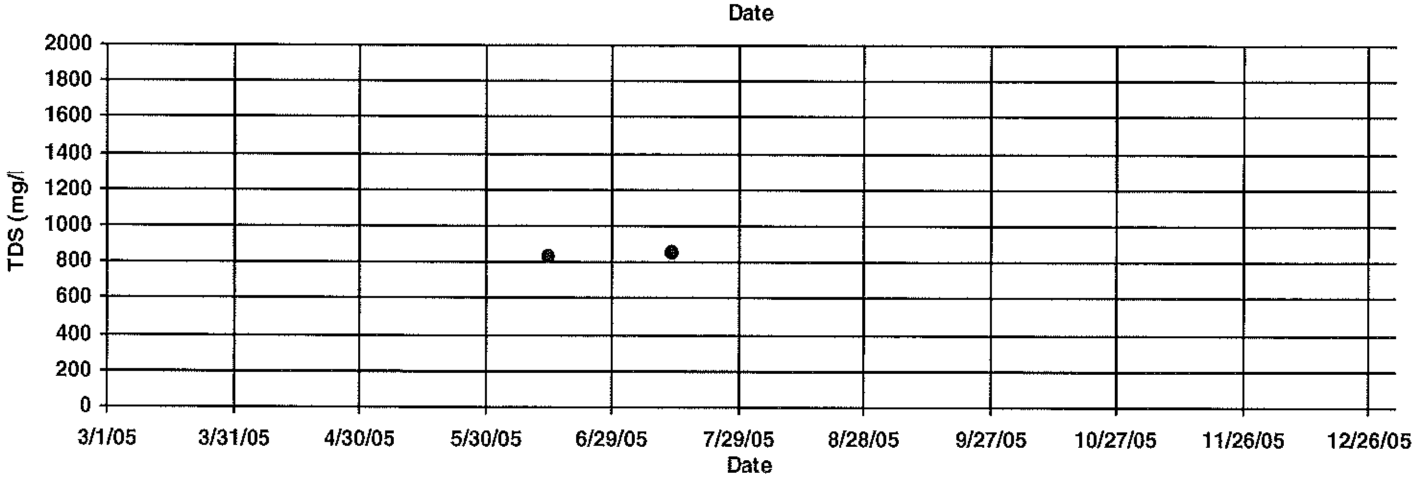
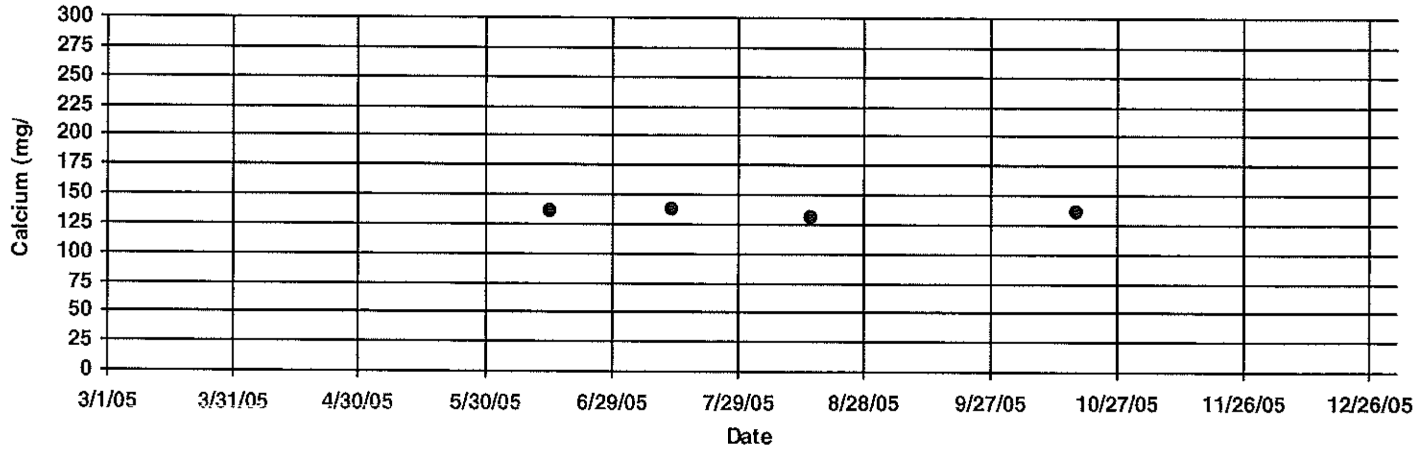


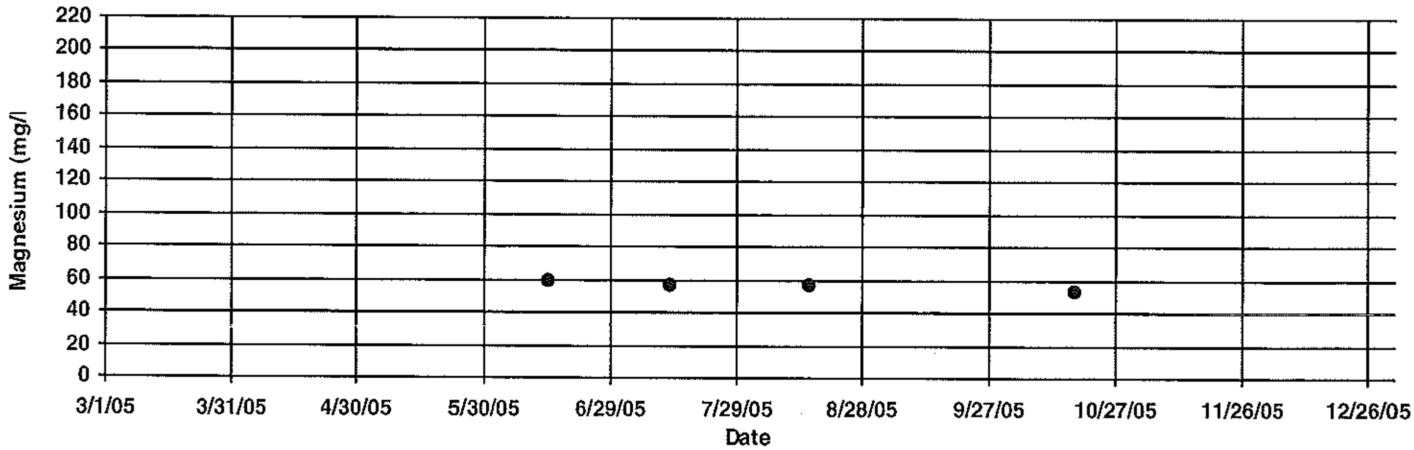


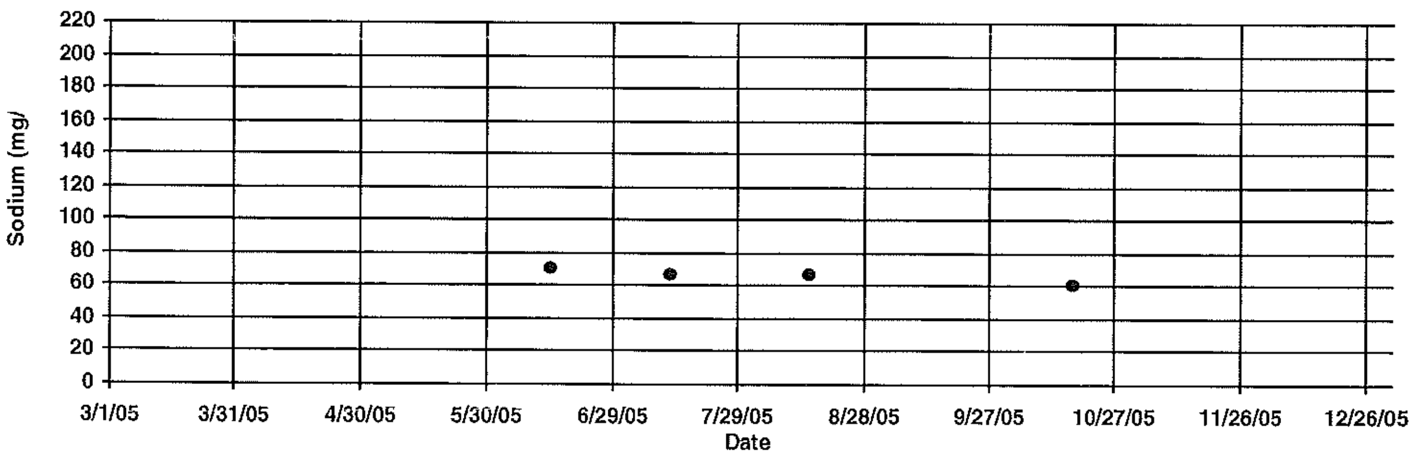


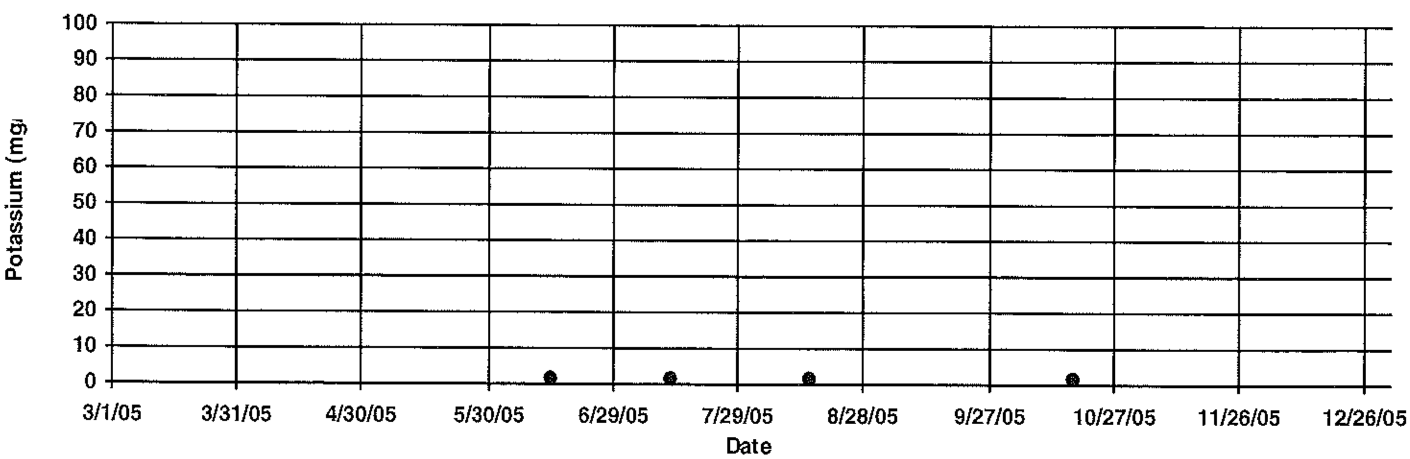
Study Site No. HG07 Ken2 Pool Site No.: 6

GENERAL MINERAL DATA



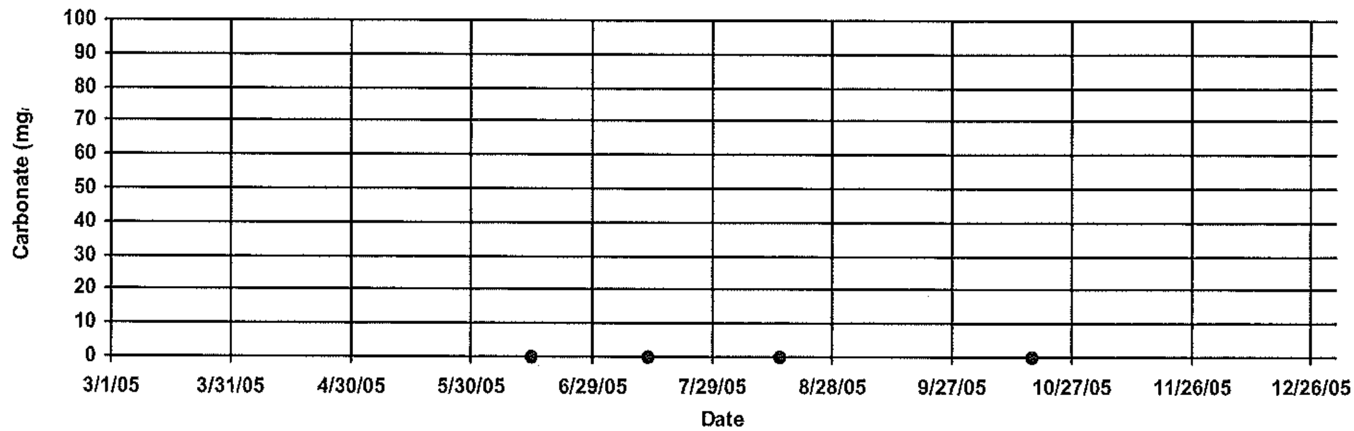


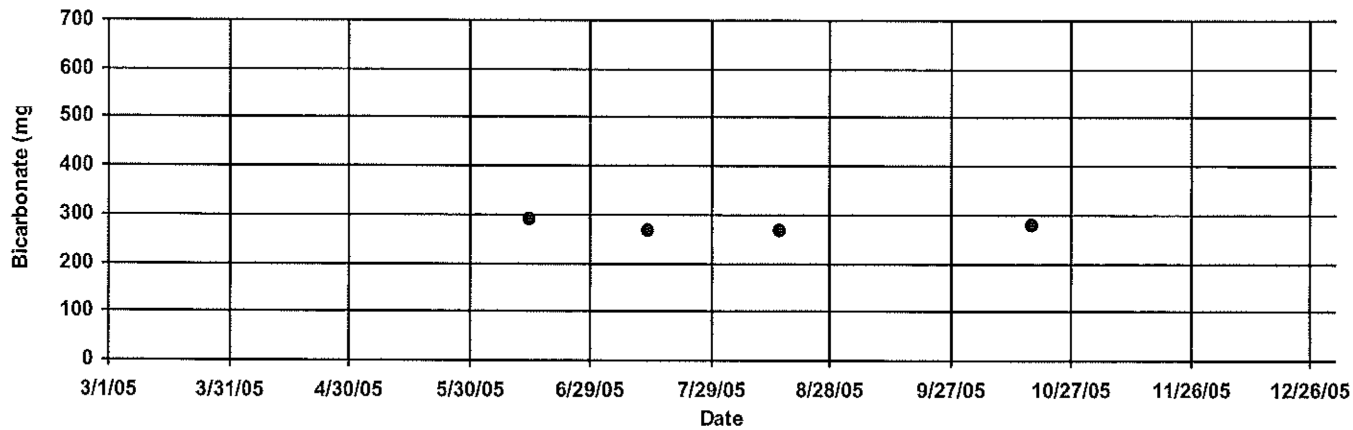


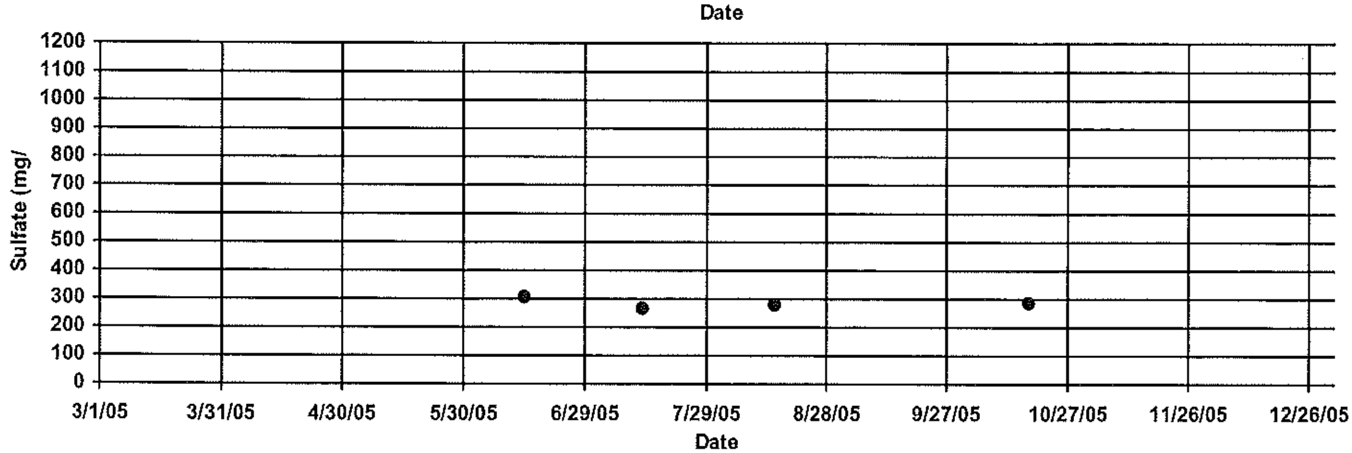


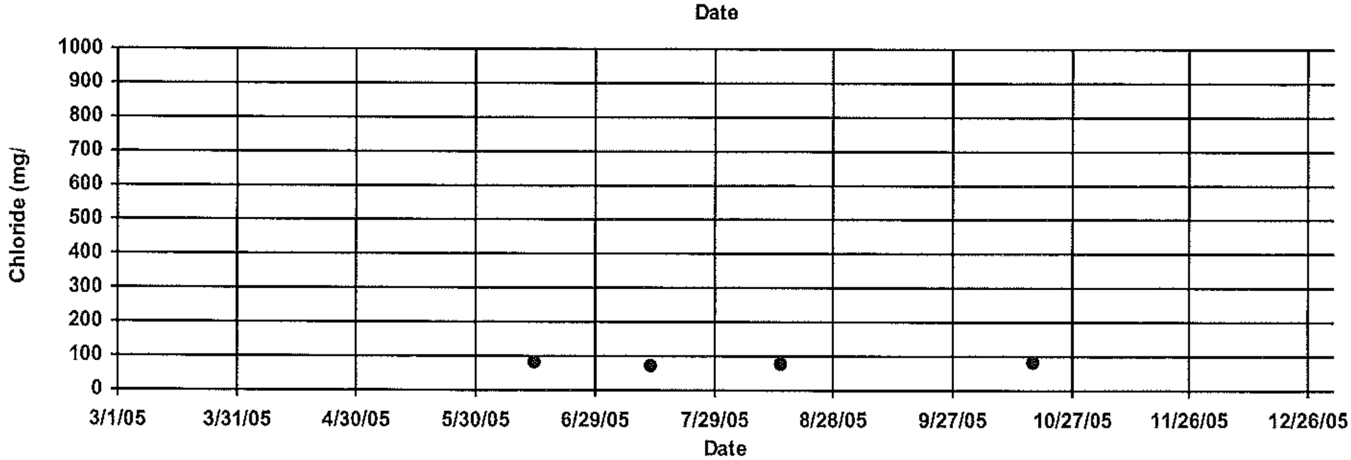
Study Site No. HG07 Ken2 Pool Site No.: 6

GENERAL MINERAL DATA



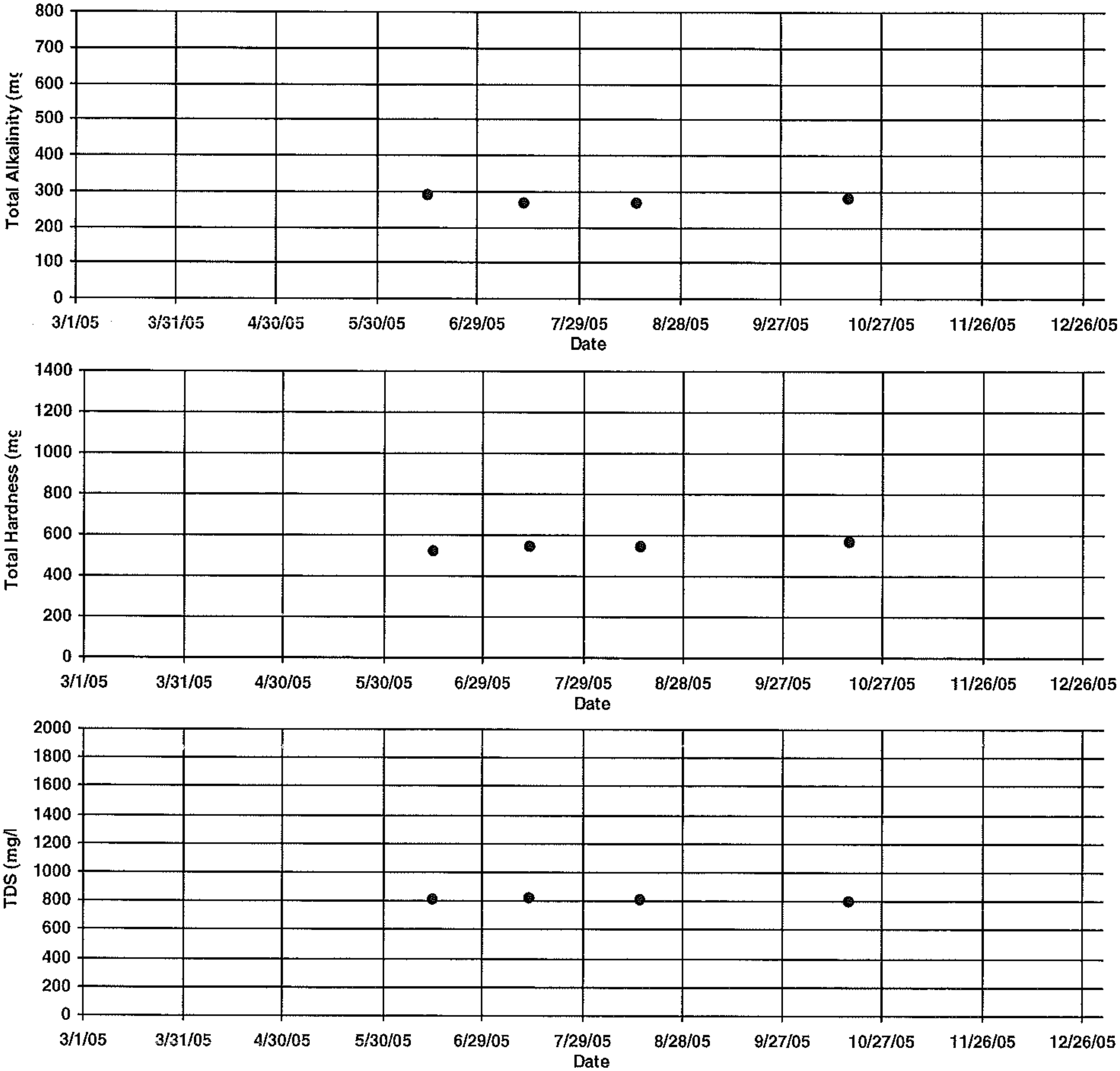






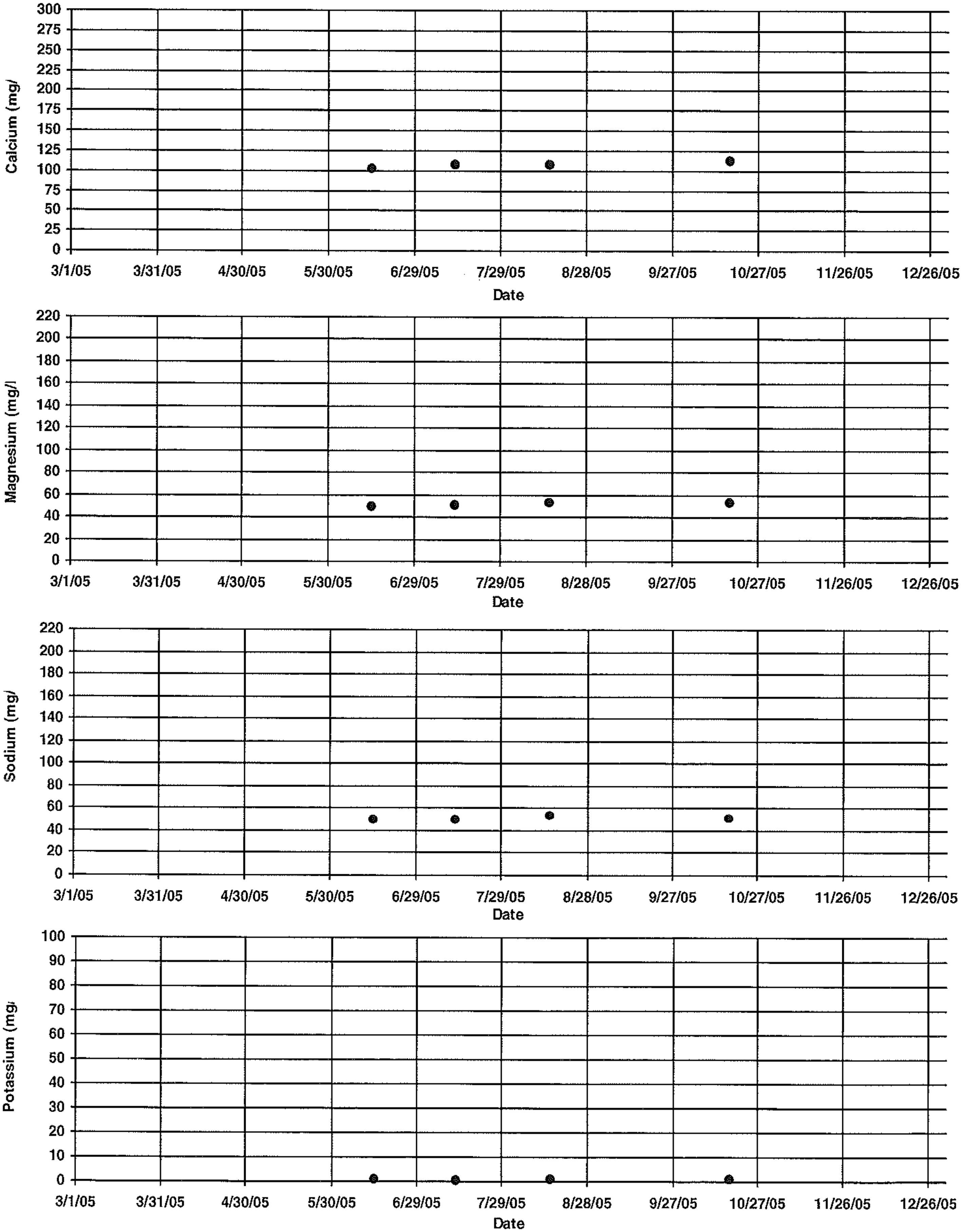
Study Site No. HG07 Ken2 Pool Site No.: 6

GENERAL MINERAL DATA



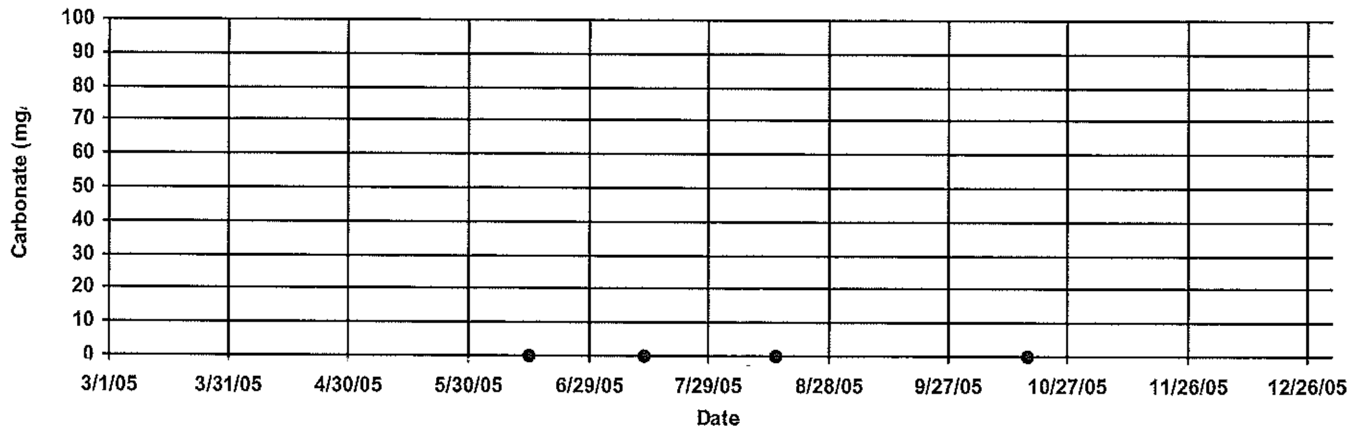
Study Site No. HG08 Alder Grove Site No.: 13

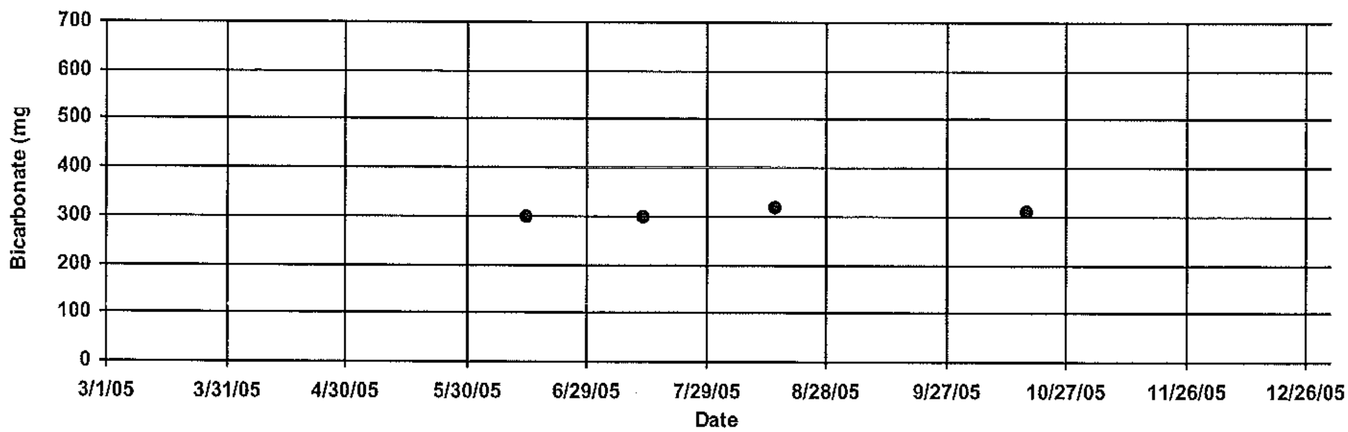
GENERAL MINERAL DATA

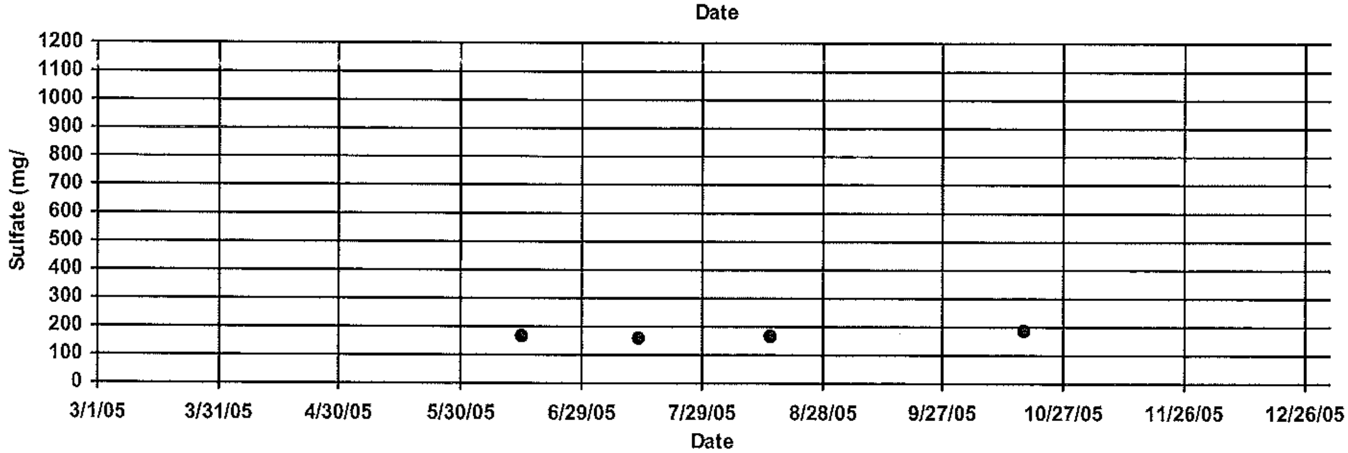


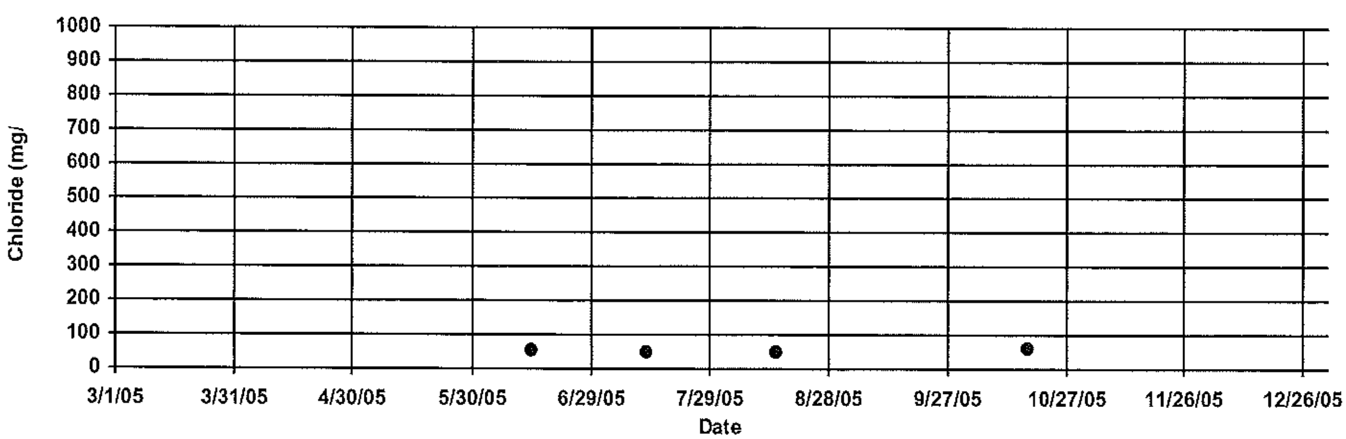
Study Site No. HG08 Alder Grove Site No.: 13

GENERAL MINERAL DATA



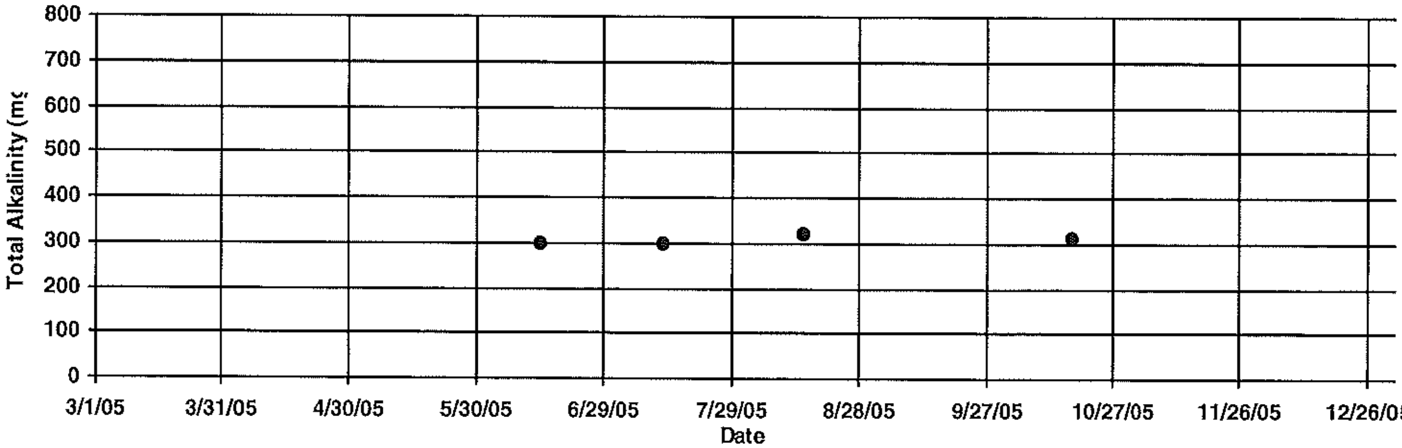


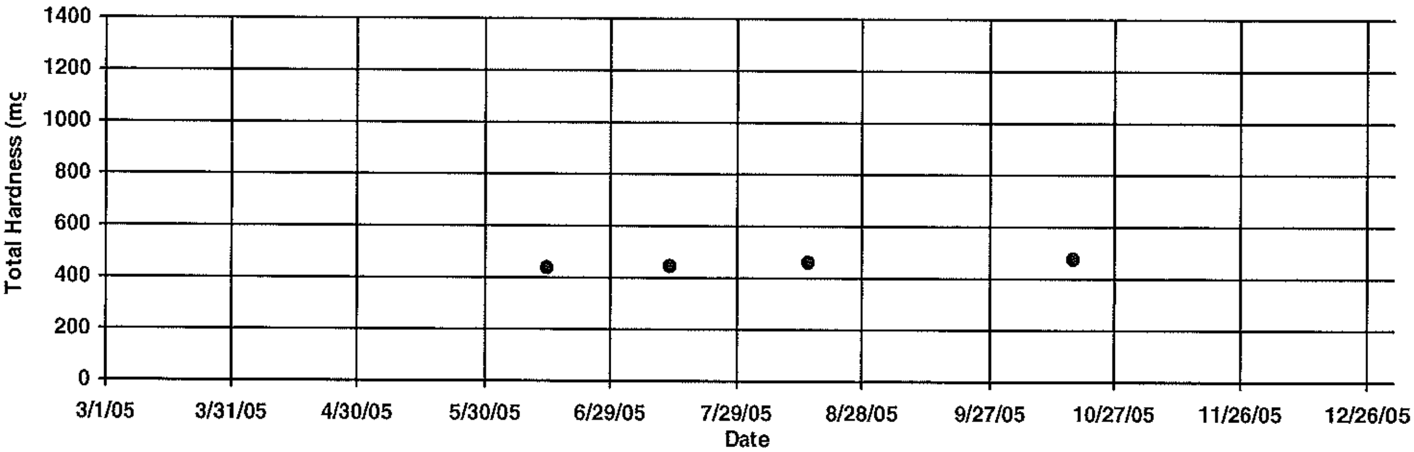


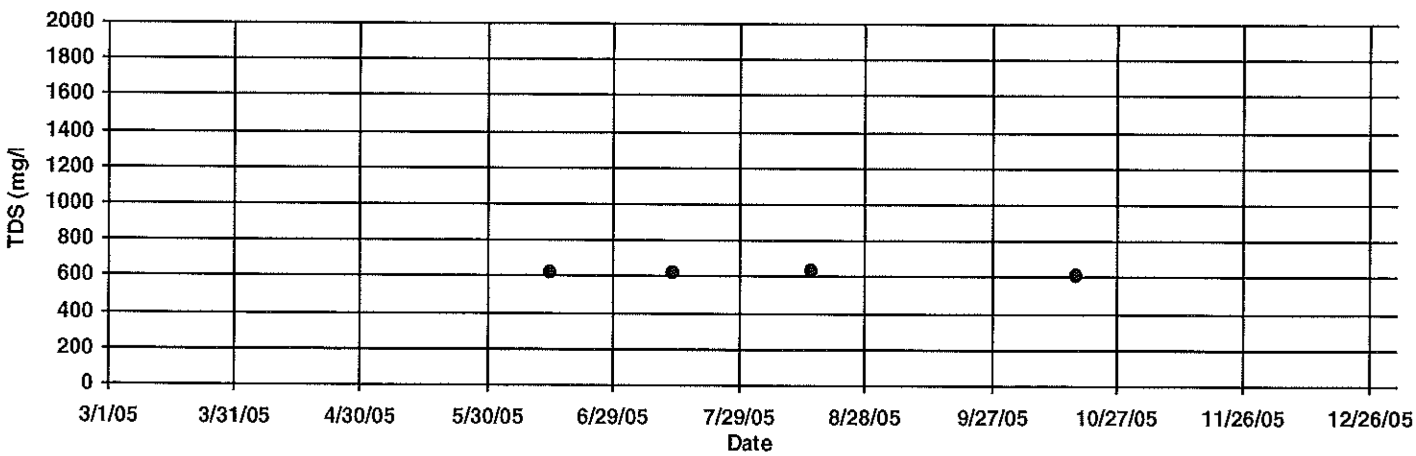


Study Site No. HG08 Alder Grove Site No.: 13

GENERAL MINERAL DATA

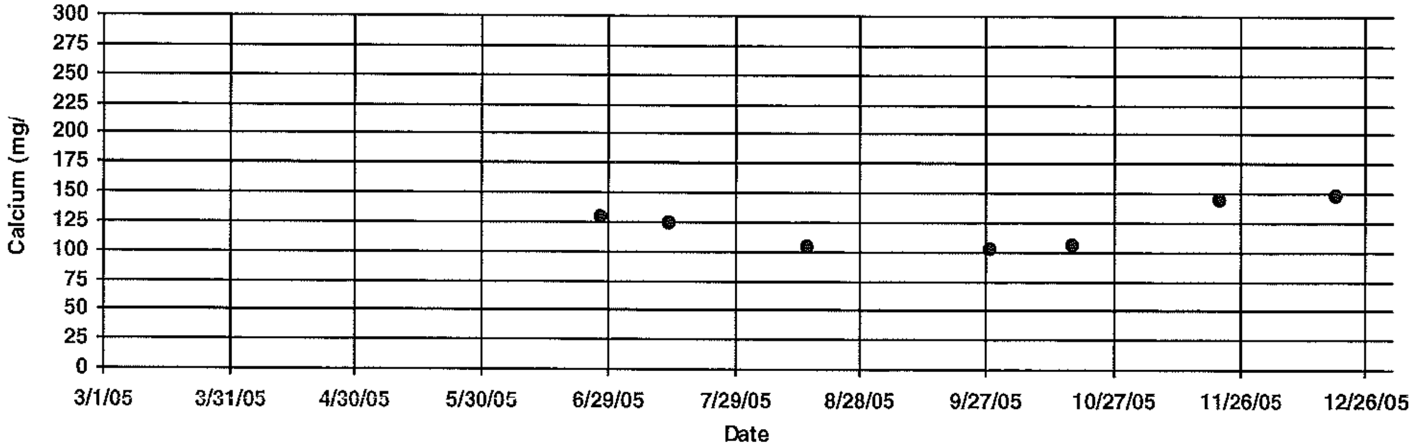


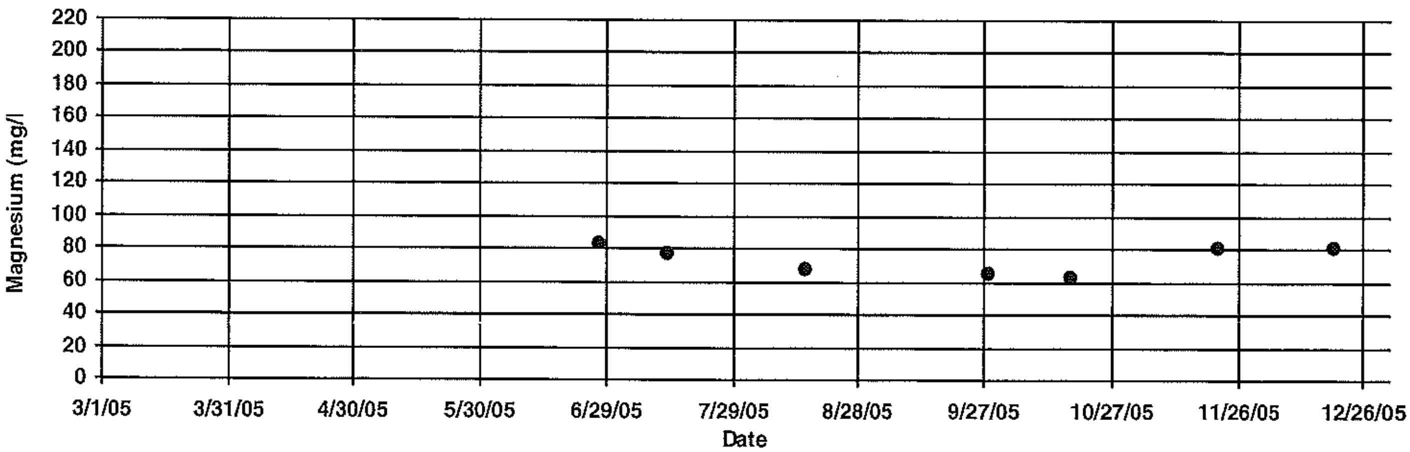


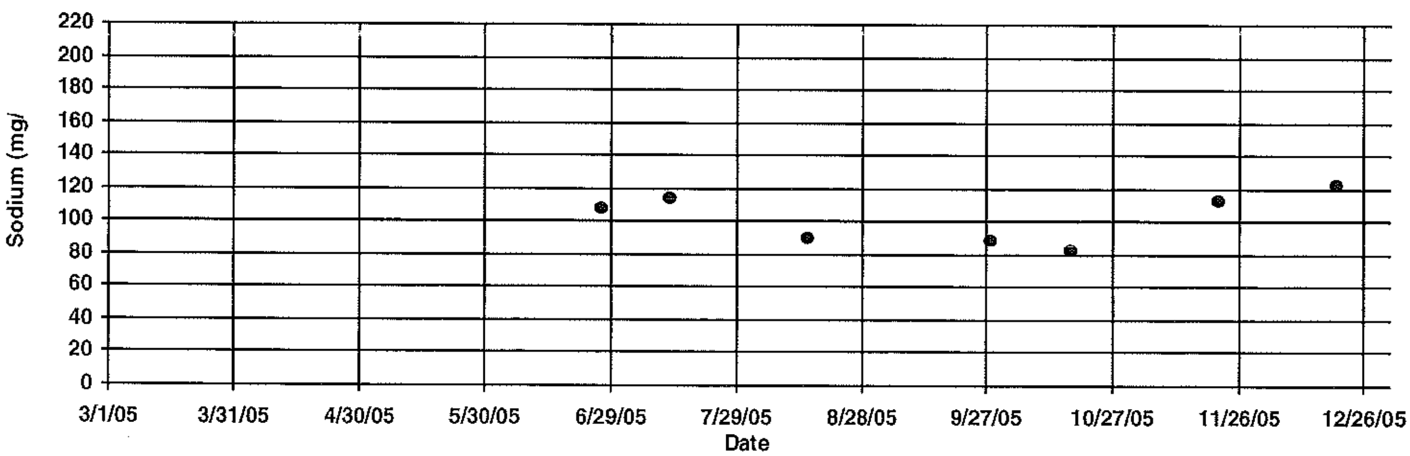


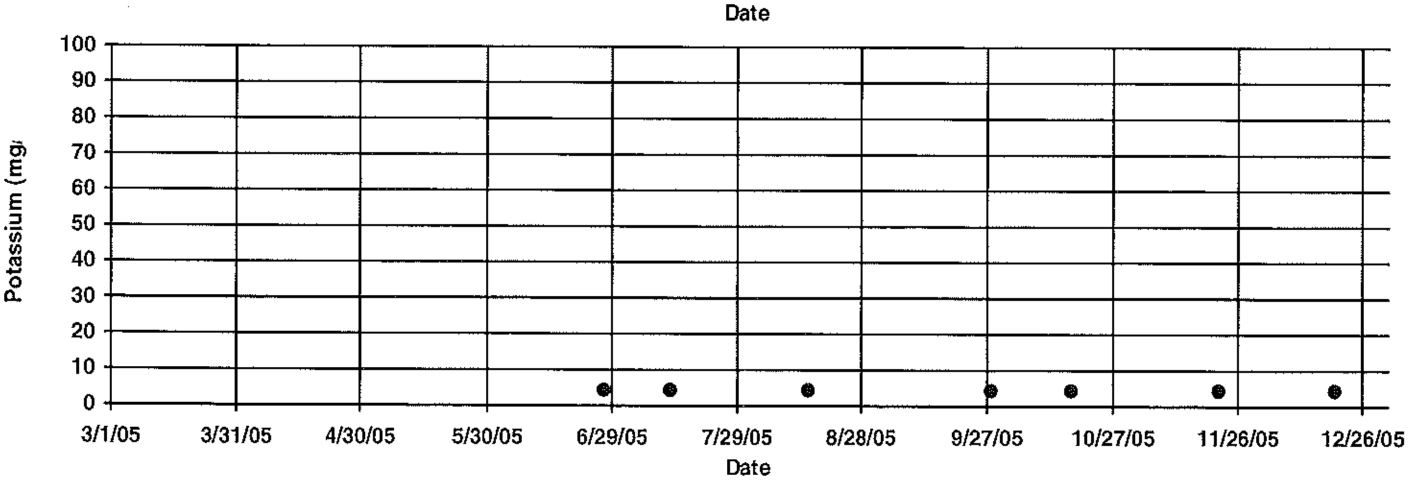
Study Site No. HG09 Bridge Site No.: 303

