OFF-SITE CORRECTIVE ACTION PLAN
AVIS / PAYLESS CO-MINGLED
PETROLEUM HYDROCARBON PLUME
LAS VEGAS, NEVADA

Prepared for:

State of Nevada
Department of Conservation and Natural Resources
Division of Environmental Protection
Las Vegas Office
555 East Washington Avenue, Suite 4300
Las Vegas, Nevada 89101

Prepared by:

BROADBENT & ASSOCIATES, INC.
8 West Pacific Avenue
Henderson, Nevada 89015
(702) 563-0600
Project No. 95150

URS Corporation
7115 Amigo Street, Suite 110
Las Vegas, Nevada 89119
(702) 837-1500
Project No. 38257-004-169

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

URS

October, 2000

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October 5, 2000

State of Nevada
Department of Conservation and Natural Resources
Division of Environmental Protection
Las Vegas Office
555 East Washington Avenue, Suite 4300
Las Vegas, Nevada 89101

Attn: Mr. Todd Croft

Re: Off-Site Corrective Action Plan, Avis / Payless Co-Mingled Petroleum Hydrocarbon Plume, Las Vegas, Nevada.

Dear Mr. Croft:

Enclosed is an Off-Site Corrective Action Plan for the Avis / Payless co-mingled petroleum hydrocarbon plume in the vicinity of McCarran Airport in Las Vegas, Nevada. This report includes a summary of characterization and remediation to date, remedial options for impacted ground water, the feasibility of the considered remedial options, costs of feasible remedial options, and recommendations for additional options to be considered.

Should you have questions or require additional information, please do not hesitate to contact us.

Sincerely,
BROADBENT & ASSOCIATES, INC.

Kirk Stowers, EM 1549 (exp. 10/11/02)
Senior Geologist

URS Corporation

Scott Ball, EM 1316 (exp. 10/15/01)
Geoscience Division Manager

cc: Todd Croft - NDEP, Las Vegas
Valerie King - NDEP, Carson City
Julie Chadburn - Department of Aviation
Rose Pelino – Avis Rent A Car System, Inc.
Edward Conti - MFG, Inc.
Nick Willden - Payless Car Rental
Greg Walch - James, Driggs, Walch, et al.
Linda Bowman – Law Office of Linda A. Bowman

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1.0 INTRODUCTION

The Nevada Division of Environmental Protection (NDEP) has requested the formulation of a corrective action plan to address a co-mingled plume of petroleum hydrocarbons in ground water located near the northeast corner of McCarran Airport in Las Vegas, Nevada. Two contributors to the plume are believed to be the Avis Rent A Car System, Inc. (Avis) facility located at 5164 Rent A Car Road in Las Vegas, Nevada and the Payless Car Rental (Payless) facility located at 5175 Rent A Car Road in Las Vegas, Nevada (Responsible Parties or RPs).

This document represents a coordinated effort between Broadbent & Associates, Inc. (BAI), environmental consultant for Avis, and URS Corporation (URS), environmental consultant for Payless. The purpose of this document is to prepare a corrective action plan for a portion of the co-mingled petroleum hydrocarbon plume and to explore remedial options for the remainder of the plume.

1.1 Project Summary

The following sections summarize the environmental characterization and remedial actions performed to date by both RPs.

1.1.1 Avis Facility Project History and Remediation System

During a November 1993 soil investigation in the vicinity of gasoline underground storage tanks (USTs) at the Avis facility, a soil sample was collected from just above the capillary fringe. Analysis of this sample indicated a concentration of petroleum hydrocarbons in the gasoline range above the Nevada state action level for total petroleum hydrocarbons (TPH).

Based on this soil sample, the Clark County Health District, the regulatory agency at the time, requested the installation of a monitoring well on the Avis facility. This well, MW-1, is depicted on Drawing No. 1. Ground-water samples from the monitoring well indicated concentrations of dissolved benzene above the Nevada state action level.

Additional characterization of ground water beneath the Avis facility suggested the presence of a petroleum hydrocarbon plume containing benzene, toluene, ethylbenzene, and total xylenes (BTEX). In October of 1995, the Clark County Health

District requested the preparation of a corrective action plan to address dissolved BTEX in ground water beneath the Avis property. Air sparge (AS), vapor extraction (VE), and aquifer pilot tests were performed to evaluate appropriate remedial techniques, and on March 18, 1997, a closed-loop air sparge/vapor extraction (AS/VE) remediation system was put into operation on the Avis property. Twelve VE wells and thirteen AS wells were installed on the Property in association with the operation of the remediation system. Drawing No. 1 depicts the locations of the VE wells, the AS wells, and the on-site monitoring wells.