GENERAL MINERAL DATA









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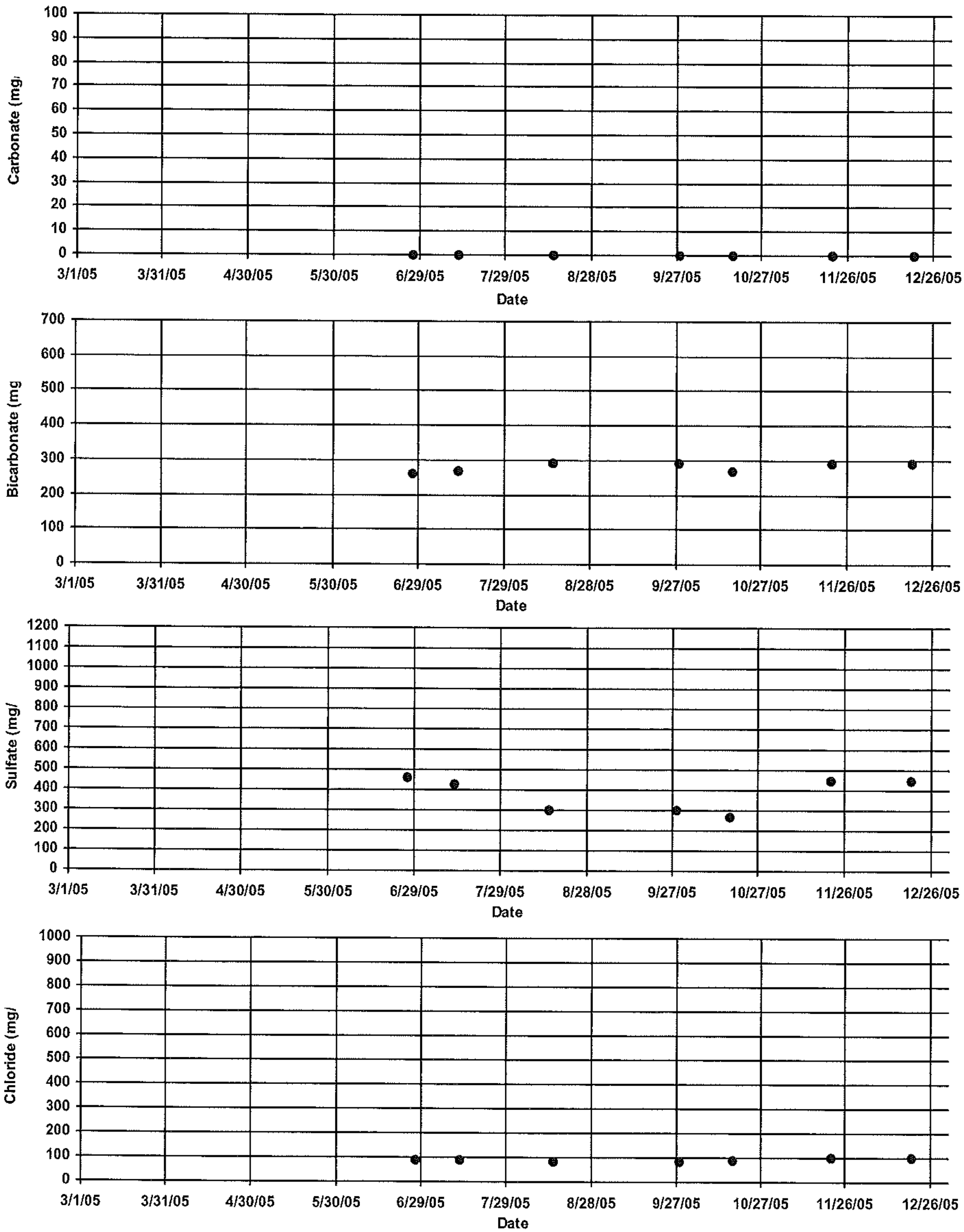

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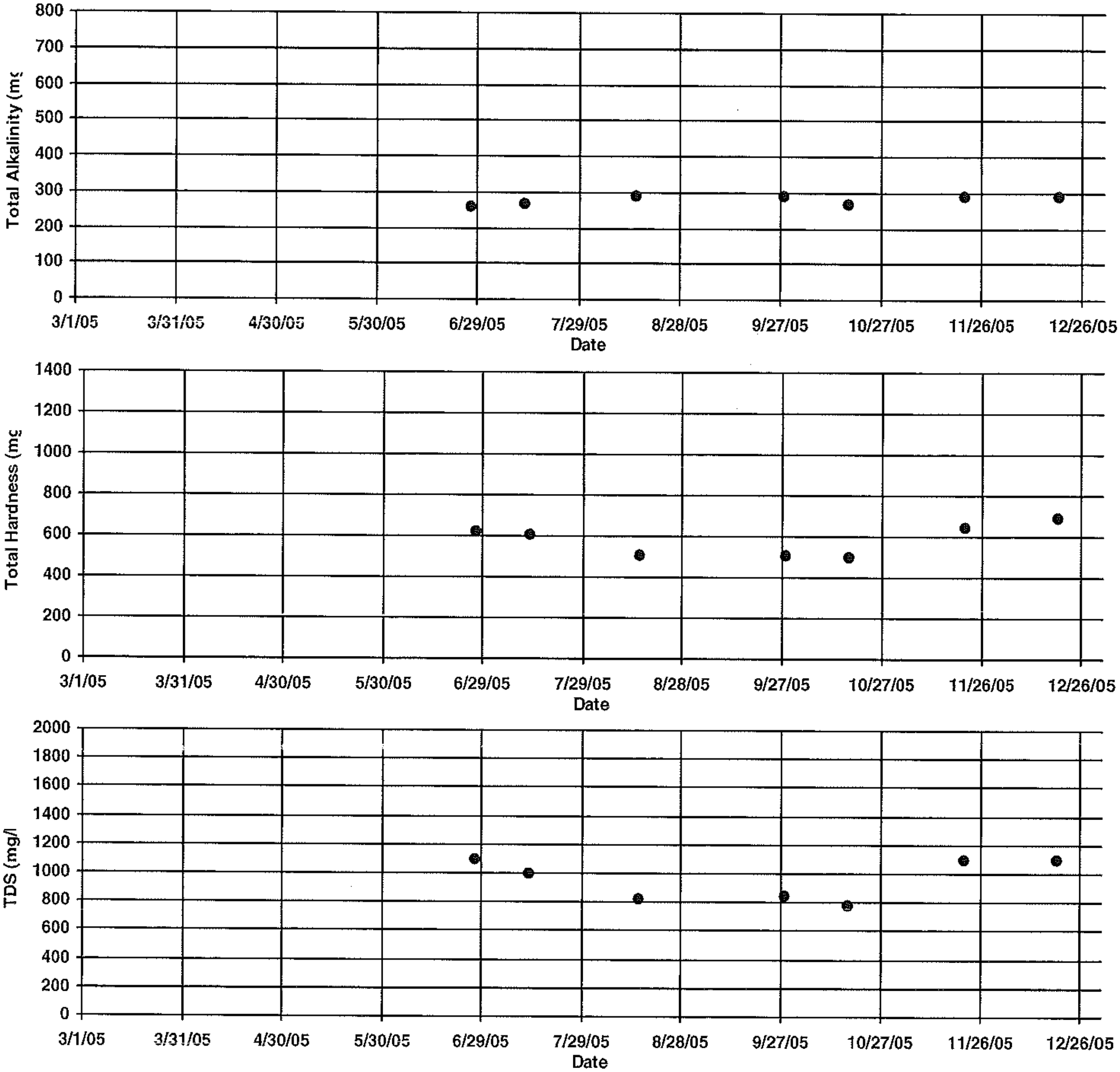
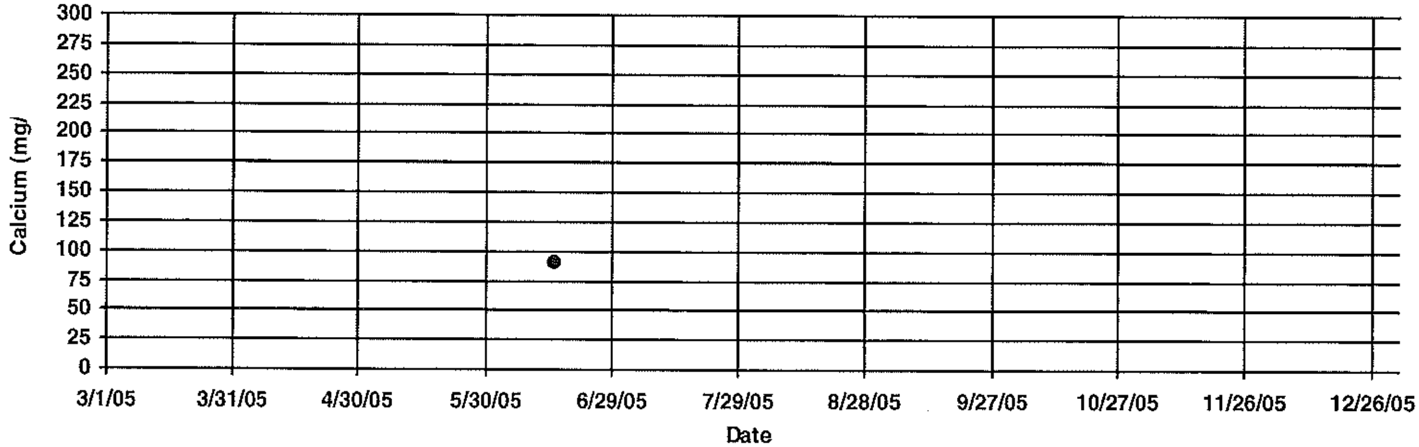
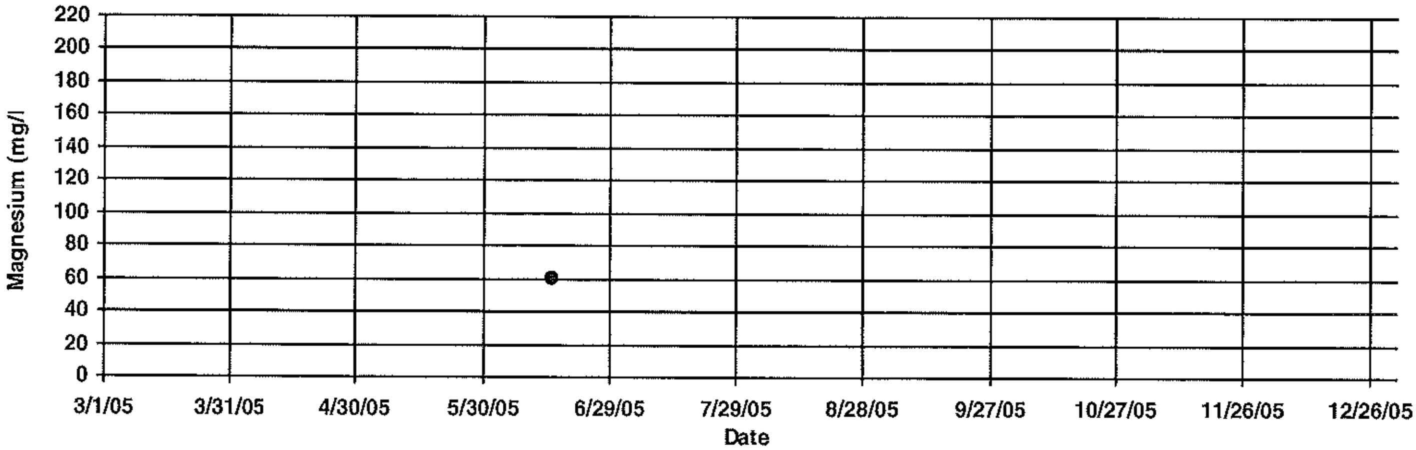
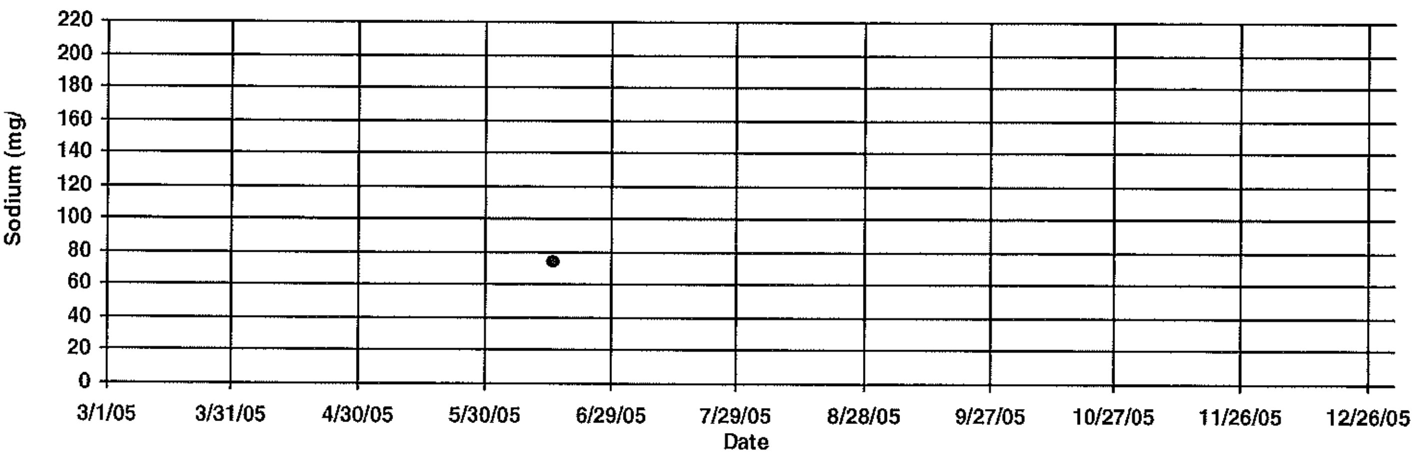


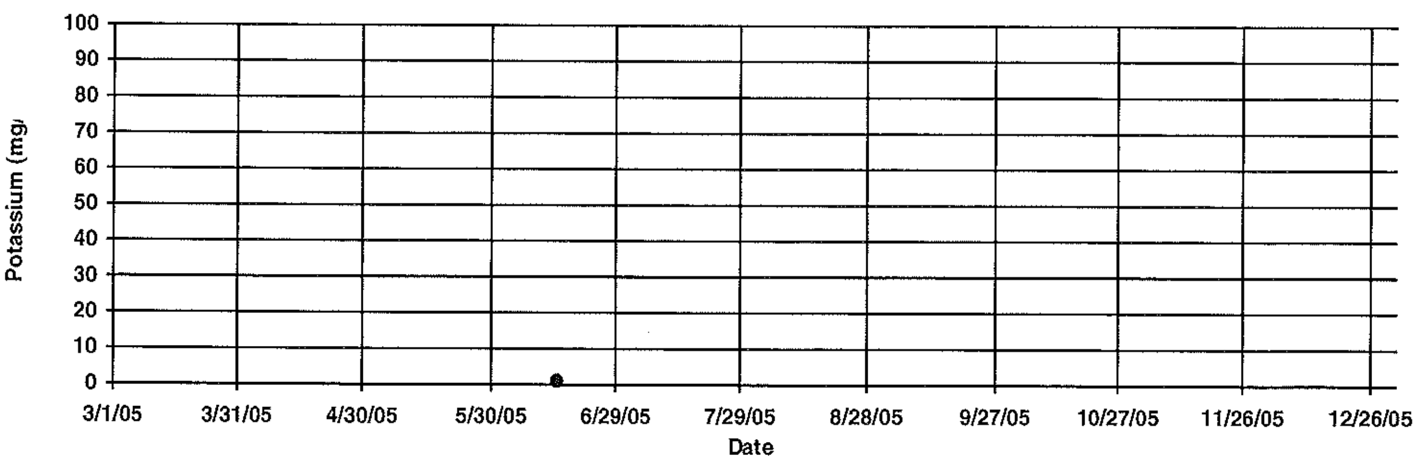
Study Site No. HG10 Sycamore Tree Site No.: 17

GENERAL MINERAL DATA



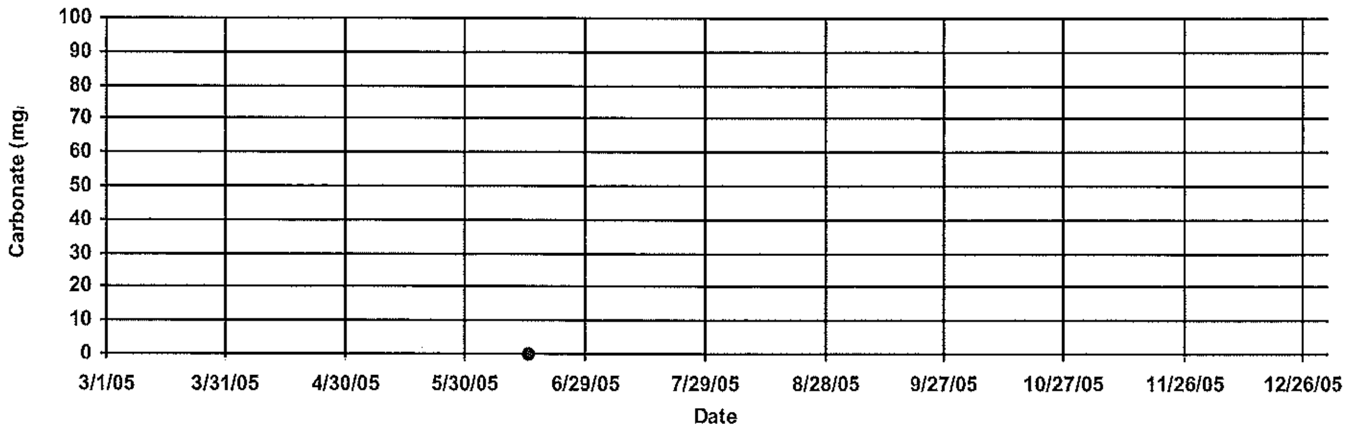


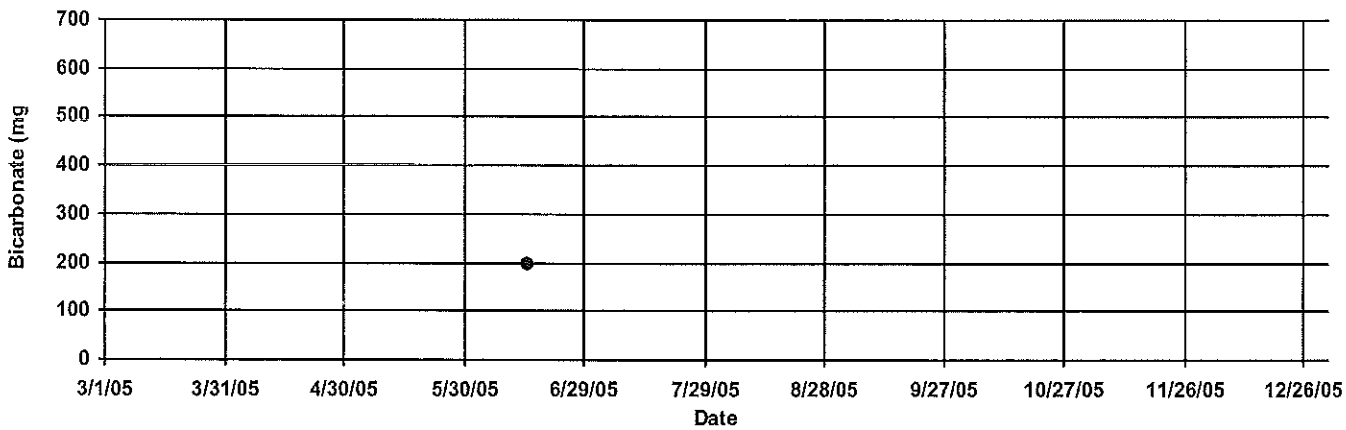


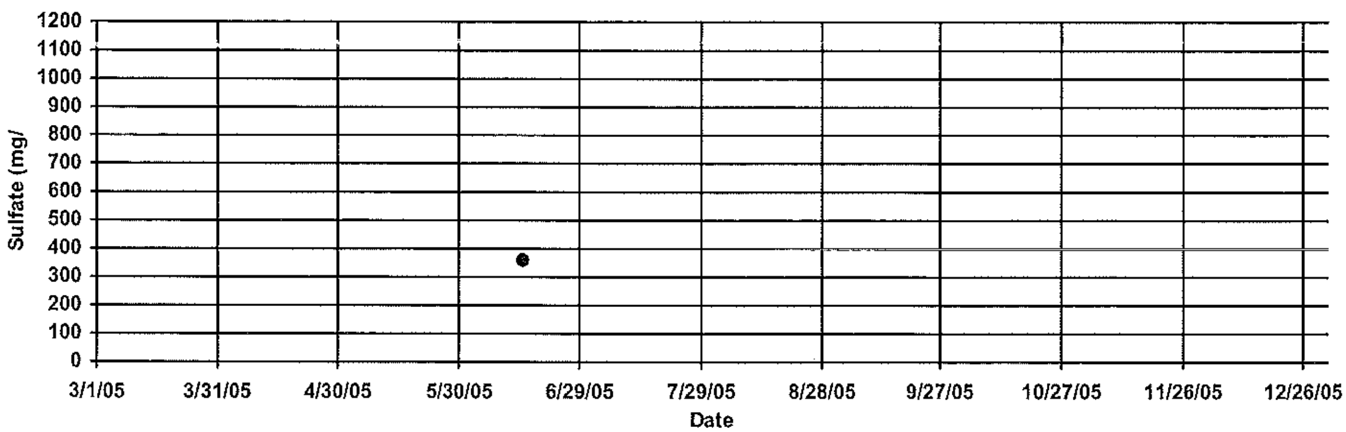


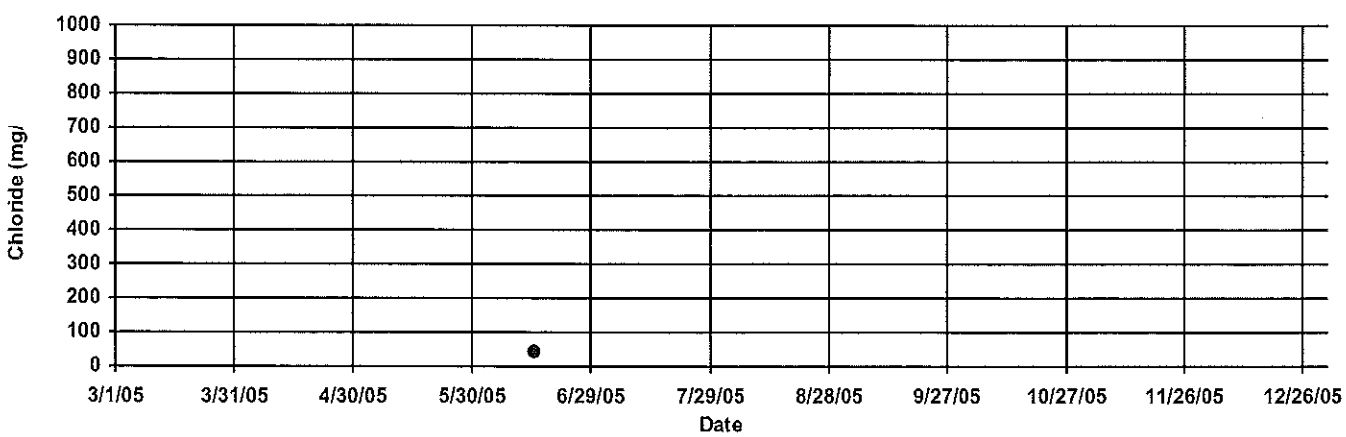
Study Site No. HG10 Sycamore Tree Site No.: 17

GENERAL MINERAL DATA









Study Site No. HG10 Sycamore Tree Site No.: 17

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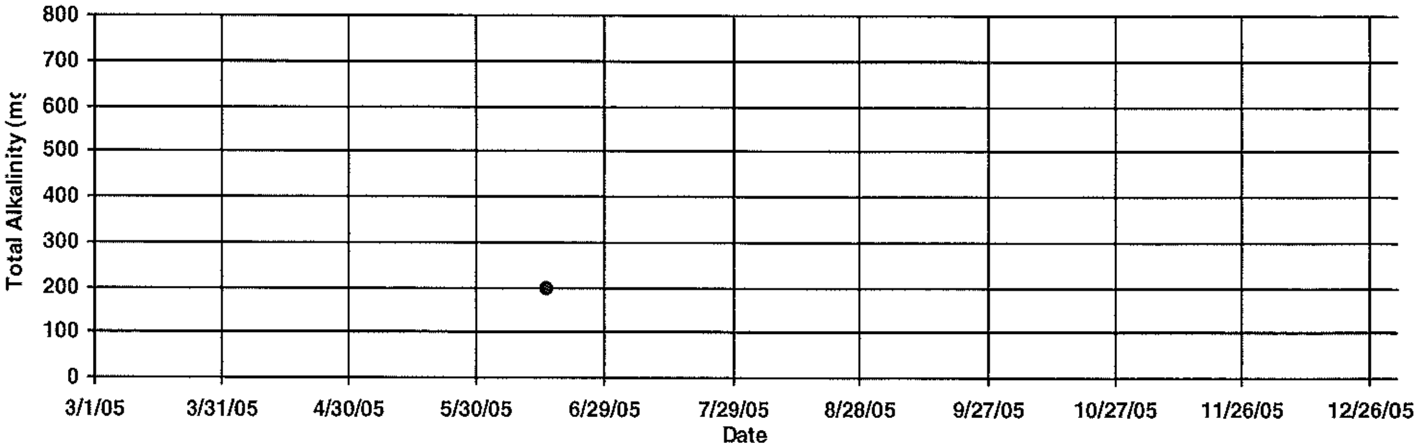
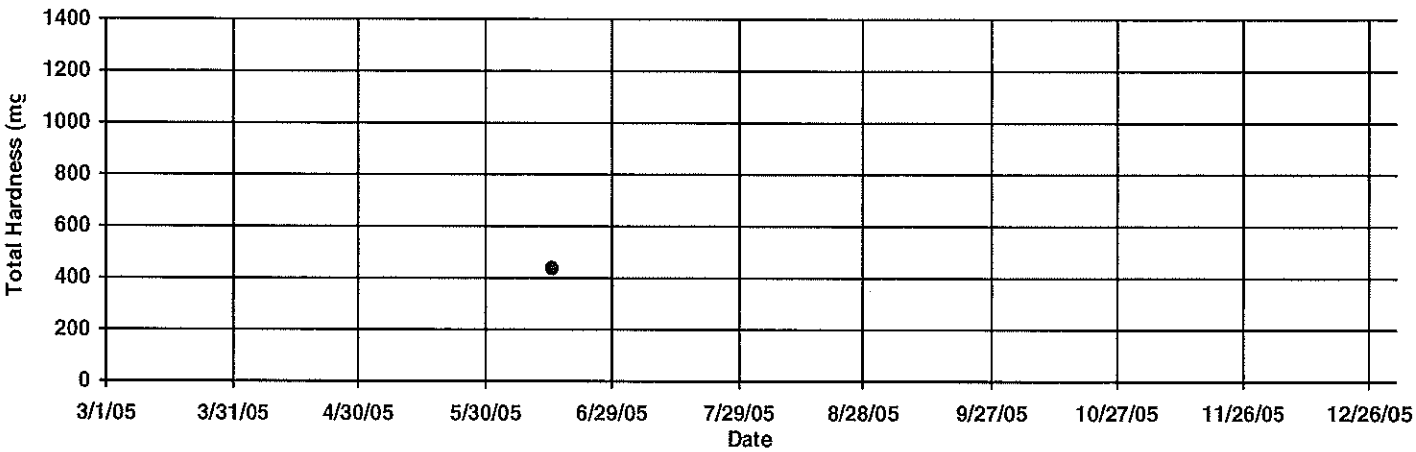
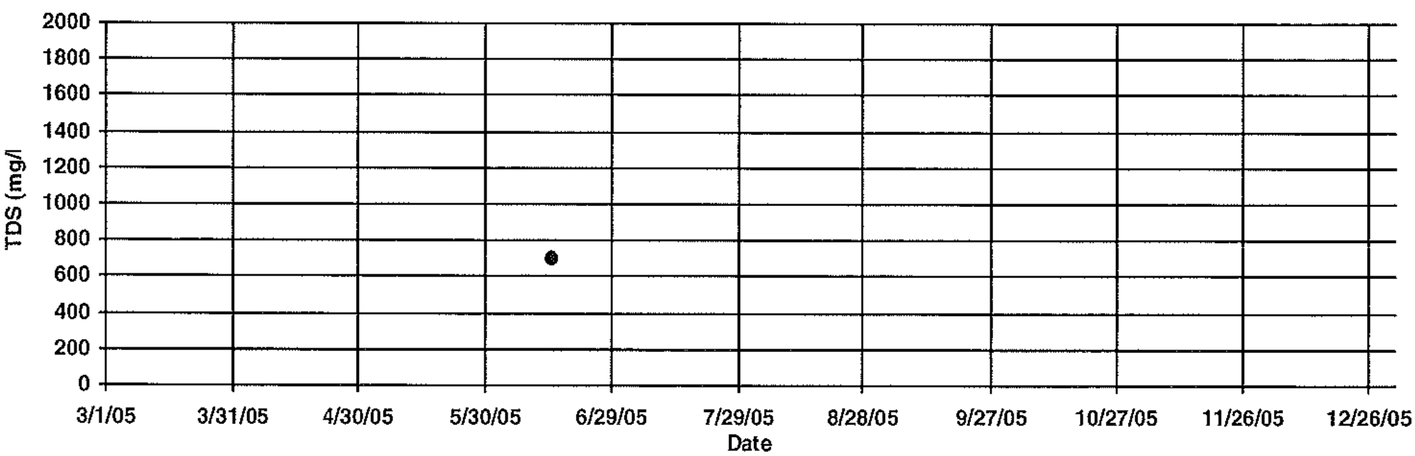
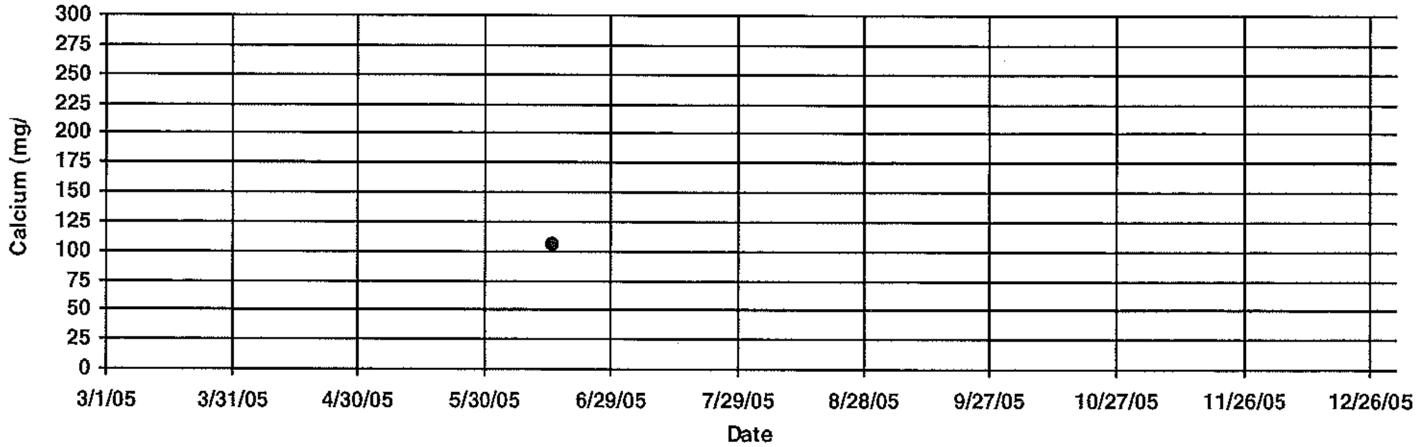


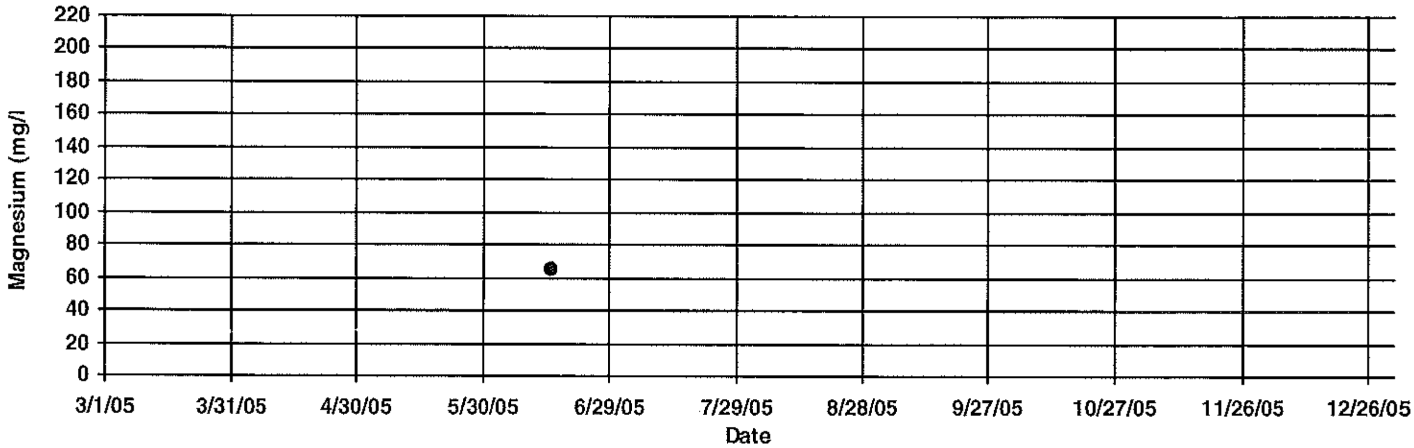


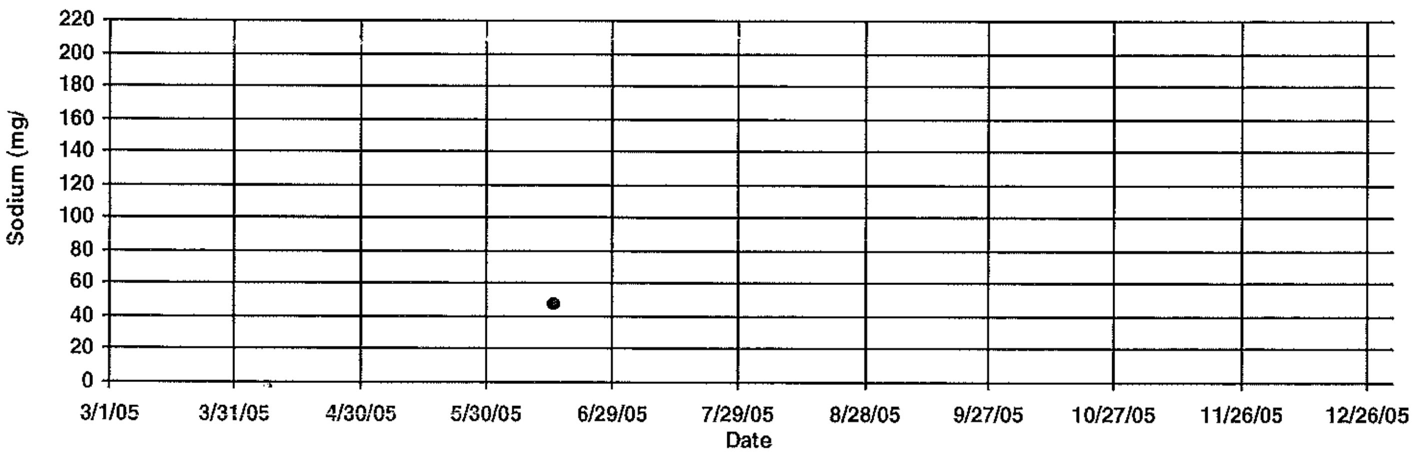


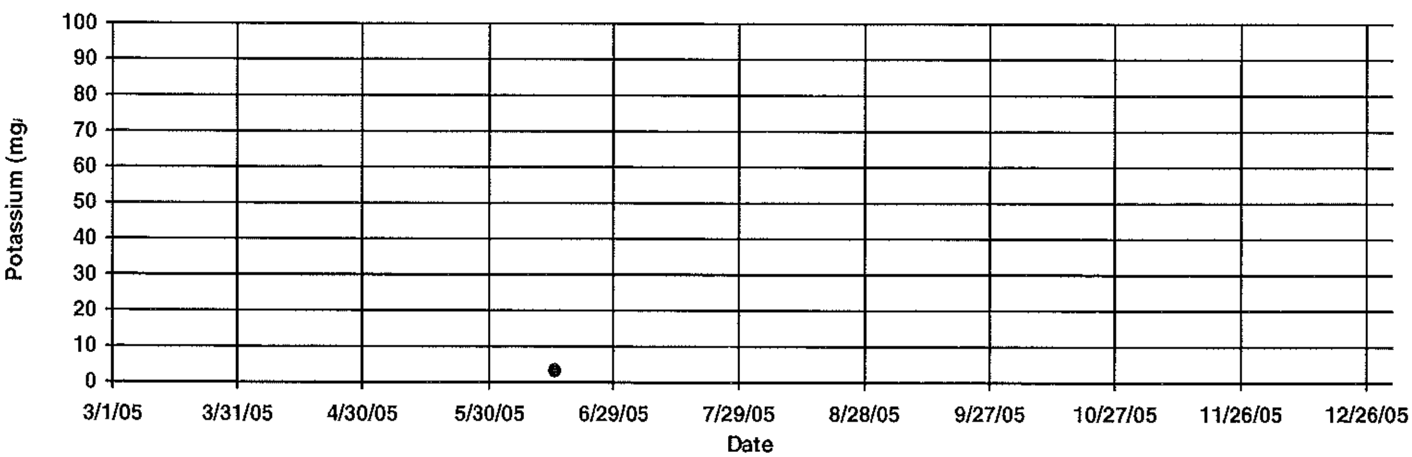
Study Site No. HG11 Maidenhair Fern Seep Site No.: 18

GENERAL MINERAL DATA



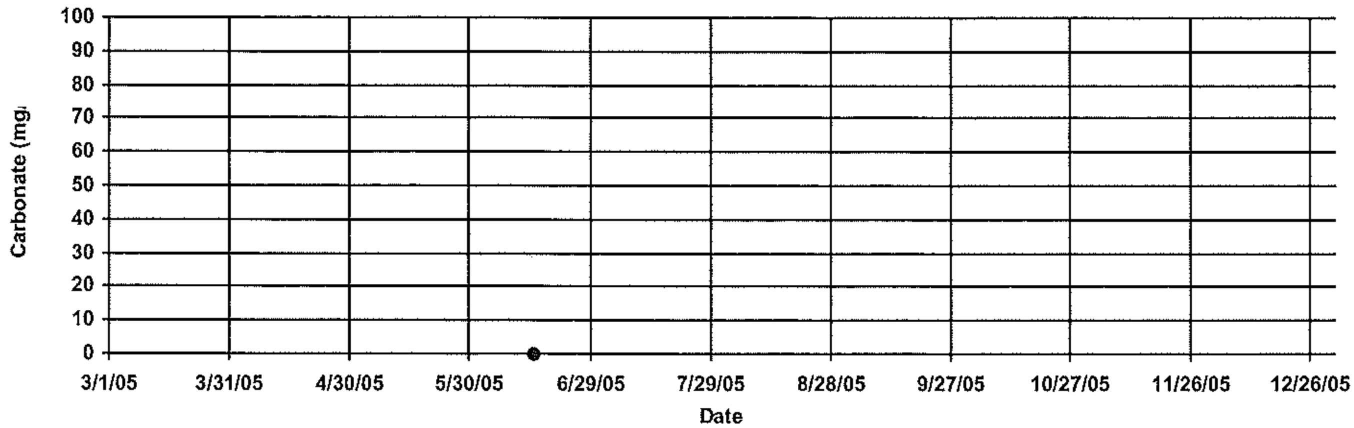


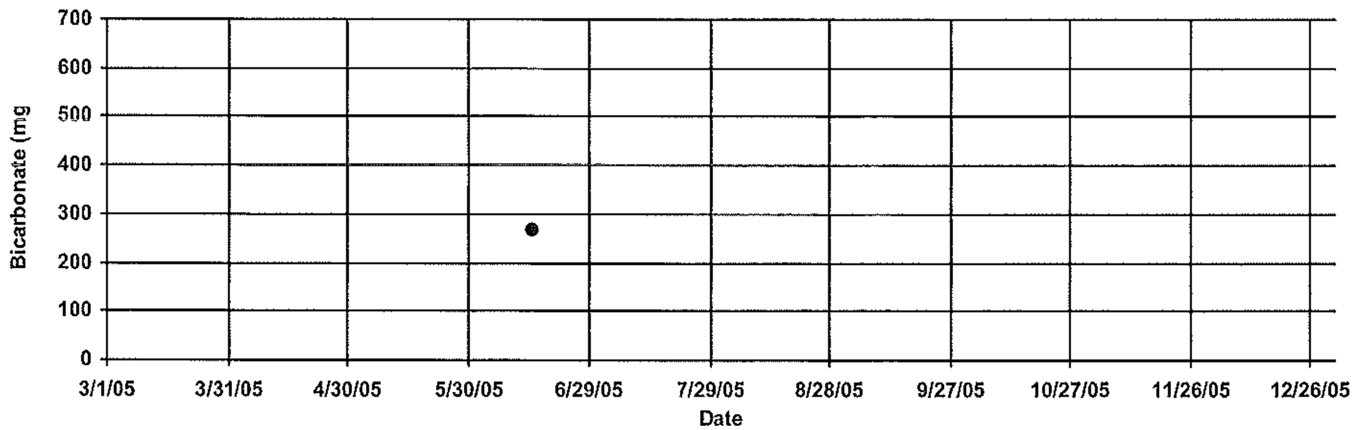


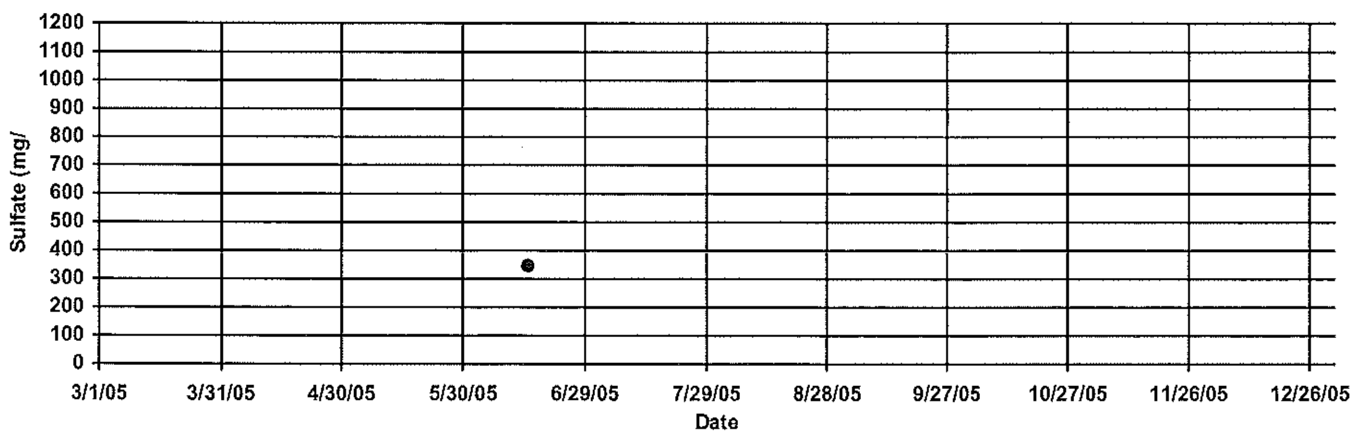


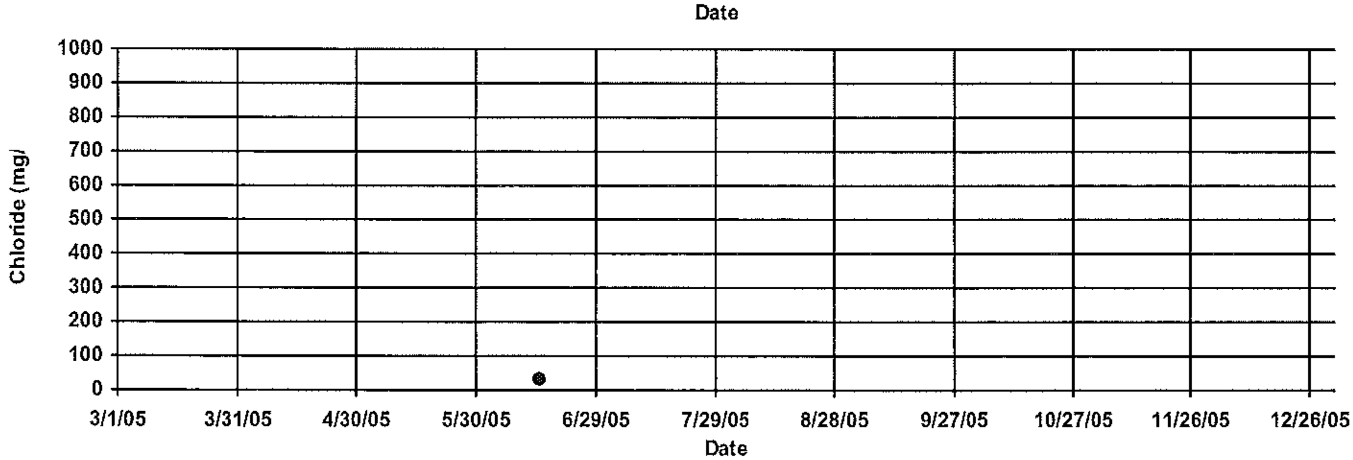
Study Site No. HG11 Maidenhair Fern Seep Site No.: 18

GENERAL MINERAL DATA



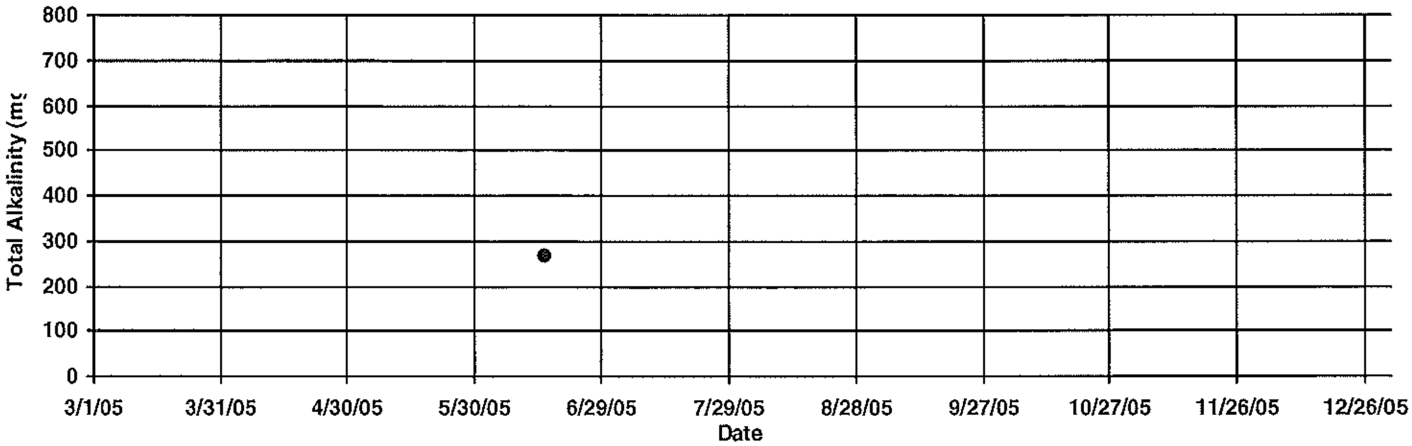


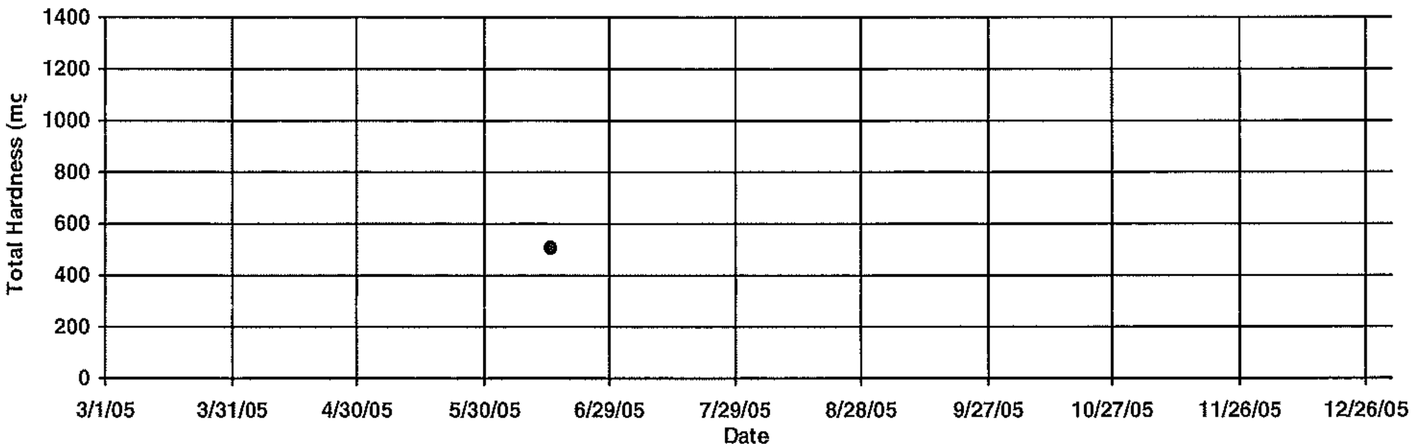


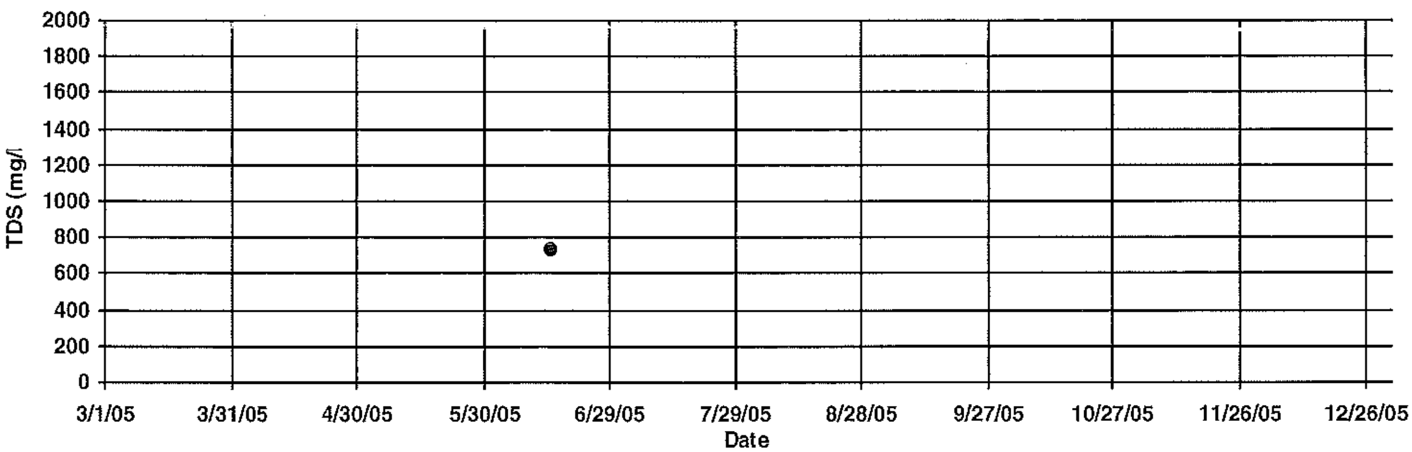


Study Site No. HG11 Maidenhair Fern Seep Site No.: 18

GENERAL MINERAL DATA

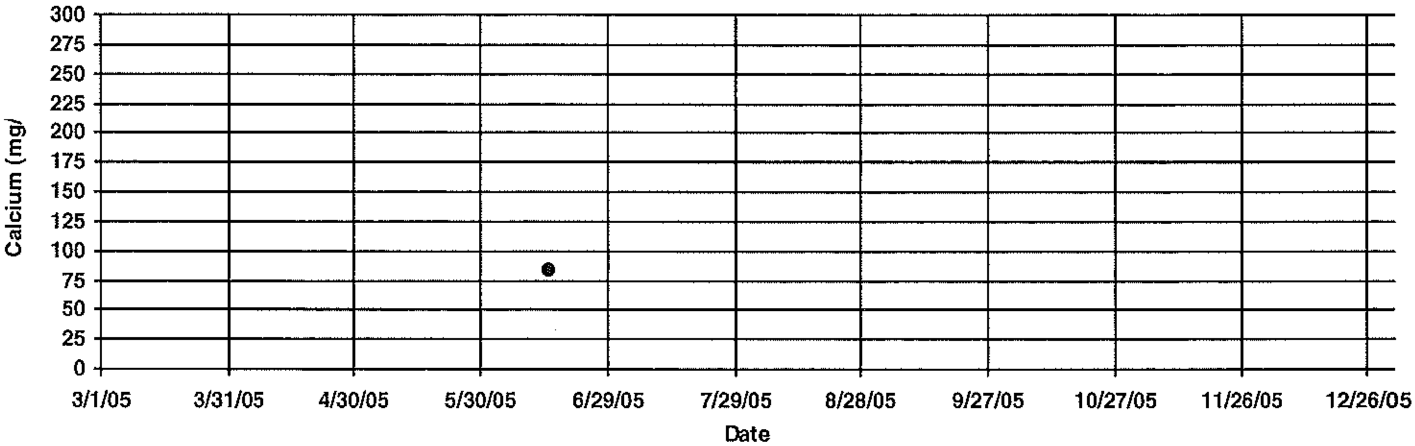


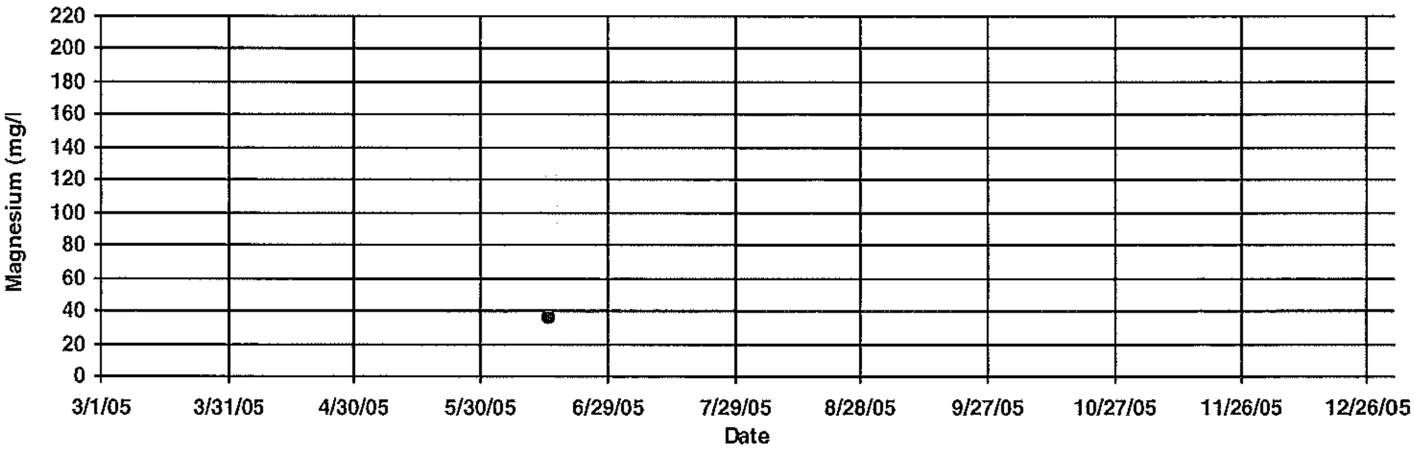


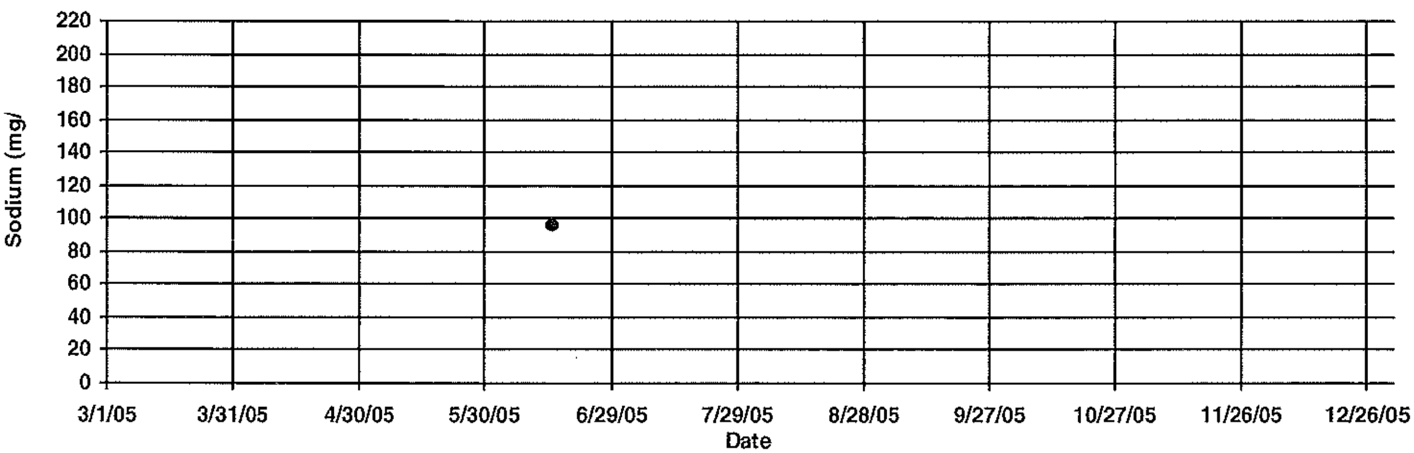


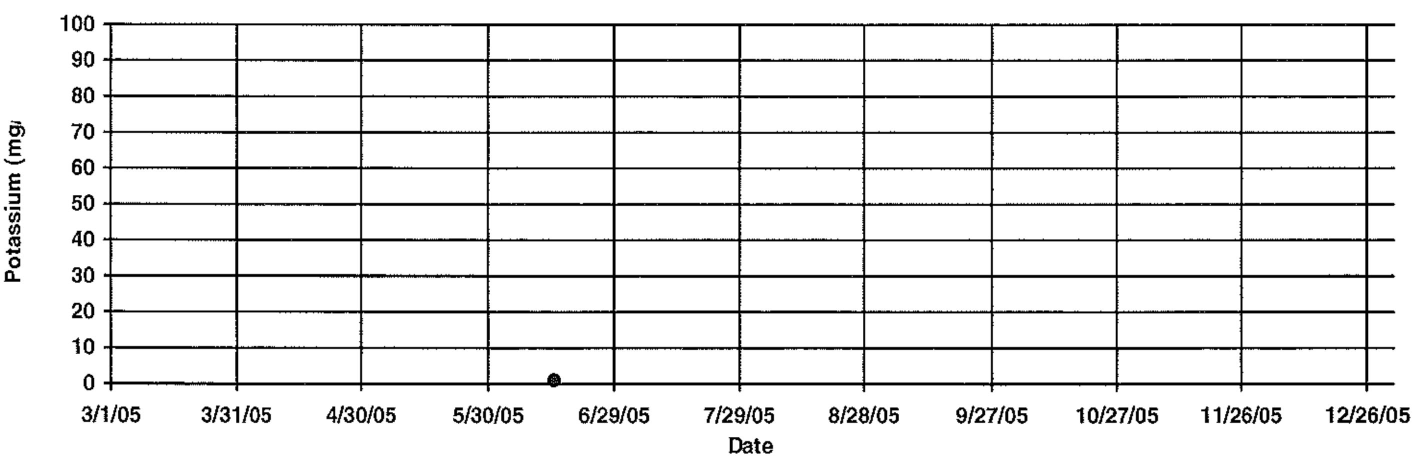
Study Site No. HG12 No Parking Alder Seep Site No.: 34

GENERAL MINERAL DATA









Study Site No. HG12 No Parking Alder Seep Site No.: 34

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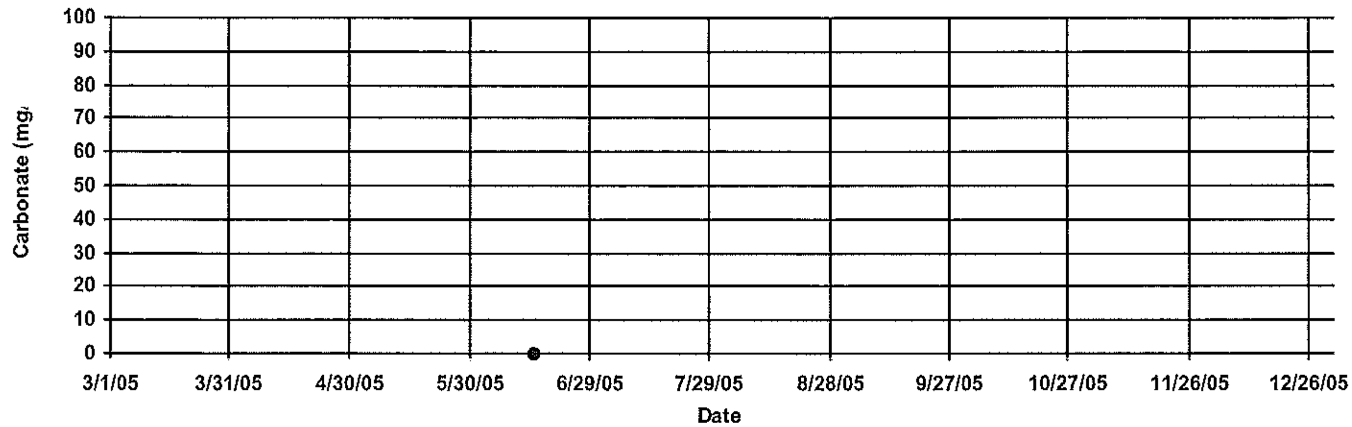

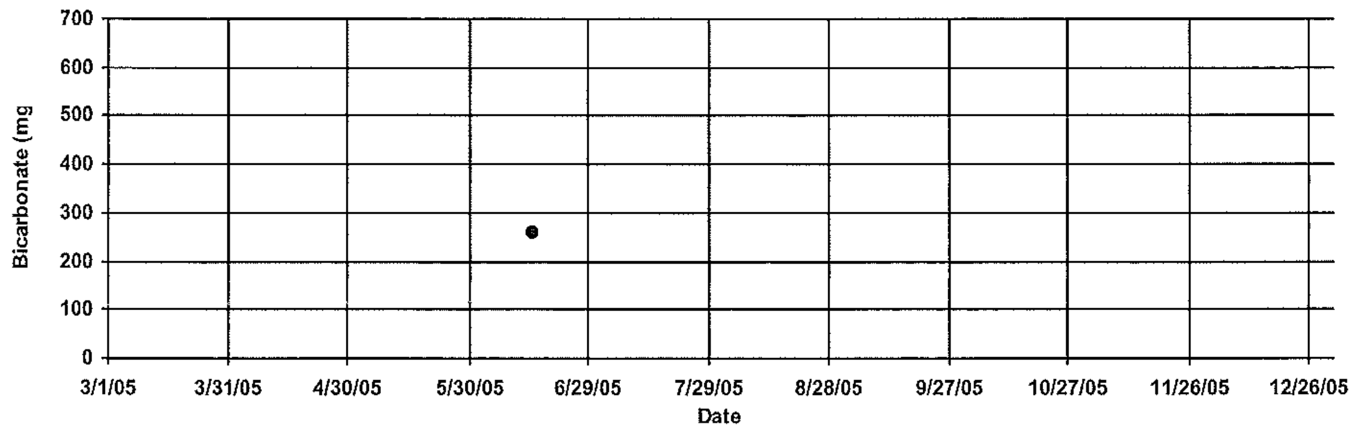

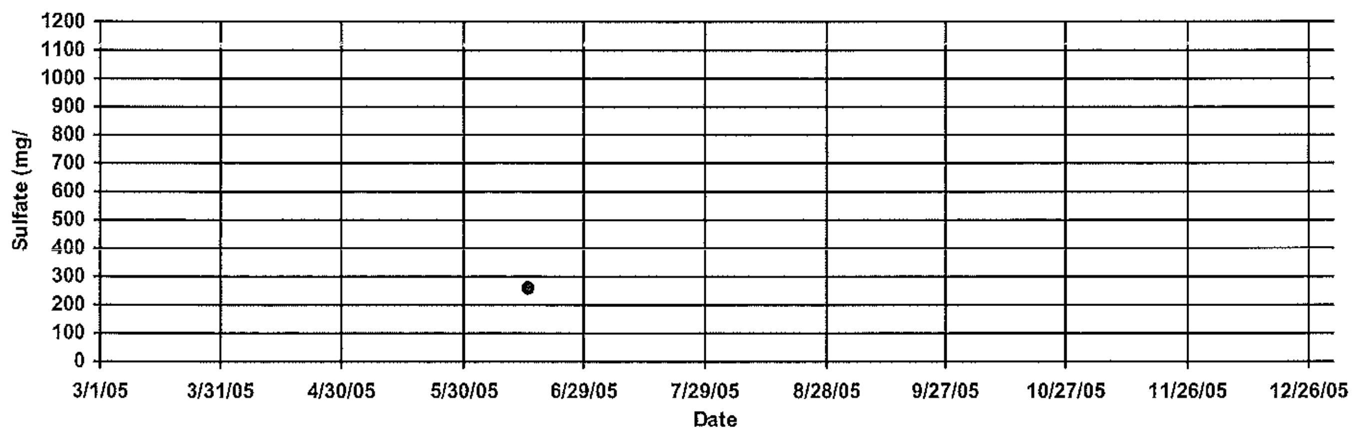

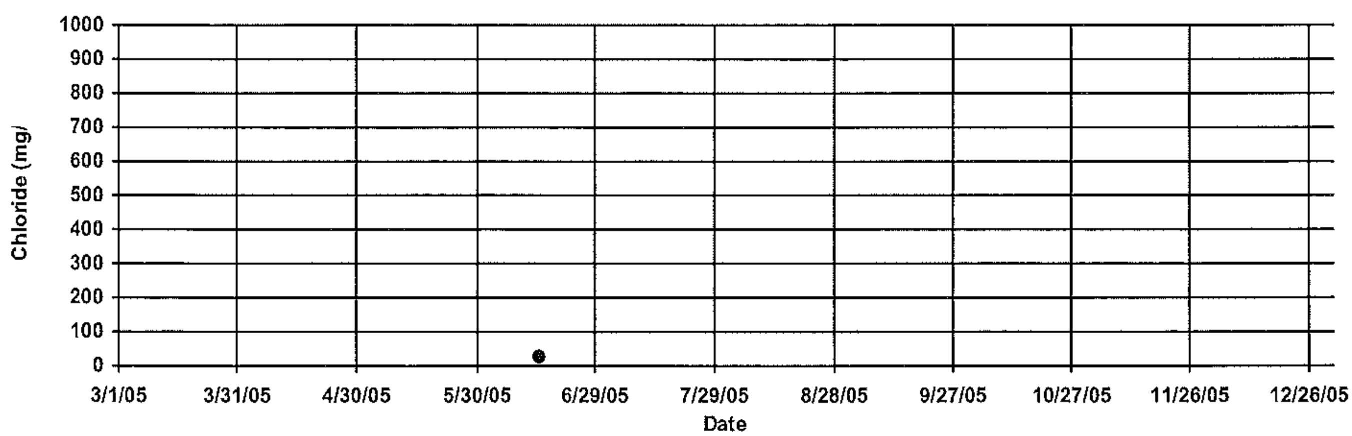

Study Site No. HG12 No Parking Alder Seep Site No.: 34

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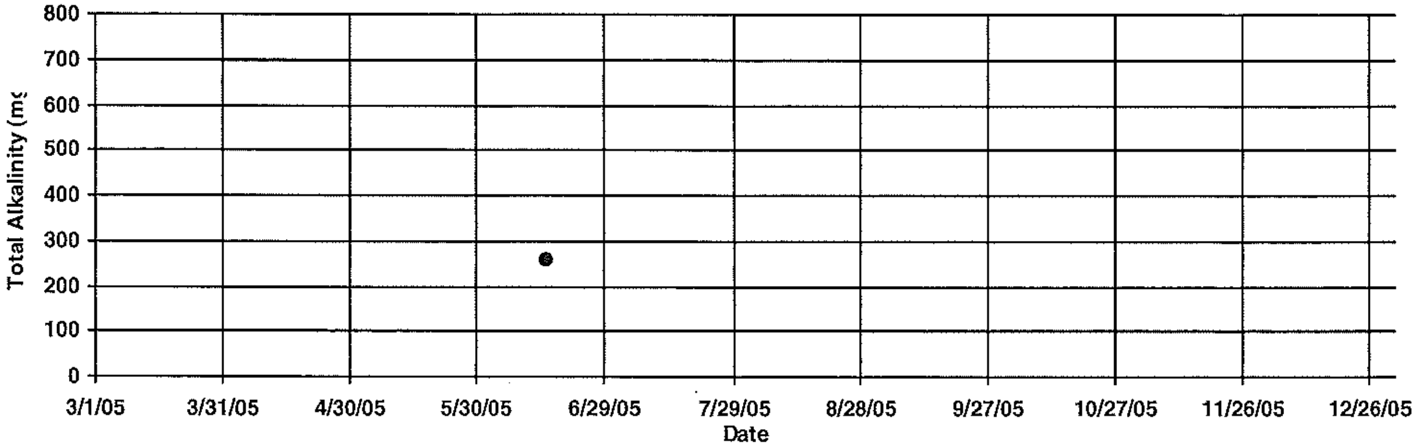

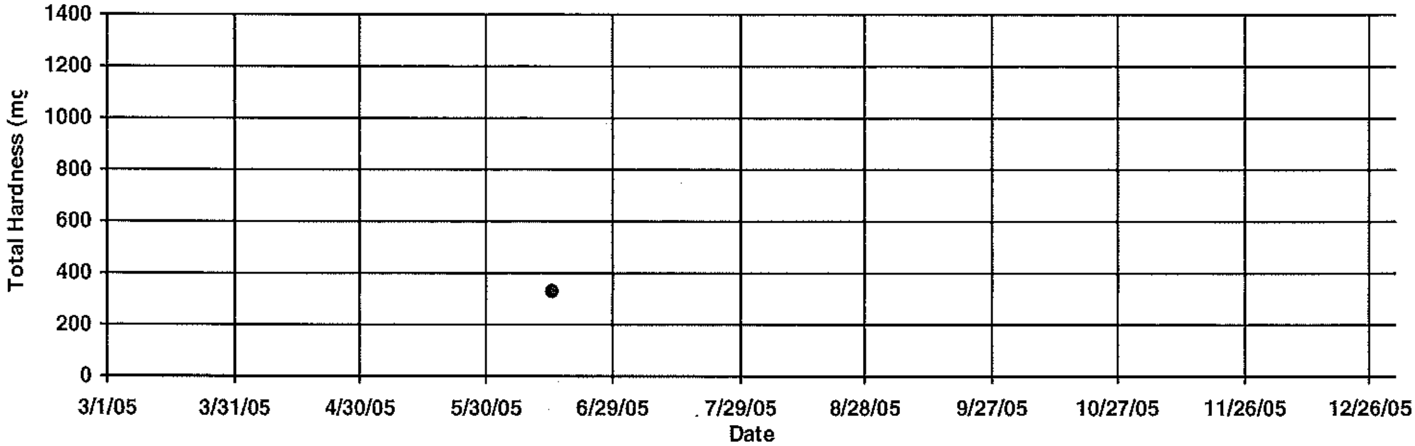

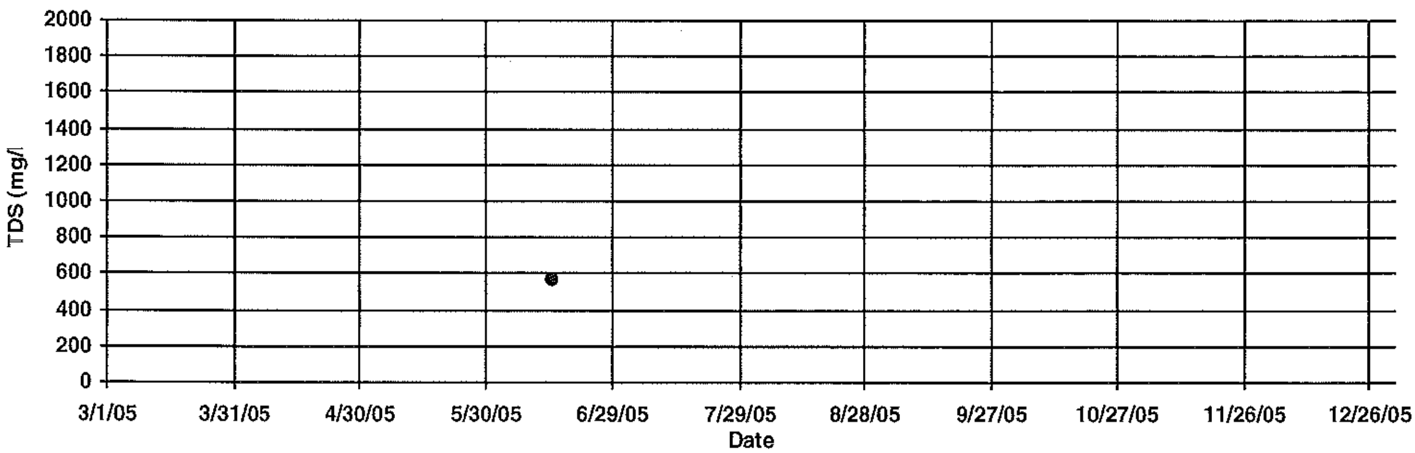

Study Site No. HG13 Narrows Seep Site No.: 19

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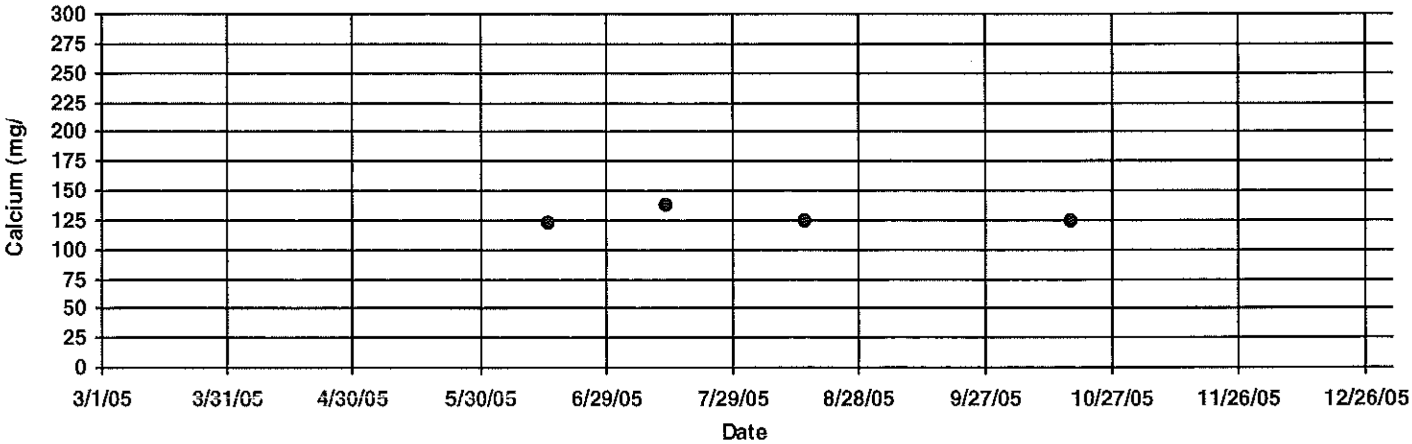

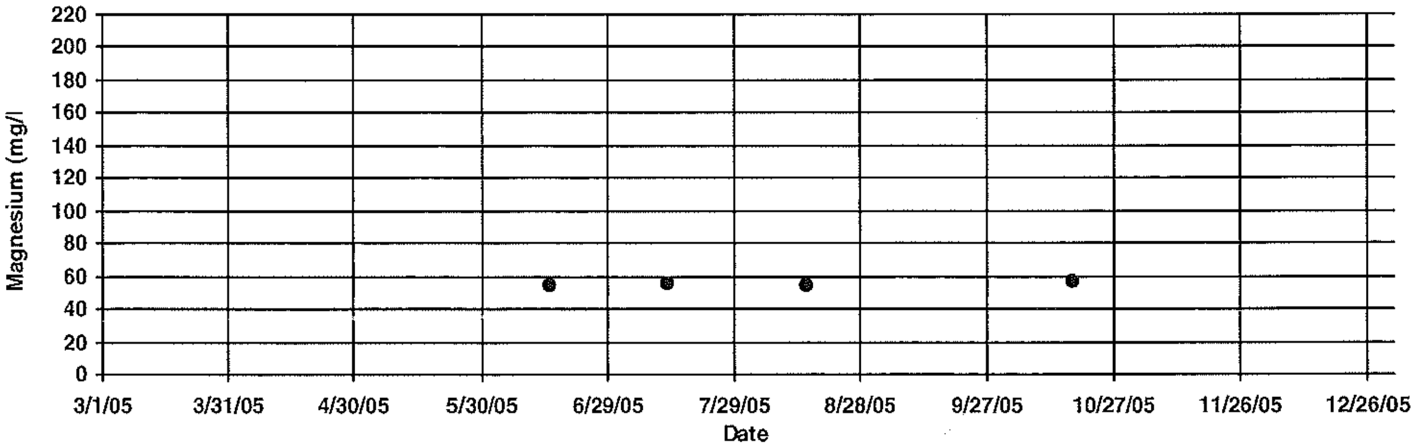

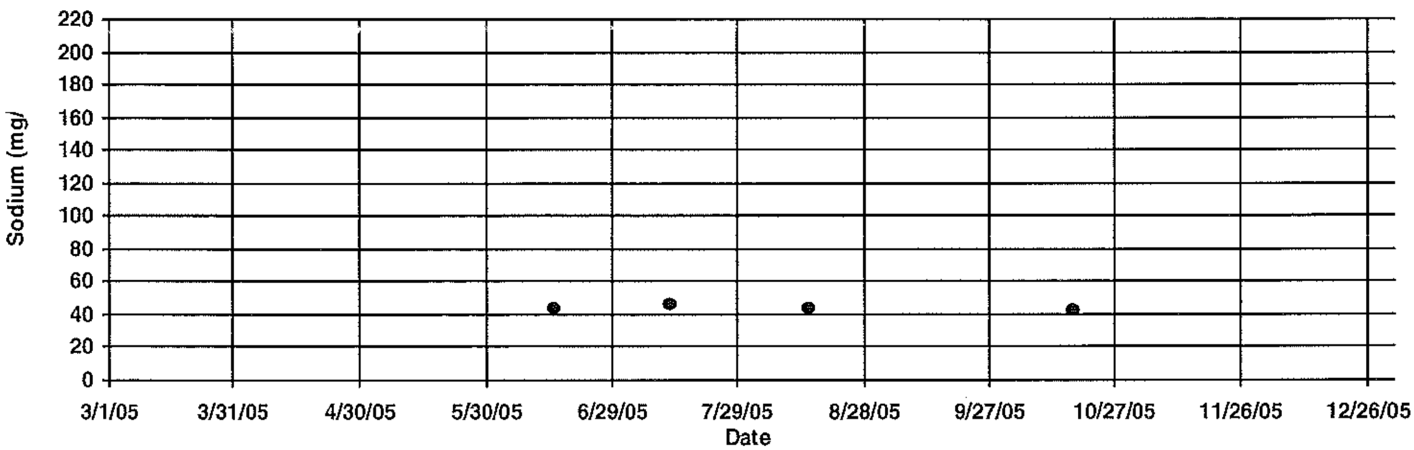

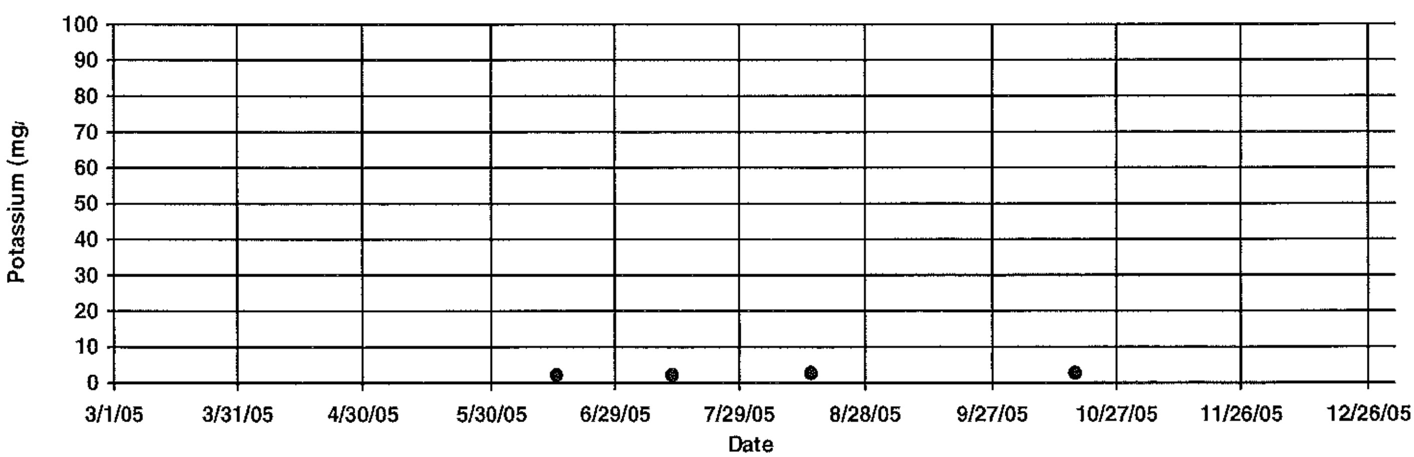

Study Site No. HG13 Narrows Seep Site No.: 19

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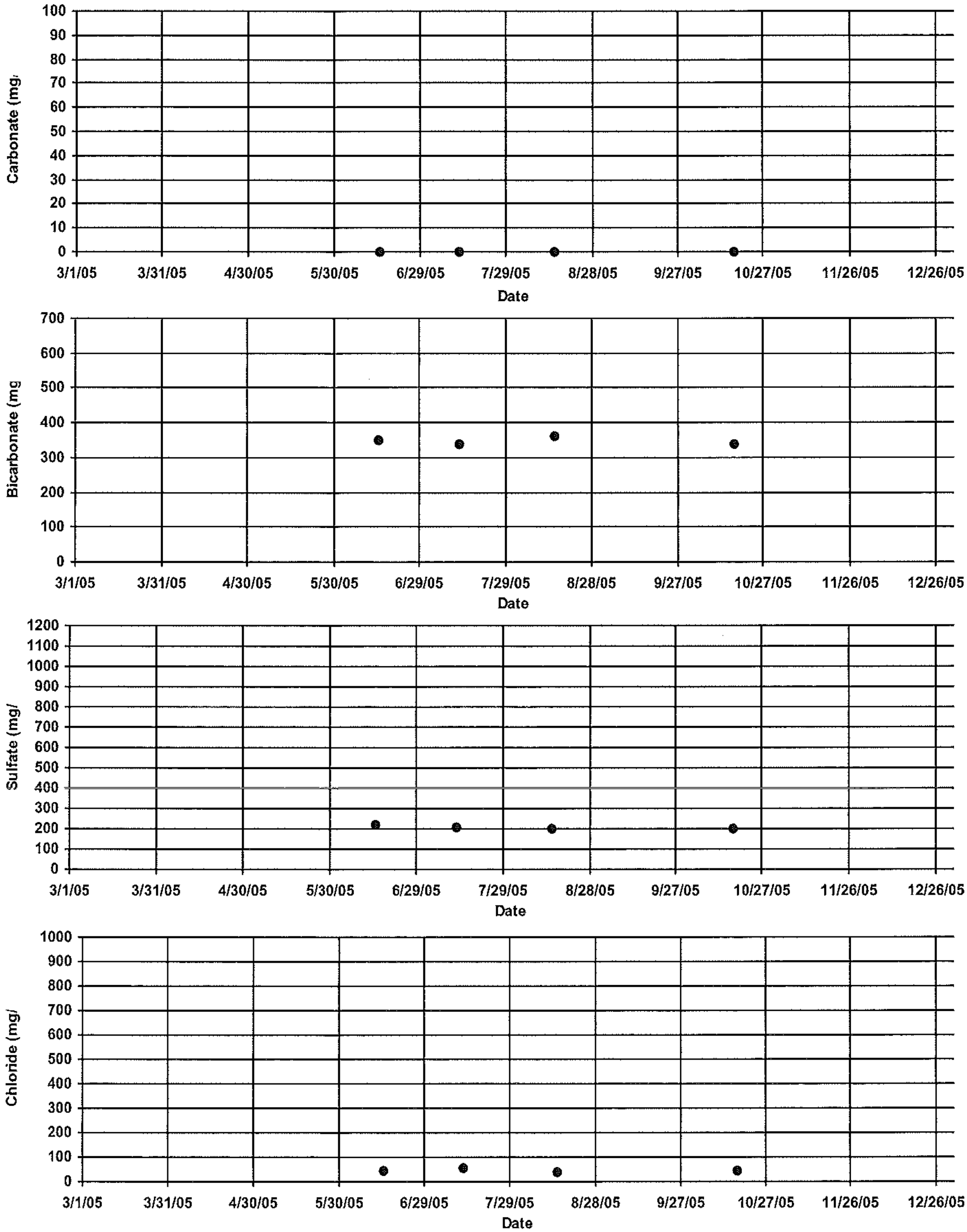