In October of 1997, the injection of a hydrogen peroxide solution into selected wells on the Avis property was instituted as an additional remedial technique. On August 10, 1998, the closed-loop AS/VE remediation system was converted to a conventional system with extracted soil vapors emitted to the atmosphere.

1.1.2 Payless Facility Project History and Remediation System

In February of 1997, ground-water samples collected from newly installed Avis monitoring well MW-20 seemed to indicate that an off-site facility was contributing to ground-water contamination beneath the Avis property. Characterization of the Payless Rent A Car facility in 1998 indicated that a release had occurred from beneath the Payless gasoline dispensers. Further ground-water investigations indicated that impacted ground water from the Payless facility had migrated offsite and co-mingled with ground water impacted by hydrocarbons at the Avis facility. In September 1998, the Payless UST system was upgraded to comply with Federal UST requirements and the leaks beneath the dispenser pumps were repaired.

An AS/VE remediation system was installed on the Payless property in May and June of 2000. The system includes six AS wells and six VE wells, depicted on Drawing No. 1. The remediation system became operational on July 18th, 2000. A program of hydrogen peroxide injection has also been instituted on the Payless property to enhance the ground-water remediation.

1.1.3 Off-Site Characterization of Ground Water

Off-site characterization of the petroleum hydrocarbon plume has been performed by both Avis and Payless. Ground-water data has indicated that the ground-water flow direction beneath the Payless and Avis properties is generally from west to east. A potentiometric surface contour map of the ground water is included as Drawing No. 2. The contours represent the elevation of ground water beneath the surface and show the change in elevation of the ground water from 2,048 feet above mean sea level (msl) on the west to 2,016 feet msl on the east.

To date, Avis has installed twelve on-site monitoring wells and fifteen off-site monitoring wells. Payless has installed six on-site monitoring wells, one monitoring well on the Avis property, and five off-site monitoring wells. The locations of these wells are shown in Drawing No. 2.

An approximation of the BTEX portion of the hydrocarbon plume suggests that it exists from its furthest western extent in monitoring well AMW-2 on the Payless property, through the Avis property, and to its eastern extent in monitoring well MW-24 at the corner of Durante Street and Colby Avenue. A graphical depiction of the benzene portion of the plume is given in Drawing No. 3.

In March of 1997, the NDEP requested the addition of methyl tertiary-butyl ether (MTBE) analyses for ground-water samples collected from the petroleum hydrocarbon plume. An approximation of the MTBE portion of the hydrocarbon plume suggests that it extends from its furthest western extent in monitoring well AMW-2 on the Payless property, through the Avis property, and to its eastern extent past monitoring well MW-28 on Wilbur Street. A graphical depiction of the MTBE portion of the plume is shown in Drawing No. 4.

1.2 Off-Site Soil Lithology

The geology of the off-site project area is typical of the Las Vegas Valley, primarily basin-fill sediments derived from the surrounding mountain ranges. The local lithology has been evaluated from soil boring logs created during the drilling of off-site monitoring wells. The local lithology is described below.

The uppermost lithologic layer that is found throughout most of the off-site area is a brown or red silty sand with little to some (10% to 35%) gravel (SM in the United Soil Classification System). The average size of the gravel is 0.5 inches in diameter; however, gravels were observed as large as 4 inches. This unit ranges in depth from three feet below ground surface (bgs) to 24 feet bgs with an average depth of approximately 17 feet. The average thickness of the unit is approximately 14 feet.

The uppermost layer west of Swenson Street is generally underlain by brown silty clay, exhibiting plastic qualities, with some (20% to 35%) gravel (SC). The silty clay unit starts at an approximate depth of 17 feet bgs and continues to the bottom of the borings (approximately 30 feet bgs). East of Swenson Street, the unit is a brown sandy clay with slight plasticity and some gravel (CL). The sandy clay unit starts at an approximate depth of 21 feet and continues to the bottom of the borings (approximately 27 feet bgs in wells east of Swenson Street).

Much like the on-site lithology, caliche is present throughout the off-site area at varied thicknesses, depths, and quantity of layers. The thickness and number of caliche layers generally decreases from west to east across the map area. The layers of caliche are inter-fingered throughout the above described units and are generally two to three feet in thickness.