Study Site No. HG13 Narrows Seep Site No.: 19

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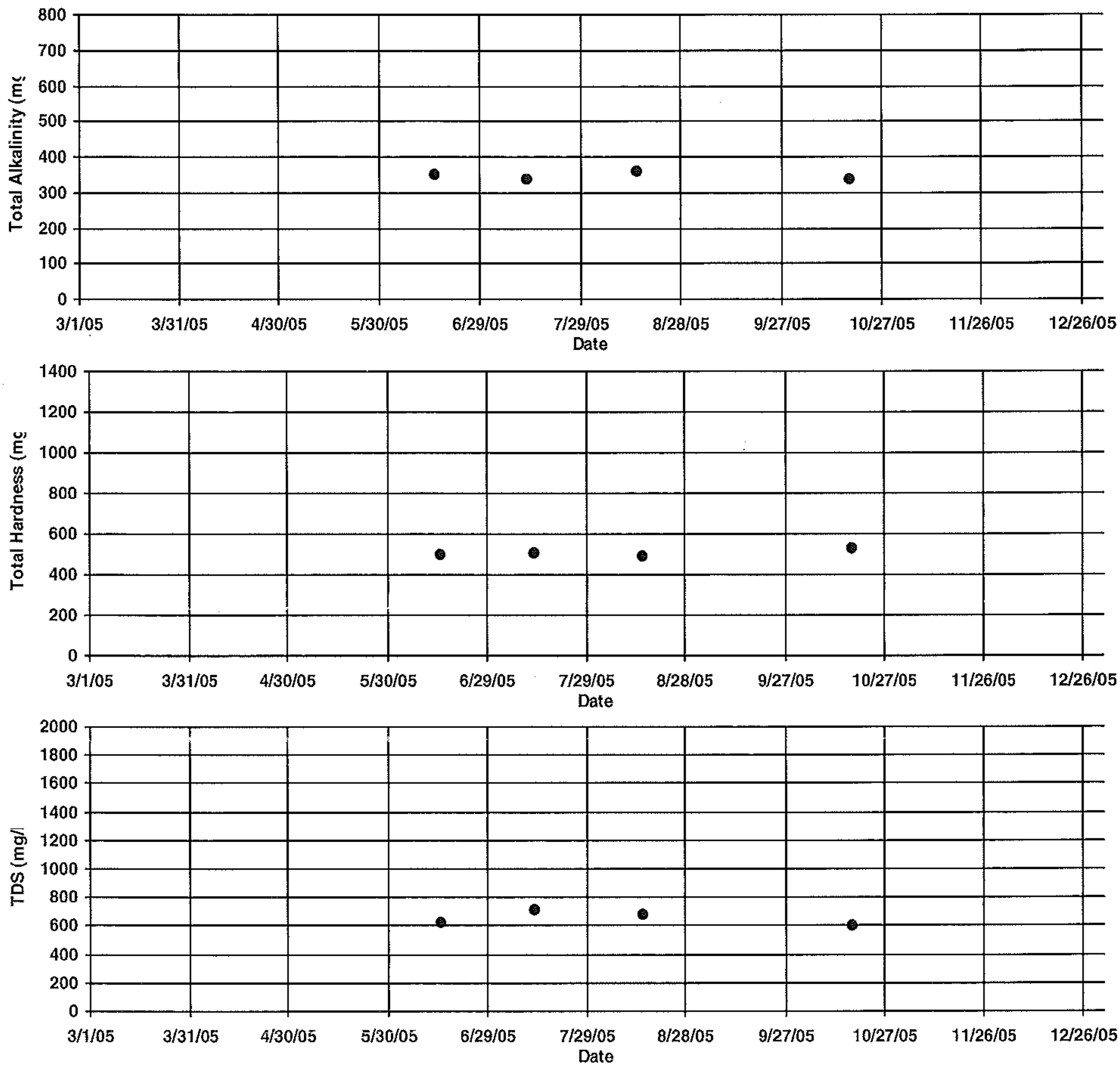
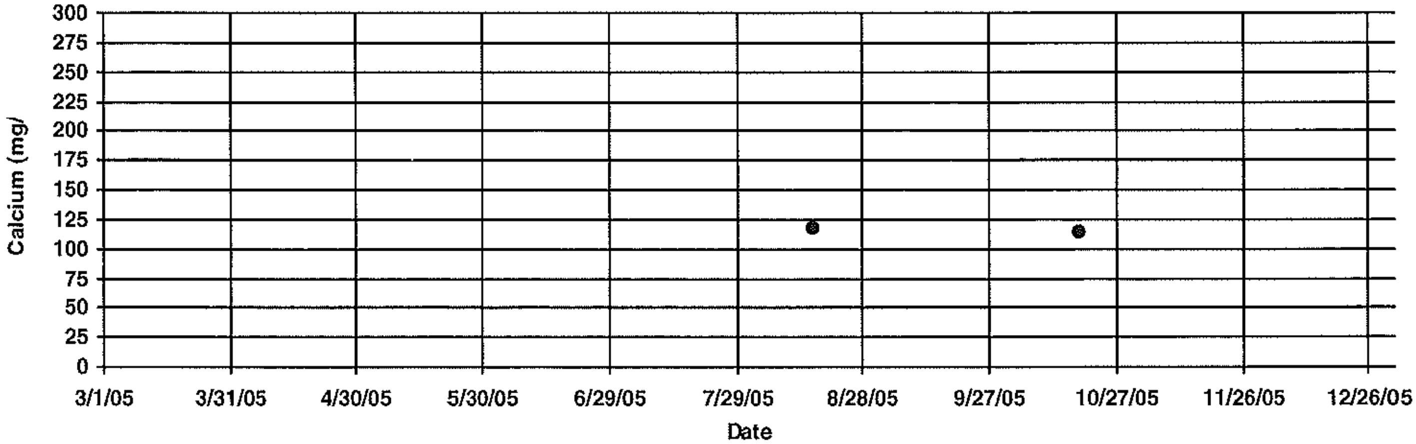
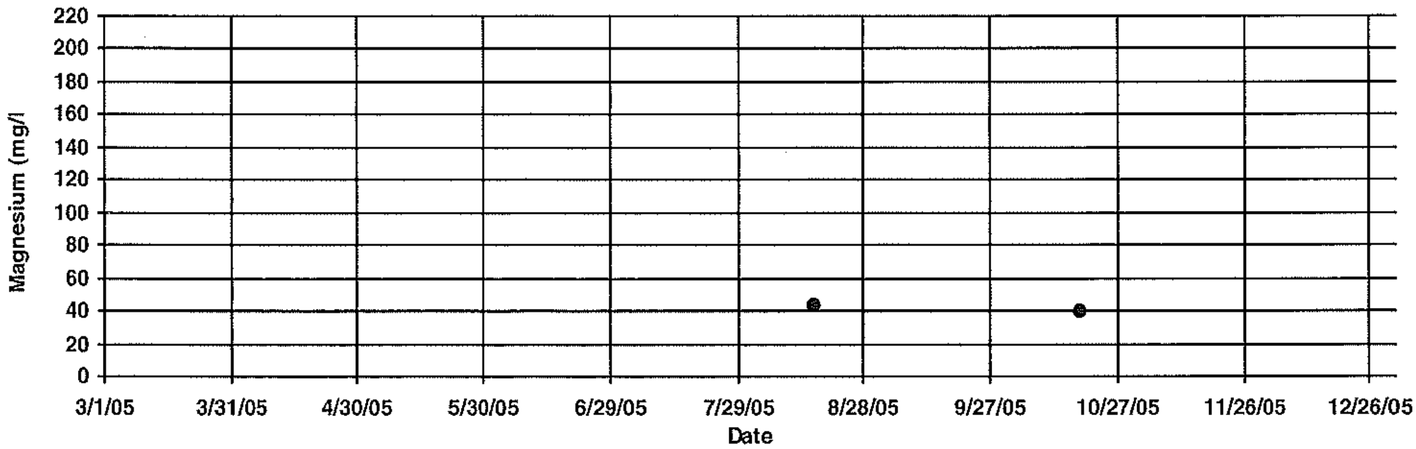
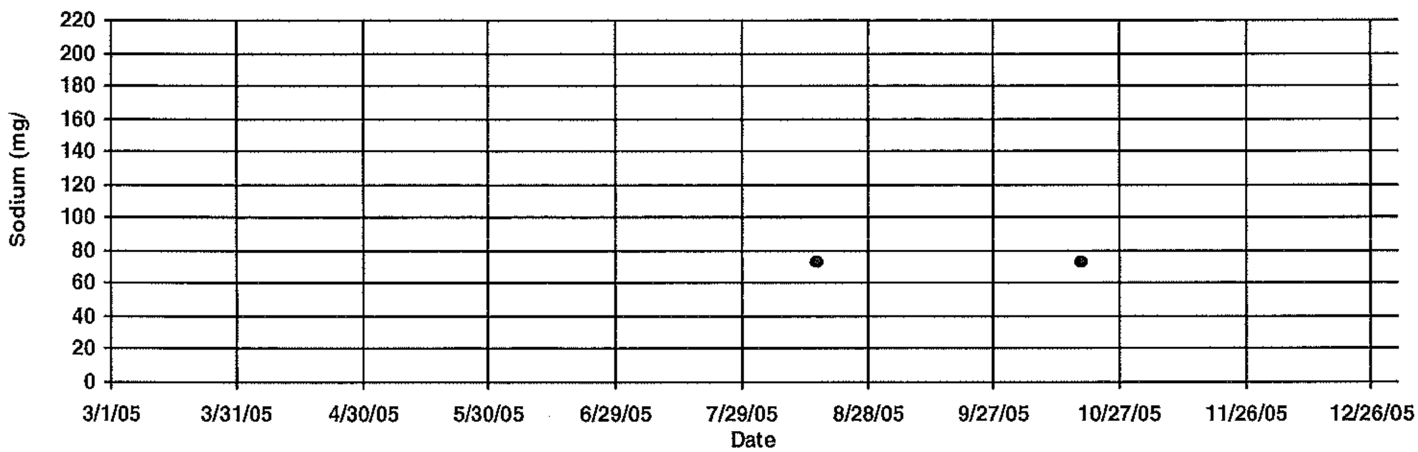


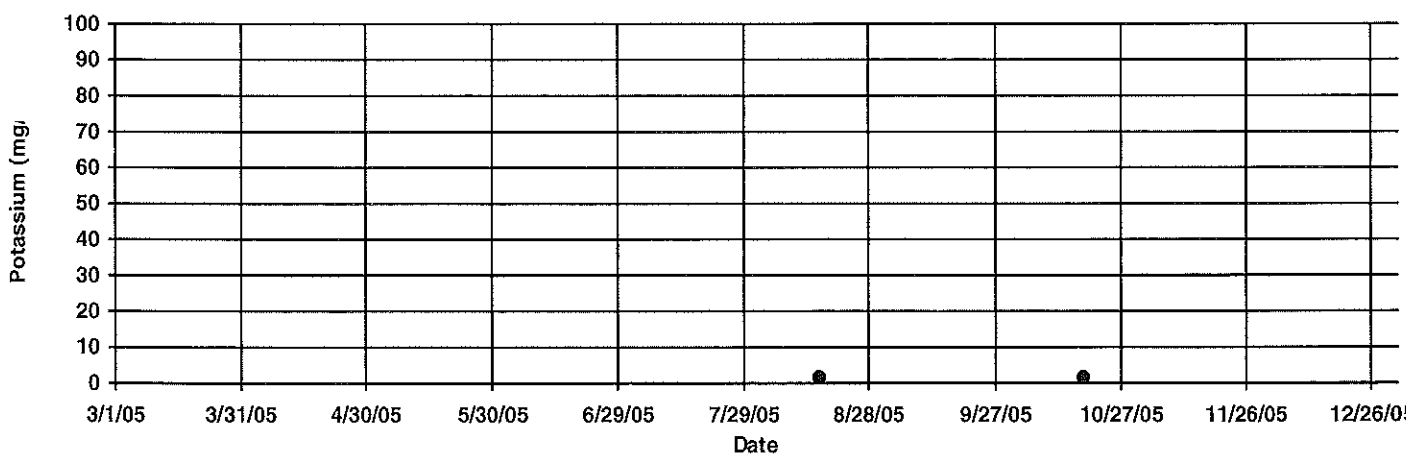
Study Site No. HG14 Duck Seep/Kevin Pool Site No.: 20

GENERAL MINERAL DATA



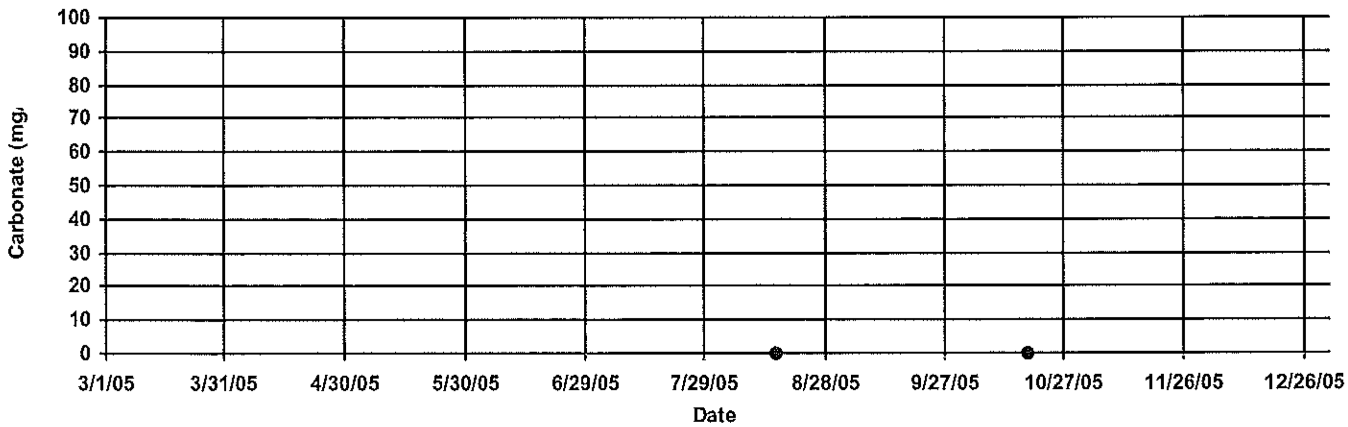


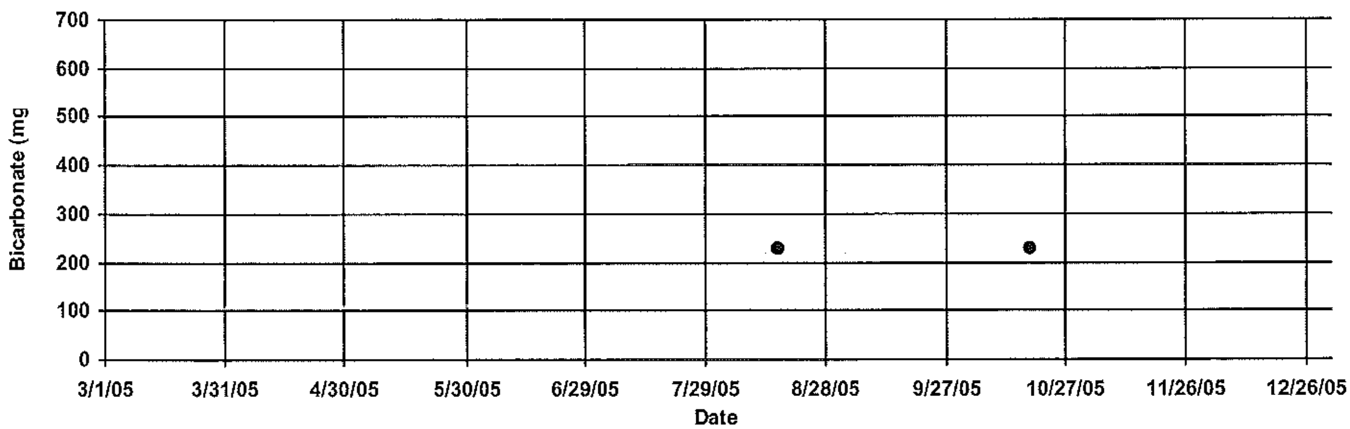


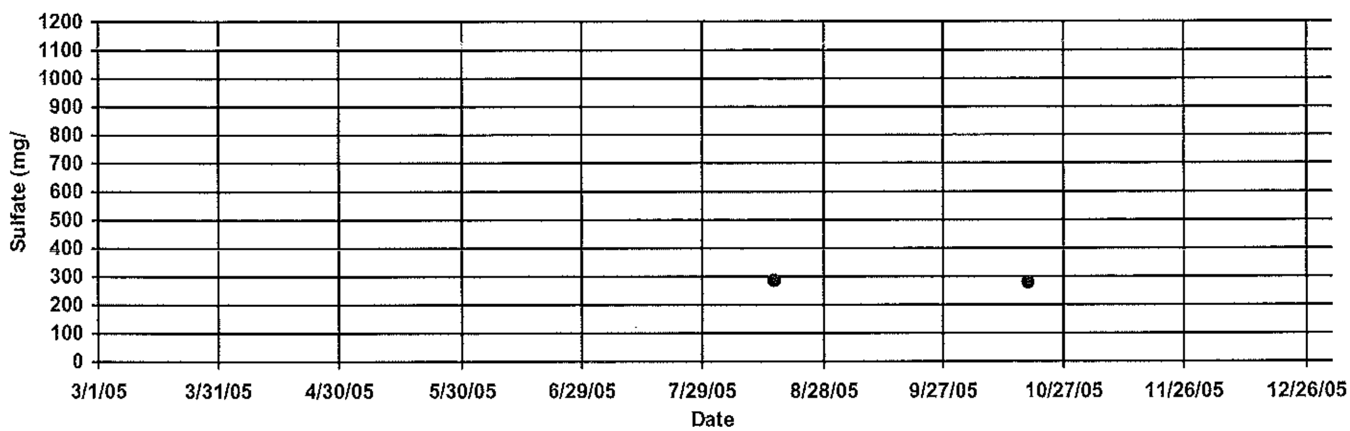


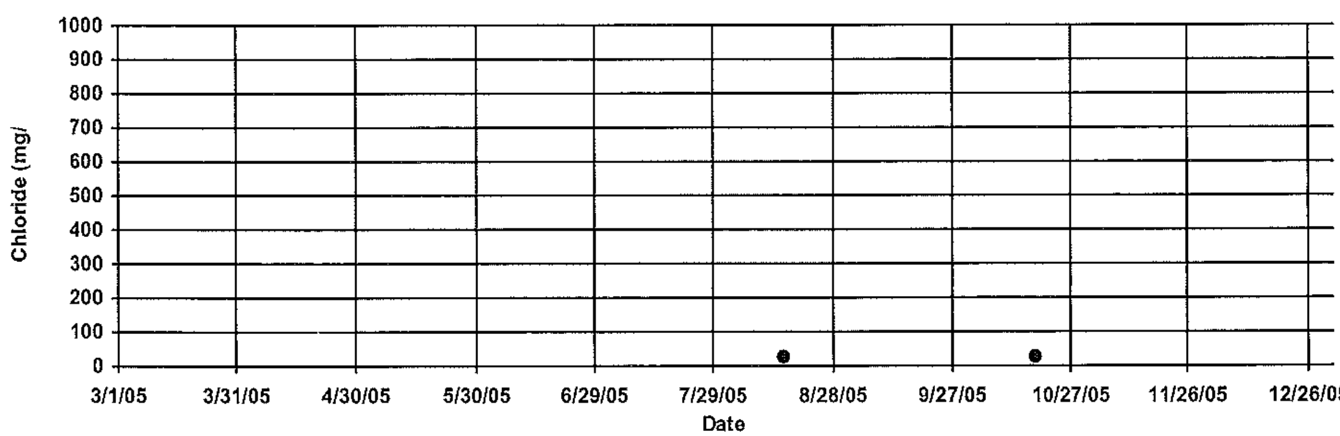
Study Site No. HG14 Duck Seep/Kevin Pool Site No.: 20

GENERAL MINERAL DATA



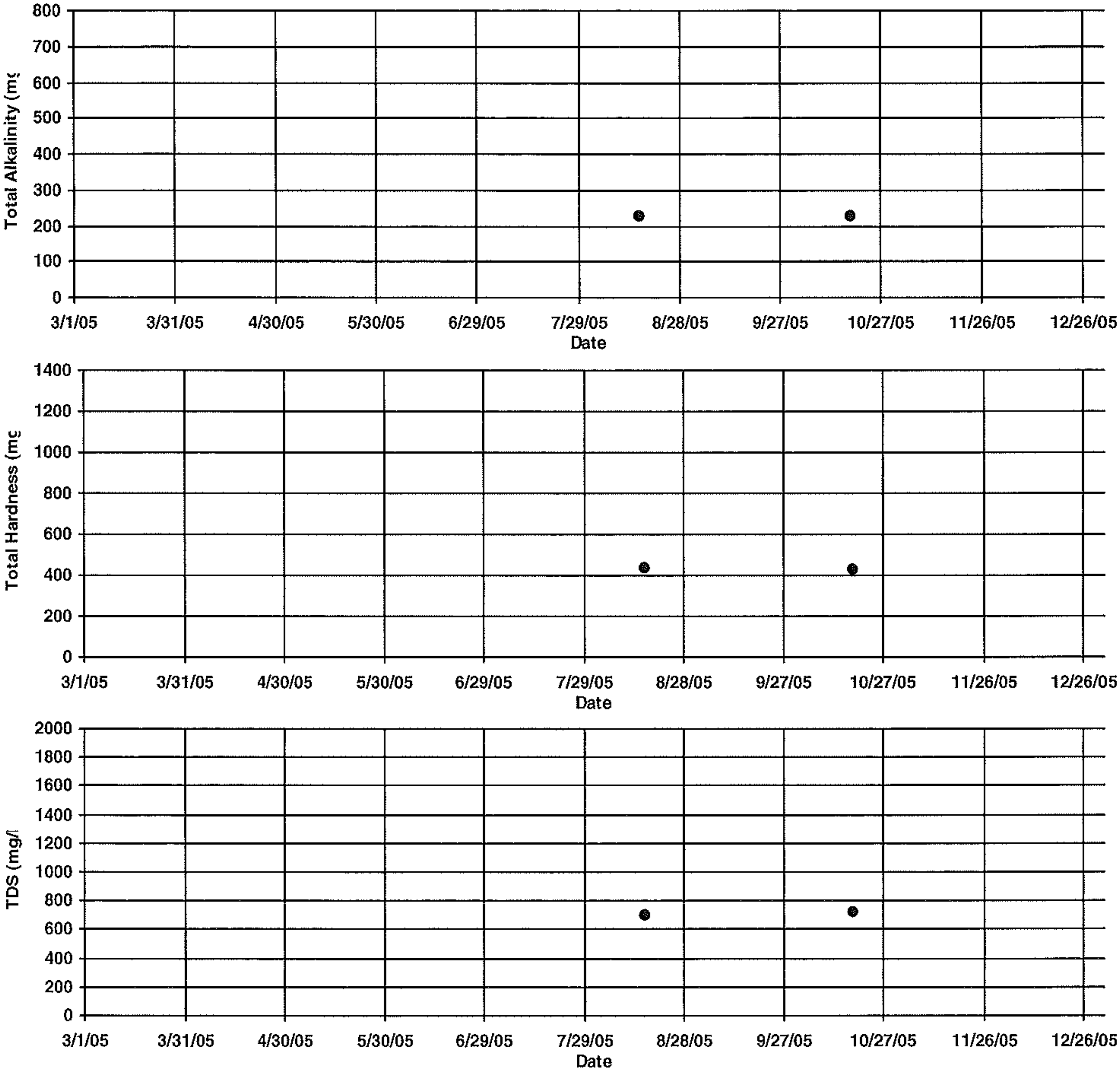






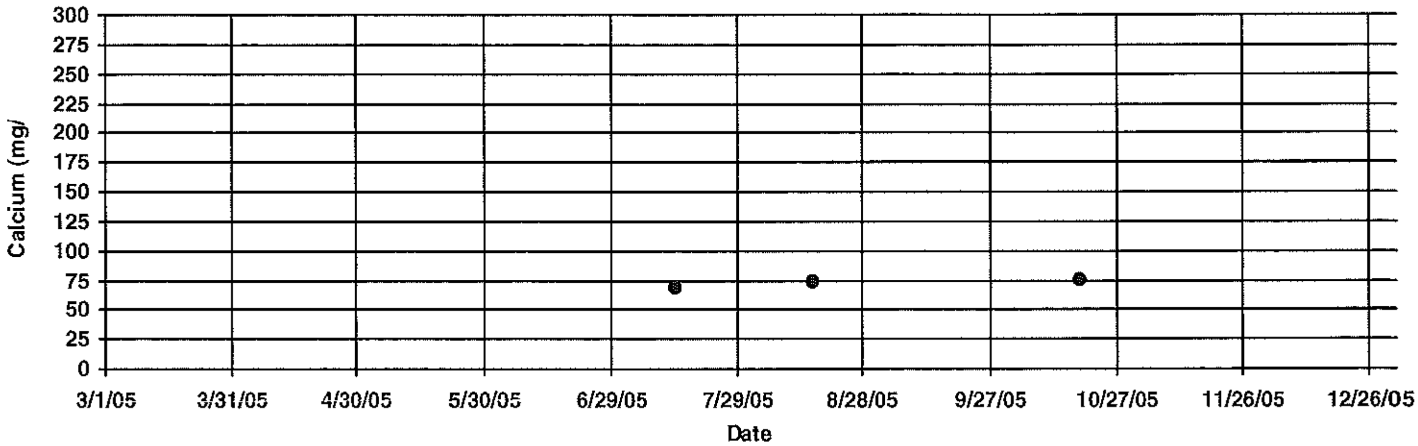
Study Site No. HG14 Duck Seep/Kevin Pool Site No.: 20

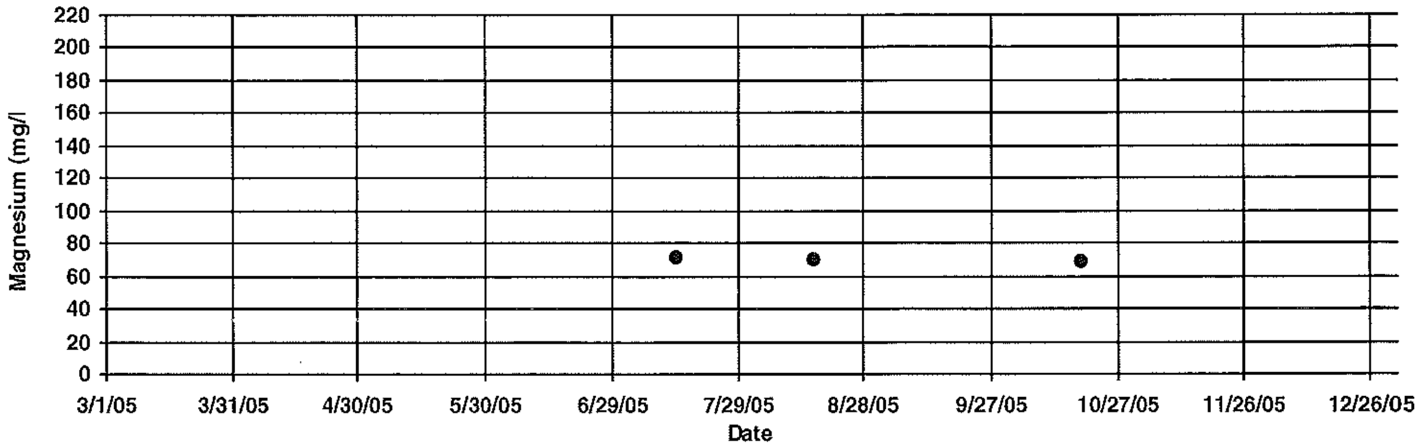
GENERAL MINERAL DATA

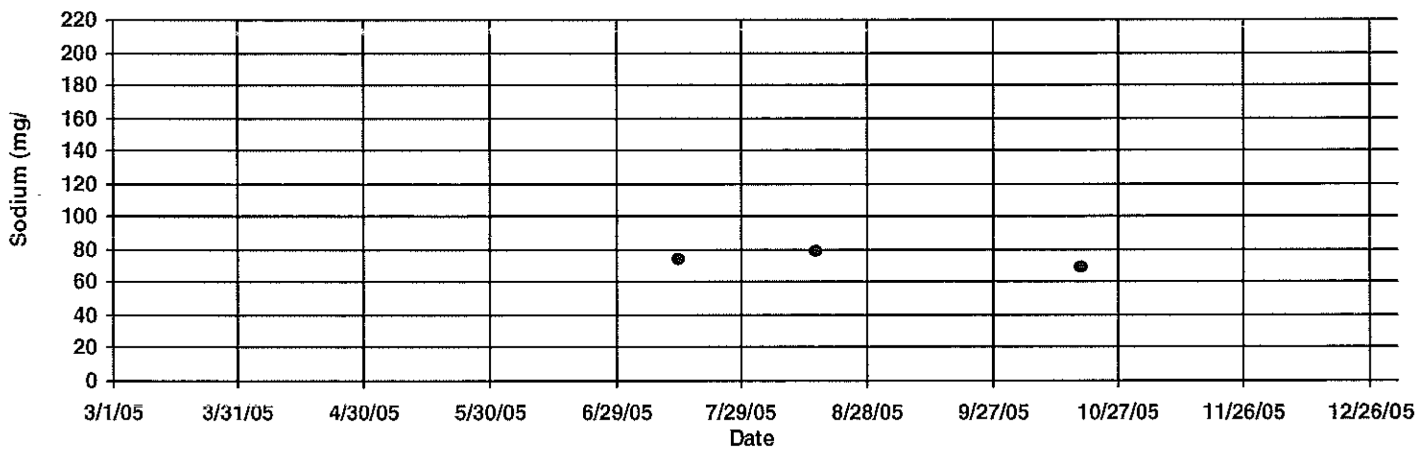


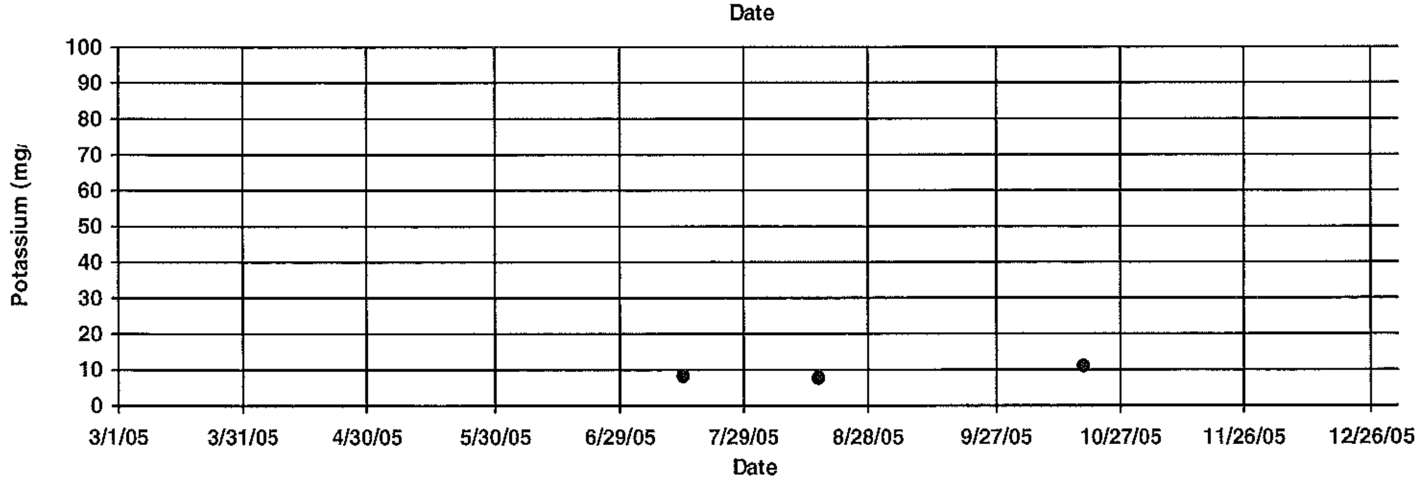
Study Site No. HG15 Storm Falls Site No.: 27

GENERAL MINERAL DATA



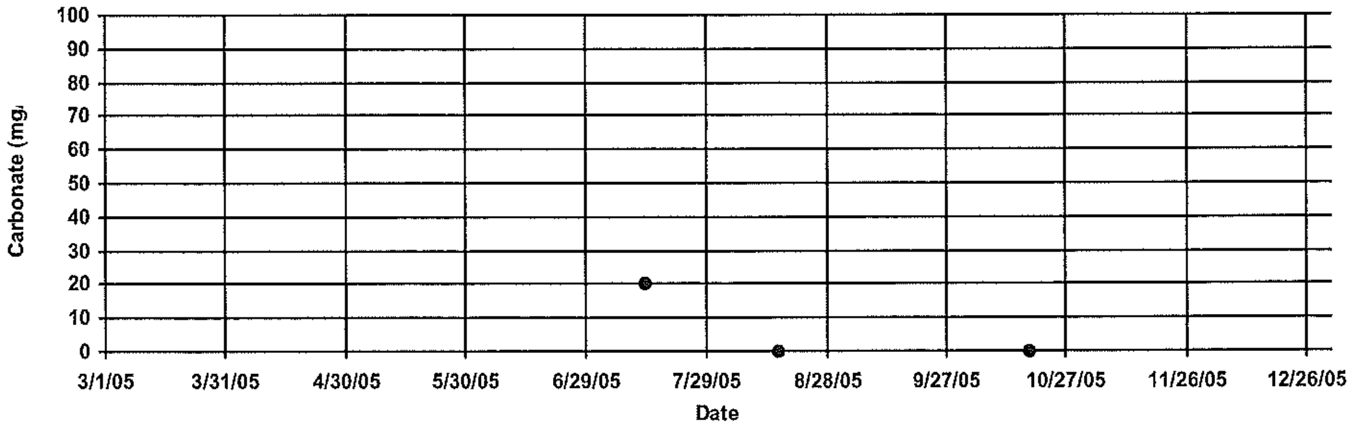


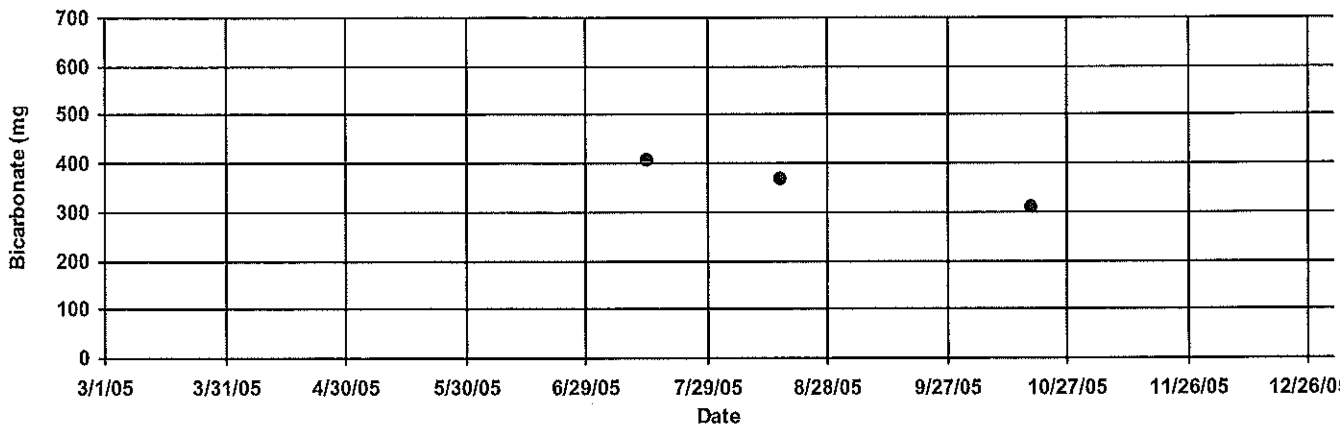


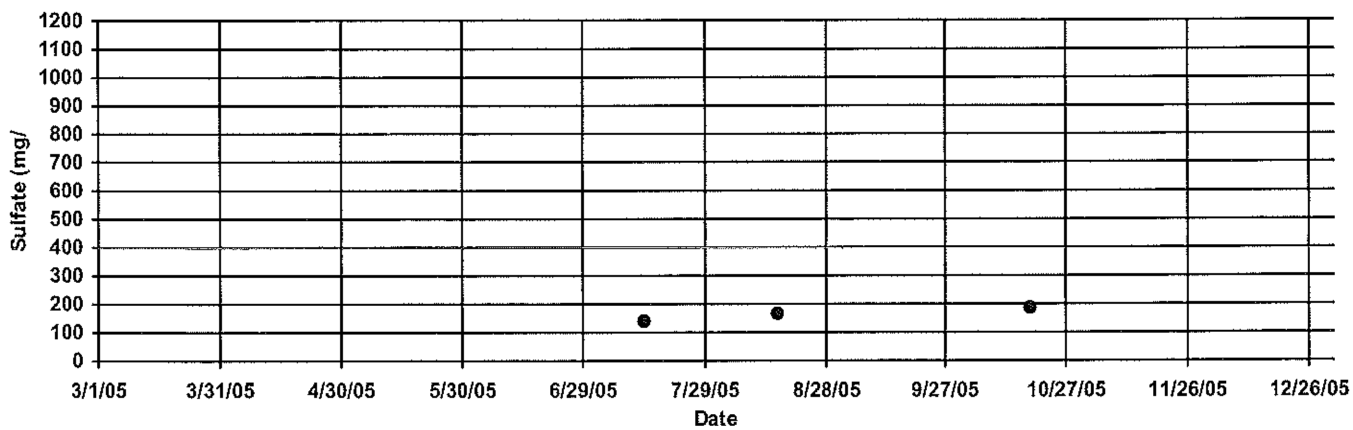


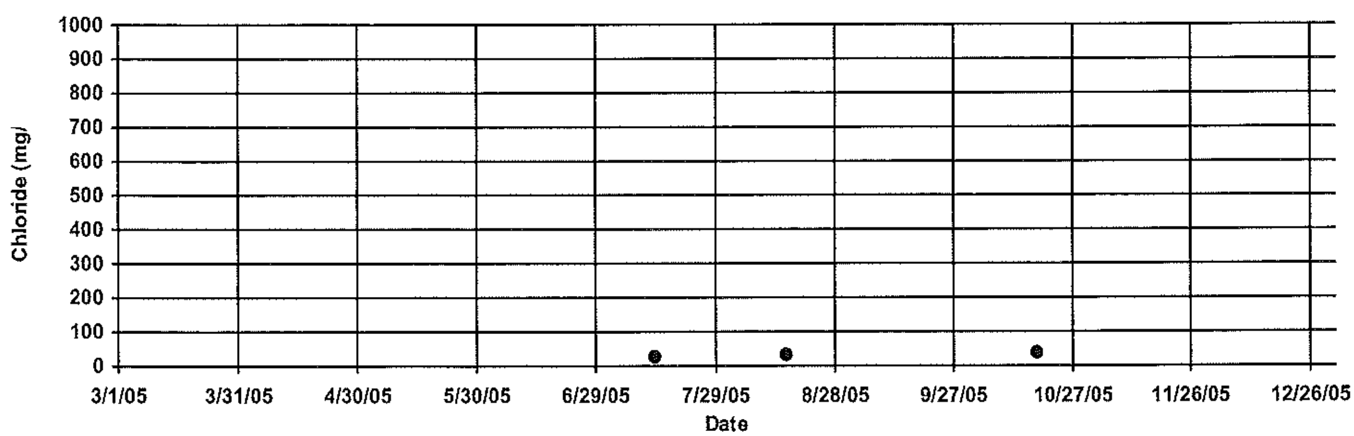
Study Site No. HG15 Storm Falls Site No.: 27

GENERAL MINERAL DATA



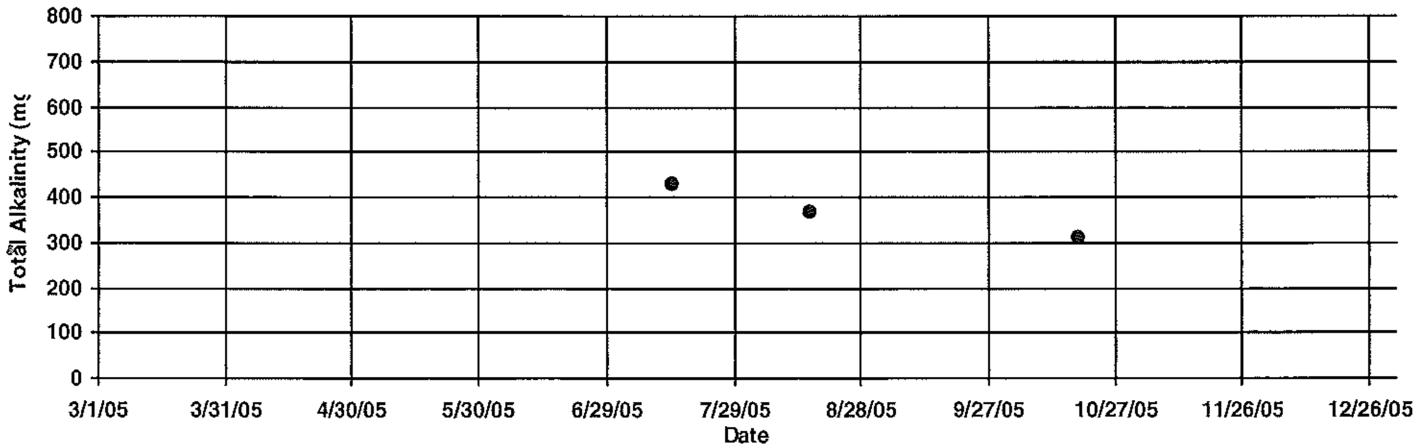


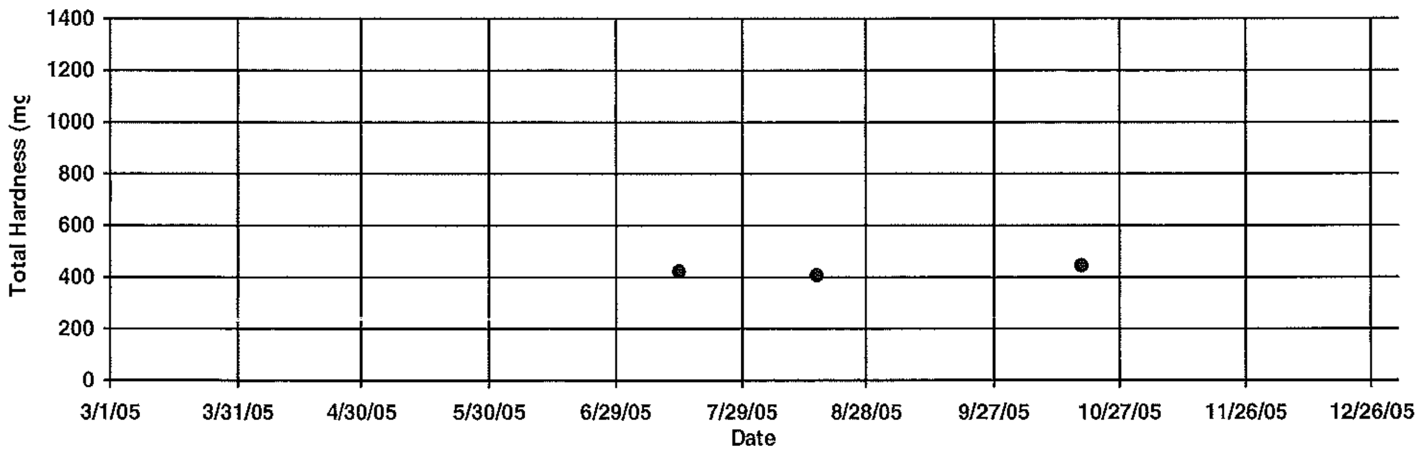


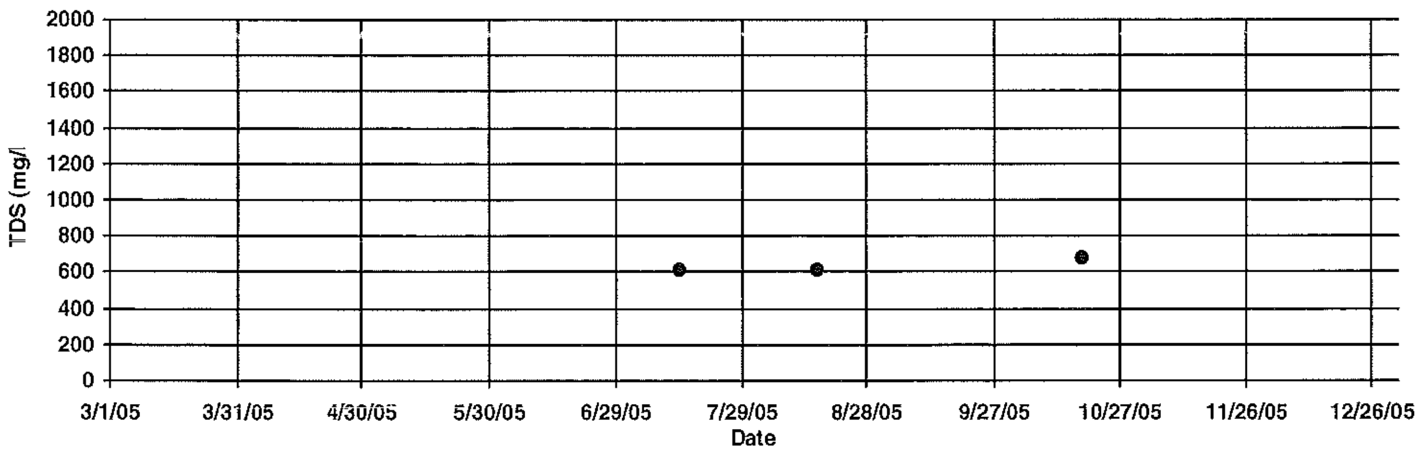


Study Site No. HG15 Storm Falls Site No.: 27

GENERAL MINERAL DATA

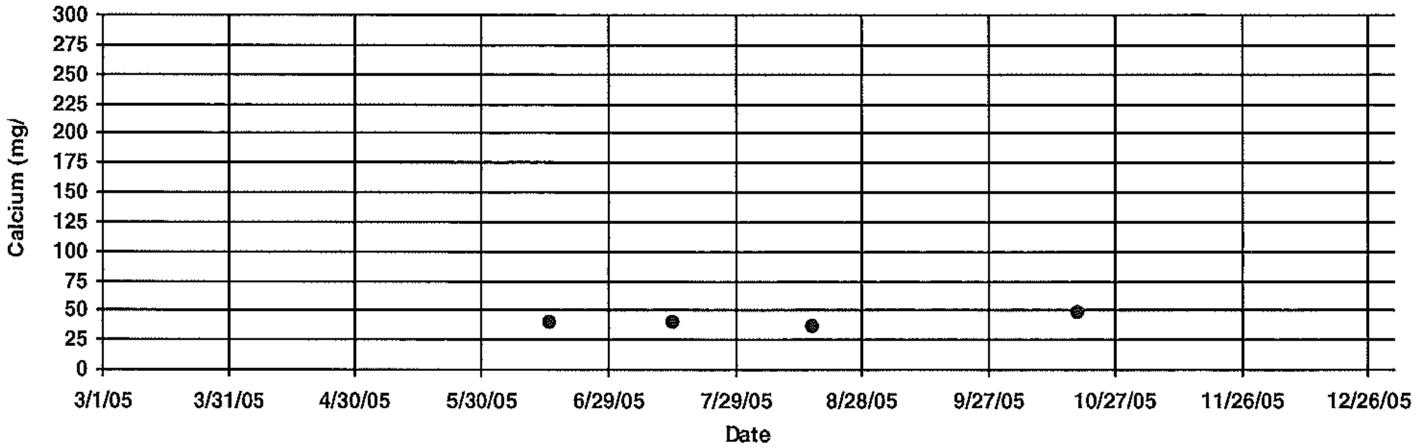


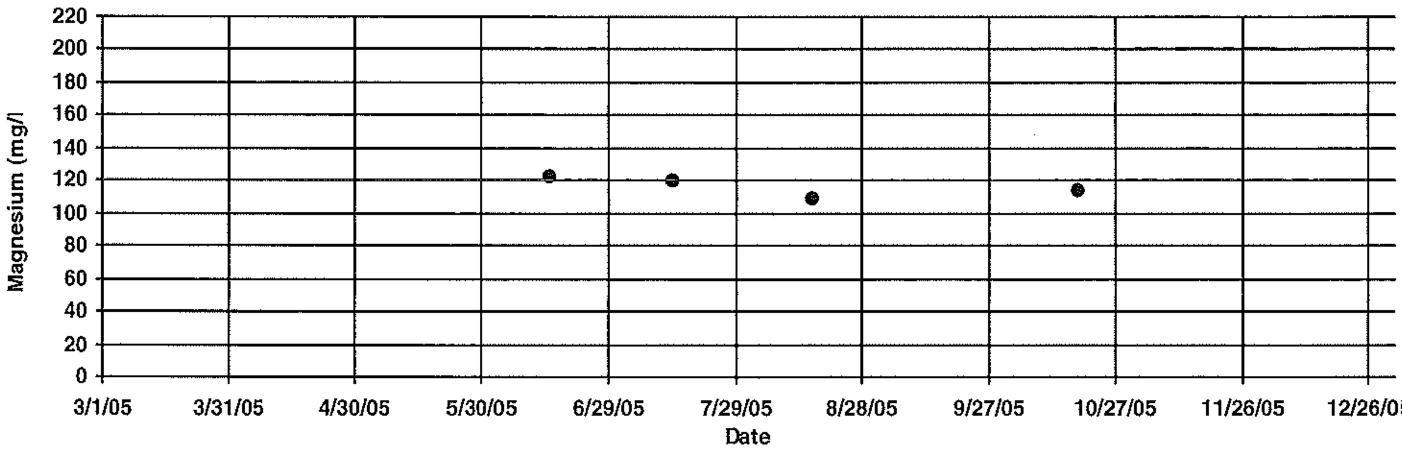


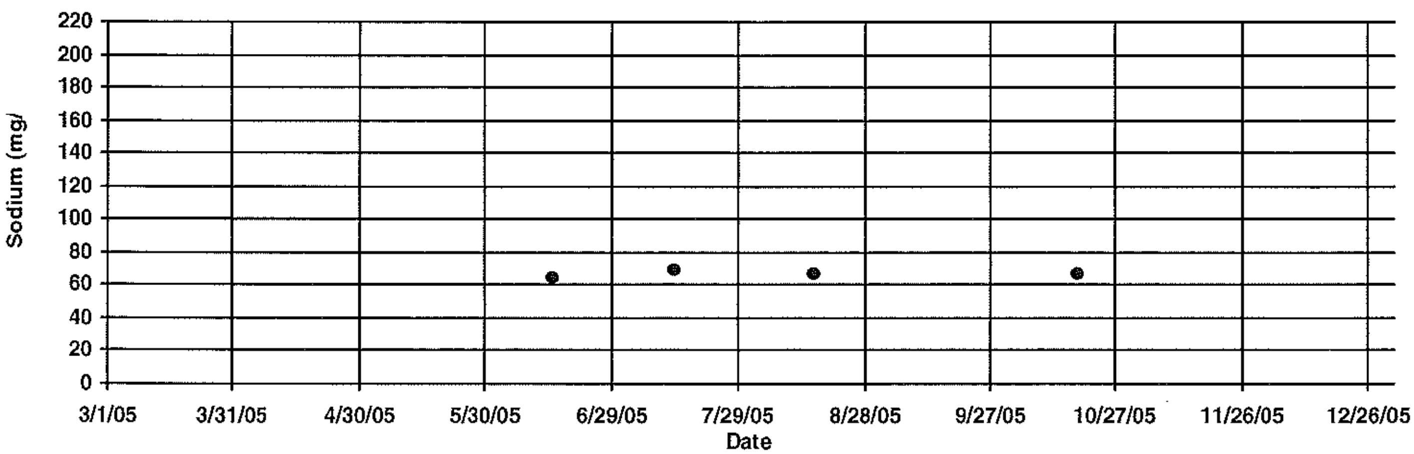


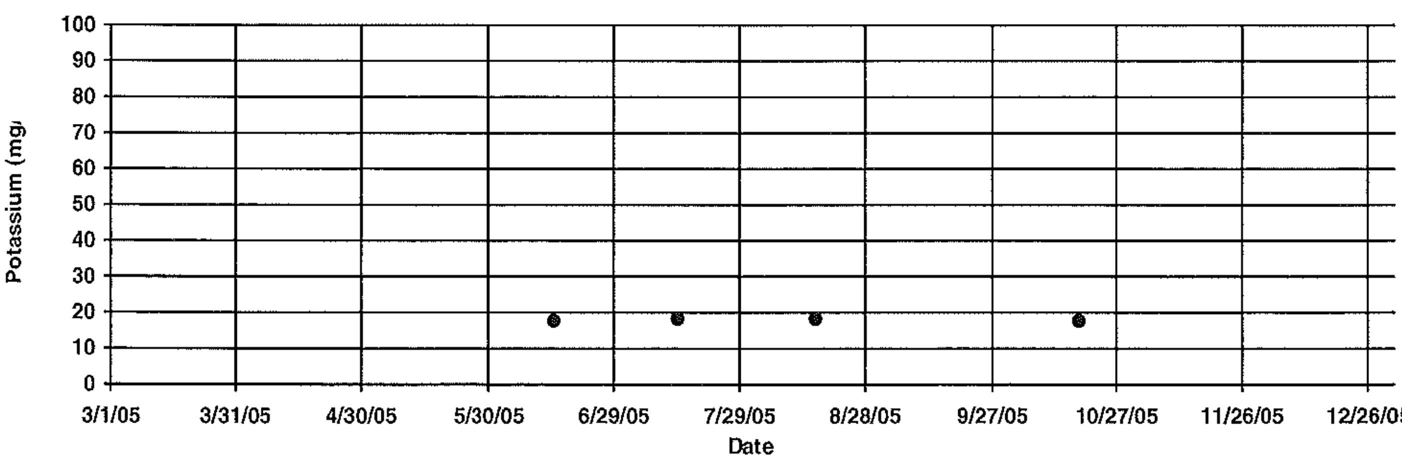
Study Site No. HG16 Dead Alder Falls Site No.: 31

GENERAL MINERAL DATA



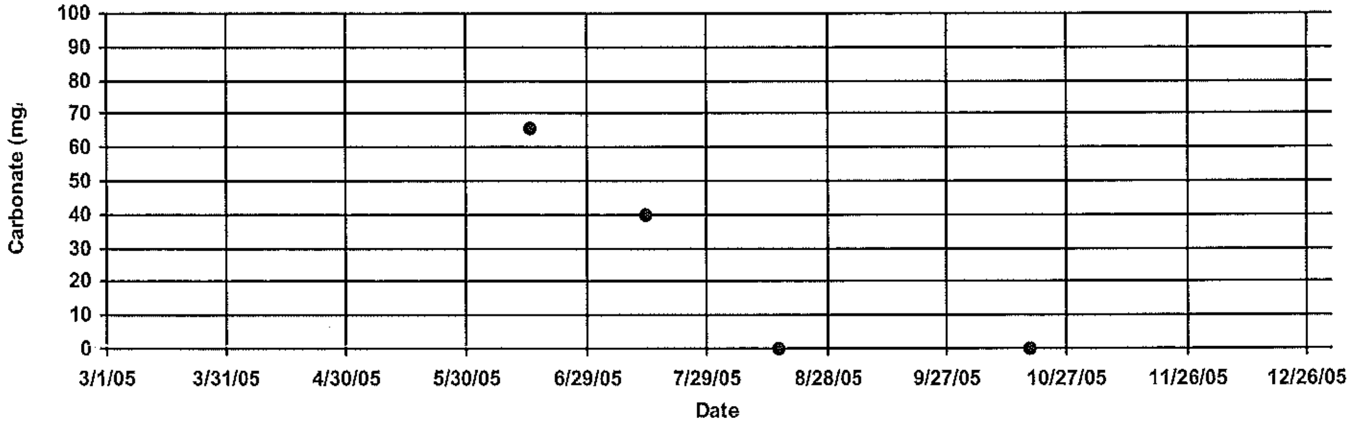


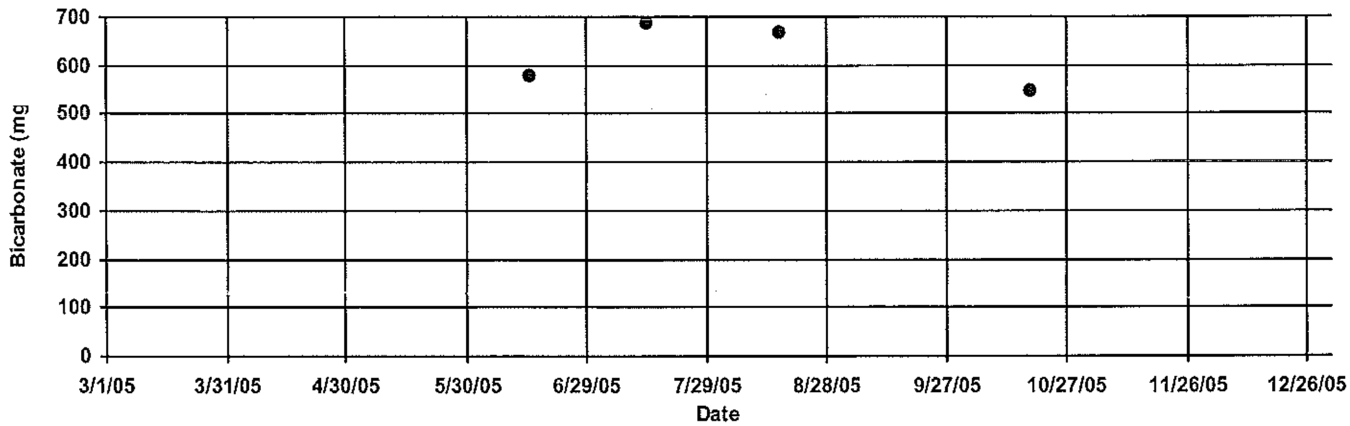


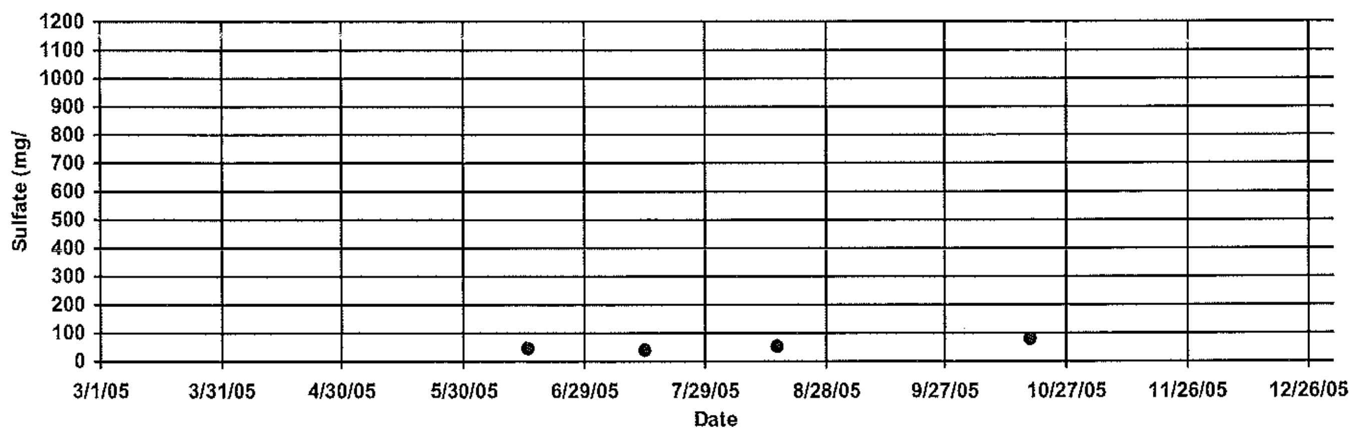


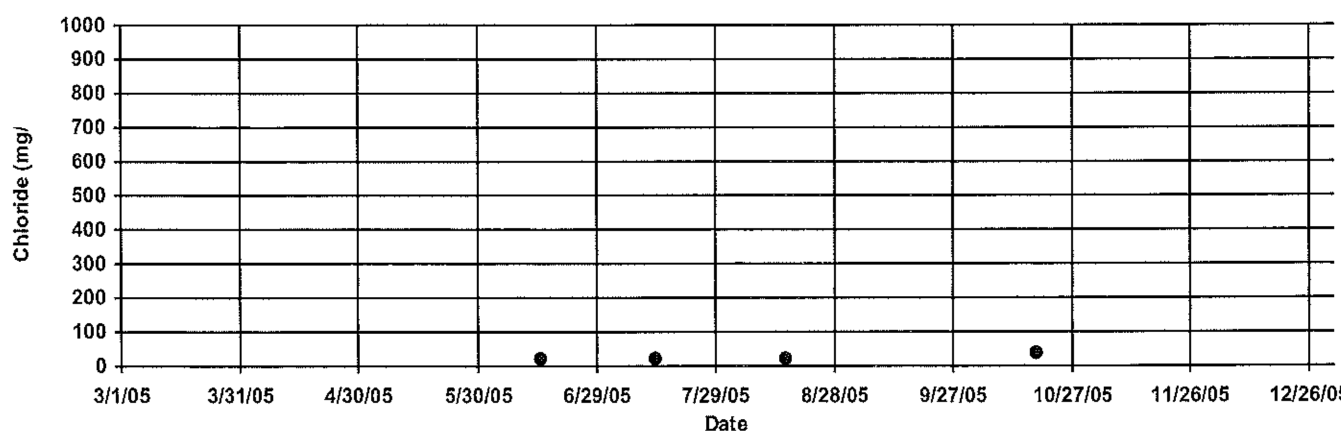
Study Site No. HG16 Dead Alder Falls Site No.: 31

GENERAL MINERAL DATA



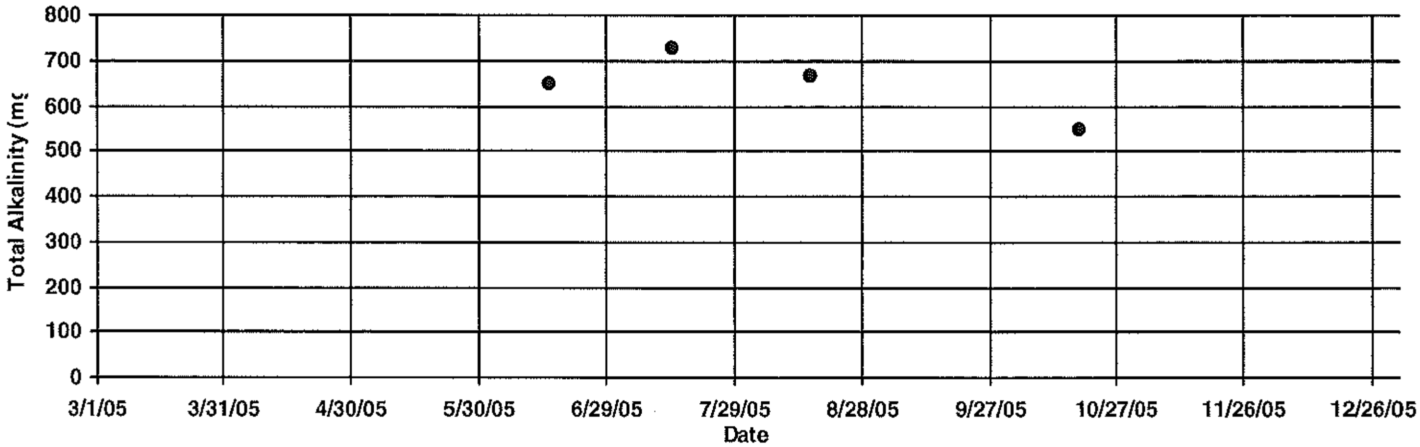


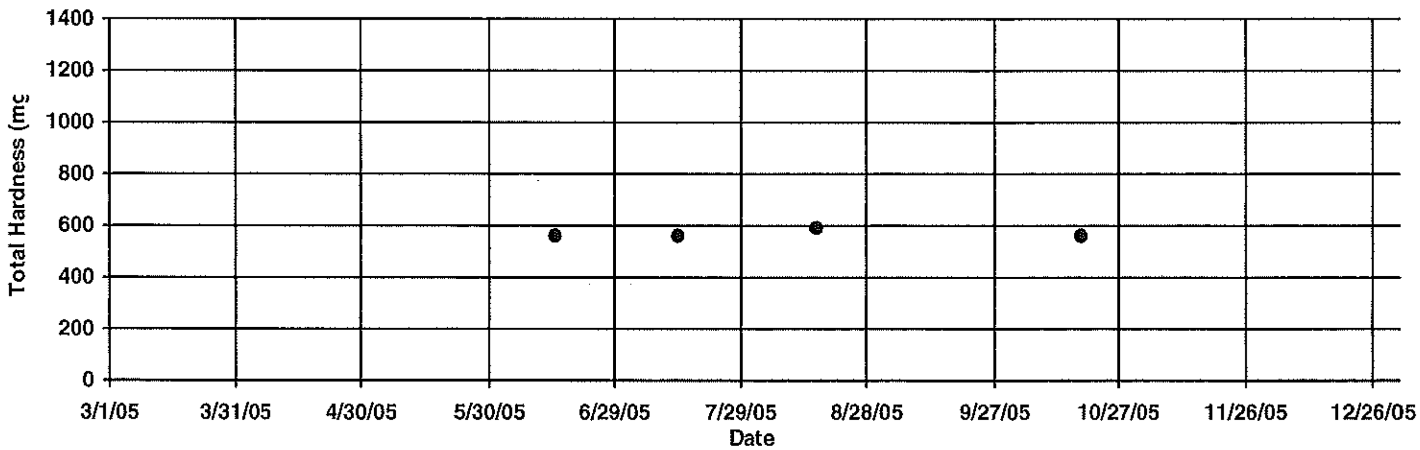


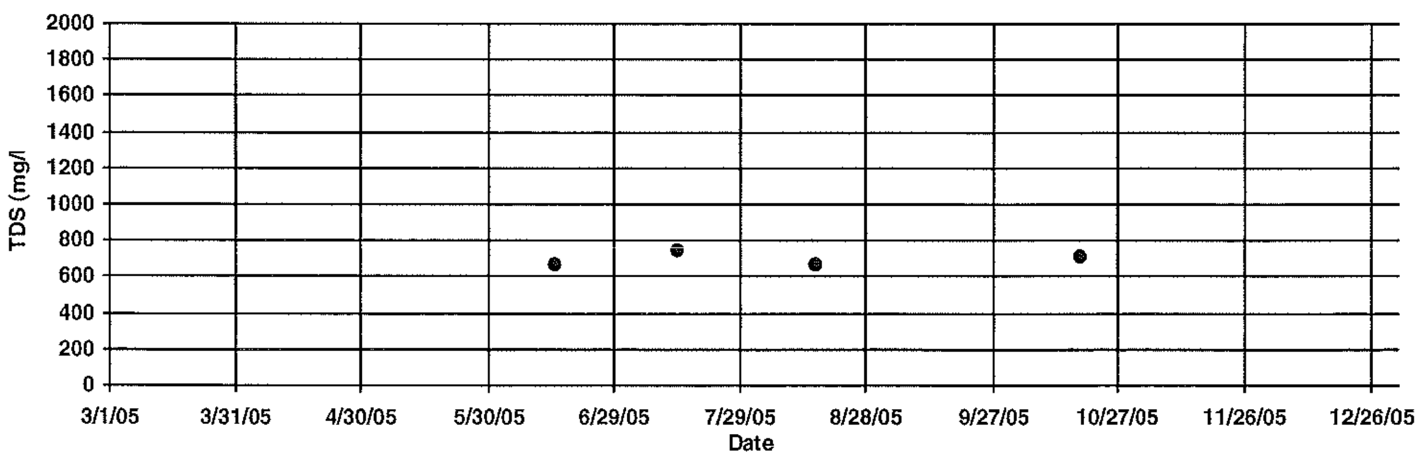


Study Site No. HG16 Dead Alder Falls Site No.: 31

GENERAL MINERAL DATA

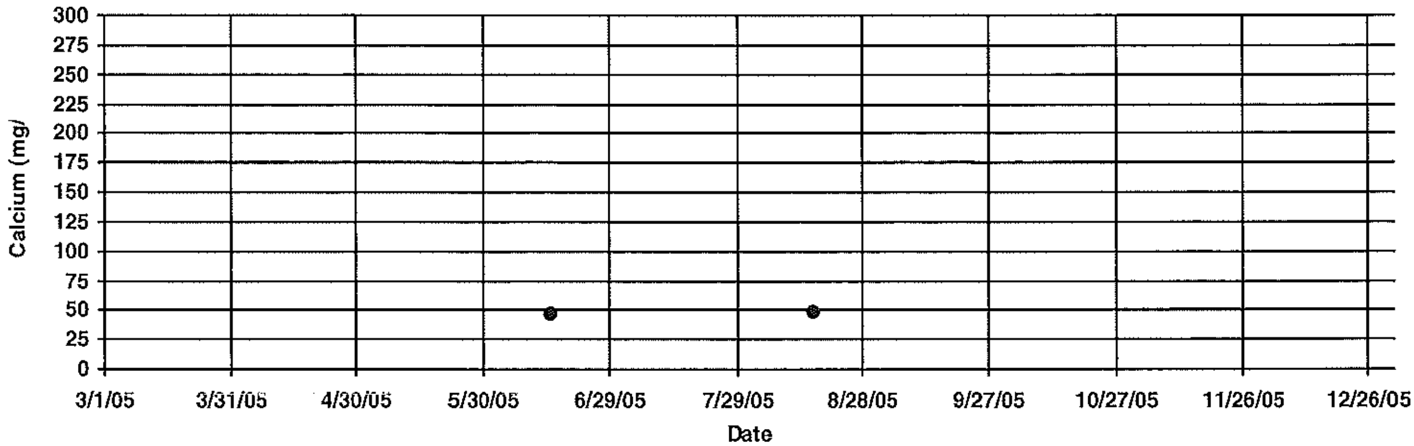


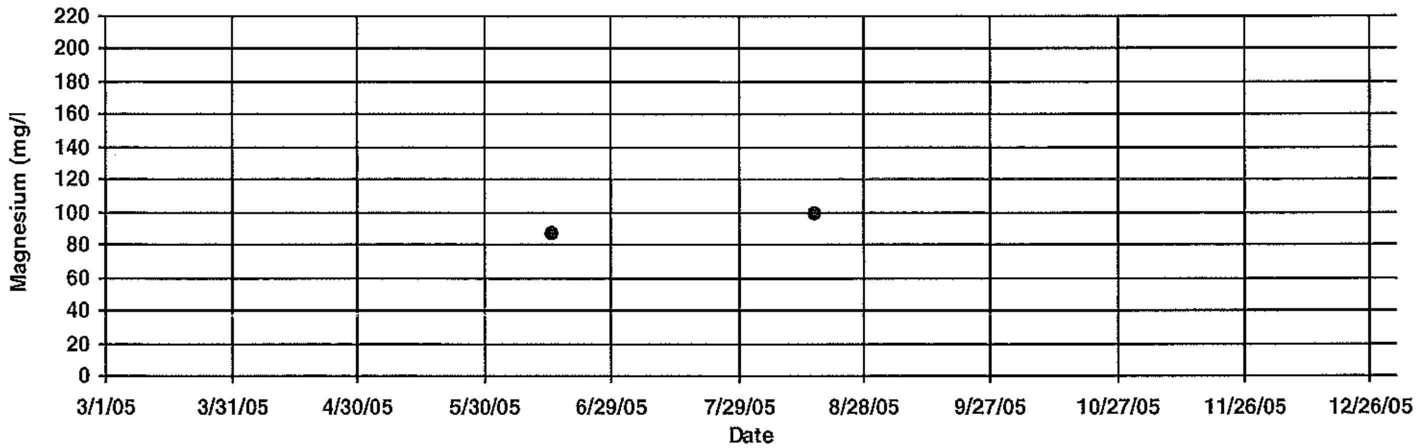


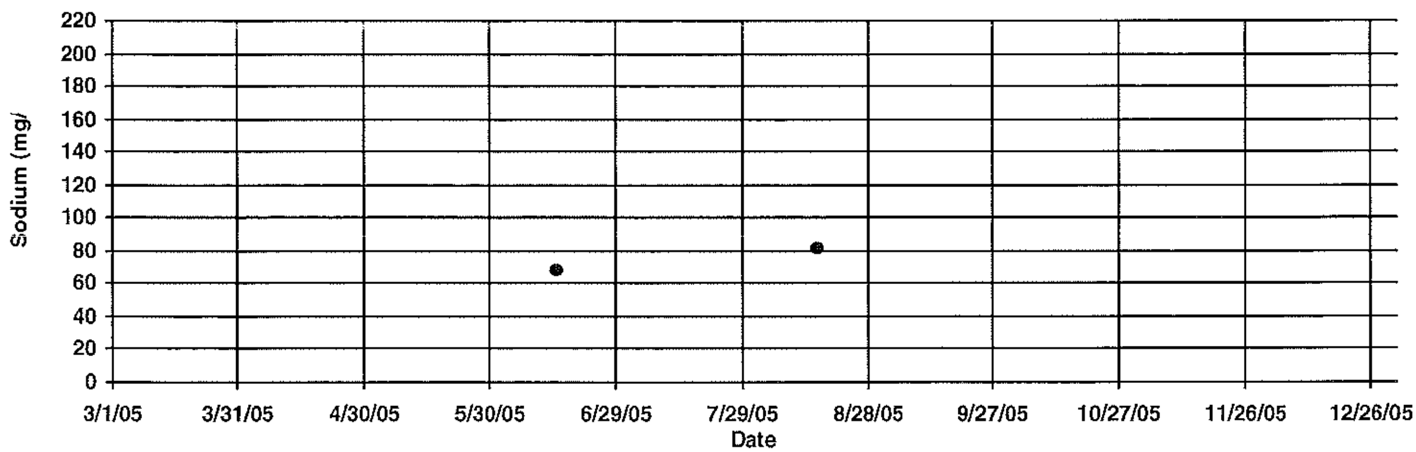


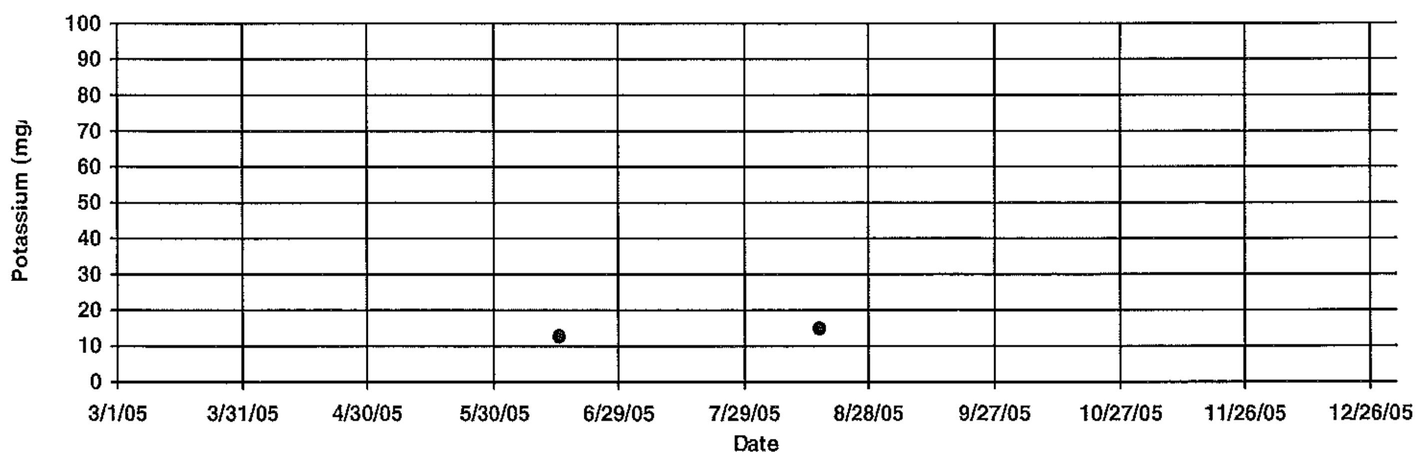
Study Site No. HG17 Elderberry Falls Site No.: 52

GENERAL MINERAL DATA



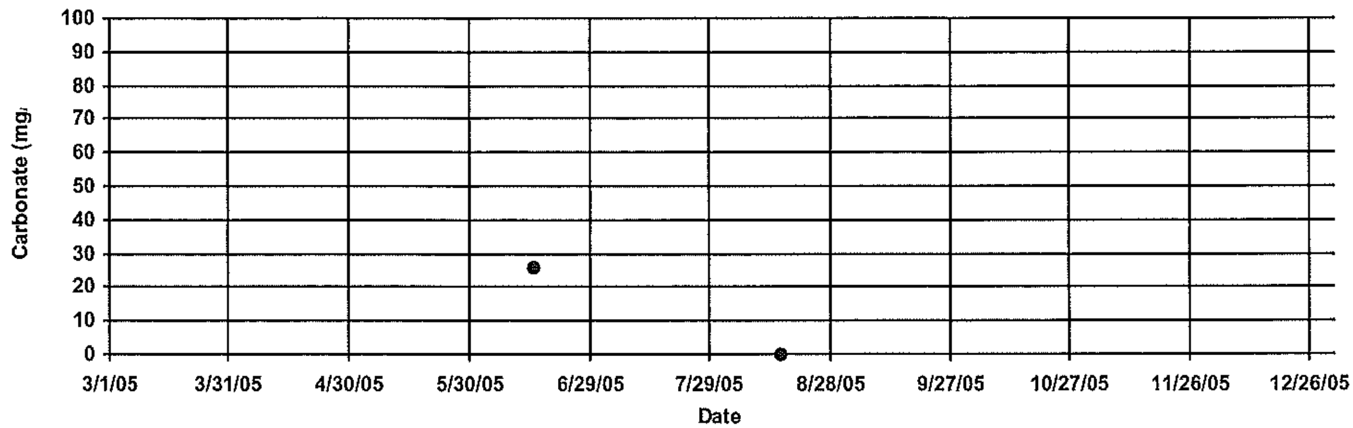


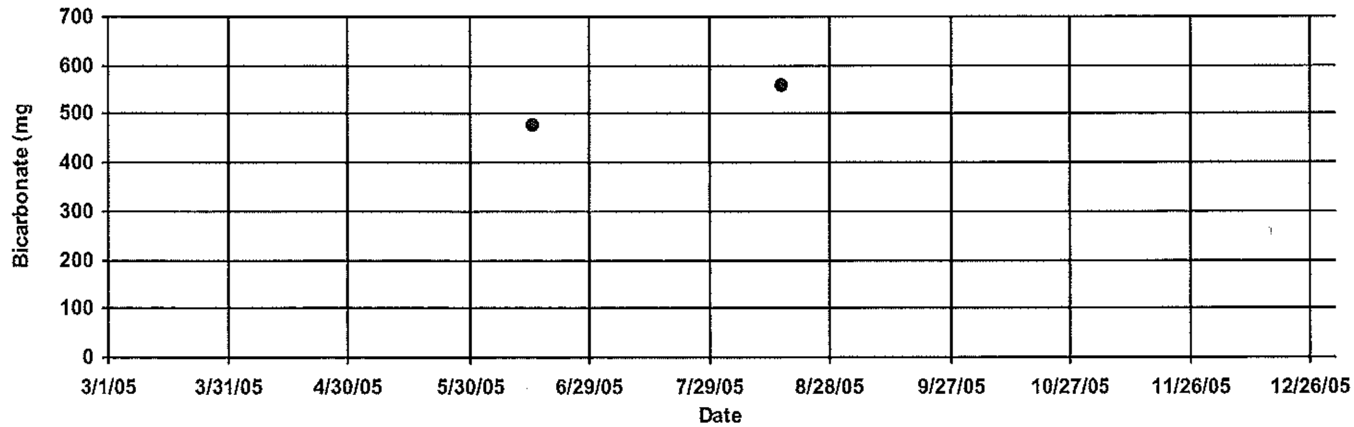


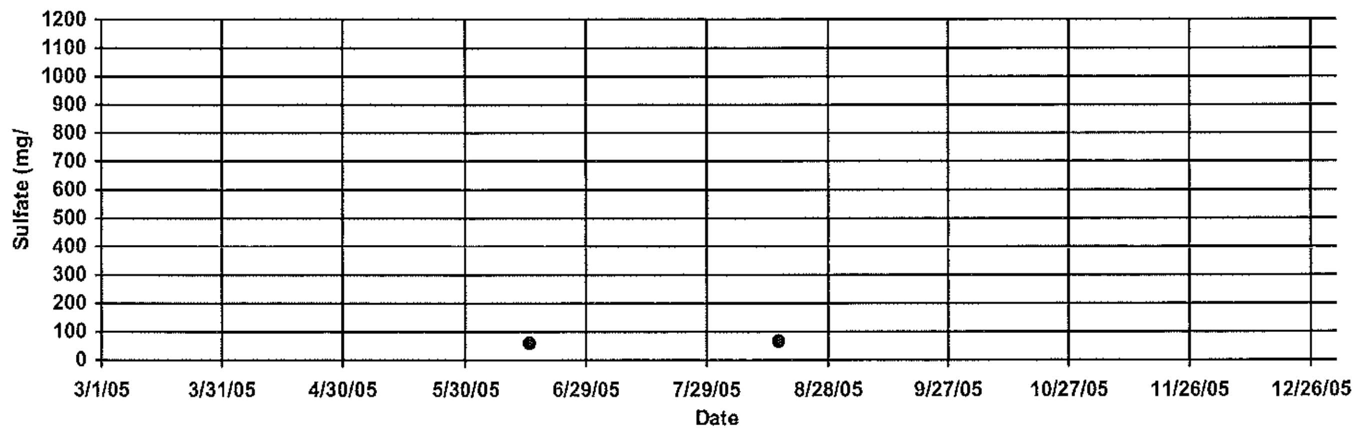


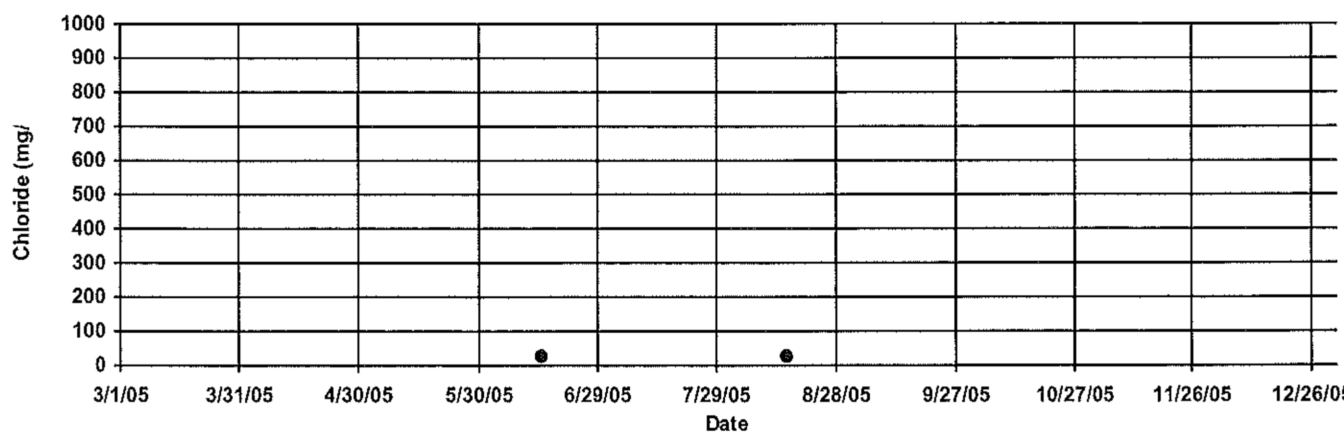
Study Site No. HG17 Elderberry Falls Site No.: 52

GENERAL MINERAL DATA



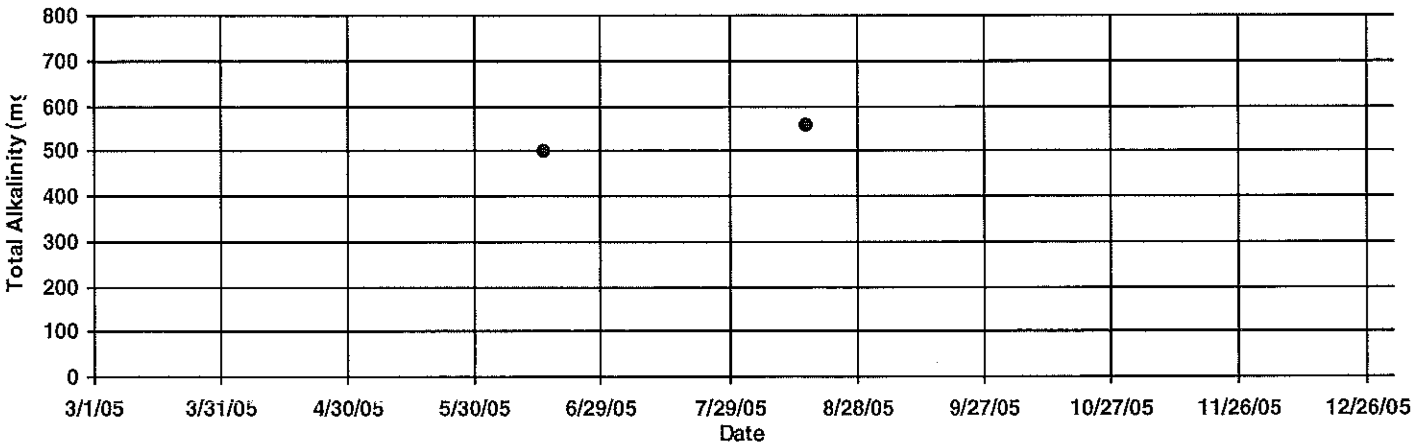


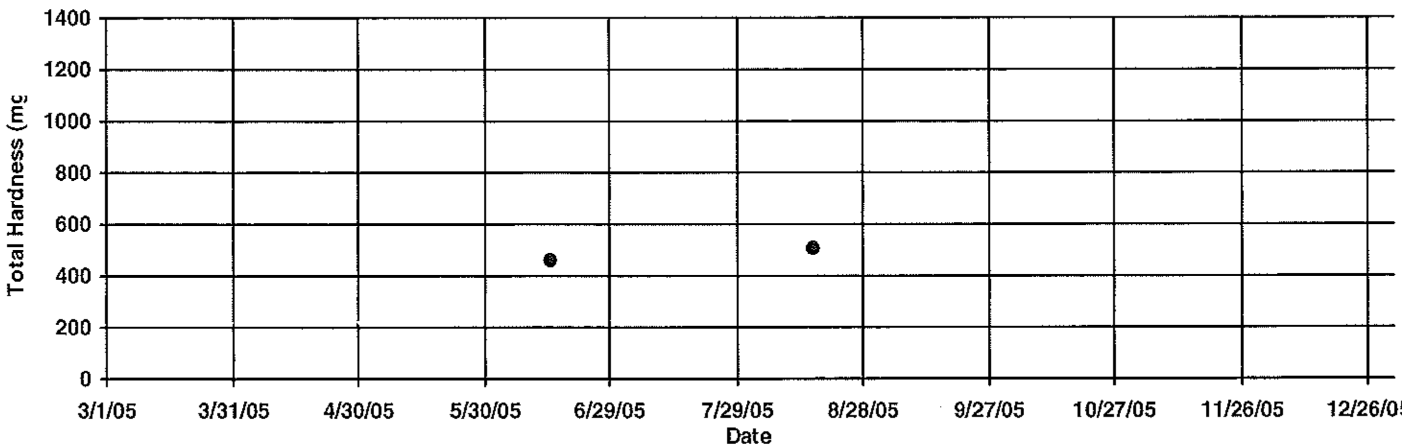


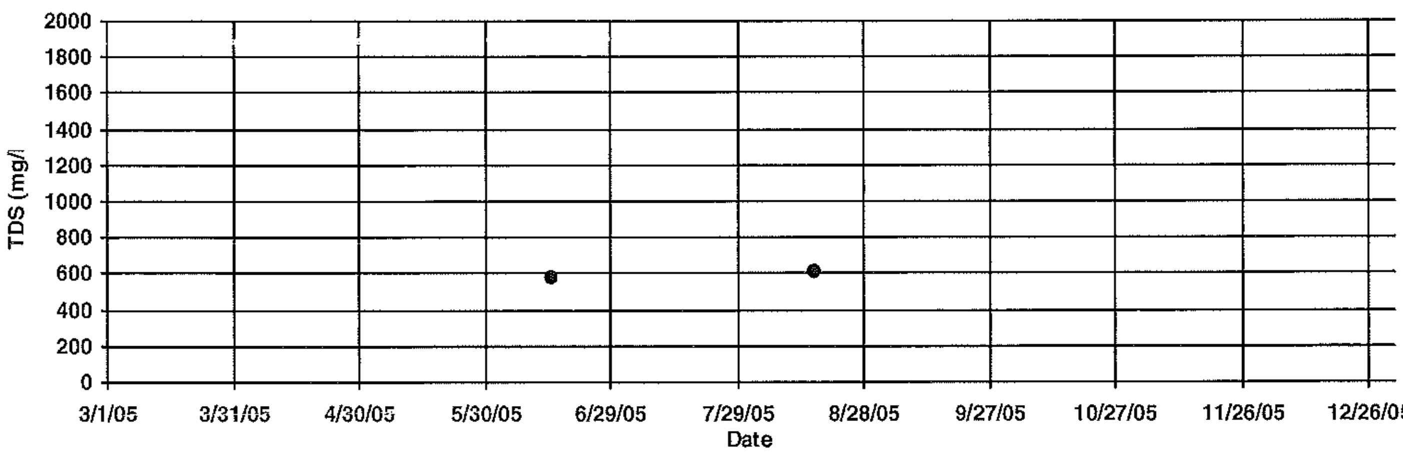


Study Site No. HG17 Elderberry Falls Site No.: 52

GENERAL MINERAL DATA

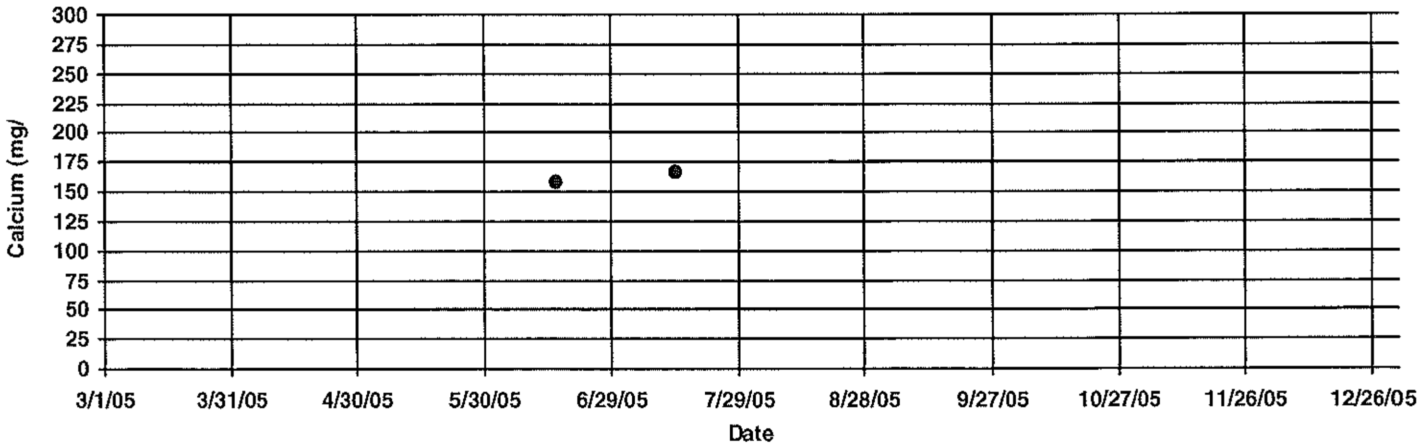


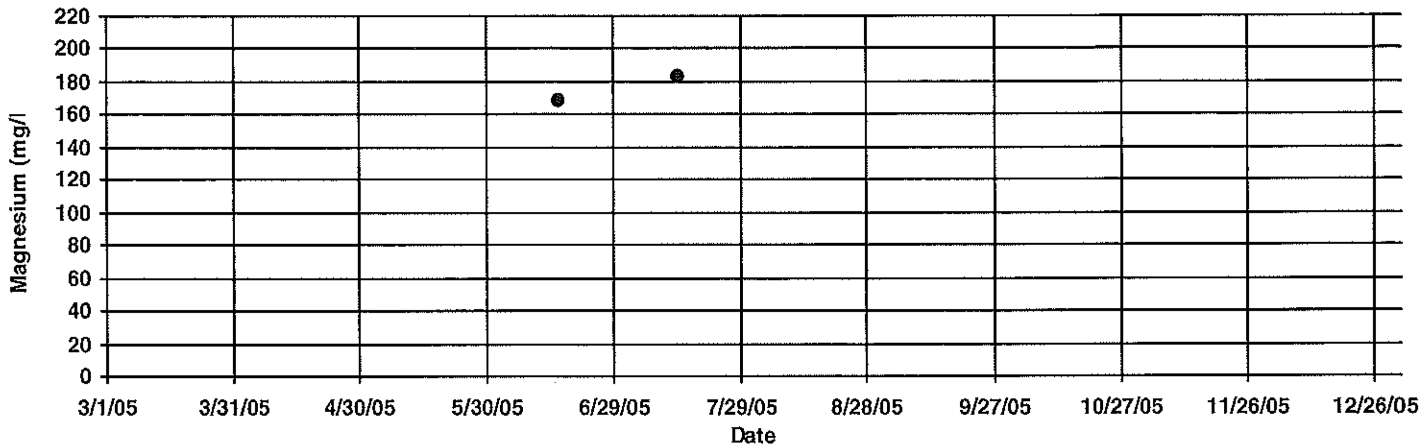


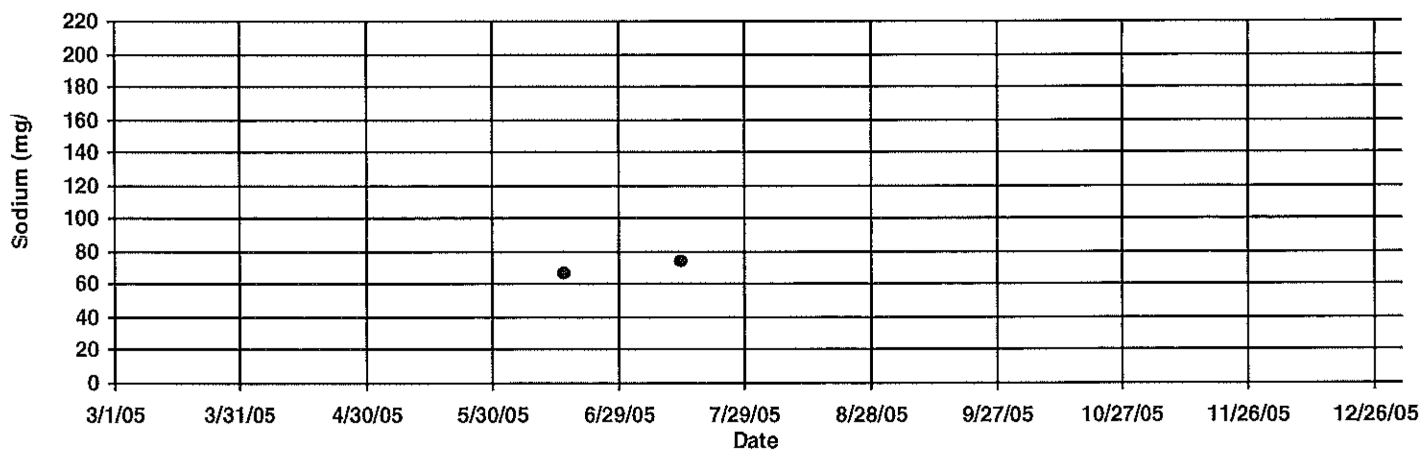


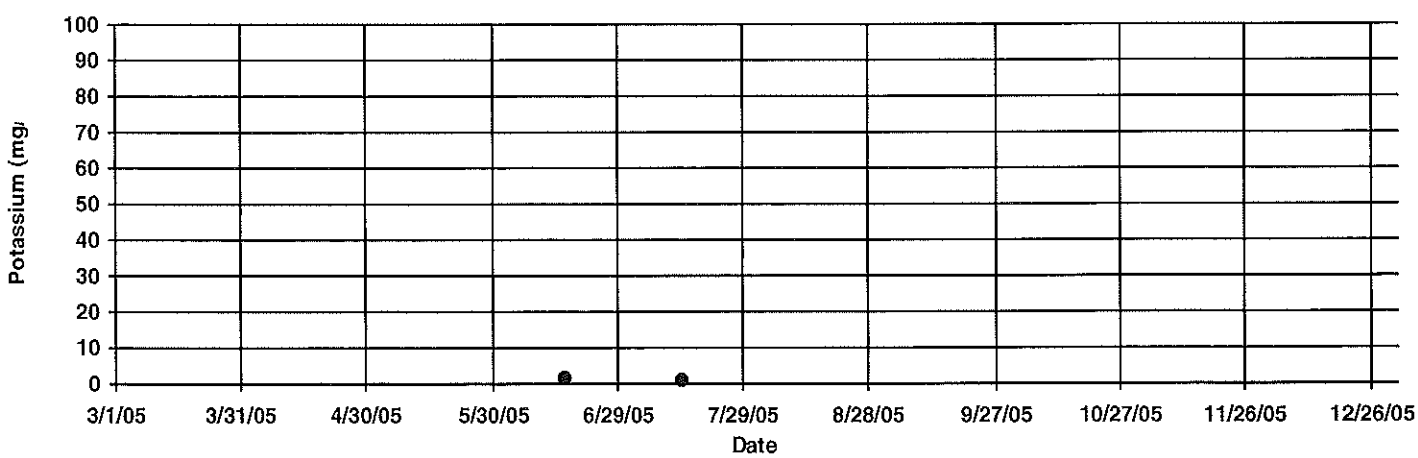
Study Site No. HG18 Tadpole Pool Site No.: 53