1.3 Off-Site Ground-Water Conditions

Petroleum hydrocarbon contamination to the east (hydraulically down-gradient) of the Avis and Payless properties has impacted the shallow aquifer. Depths to ground water in the off-site portions of the plume (measured in June of 2000) vary from 12.48 feet bgs in monitoring well AMW-12 to 22.12 feet bgs in monitoring well MW-21.

The general direction of ground water flow is from west to east in the off-site portion of the plume. The magnitude of the hydraulic gradient varies from approximately 0.015 feet/foot in the portion of the plume just east of the Avis property (between Paradise Road and Swenson Avenue) to approximately 0.006 feet/foot at the eastern-most extent of the plume (east of Swenson Avenue). This difference in the magnitude of the hydraulic gradient may be the result of a disparity in ground-water recharge beneath the Howard Johnson property and the residential community further to the east. There is currently no known ground-water recharge mechanism in the vicinity of the Howard Johnson property as this area is largely covered with asphalt or buildings. In contrast, the residential area to the east of Swenson Street may have ground-water recharge from irrigation and/or precipitation.

2.0 DESCRIPTION OF SITE CONSTRAINTS

In formulating a corrective action plan for the off-site impacted ground water, several design and construction constraints are anticipated. These constraints will effect the feasibility of certain remedial technologies. Anticipated constraints include:

- The size of contaminant plume. The MTBE portion of the plume may extend as far as 2,800 feet east of the western-most impacted well with a width that may exceed 900 feet in certain areas.

- The nature of the properties under which the plume extends. The majority of the off-site contamination is below commercial and residential properties. This may pose complications for the placement, installation, and operation of the remedial equipment.

- Constant heavy vehicular traffic (especially on Tropicana Avenue and Maryland Parkway) to and from the commercial and residential areas. This could also complicate the installation, operation, and maintenance of any remedial equipment.

- Available space for remedial equipment. Space for remedial equipment may be limited in residential and commercial areas.

- Noise and safety concerns. Certain remediation systems may be too noisy for use in residential or commercial areas without noise reduction measures. In addition, the emission of petroleum hydrocarbon vapors may be inappropriate near residences, schools, or certain businesses.

These constraints were considered in the remedial options evaluation.

3.0 REMEDIAL OPTIONS EVALUATION

This remedial option evaluation is intended to address ground-water contamination to the east (hydraulically down-gradient) of Paradise Road. For the purposes of this evaluation, the off-site portion of the hydrocarbon plume is separated into two areas, the "BTEX / MTBE Impacted Ground-Water Area" and the "MTBE Impacted Ground-Water Area". As the name would suggest, the BTEX / MTBE

Impacted Ground-Water Area, depicted on Drawing No. 5, is the portion of the co-mingled plume which is currently impacted by both BTEX and MTBE dissolved hydrocarbons. The MTBE Impacted Ground-Water Area is currently impacted primarily by MTBE. Recent laboratory analyses suggest that the dividing line between these two areas is somewhere between monitoring well MW-24 (which contains all four of the BTEX hydrocarbons as well as MTBE) and monitoring well MW-25 (where BTEX have not been detected since March of 1998).

These two areas are being considered separately as the effectiveness of ground-water remedial techniques appears to be related to plume constituents, specifically the presence of BTEX and MTBE combined or MTBE only.

3.1 BTEX / MTBE Impacted Ground-Water Area

The BTEX / MTBE Impacted Ground-Water Area is defined as the portion of the co-mingled plume that extends from the eastern boundary of the Avis Property at Paradise Road to approximately monitoring well MW-24 at the corner of Durante Street and Colby Avenue (Drawing No. 5).

3.1.1 Potential Remedial Options

The following remedial techniques were evaluated for the BTEX / MTBE Impacted Ground-Water Area.

Natural Attenuation - Natural attenuation involves the use of a risk assessment to demonstrate that the application of active remedial technologies is not necessary because of the limited risk to potential receptors and the expectation that contaminant concentrations will decrease with time.