GENERAL MINERAL DATA



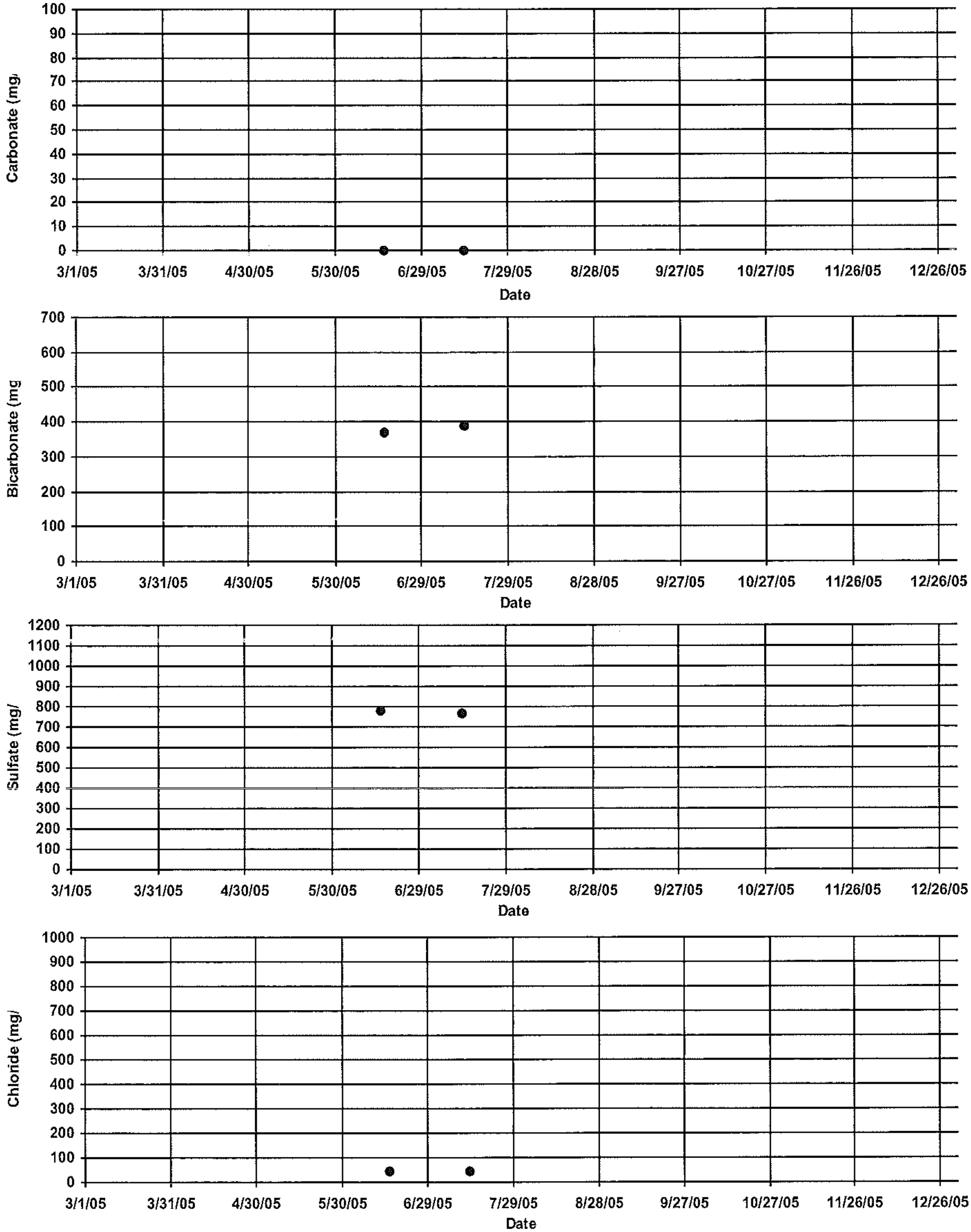






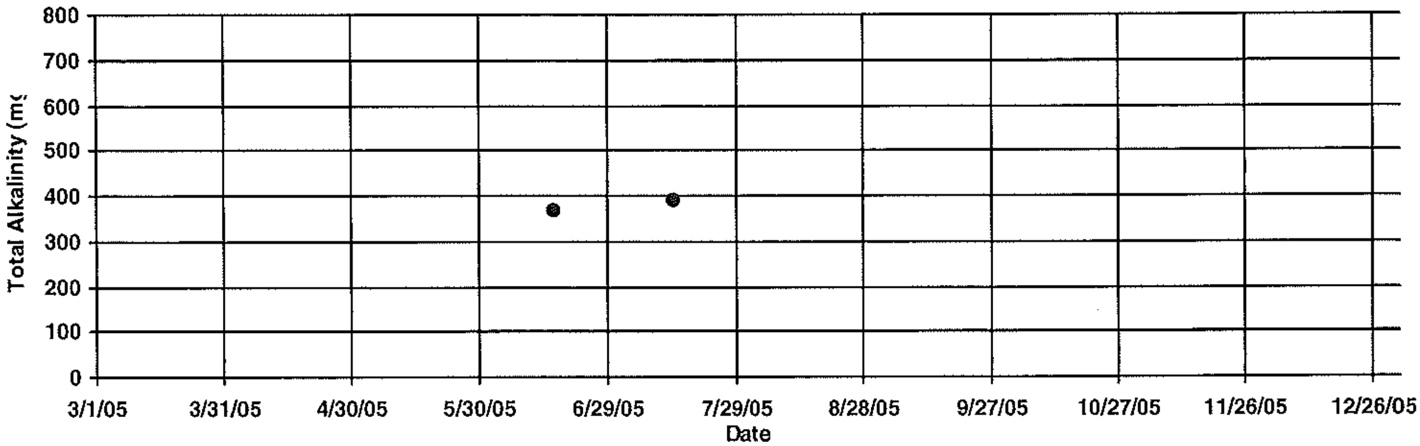
Study Site No. HG18 Tadpole Pool Site No.: 53

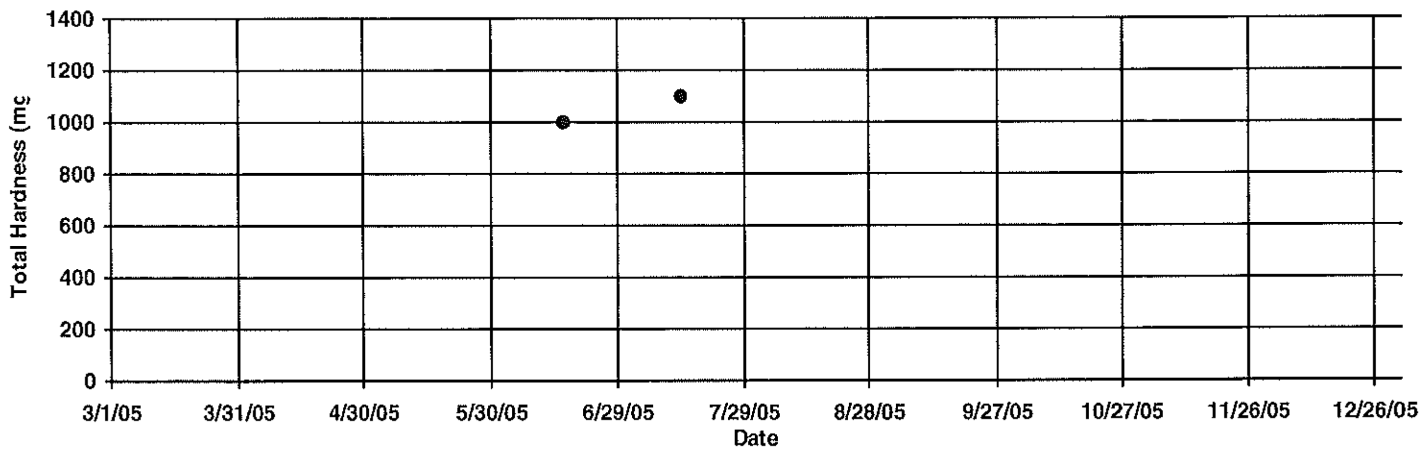
GENERAL MINERAL DATA

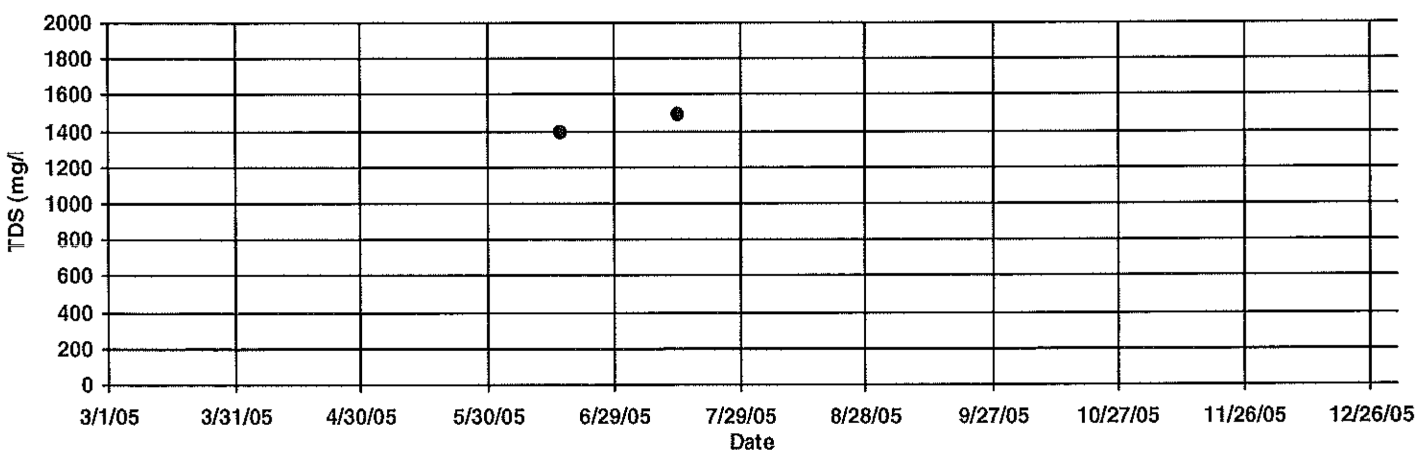


Study Site No. HG18 Tadpole Pool Site No.: 53

GENERAL MINERAL DATA

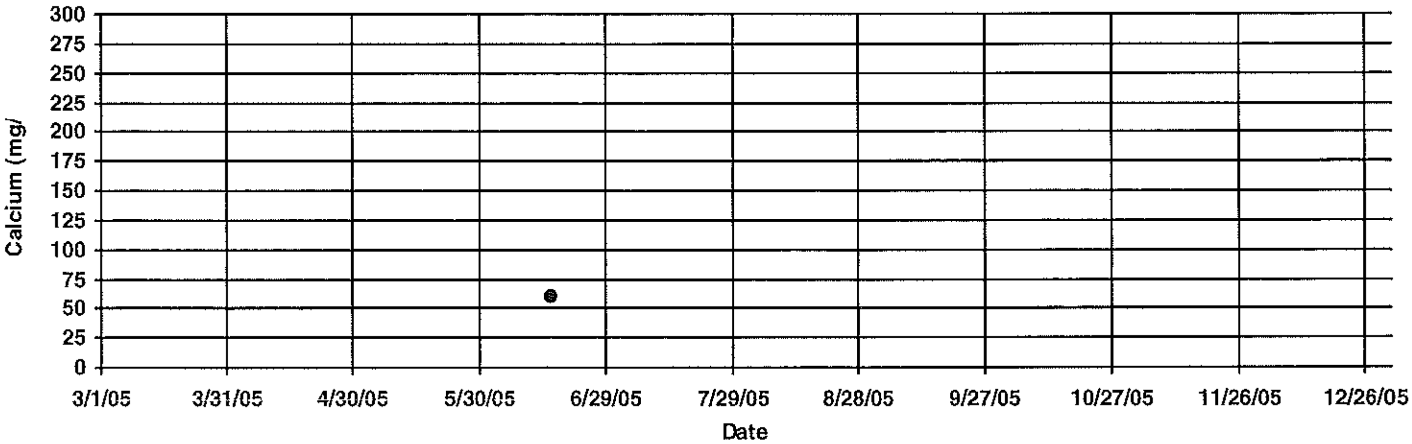


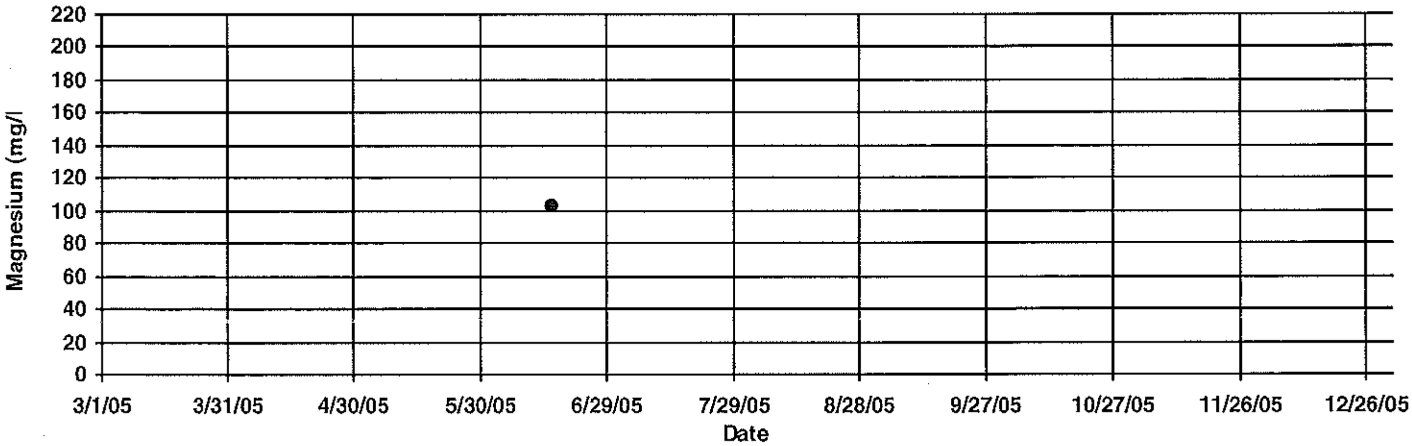


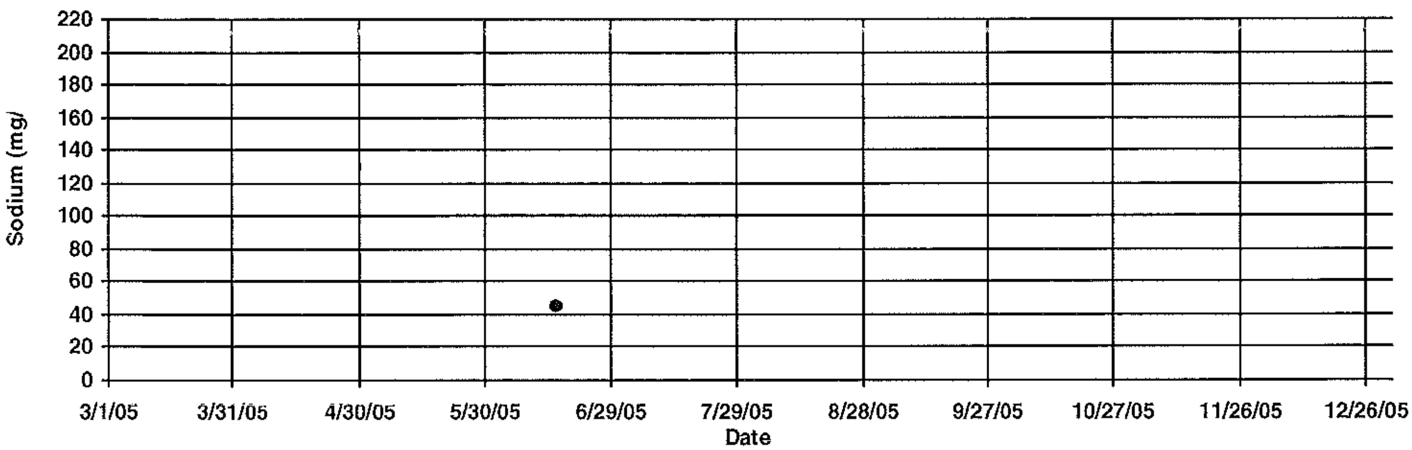


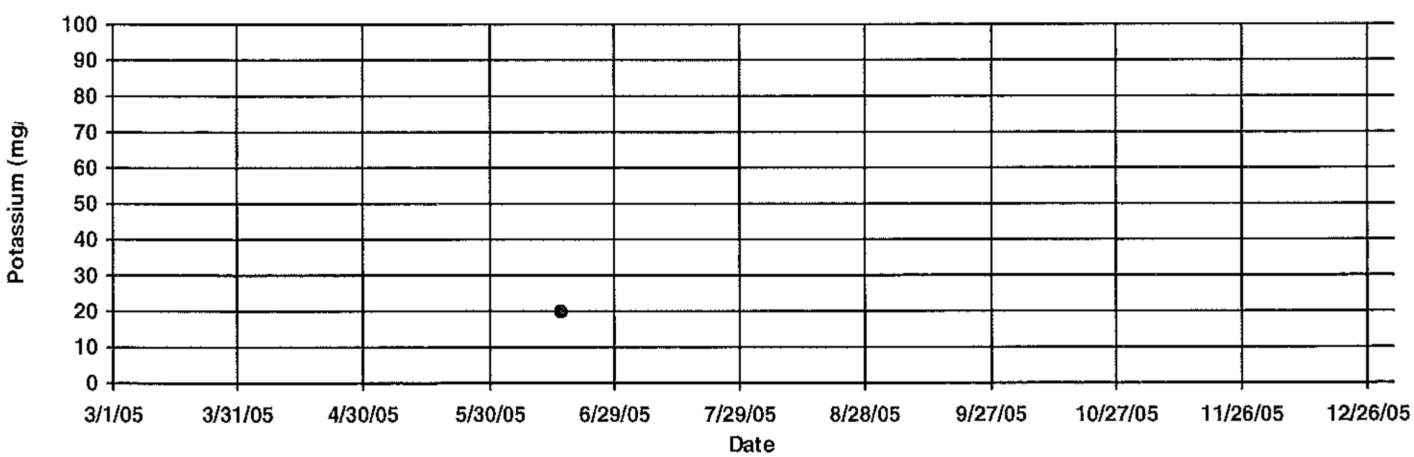
Study Site No. HG19 Pool of Many Drips Site No.: 54

GENERAL MINERAL DATA



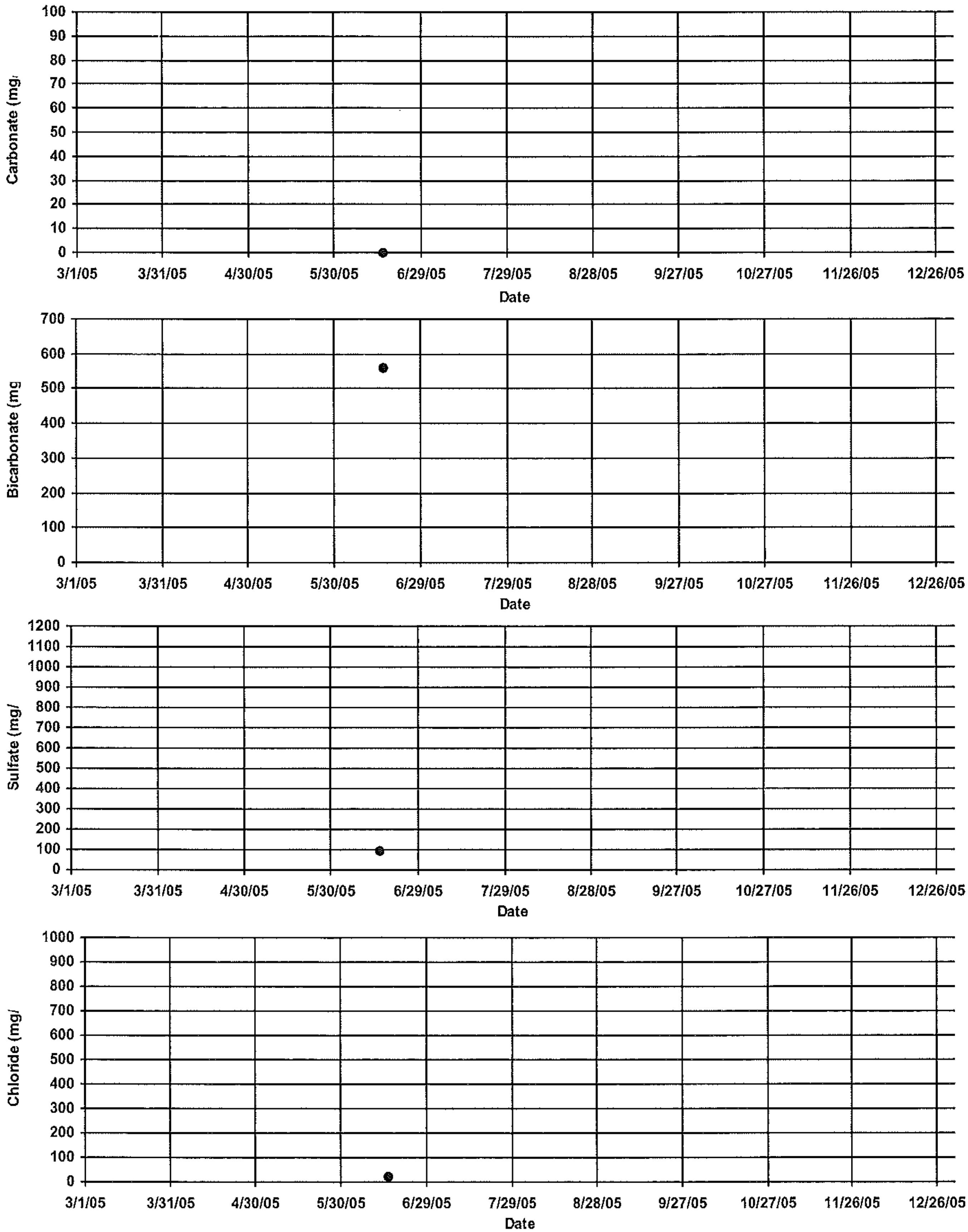






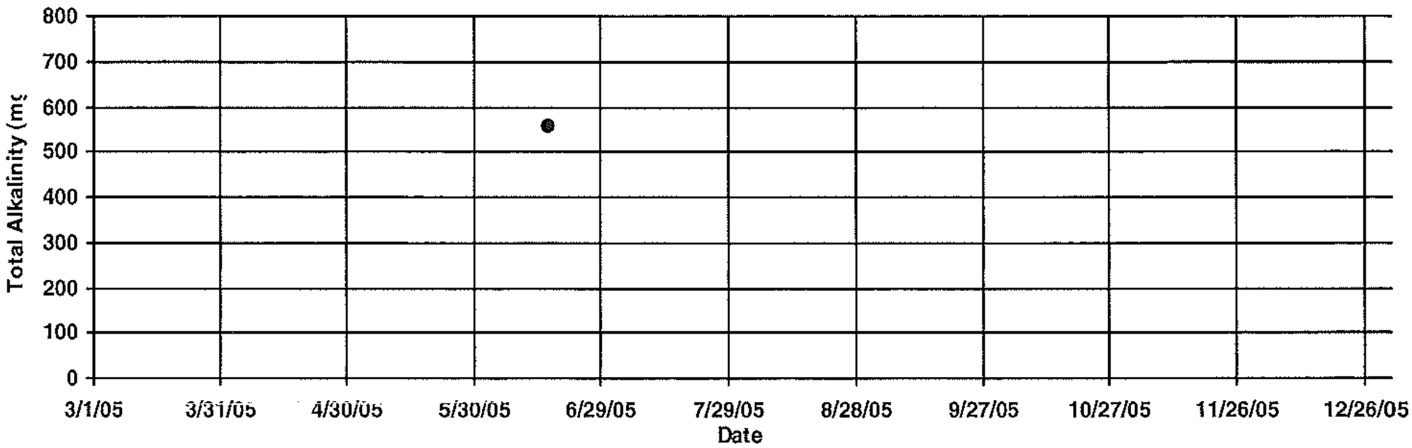
Study Site No. HG19 Pool of Many Drips Site No.: 54

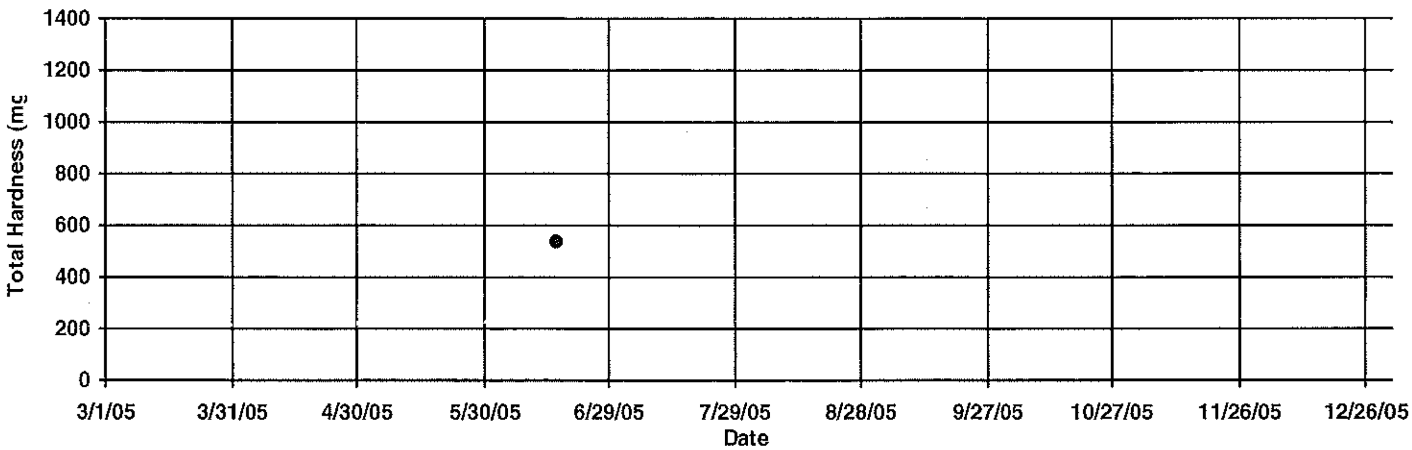
GENERAL MINERAL DATA

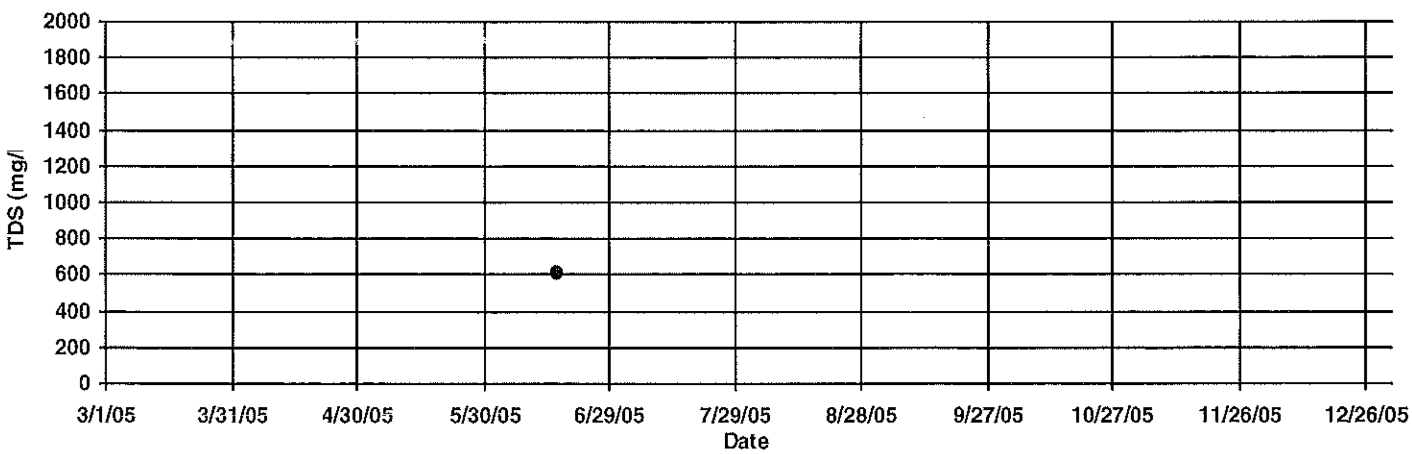


Study Site No. HG19 Pool of Many Drips Site No.: 54

GENERAL MINERAL DATA

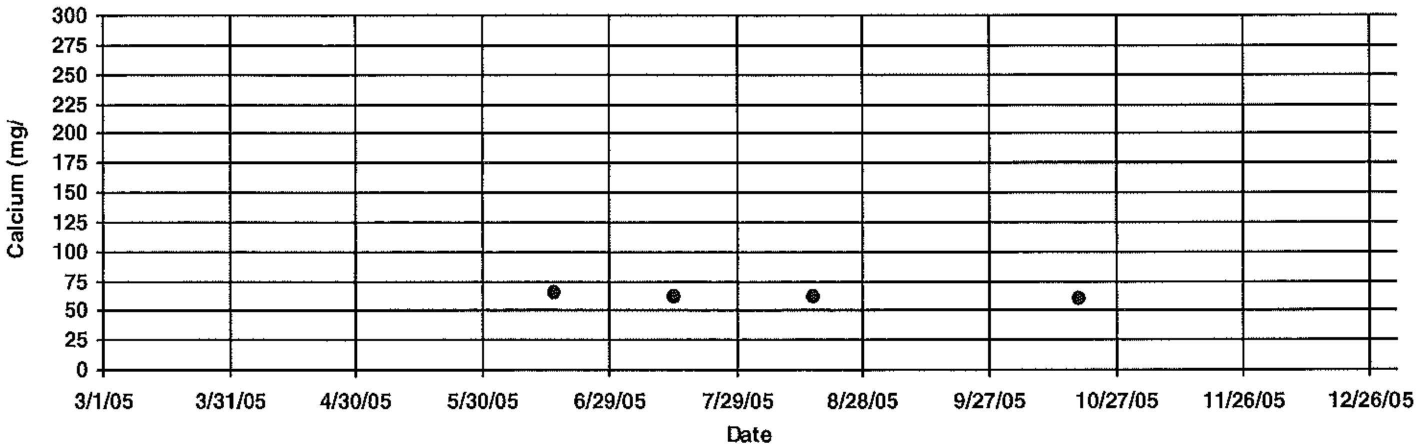


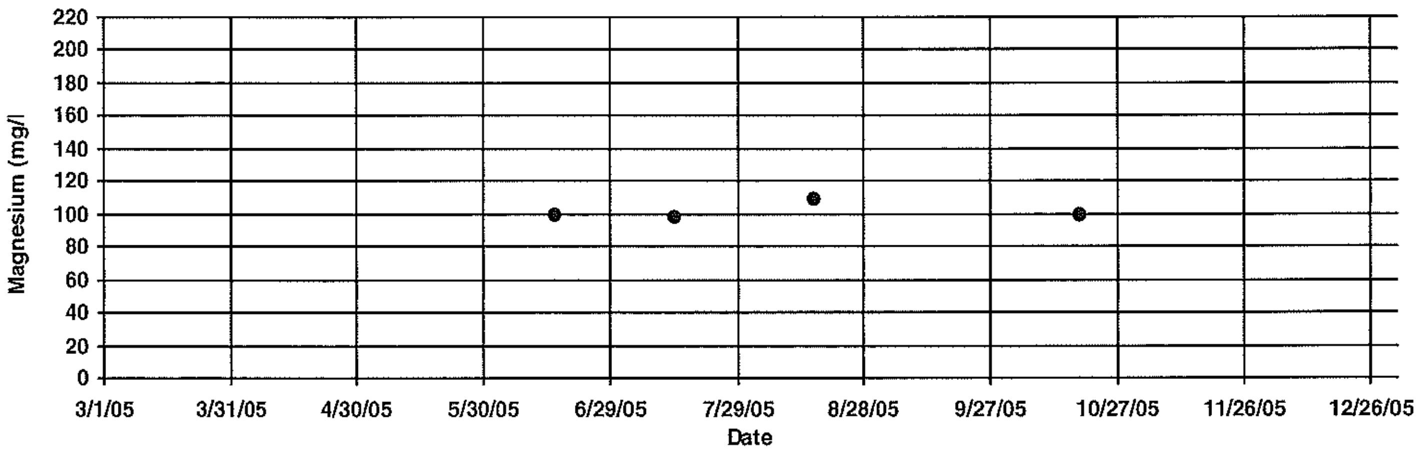


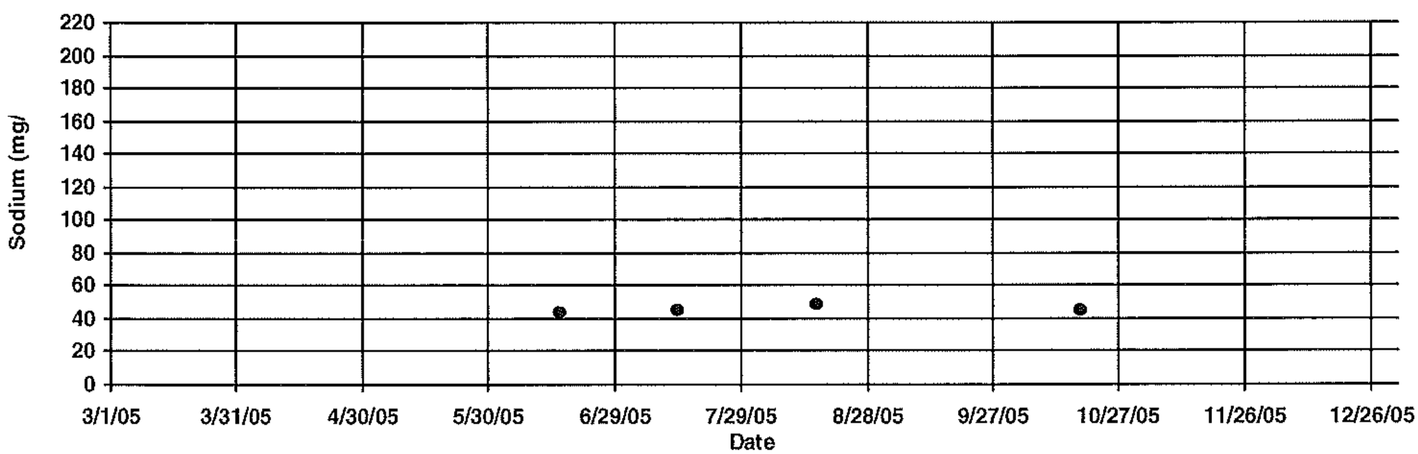


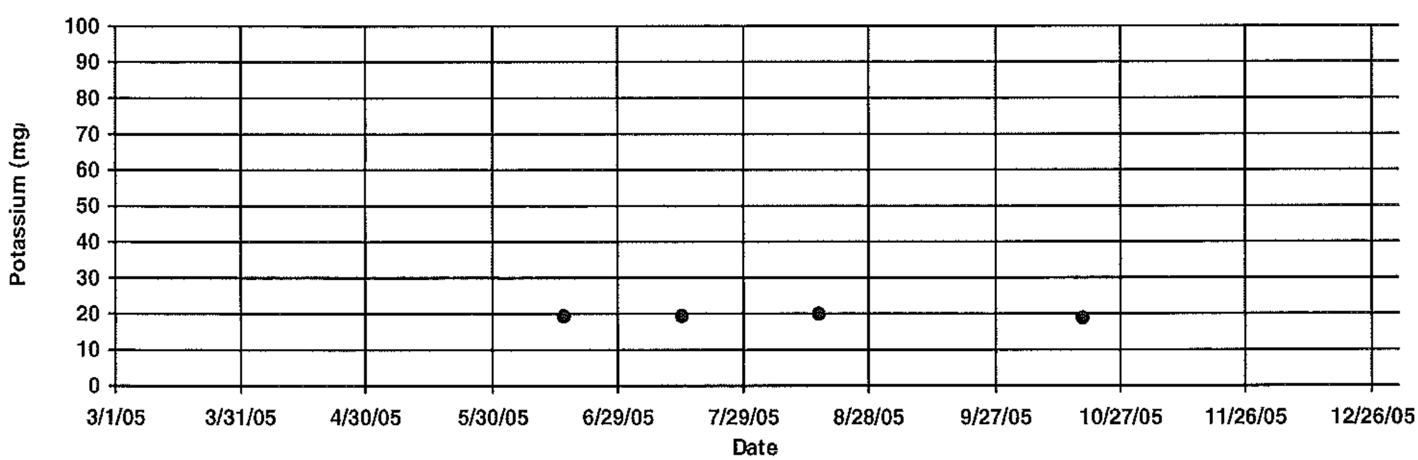
Study Site No. HG20 Bigleaf Maple Pool Site No.: 35

GENERAL MINERAL DATA



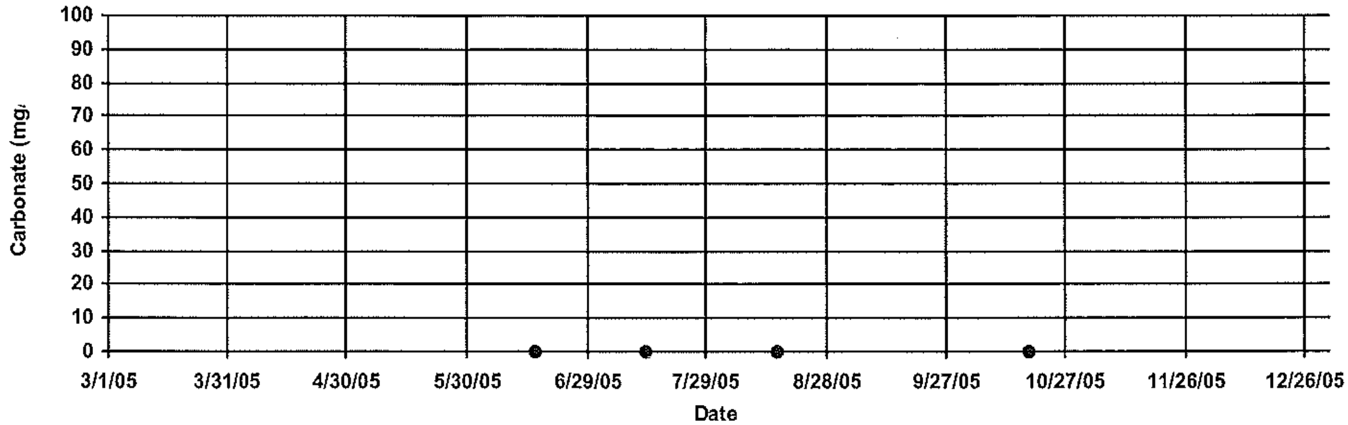


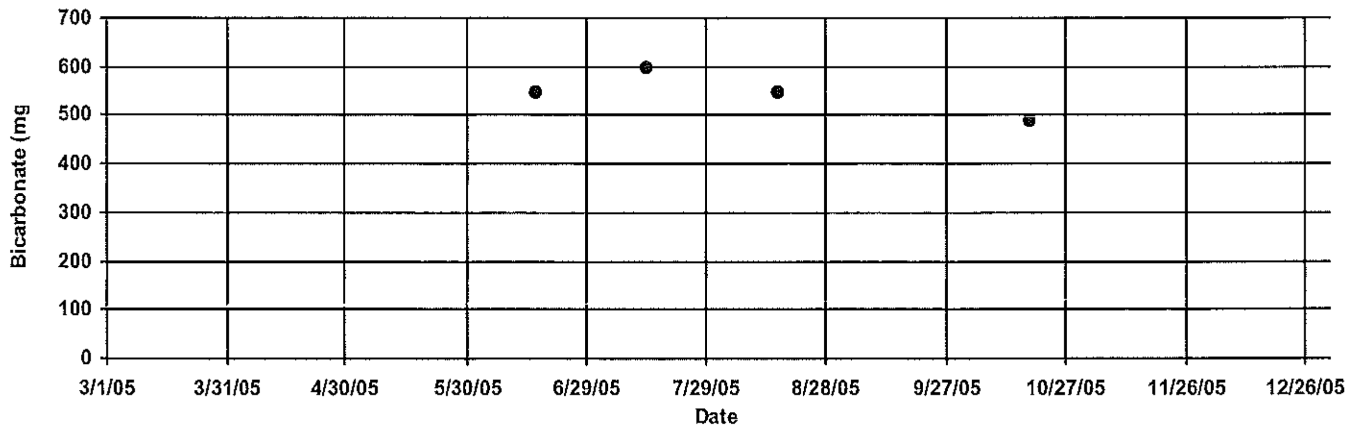


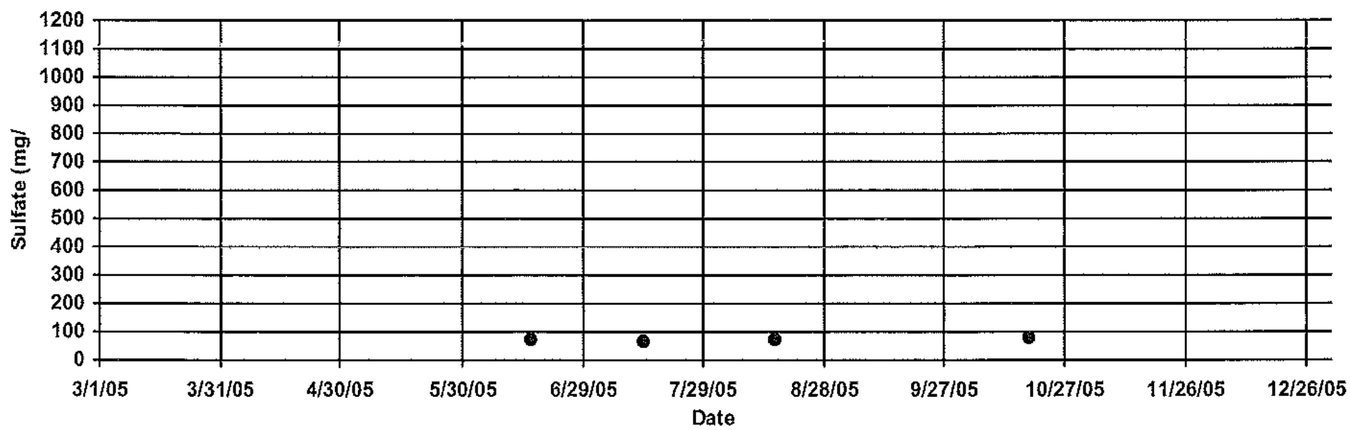


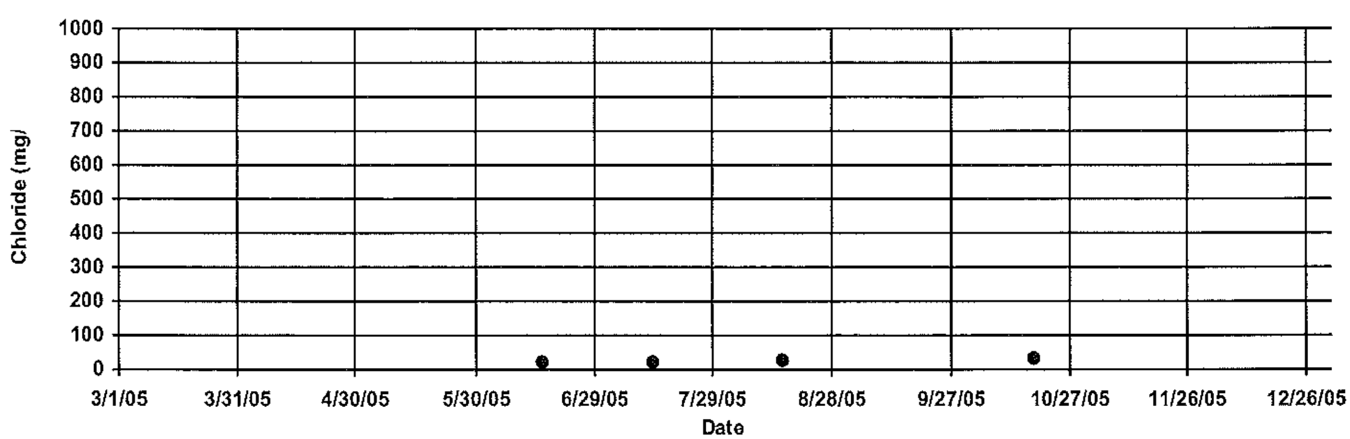
Study Site No. HG20 Bigleaf Maple Pool Site No.: 35

GENERAL MINERAL DATA









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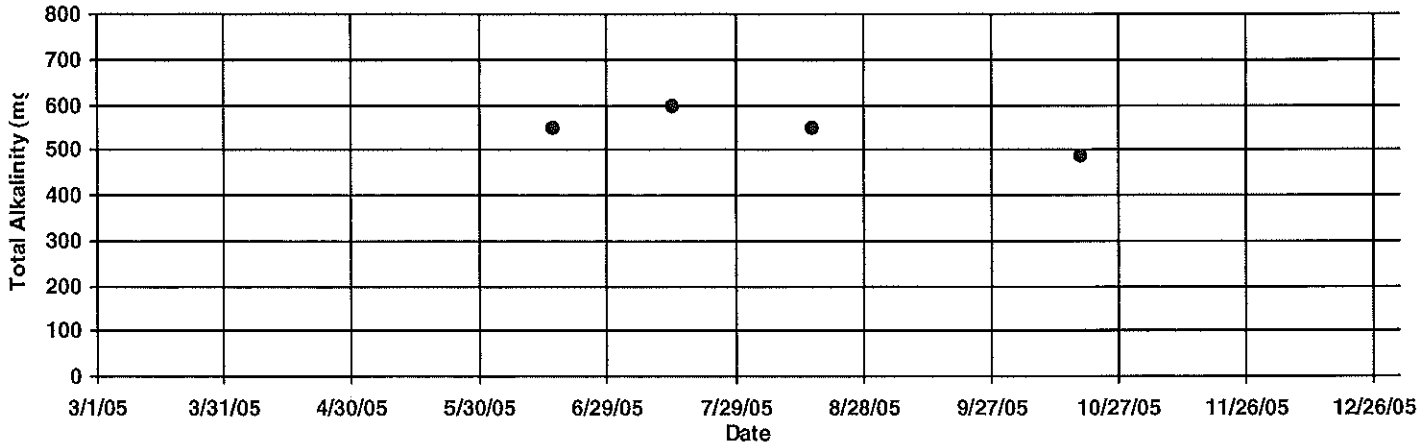
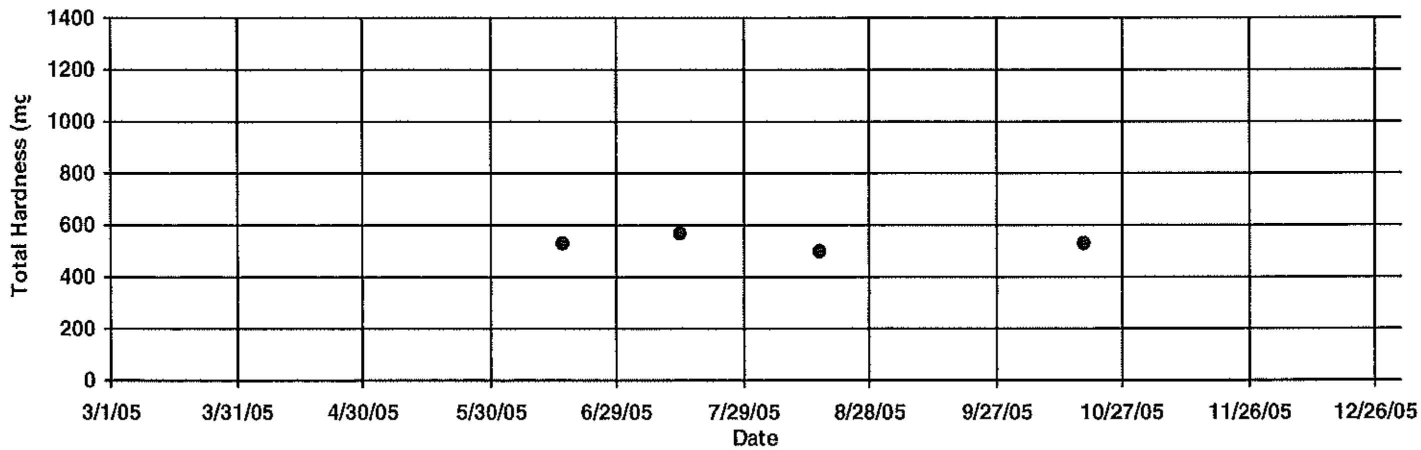
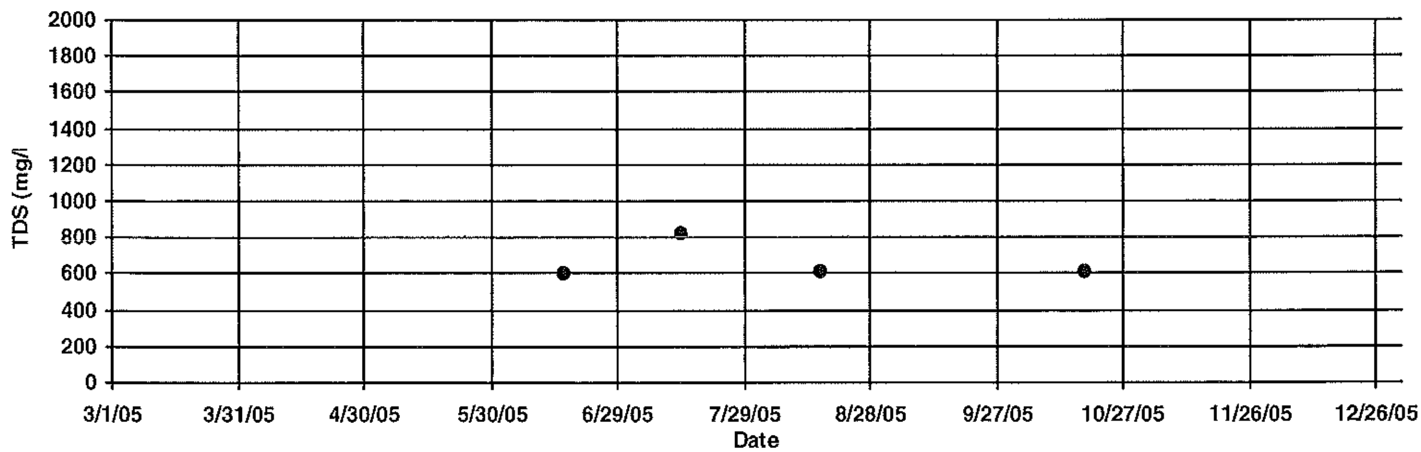
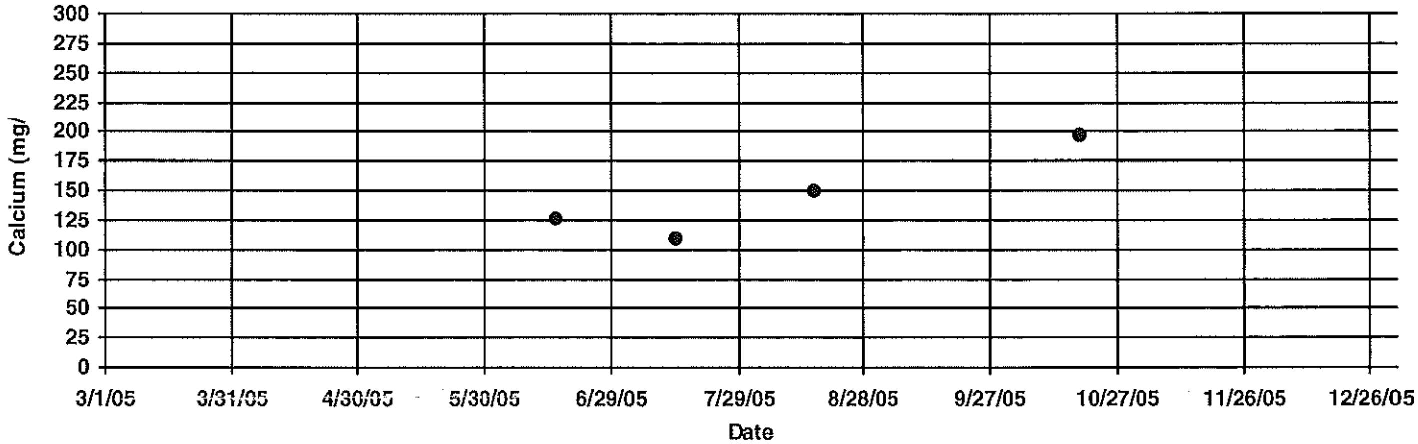


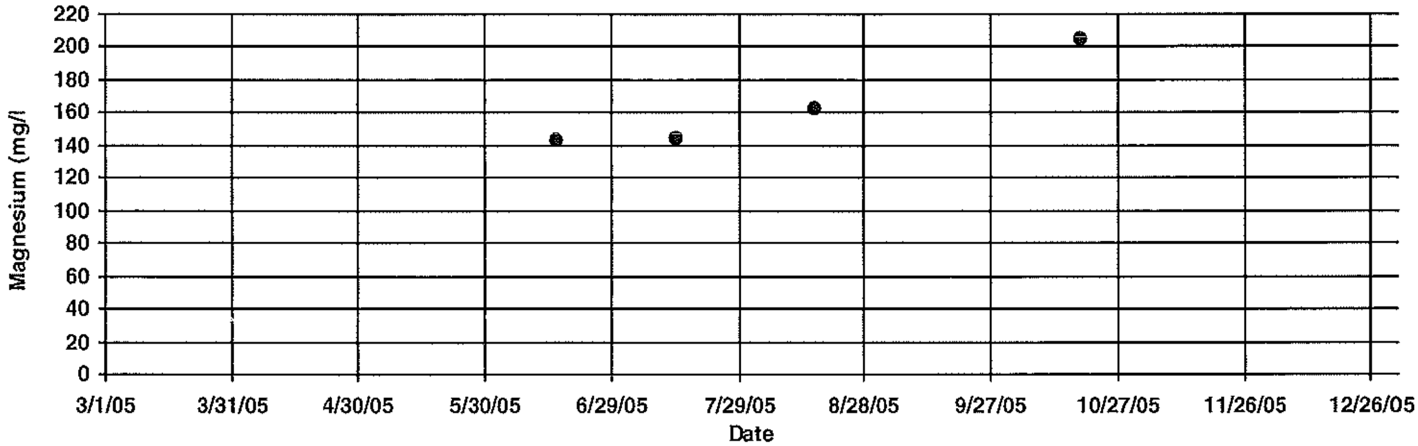


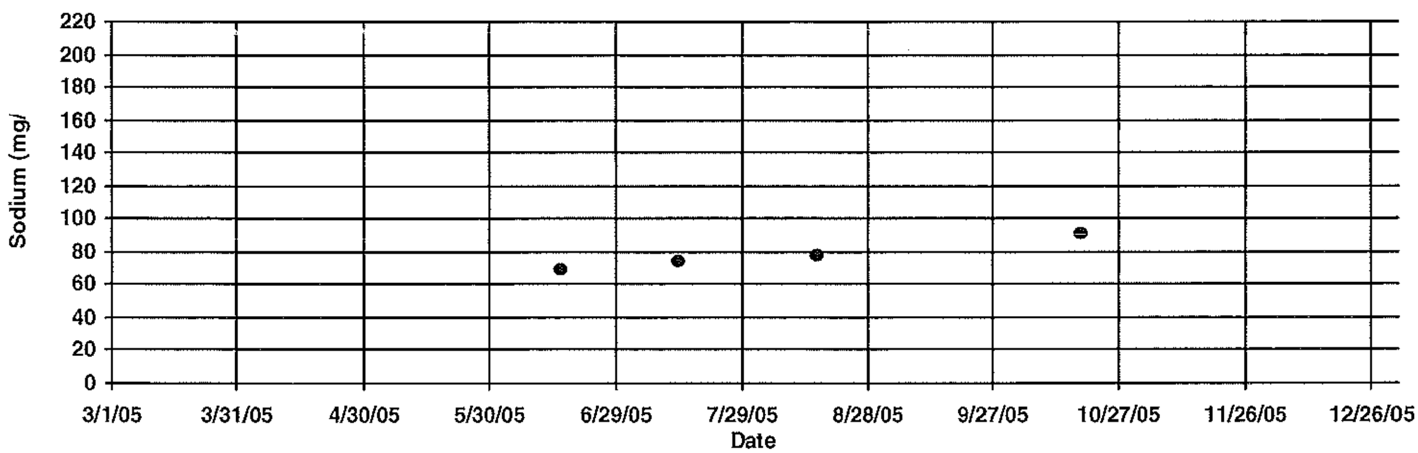


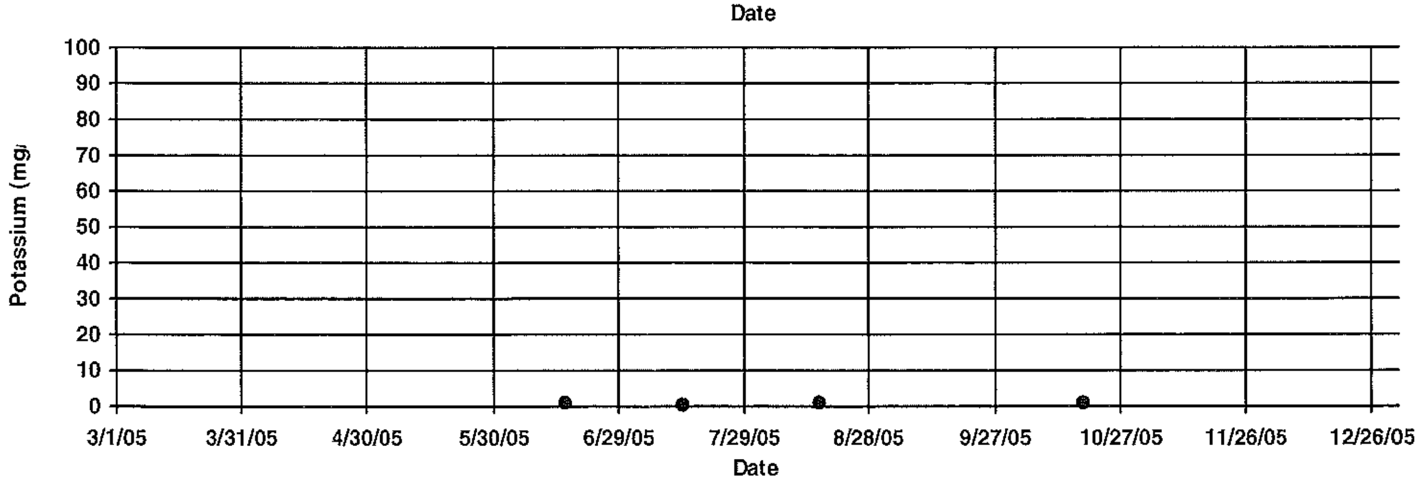
Study Site No. HG21 Up and Down Trib Site No.: 56

GENERAL MINERAL DATA



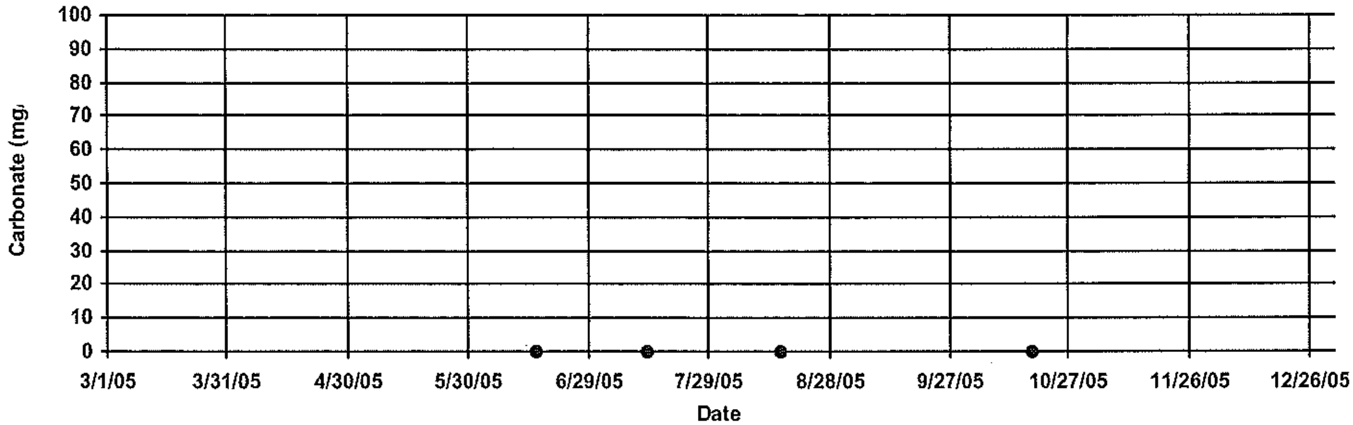


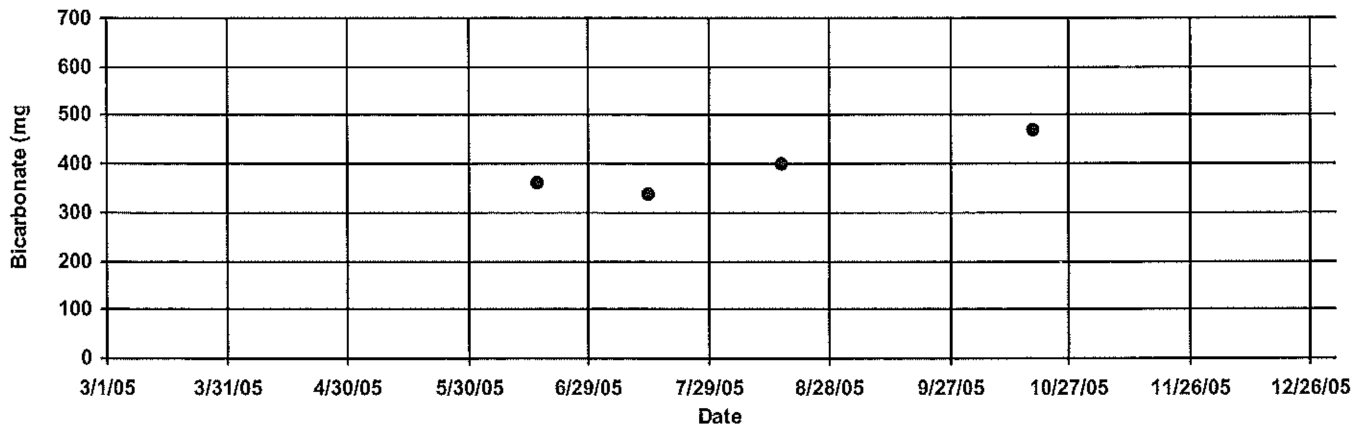


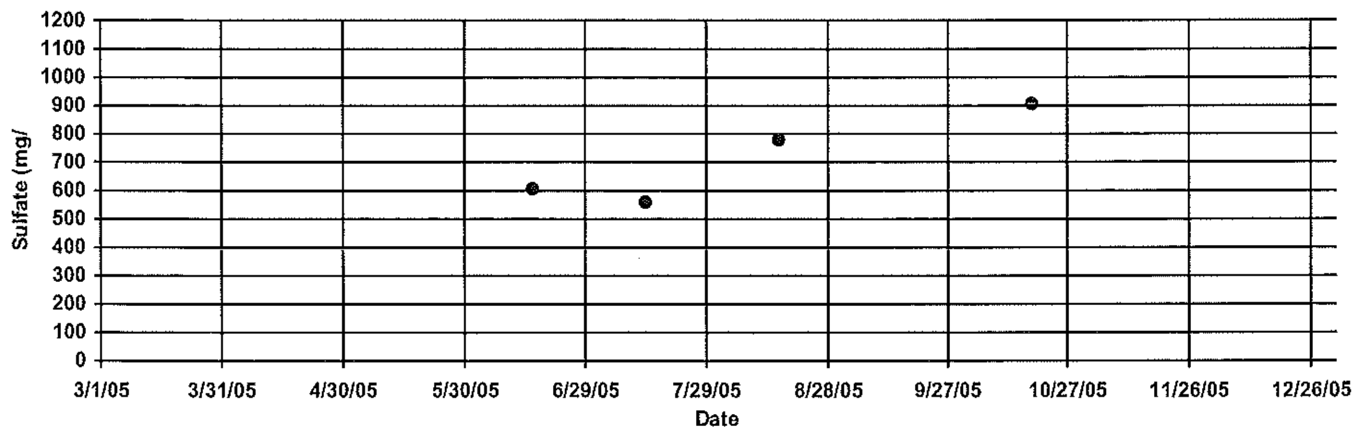


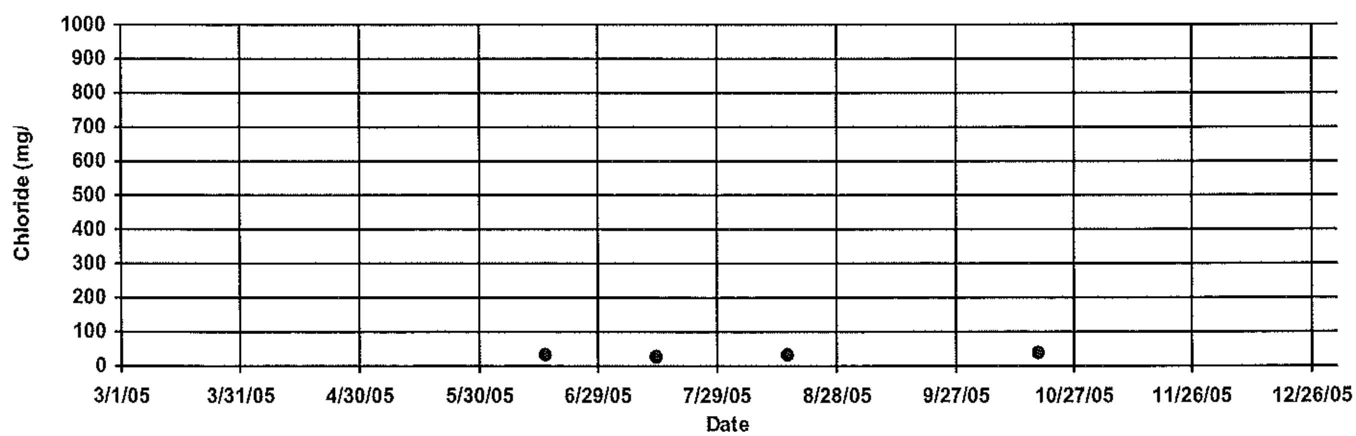
Study Site No. HG21 Up and Down Trib Site No.: 56

GENERAL MINERAL DATA



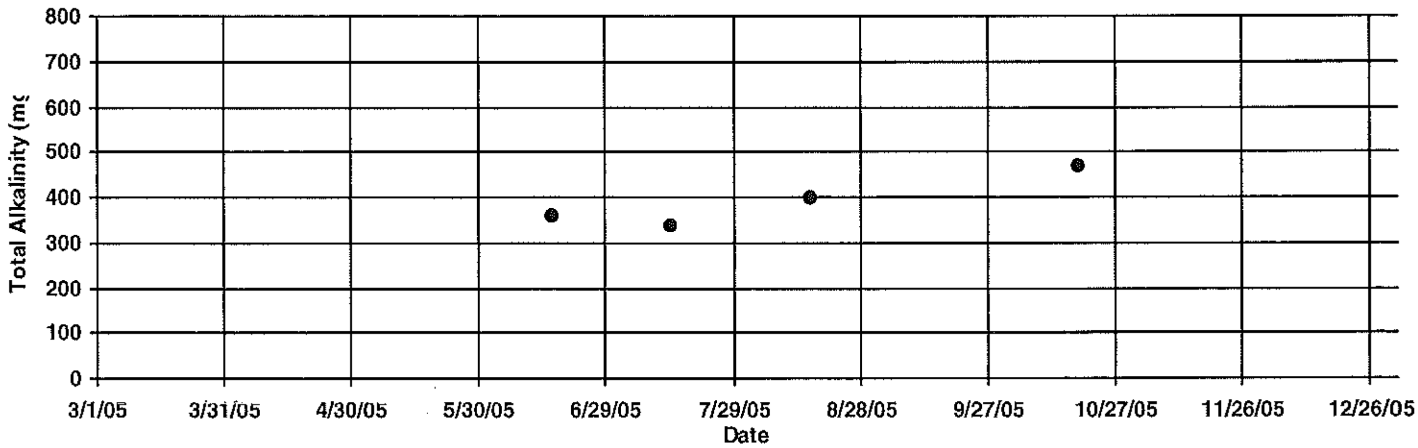


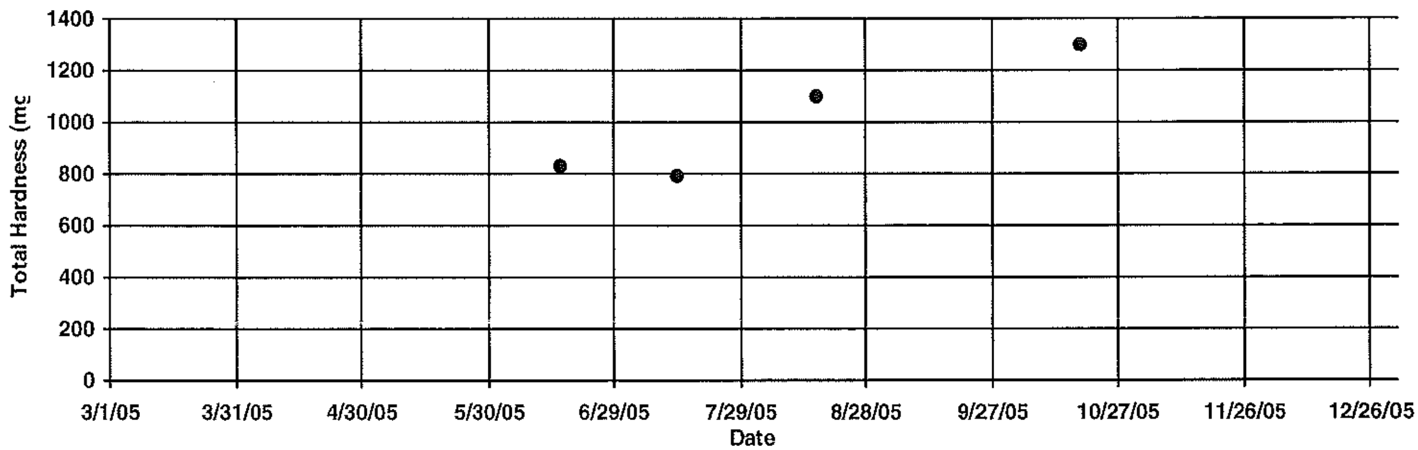


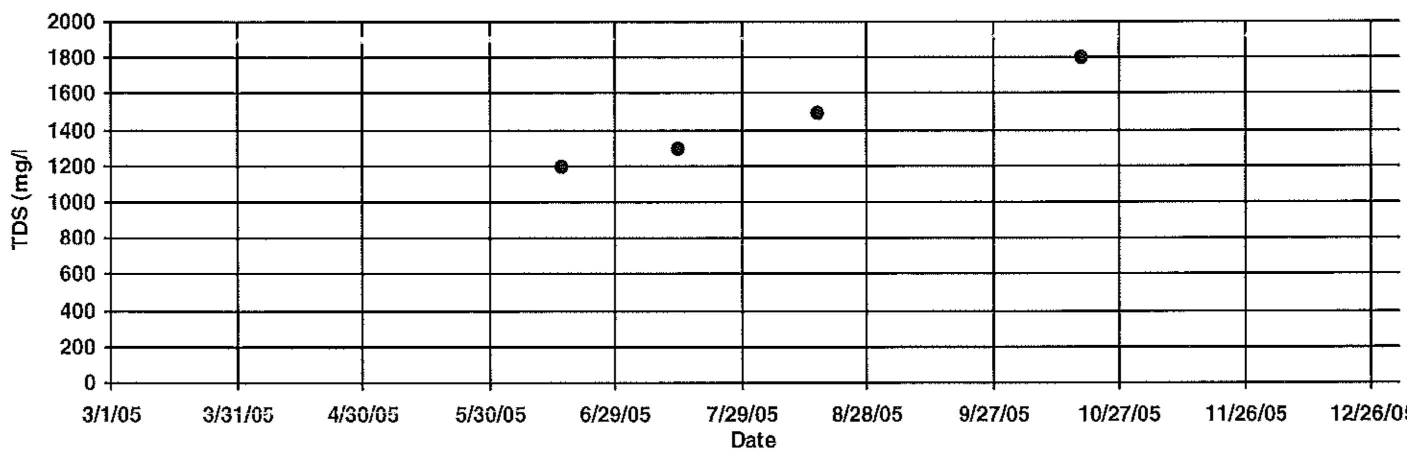


Study Site No. HG21 Up and Down Trib Site No.: 56

GENERAL MINERAL DATA

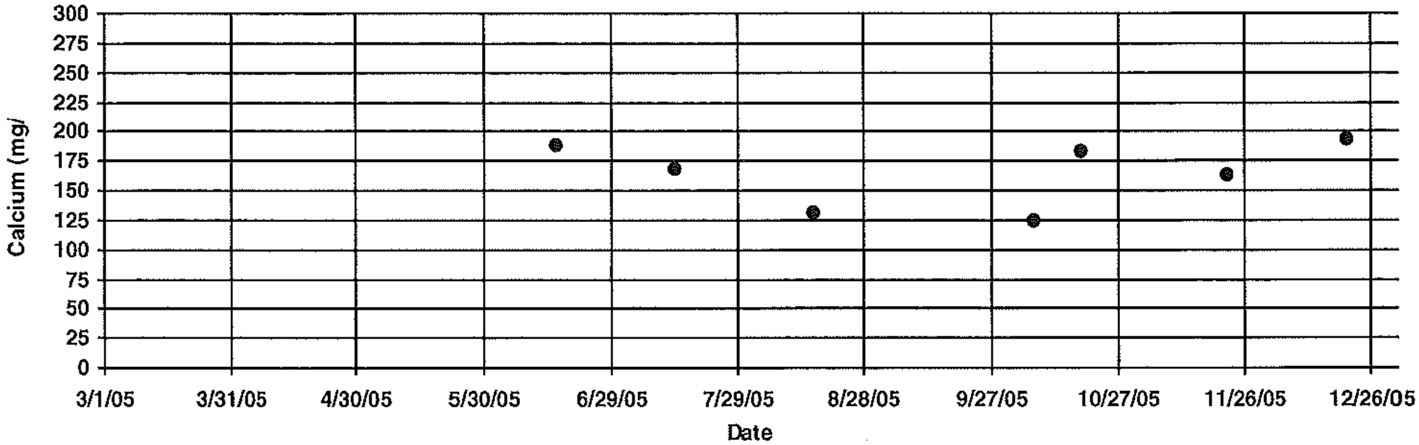


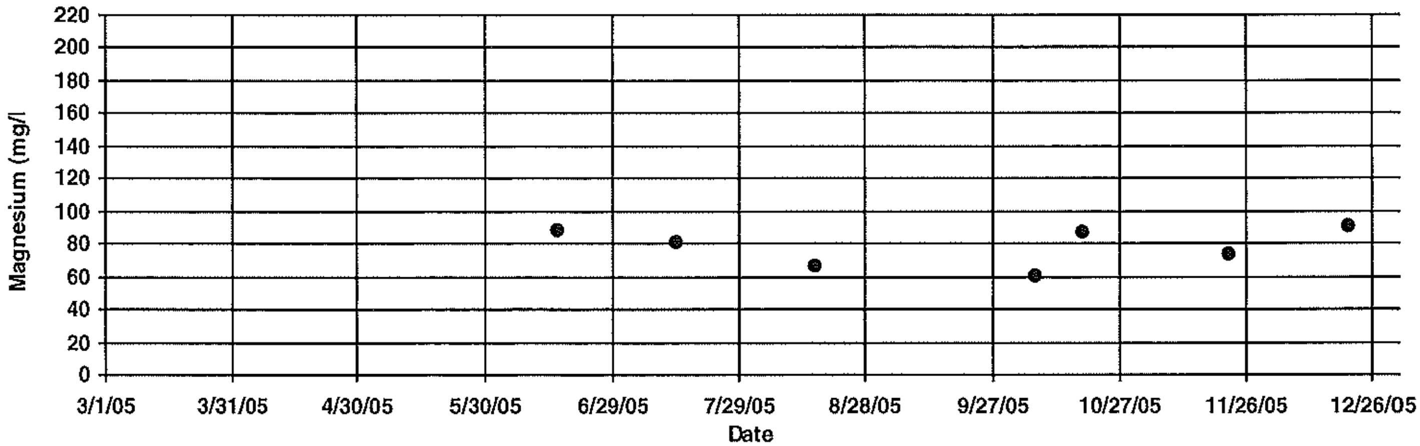


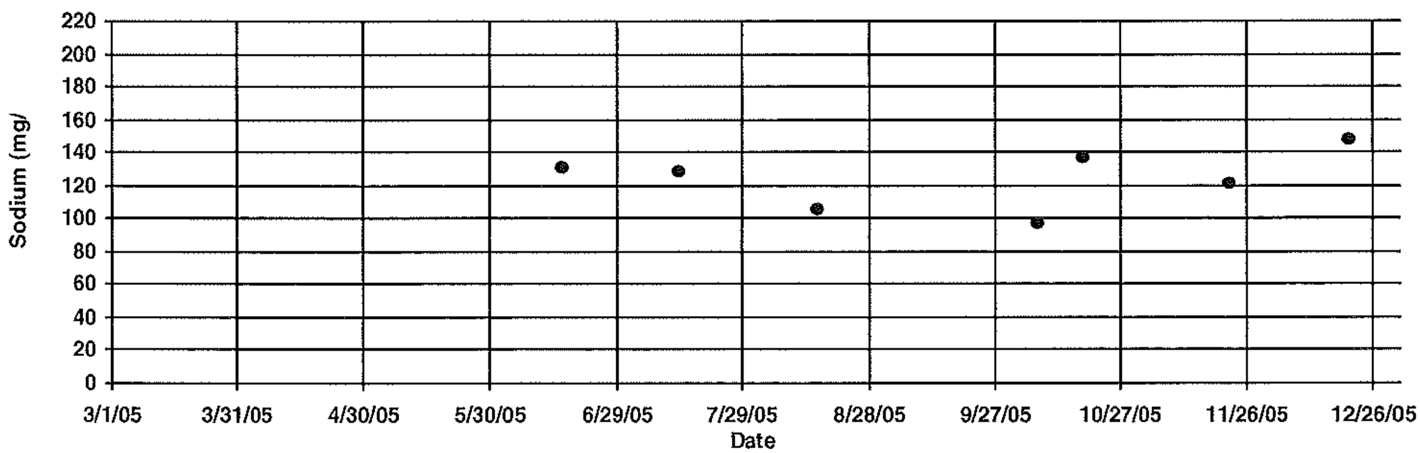


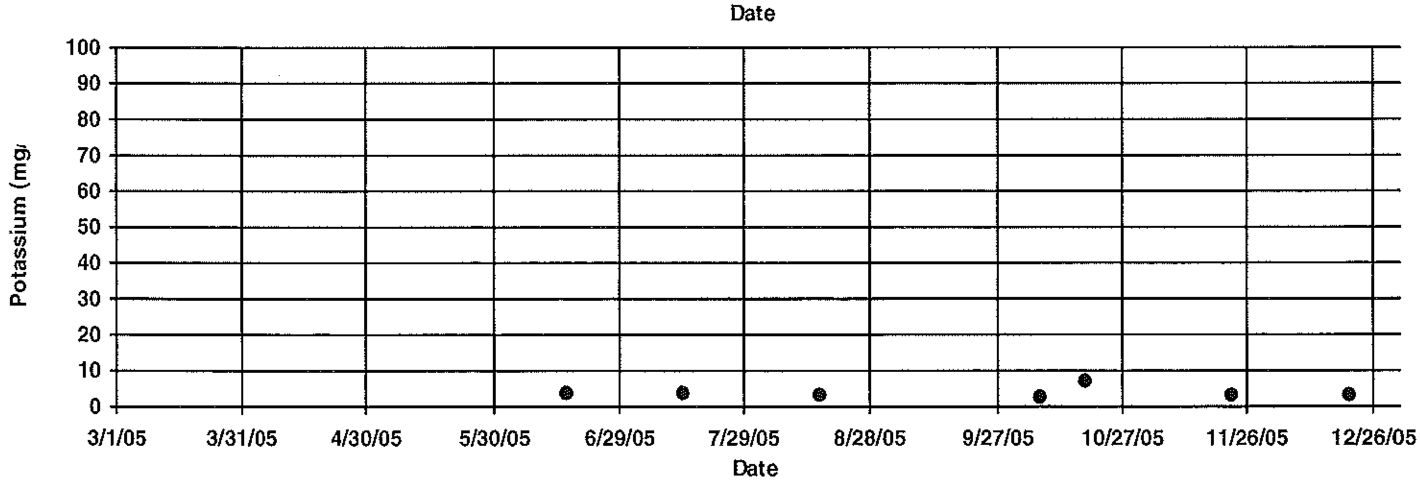
Study Site No. HG22 Rope Swing Pool Site No.: 304

GENERAL MINERAL DATA



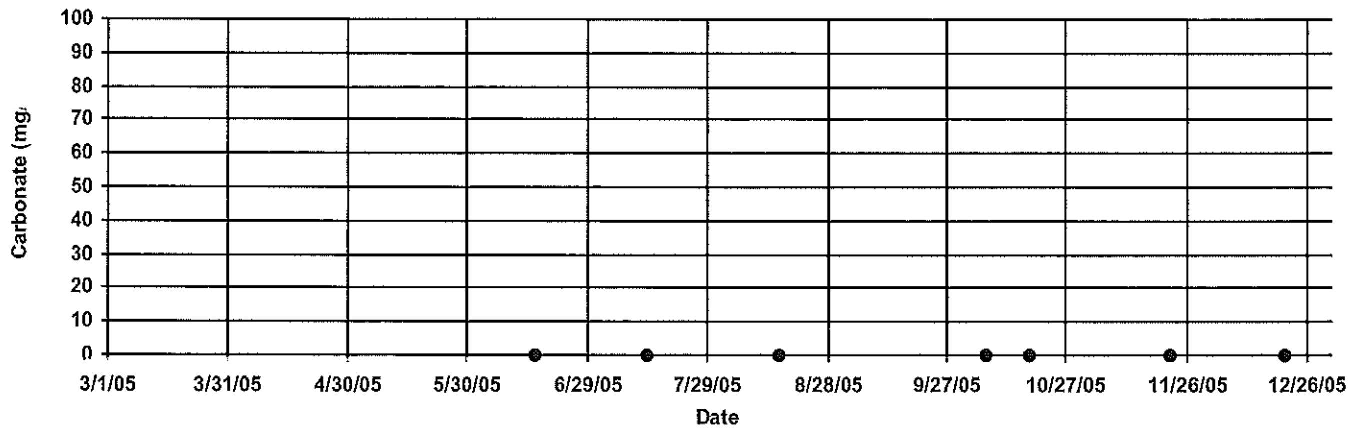


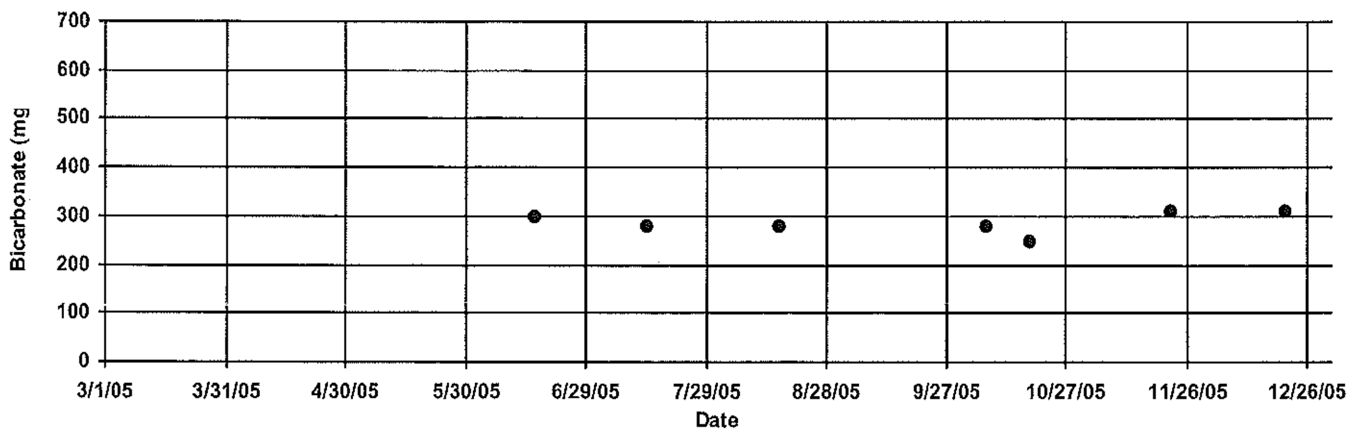


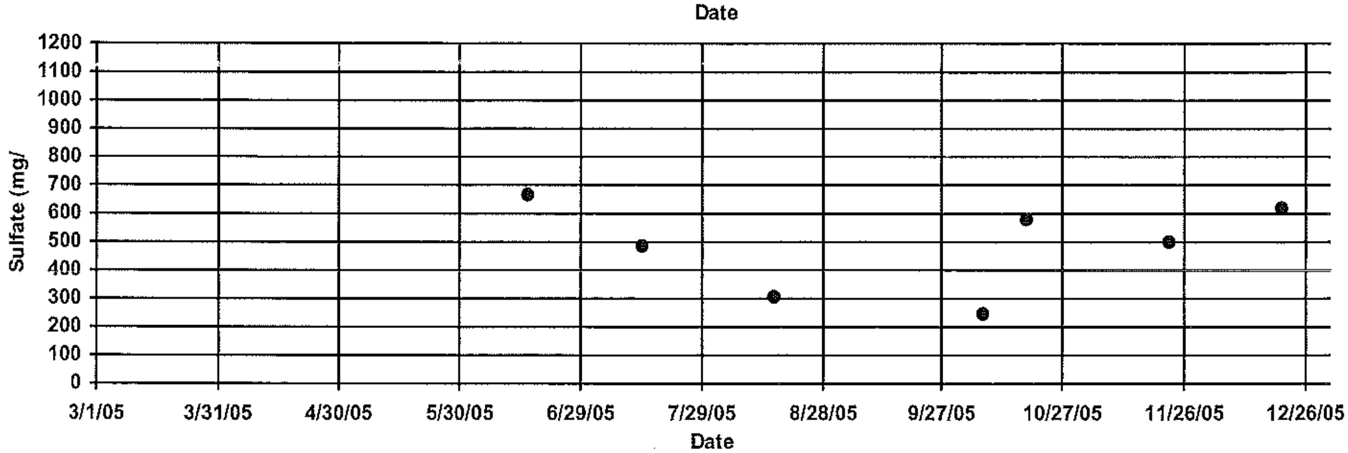


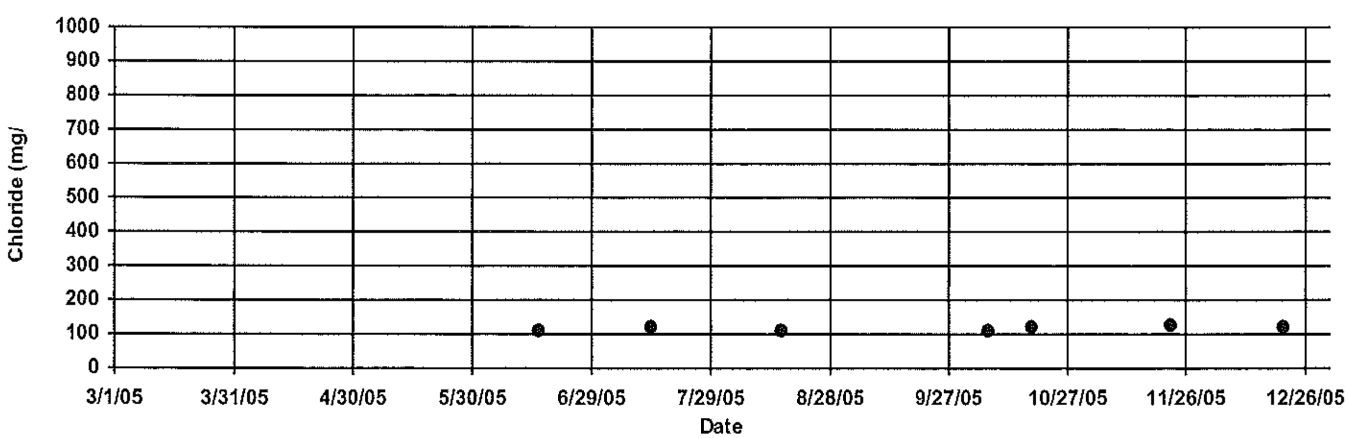
Study Site No. HG22 Rope Swing Pool Site No.: 304