Pump-and-Treat Technology - With this option, ground water is pumped from one or more wells impacted by petroleum hydrocarbons into a treatment unit. After treatment, the ground water is discharged to the sanitary sewer system or storm sewer system, or re-injected into the aquifer. Discharge to a storm sewer system would require a National Pollutant Discharge Elimination System (NPDES) permit and re-injection into the near surface aquifer would require an Underground Injection Control (UIC) permit. Both of these permits have similar monitoring requirements. Re-injection has the advantage of replacing treated ground water back into the aquifer from which it was extracted. Re-injection near the up-gradient edge of the contaminant plume tends to direct contamination toward the extraction wells, thereby increasing effectiveness of the pump-and-treat system.

Pump-and-treat systems have been demonstrated to be effective in controlling further contaminant migration and reducing contaminant concentrations, particularly when treated ground water is re-injected at the up-gradient edge of the plume. However, pump-and-treat systems in the Las Vegas Valley may require longer remediation times than other technologies.

Ground-Water Circulation Wells (GCWs) - A vertical GCW system focuses on creating an in-situ vertical ground water circulation cell. This is accomplished by drawing ground water from an aquifer through one screened section of a double-screened well, treatment of the ground water within or outside the well, and discharge of the ground water through the second screened section. In this technology, the water serves as the in-situ carrier, bringing ground water containing contaminants from throughout the ground-water capture zone to the GCW system where it is treated and discharged back into the formation. Common remedial treatments associated with the GCW system are ultraviolet light, ozone, resin beds, hydrogen peroxide, biotic and abiotic processes, or a combination of these technologies to effect contamination removal or destruction.

Air Sparge / Vapor Extraction with Hydrogen Peroxide Injection - AS/VE involves the injection of air into the ground water to volatilize petroleum contaminants. AS is usually more effective when used in conjunction with VE as a control measure for vapor migration. Systems of this type are already in use as both the Avis and Payless remediation systems.

Hydrogen peroxide injection involves the injection of a dilute solution of hydrogen peroxide into the ground water to add oxygen to the ground water, aiding the biodegradation of petroleum contaminants. This remedial technique is also currently being used at both the Avis and Payless properties to enhance the AS/VE systems.

3.1.2 Remedial Option Feasibility Evaluation

The feasibility of each of the aforementioned remedial options for the BTEX / MTBE portion of the hydrocarbon plume is discussed below.

Natural Attenuation - Natural attenuation is not considered a feasible option at this time as the Nevada state action levels for BTEX and MTBE in ground water are currently exceeded and the time to achieve cleanup levels using this method will allow further migration of the contaminants. In addition, viable treatment methods can be applied to this site and remedial action has been required by the NDEP.

Pump and Treat Technology – An aquifer test was performed on the Avis property in March of 1996. The results of this test suggested that the pump-and-treat technology was a feasible option to contain further migration and reduce contaminant concentrations within ground water. Details of this aquifer test can be found in a Broadbent & Associates, Inc. report dated April 11, 1996 entitled *Results of Fourth Quarter, 1995 Monitoring, Remedial Option Evaluation, and Remedial Action Workplan, Avis Rent-A-Car, Inc.*

While pump and treat technology is generally effective for hydraulic control of contaminant migration, its limitations include a limited cleanup effectiveness and an estimated operation time of several years, thus increasing the cost. In addition, this technology may not be viable for use in the residential area to the north of the Howard Johnson's property as the residents in this area have indicated their intention to prevent work on their properties in the past. Even considering these limitations, a pump and treat system appears technically feasible for remediation of the BTEX / MTBE portion of the hydrocarbon plume.

Permits required for the operation of a pump and treat system would include: a Permit to Appropriate the Public Waters of the State of Nevada which would allow for the pumping of impacted ground water, a UIC permit for injecting ground water back into the aquifer, and an Authority to Construct permit to emit hydrocarbon vapors to the atmosphere. A building permit may also be necessary to enable the construction of a unit to hold any treatment systems. Appropriate "Right-of-Way" or Encroachment permits for installation of wells on public ways may be required from Clark County Department of Public Works.

GCW Wells – GCW wells have been utilized, with success on a number of sites for remediation of ground water. Compared to other known technologies, the GCW well technology has a high cost per unit, making it an expensive solution to ground-water contamination remediation projects. Access problems may also be encountered for this technology in the residential area north of the Howard Johnson's property. However, these wells should require less of a surface expression than a pump and treat system.

Permits that may be needed for operation of this system include: a Permit to Appropriate the Public Waters of the State of Nevada, a UIC permit, and an Authority to Construct permit. It is also likely that this system would require a building permit to enable the construction of a unit to hold any treatment systems. Appropriate "Right-of-Way" or Encroachment permits for installation of wells on public ways may also be required from Clark County Department of Public Works.