GENERAL MINERAL DATA



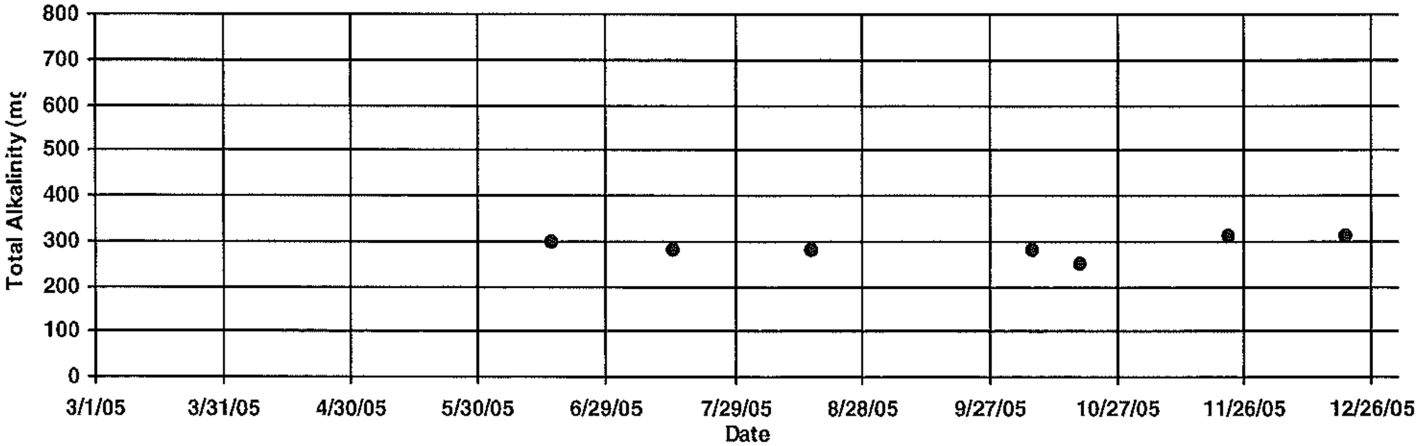


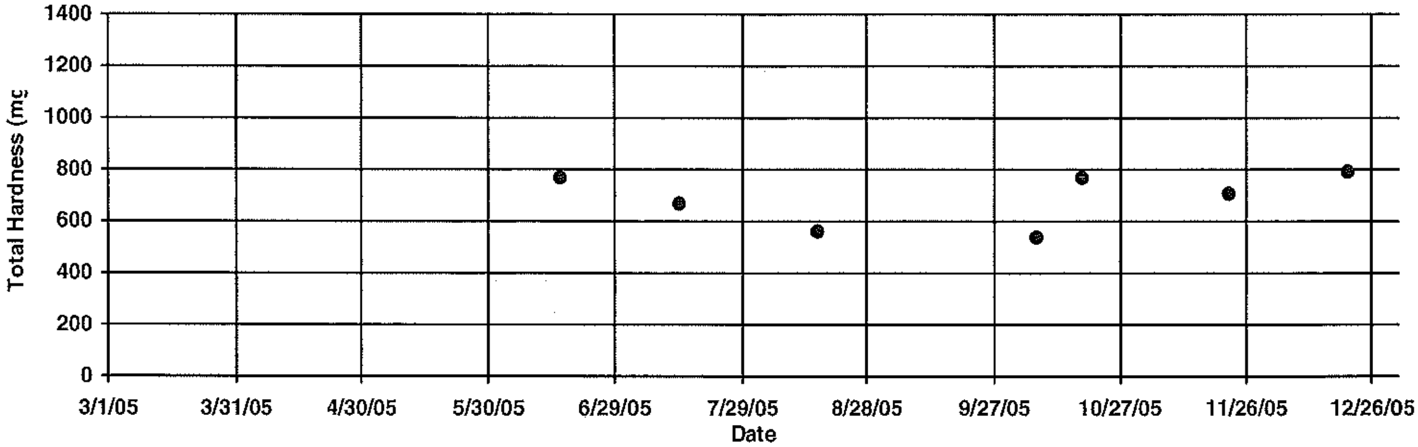


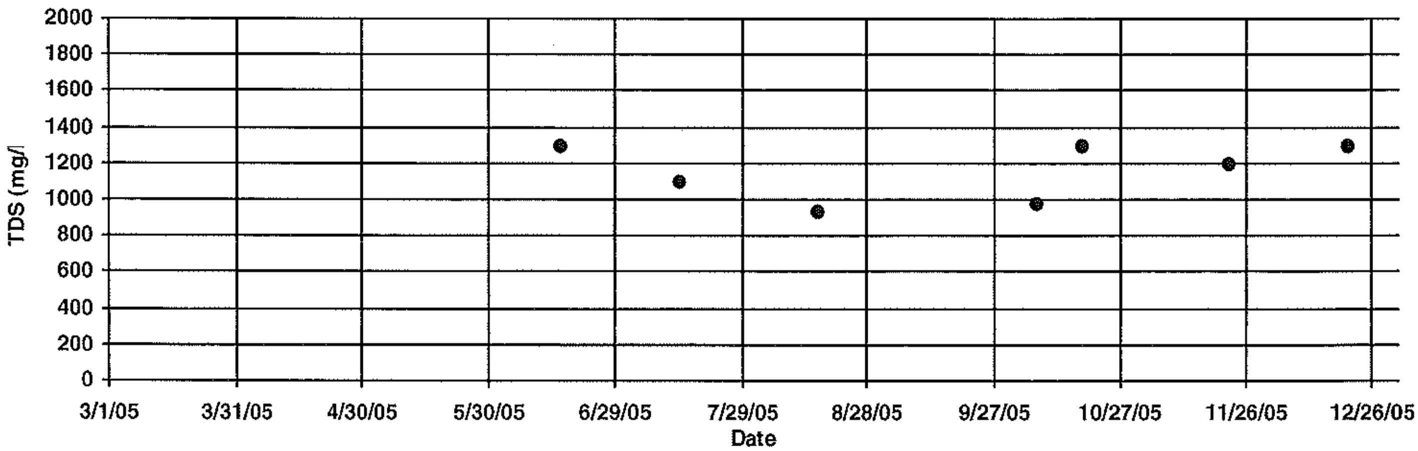


Study Site No. HG22 Rope Swing Pool Site No.: 304

GENERAL MINERAL DATA

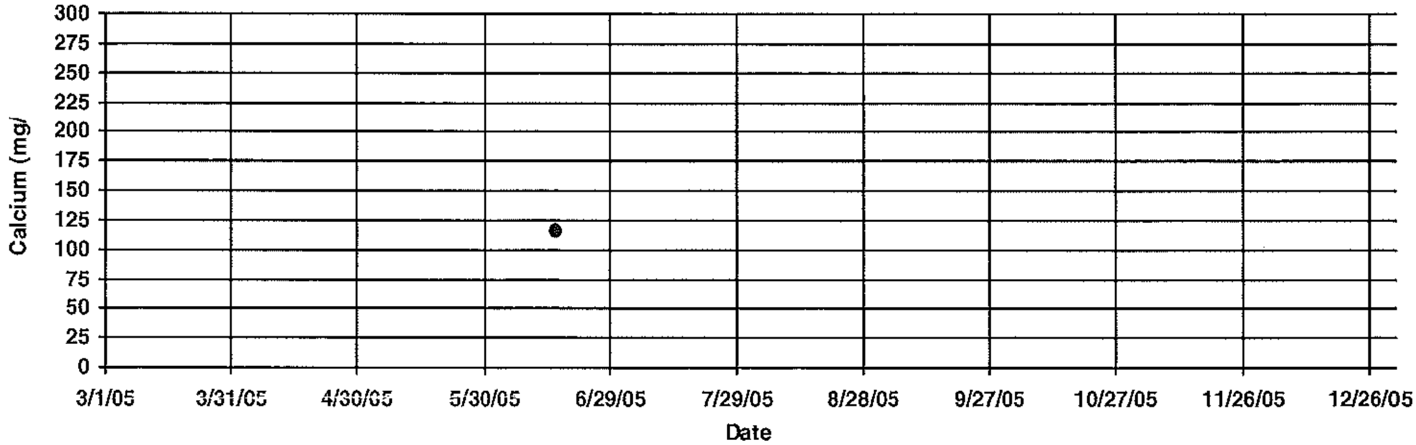


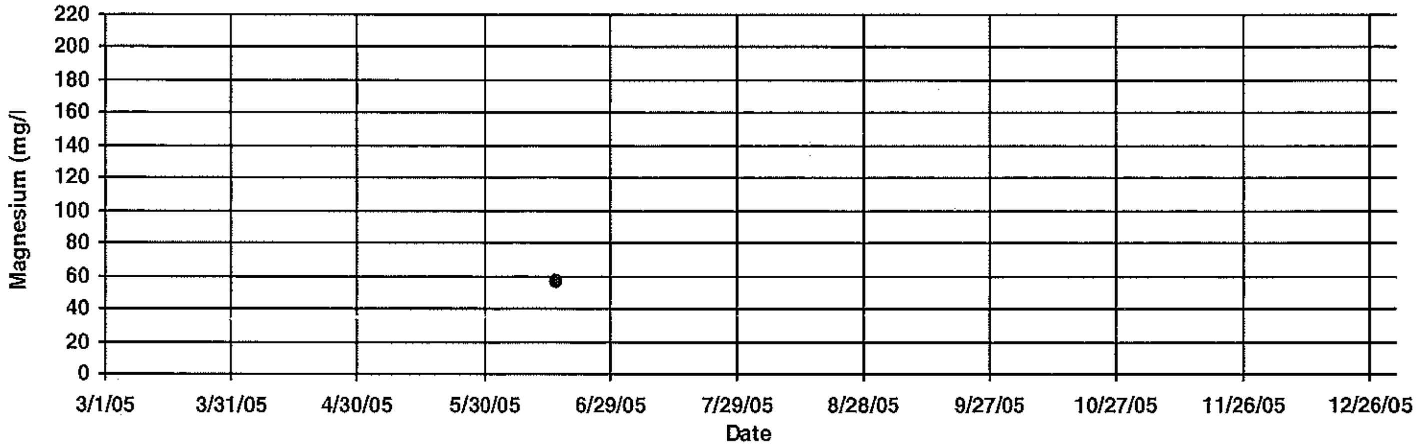


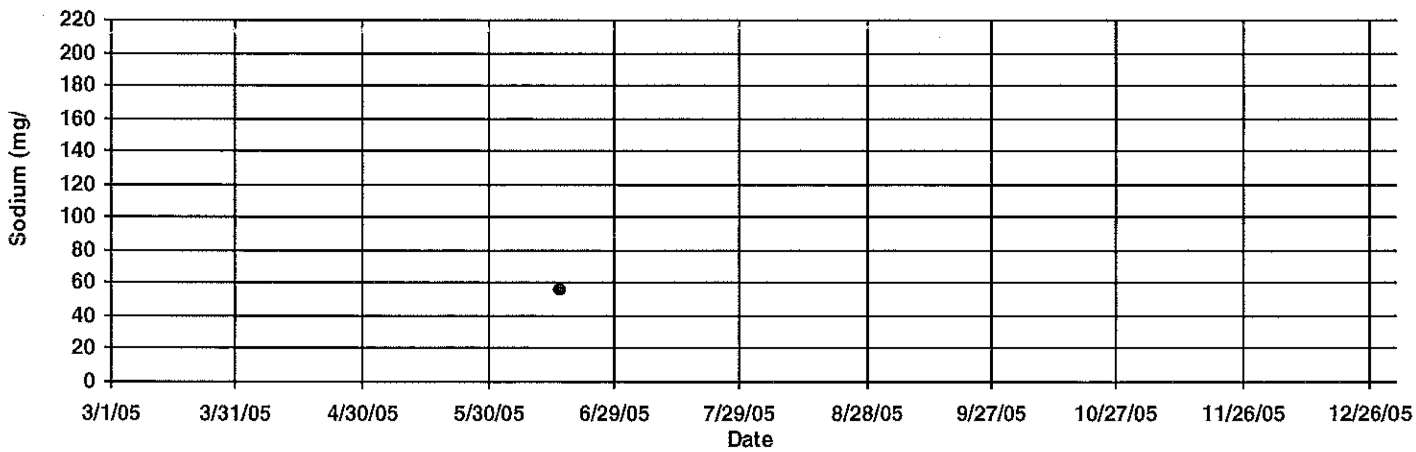


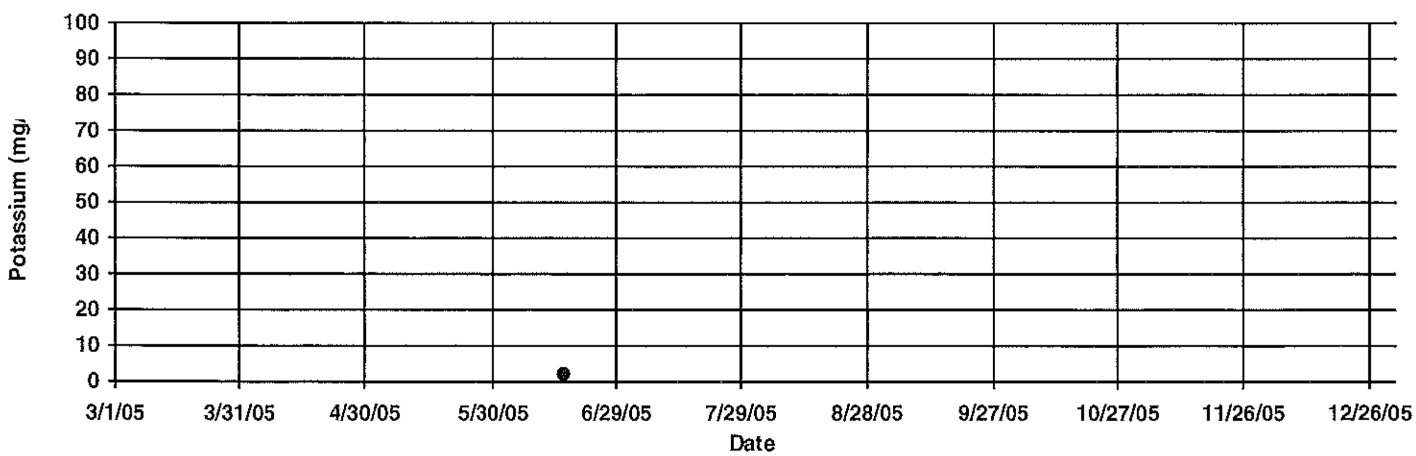
Study Site No. HG23 Time Tunnel Site No.: 39

GENERAL MINERAL DATA



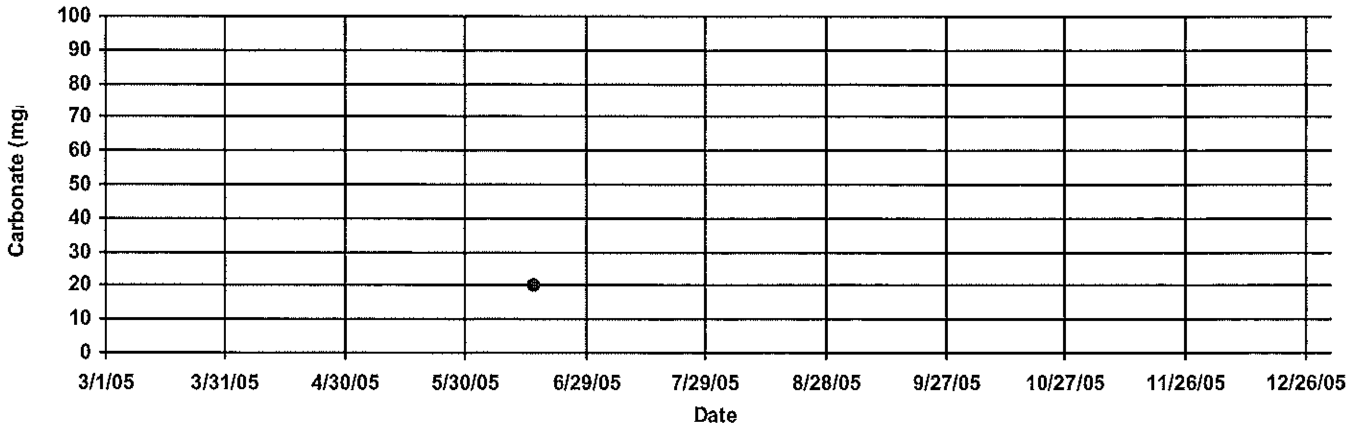


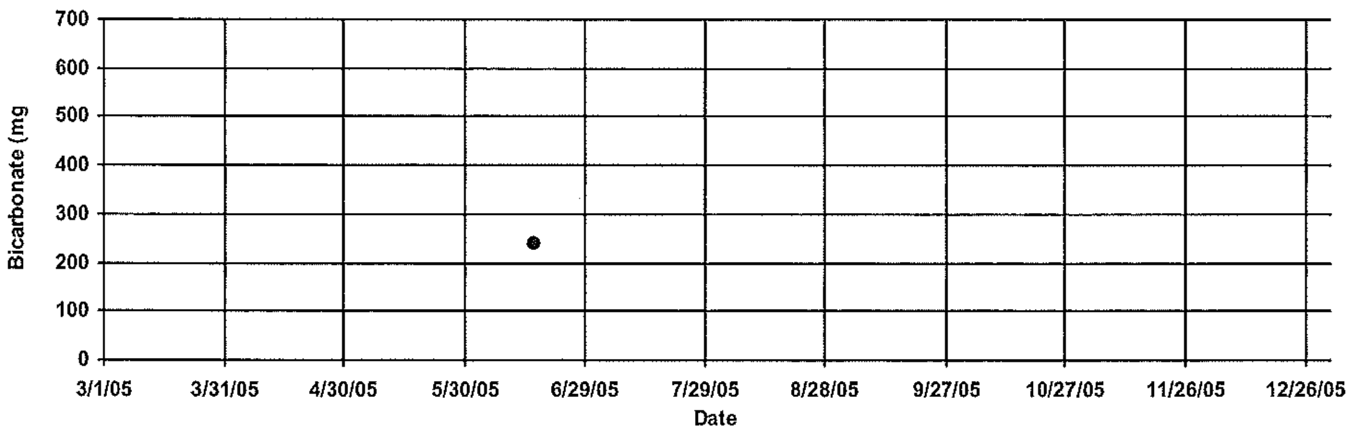


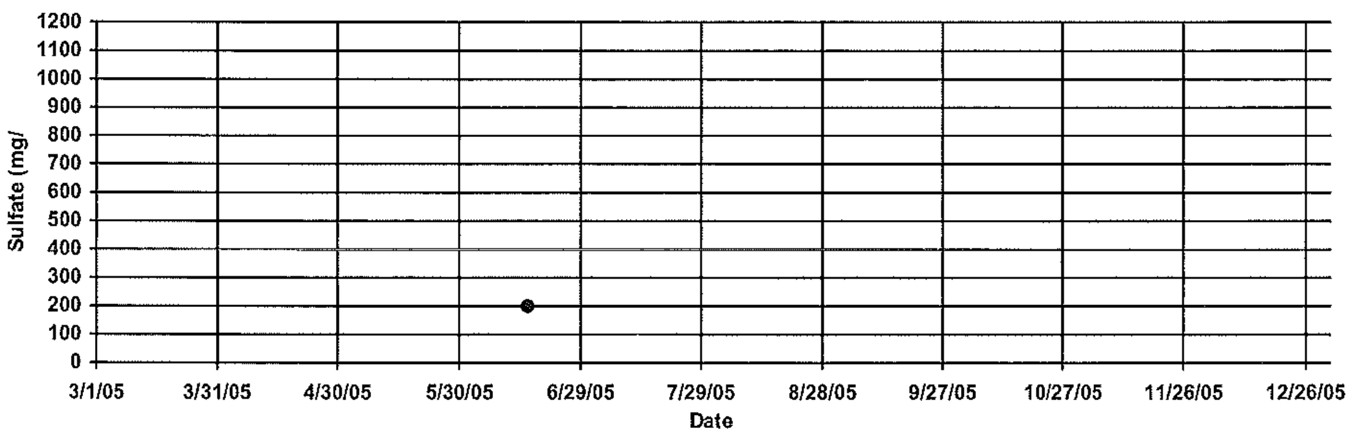


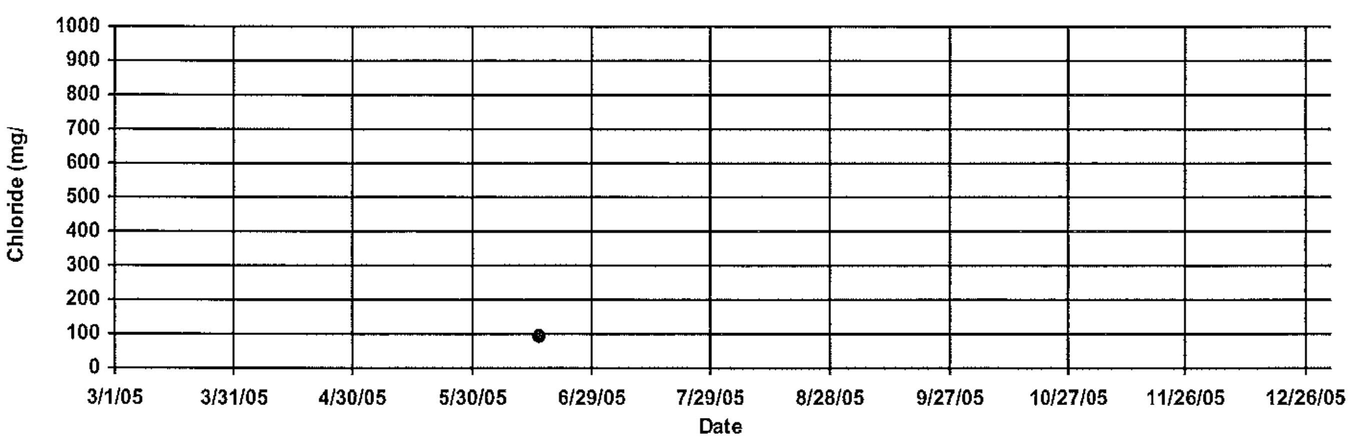
Study Site No. HG23 Time Tunnel Site No.: 39

GENERAL MINERAL DATA



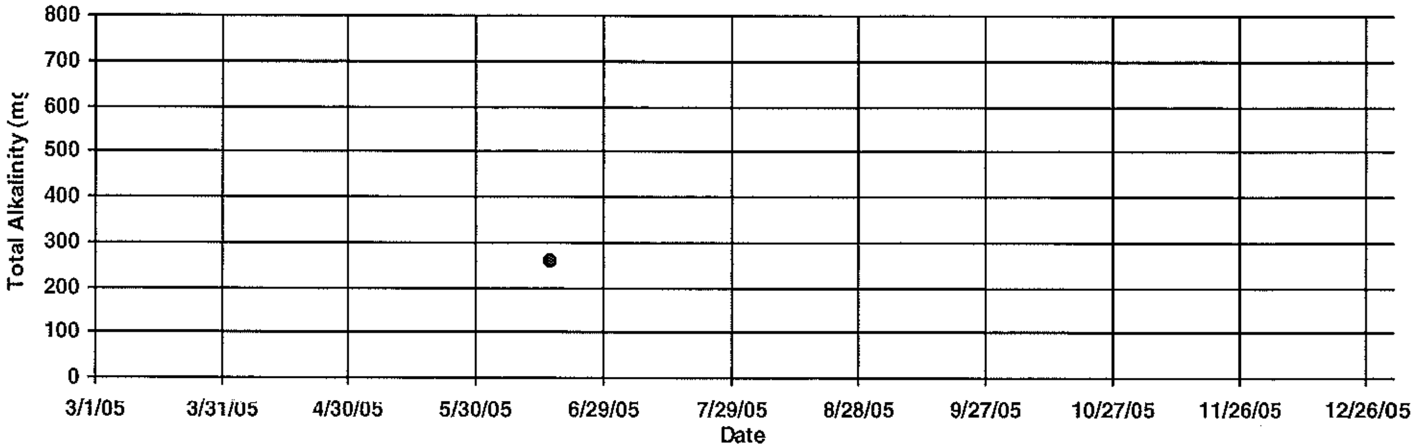


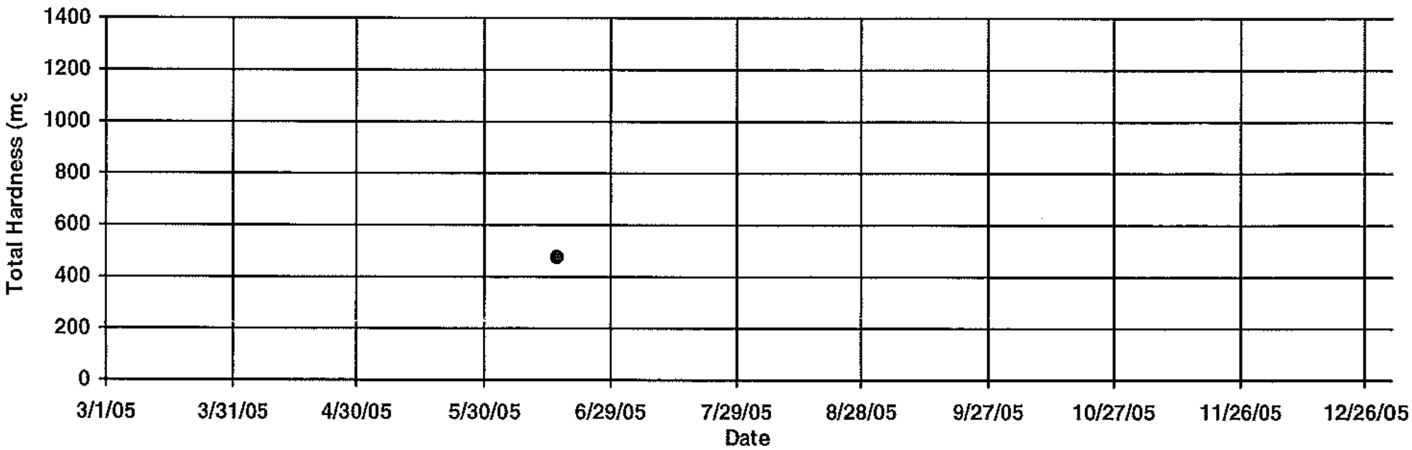


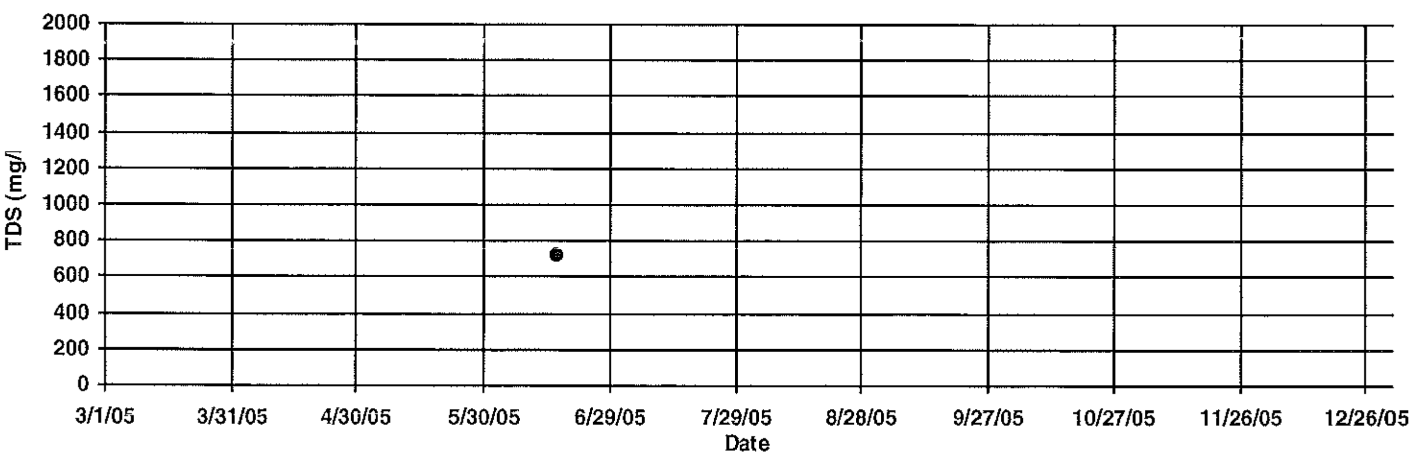


Study Site No. HG23 Time Tunnel Site No.: 39

GENERAL MINERAL DATA

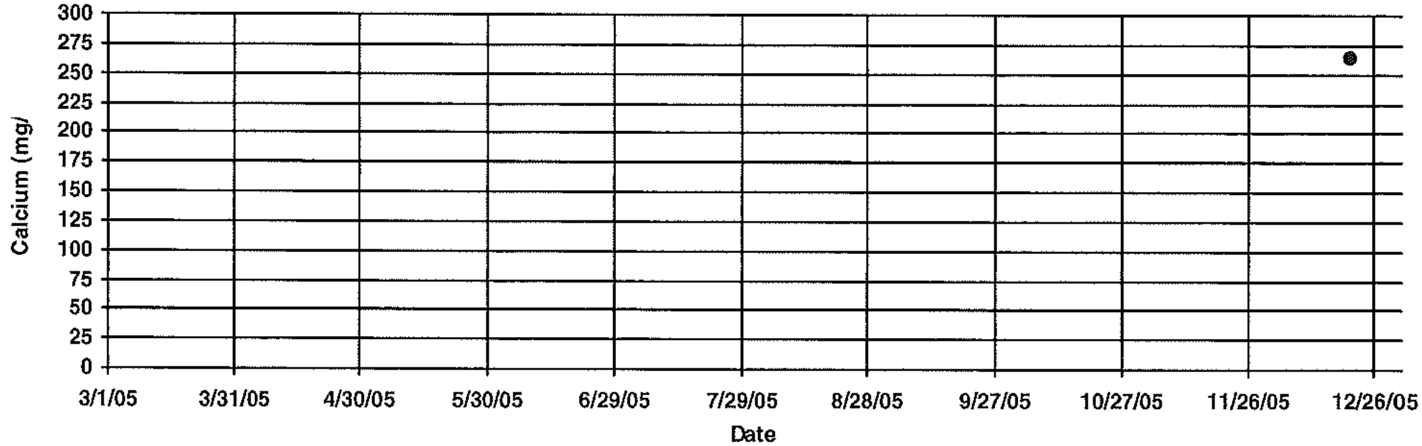


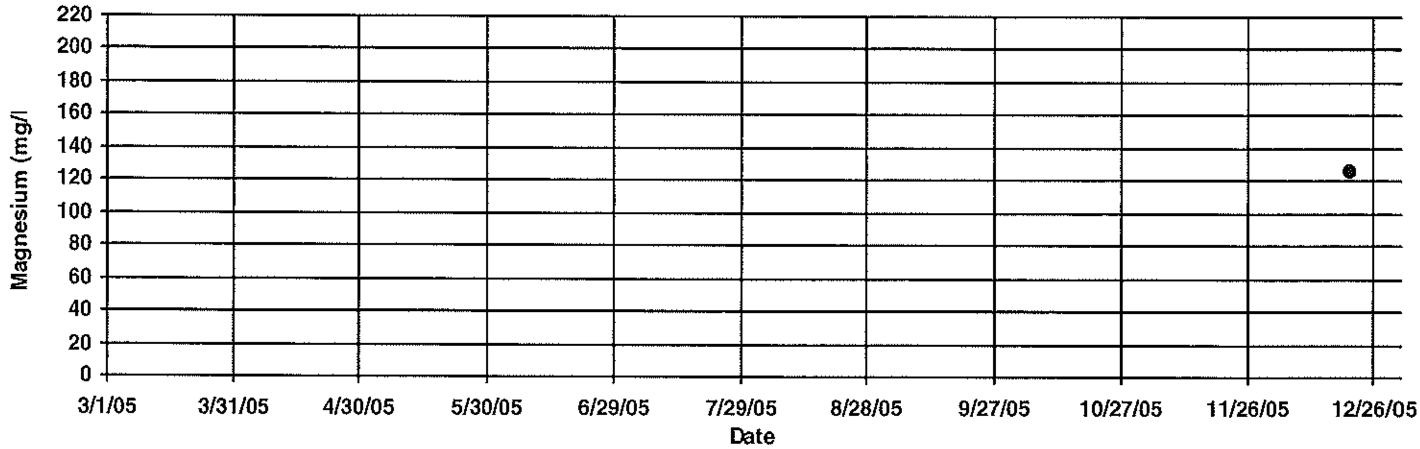


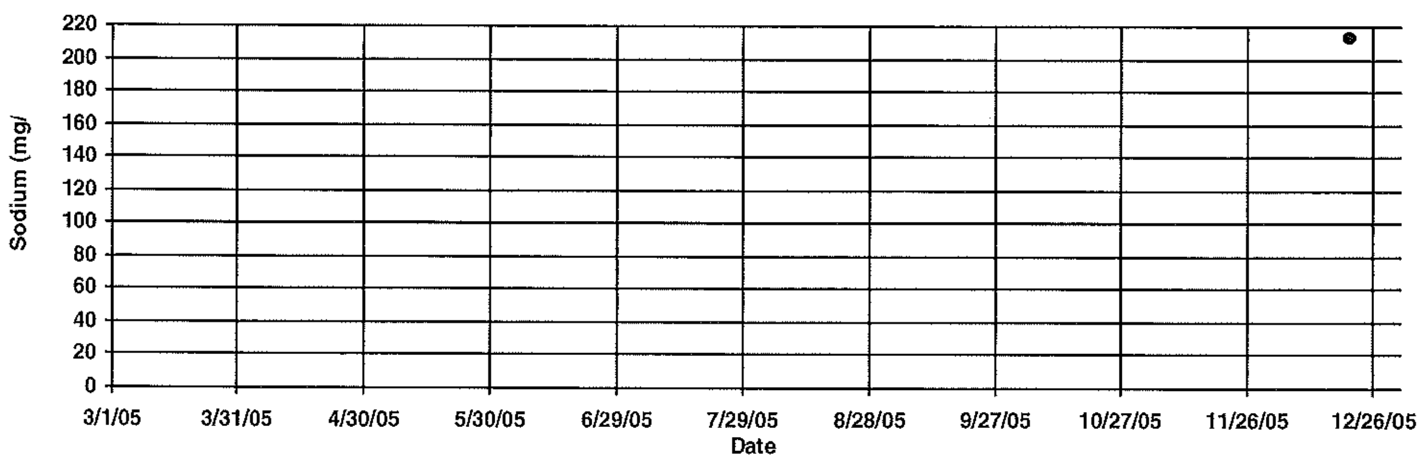


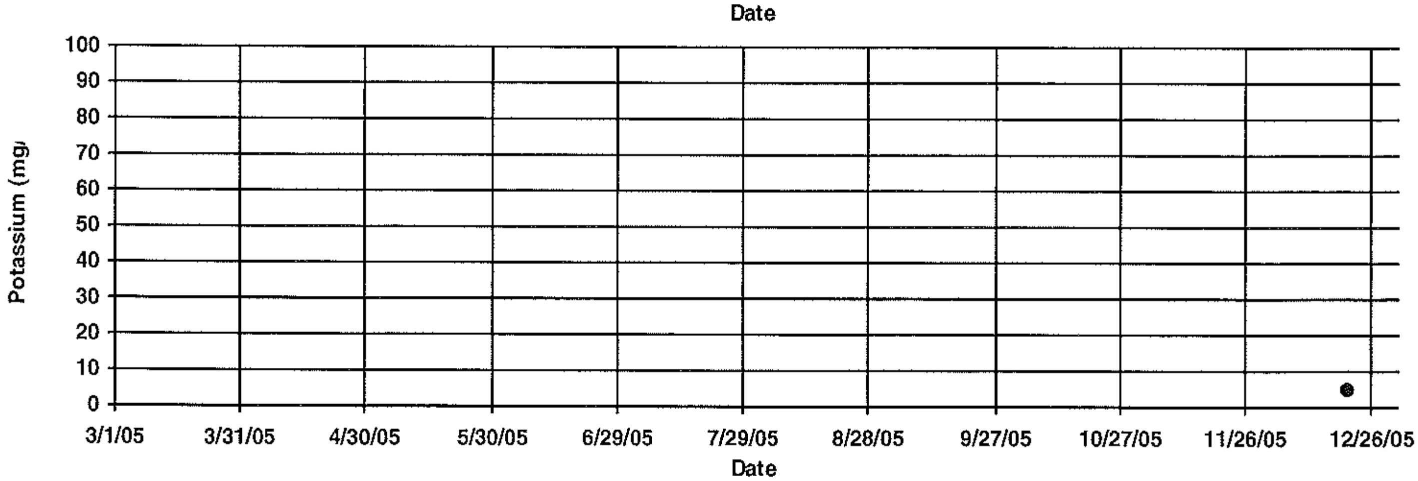
Study Site No. HG24 Abuelita's Site No.: 305

GENERAL MINERAL DATA



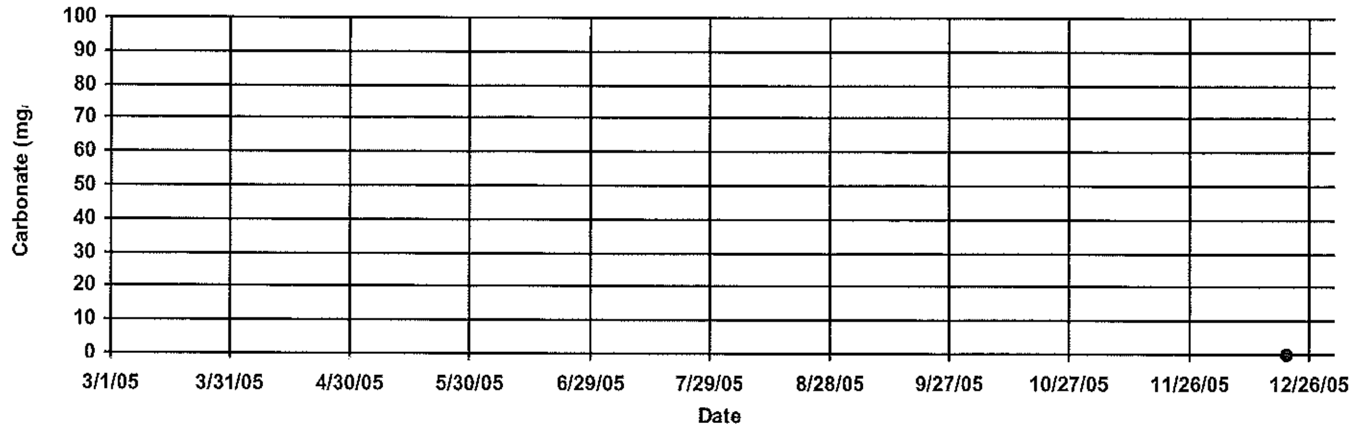


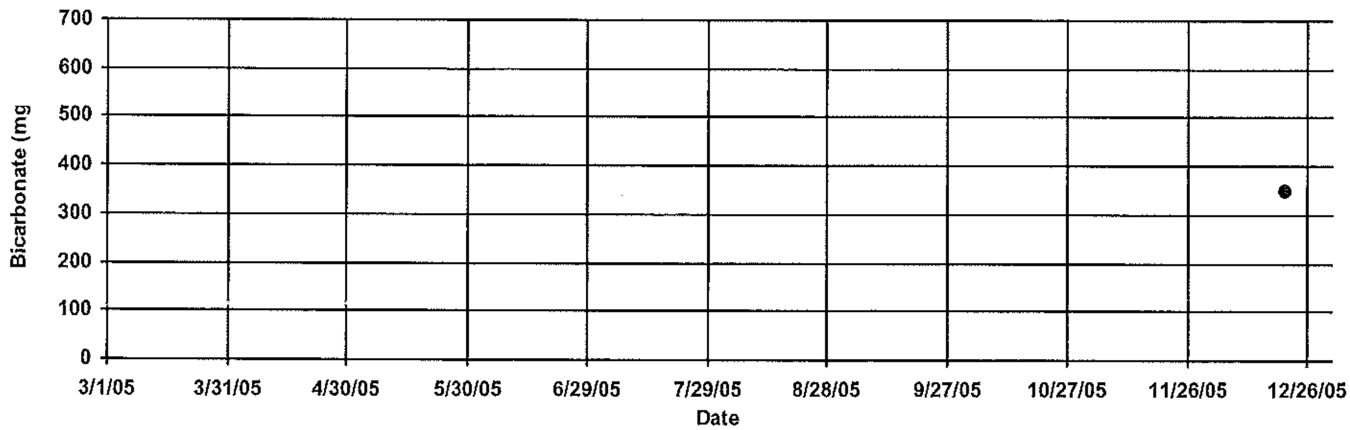


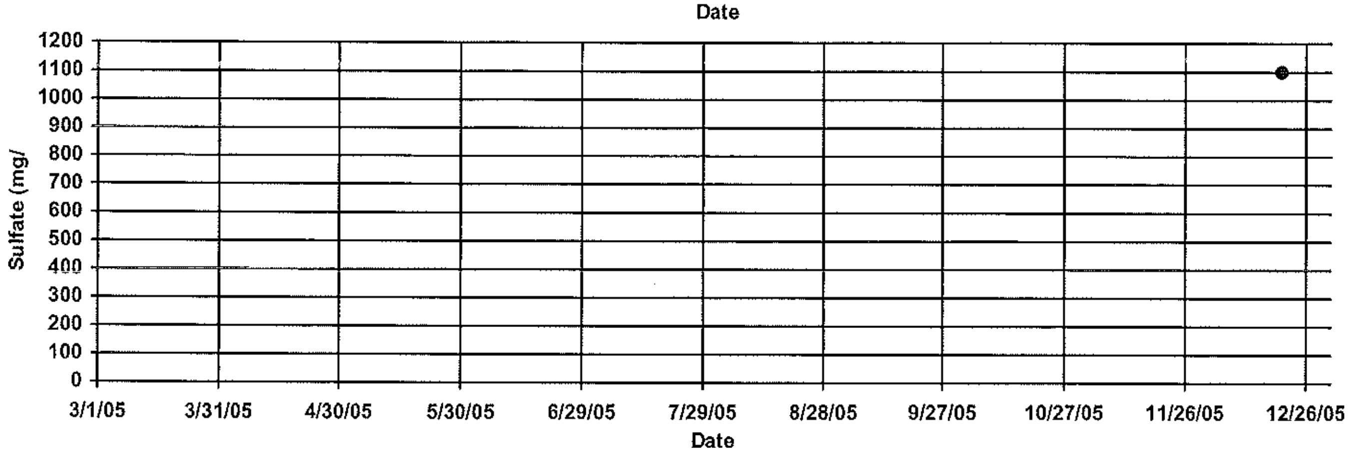


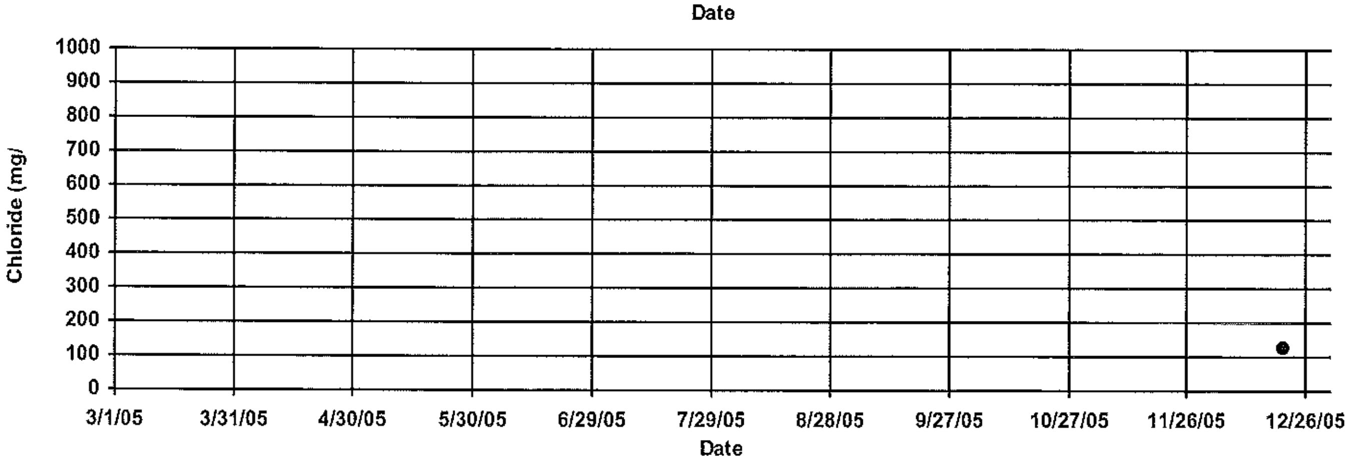
Study Site No. HG24 Abuelita's Site No.: 305

GENERAL MINERAL DATA









Study Site No. HG24 Abuelita's Site No.: 305

GENERAL MINERAL DATA