Air Sparge / Vapor Extraction with Hydrogen Peroxide Injection – AS and VE tests performed on the Avis property in 1996 indicated that an AS/VE remediation system was a viable technology for ground-water remediation in this area. Geochemical analyses performed on the Avis property have suggested that hydrogen peroxide injection appears to be a viable remedial option in this area. This remedial technique appears to have enhanced the ground-water remediation currently in operation on the Avis property.

In addition, the institution of a program of hydrogen peroxide injection in the residential area north of the Howard Johnson will be less intrusive than pump and treat or GCW technologies as no treatment compounds are necessary. Therefore, operation of an AS/VE system with a program of hydrogen peroxide injection is considered a feasible remedial option for the BTEX / MTBE portion of the hydrocarbon plume.

It should be noted that some successful remediations of ground water in the Las Vegas Valley using a combination AS/VE and the injection of hydrogen peroxide have resulted in the discontinuation of the AS/VE system towards the end of the remediation. Often times it is feasible to continue a program of only hydrogen peroxide injection after BTEX and MTBE concentrations have significantly declined. This option may be explored towards the end of the remediation if approval from the NDEP is granted.

Permits required for the operation of an AS/VE system enhanced by hydrogen peroxide injection would include: a UIC permit for injecting hydrogen peroxide into the aquifer and an Authority to Construct permit to emit hydrocarbon vapors to the atmosphere. As with the Pump and Treat and GCW wells technologies, a building permit may also be necessary to construct treatment systems. Appropriate "Right-of-Way" or Encroachment permits for the installation of wells on public ways may also be required from Clark County Department of Public Works.

3.1.3 Feasible Remedial Option Cost Evaluation

Table 1 presents a comparison of projected costs associated with each of the three feasible remedial options presented above. Costs were based on construction and installation of the remediation system; two years of operation, maintenance, and sampling; one year of closure monitoring; and decommissioning of wells and systems. This schedule is not intended to necessarily reflect the length of the remediation, but is a means to compare costs. Of the three treatment methods for which costs were generated, AS/VE with hydrogen peroxide injection appears to be the most cost effective of the feasible remedial options. Estimated costs are $0.6 million for AS/VE and hydrogen peroxide injection versus $0.8 and $0.9 million for pump-and-treat and GCW, respectively. Therefore, a workplan for the implementation of a AS/VE system with hydrogen peroxide injection is provided in Section 4.0 – Corrective Action Workplan.

3.2 MTBE Impacted Ground-Water Area

The MTBE Impacted Ground-Water Area is defined as the portion of the co-mingled plume that extends from approximately monitoring well MW-24 to the furthest eastern extent of the plume as currently defined, near Young Street and Toni Avenue. The MTBE Impacted Ground Water Area is depicted in Drawing No. 5.

3.2.1 Potential Remedial Options

The following are the potential remedial options considered for the MTBE Impacted Ground-Water Area.

Natural Attenuation – As noted in the options discussed for the BTEX / MTBE Impacted Ground-Water Area, natural attenuation involves the use of a risk assessment to demonstrate that the application of active remedial technologies is not necessary because of the limited risk to potential receptors and the expectation that contaminant concentrations will decrease with time.

Pump and Treat and GCW Wells – These technologies are discussed in Section 3.1.2 of this report. Both technologies are considered technically feasible for the MTBE portion of the project and will be reconsidered after testing of other technologies (discussed below).

ISO-GEN(TM) Technology – The ISO-GEN(TM) system is a ground-water remediation technology that has only recently been considered for the Las Vegas Valley. This system acts essentially as an in-well air stripper through the electrolysis of ground water. According to SECOR International Incorporated (SECOR), the consulting firm that is currently using this technology in Las Vegas, contaminated ground water is pulled through an in-well pump intake, moves through a cell which disassociates water molecules into gaseous oxygen and hydrogen, and then the treated ground-water that has not been disassociated exits through a distribution tube. This process has the added benefit of increasing dissolved oxygen concentrations in the ground water through the return of treated ground water to the subsurface. Increased dissolved oxygen in the ground water is believed to aid in the biodegradation of petroleum contaminants.

Ozone Sparging into AS Wells with Vapor Extraction (C-Sparge) – Ozone sparging into AS wells as part of an AS/VE system is an active approach to remediate MTBE impacted ground water. The addition of ozone to the ground water stimulates oxidation (or breakdown) of MTBE through electron exchange processes and creates breakdown components such as tertiary butyl alcohol that can be oxidized further by addition of more ozone. Ozone also increases the dissolved oxygen content of the ground water stimulating increased biological activity for the degradation of MTBE. The ozone has a potential to change the biological environment from an an-aerobic (oxygen poor) to an aerobic (oxygen rich) condition. This aerobic condition can stimulate biological colony growth and consumption of MTBE as a food source in the absence of BTEX.

Hydrogen Peroxide – As described in Section 3.1.1, hydrogen peroxide remediation involves the injection of a solution of hydrogen peroxide into the ground water to add dissolved oxygen to the ground water, aiding in the biodegradation of petroleum contaminants. However, hydrogen peroxide is also an oxidizer that breaks down MTBE through electron exchange processes similar to that of ozone. The components can then be broken down further by additional oxidation and bioremediation.

Fenton's Reagent Oxidation – Fenton's Reagent is an acidified mixture of hydrogen peroxide (H_2O_2) and ferrous iron (Fe II) whose strong oxidizing potential was first reported in 1894 by H.J.H. Fenton. Fenton's reagent is typically employed because it decomposes readily in the subsurface to oxygen and water, and is non-persistent in the environment. Fenton's reagent is capable of complete, non-selective oxidation of organic compounds in soil and ground water. As a result, it can be used to remediate dissolved petroleum fuels as found in ground water on and off of the properties. Some factors to consider when evaluating Fenton's reagent include (1) rapid reaction (usually within minutes); (2) potential for complete mineralization; (3) the necessity to add it as an acidified solution (pH less than 4.5) in order to keep the Fe II in solution; (4) the rapid generation of oxygen gas and heat by the decomposition of the Fenton's reagent; and (5) reactions with soil and ground water high in alkalinity or natural organic matter which may consume Fenton's reagent before it can effectively react with the chemical of concern.

Potassium Permanganate Oxidation - Injection of a potassium permanganate solution is an emerging technology for the in-situ oxidation of organic compounds, though its effectiveness with MTBE is unknown. Like Fenton's reagent, permanganate is a non-selective oxidizing agent that may be consumed by natural organic matter and other oxidizable species as well as the chemical of concern. In general, the soil demand for permanganate is significantly greater than the demand of the chemical of concern. When considering injection of permanganate into the subsurface, the formation and fate of hexavalent chromium (Cr VI) must be taken into account. Permanganate contains chromium as an impurity and can oxidize soil chromium to water-soluble hexavalent chromium. Some factors to consider when evaluating permanganate include (1) it is intensely purple; (2) it is consumed relatively slowly by soil which may enhance subsurface transport of potassium permanganate; (3) demand of the soil is usually significantly greater (but slower) than the demand of the contaminant; and (4) hexavalent chromium may be formed during treatment.

3.2.2 Remedial Option Feasibility Evaluation and Further Testing Recommendations

The following is a discussion of evaluating the feasibility of the remedial options for the MTBE Impacted Ground-Water Area.

Natural Attenuation – As with the BTEX / MTBE portion of the plume, natural attenuation is not considered a feasible option for the MTBE portion of the plume at this time. This is because the Nevada state action level for MTBE in ground water is currently exceeded and the time to achieve cleanup levels using this method will allow further migration of the contaminant. Natural attenuation may become a feasible remedial option during a later portion of the project once the chosen technology has significantly reduced the mass of contaminant in the plume.

ISO-GEN(TM) Technology - SECOR is currently performing a pilot test of the ISO-GEN(TM) technology in the Las Vegas Valley. The results of this test are scheduled to be published in December of 2000. At that time, the feasibility of using the ISO-GEN(TM) technology for ground-water remediation will be evaluated. The ISO-GEN(TM) system is an in-well system and, therefore, should be implementable in residential areas. A power source would be the most intrusive portion of the system. If the pilot test data generated by SECOR looks promising, then a pilot test may be appropriate for implementation within the MTBE Impacted Ground-Water Area. This may include installation of one or more wells and ISO-GEN(TM) systems, and possibly monitoring points. A pilot test would only be implemented after approval of NDEP.

Ozone Sparging into AS Wells with Vapor Extraction (C-Sparge) - C-sparge would appear to be a desirable remedial option for residential areas due to a low operational noise level and its capacity to be installed "below-ground". Like the ISO-GEN(TM) system, a power source is necessary. A pilot test of this technology in the MTBE Impacted Ground-Water Area is recommended to evaluate its feasibility. The pilot testing would consist of the installation of several ozone sparging points and possibly installation of one or more monitoring points. Each sparge point would have one or more screened intervals below the ground-water surface at different depths, depending on site lithology. The sparge points would be connected through piping to a control unit. The control unit would consist of an ozone gas generator, an electric air blower, a pump controller, and a system timer. A pilot test would only be implemented after approval of NDEP.

Hydrogen Peroxide Injection - The benefits, feasibility, and costs associated with the injection of a hydrogen peroxide solution into BTEX- and MTBE-impacted ground water are generally considered to be favorable and have been discussed previously in this report. However, the benefits of hydrogen peroxide remediation for ground water solely impacted by MTBE is subject to debate. Specifically, it is unclear whether BTEX are necessary to initially stimulate a biological population before MTBE can eventually be metabolized. Therefore, we recommend that a pilot test be performed on a well or wells within the MTBE Impacted Ground-Water Area to evaluate the feasibility of this technology. Such a pilot test could consist of monthly injection into selected MTBE-impacted wells and associated monitoring and sampling. This may also require installation of additional monitoring points. A pilot test would only be implemented after approval of NDEP.

Fenton's Reagent Oxidation and Potassium Permanganate Oxidation – Bench scale tests can be performed to evaluate the feasibility of Fenton's reagent and potassium permanganate to destroy MTBE in ground water. Approximately 1 gallon of soil and 2 liters of ground water that are representative of the site conditions and contaminants are required to perform bench scale tests. A series of tests are conducted to examine reactions of native soil and ground water with catalysts prepared at varying pH ranges in order to determine (1) the catalyst pH range at which soil/ground water reactivity is minimized and (2) the amount of residual acid required to maintain the optimum pH (generally a pH of 5). Chemical characteristics such as total organic carbon, buffering capacity and total iron in soil and alkalinity and total iron in ground water are also determined since these characteristics result in the consumption of the hydroxyl radicals before they can effectively remediate the chemical of concern. The bench scale tests can also provide information on selected potential degradation products, such as tertiary-butyl alcohol and acetone. Pending the approval of the NDEP, we recommend that these bench tests be performed to evaluate the feasibility of these technologies.

Should these technologies appear feasible through the performance of bench tests, the injection process could be pilot-tested in the field using a series of small-diameter injection wells. This delivery system would inject the solutions under pressure to obtain direct contact with the target constituents located within the saturated and vadose zones.

4.0 CORRECTIVE ACTION WORKPLAN - BTEX / MTBE IMPACTED GROUND-WATER AREA

This section presents a brief discussion of the chosen remedial design and layout for the BTEX / MTBE Impacted Ground-Water Area. Drawing No. 6 shows the general layout of the system and the proposed location of the remedial equipment.

It is anticipated that two AS/VE units will be required to adequately cover the large area of impacted ground water beneath the Howard Johnson hotel property. The remedial system will be divided into two sections, namely a West Side and an East Side. Both systems will consist of AS/VE blowers, controllers, manifolds and monitoring equipment. The systems will be positioned in locations considering the least intrusive effects to adjacent properties and the hotel operations. For the purpose of this preliminary design, the West remedial system will be located close to Paradise Road, at the Northwest corner of the site, and the East remedial system will be located close to Swenson Street, at the Northeast corner of the site.

The AS/VE remedial systems will be covered and protected from the elements, most likely by their installation in an enclosed trailer. The systems will include engineered noise reduction to limit noise. The trailers will be placed in a screened fence enclosure to block the public view and to provide security of the system.

It is anticipated that a hydrogen peroxide solution will be injected into selected wells two out of every three months in a quarter. The concentration of the hydrogen peroxide, the volume to be injected, and the wells into which to inject the hydrogen peroxide will be determined through evaluation of ground-water contaminant concentrations, and discussions with the Bureau of Water Pollution Control of the NDEP.

4.1 Air Sparge System Design

Both AS systems will include a network of wells, piping, and AS blowers and controllers. Drawing No. 6 shows the location of the proposed system. The wells were spaced so that they would alternate across the site with VE wells. The distances between the wells range from 60 feet across the majority of the site to 100 feet along Swenson Street. These distances were selected considering pilot test data from the 1996 Avis AS and VE pilot tests. These tests suggested that the radius of influence within the formation for both AS and VE was in the range of 65 to 75 feet.

The 20 AS wells are proposed to be approximately 20 - 25 feet deep with three feet of 2-inch diameter 0.01 inch slotted PVC. Ground water ranges from 17 feet bgs to 22 feet bgs across the site. Each well will have a clean out at the top so that they can be re-developed or serviced in the future.

4.2 Vapor Extraction System Design

The two VE systems will include a network of 20 wells, underground piping, and VE blowers and controllers (one for each system). As with the AS wells, the VE wells will alternate across the site. The distance between the wells and the rationale for the distance is similar to that for the AS wells.

These 20 wells are proposed to be approximately 22 feet deep with 5 feet of 4- to 8-inch diameter 0.02 inch slotted PVC screen from 14 feet bgs to approximately 2 feet below ground water. Each well will have a clean out at the top so that they can be serviced in the future and used for hydrogen peroxide injection. The air out flow of the systems will be equipped with appropriate secondary remedial measures (carbon filters), if necessary, for removal of hydrocarbon vapor emissions prior to discharge. Once emission concentrations are low enough to not exceed air permit requirements, the secondary remedial measures will be removed.

4.3 Hydrogen Peroxide Injection

Selected VE, AS, monitoring, and injection wells will be used for injection of a hydrogen peroxide solution into the ground water. The proposed injection wells (IWs), located north of the site in "Palo Verde Circle" (Drawing No. 6) will be used for injection only. Selected VE, AS, and monitoring wells along Swenson Street will serve additionally as injection wells. VE wells will be constructed using 4- to 8-inch diameter slotted PVC screen. Injection events will most likely use a mixture of 3% hydrogen peroxide and de-ionized water that will be purchased from a local chemical company. Alternately, hydrogen peroxide will be mixed to a 3% solution in a tank after de-chlorination of the water. This solution will be pumped or gravity fed into selected wells. A record of the total volume of solution placed in the wells will be kept and reported to NDEP quarterly. Hydrogen peroxide injection will occur within one month after quarterly sampling of the monitoring wells. A minimum of one month between the last injection event and quarterly sampling will be maintained.

4.4 Permitting Requirements

An underground injection control (UIC) permit will be required prior to hydrogen peroxide injection activities in the BTEX / MTBE Impacted Ground-Water Area. In addition, two Authority to Construct permits will need to be obtained from the Clark County Health District Air Pollution Control Division to allow for the emission of petroleum hydrocarbon vapors into the atmosphere from each VE system. A building permit or a permit to alter an existing building might be needed from Clark County Department of Public Works for construction of the systems. Appropriate "Right-of-Way" or Encroachment permits for installation of wells on public ways will be required from Clark County Department of Public Works.

4.5 Monitoring Requirements

During remedial activities, the monitoring wells associated with the BTEX / MTBE Impacted Ground-Water Area will be monitored for depths to ground water and dissolved oxygen concentrations. In addition, ground-water samples will be collected quarterly and analyzed for BTEX and MTBE by EPA Method 8260, as required by the NDEP. Vapor samples will be collected monthly, from the effluent of the VE systems, to monitor petroleum hydrocarbon emission to the atmosphere, as required by the Clark County Health District.

4.6 Corrective Action Workplan Implementation Schedule

The anticipated implementation schedule for the BTEX and MTBE plume area is as follows: (See Table 2 for the projected timeline)

- November and December of 2000. The design of the remediation system and the preparation of the UIC permit applications and the Authority to Construct permit applications will be performed.

- December of 2000 and/or January of 2001. Solicitation of bids from qualified contractors will be performed.

- January and February of 2001. The remediation system will be installed at the Property.

- February or March of 2001. Anticipated remedial system start up.

5.0 CORRECTIVE ACTION WORKPLAN – MTBE IMPACTED GROUND WATER AREA

Further development of the corrective action plan for the MTBE Impacted Ground Water Area will be undertaken upon completion and evaluation of the appropriate laboratory bench-scale and field pilot testing or, in the case of the ISO-GEN$^{(TM)}$ technology, once results of SECOR's pilot test become available.

It should be noted that, once the feasibility of the potential remedial options for the MTBE Impacted Ground-Water Area are evaluated, these technologies may also be applied to the BTEX / MTBE Impacted Ground-Water Area.

The implementation of the proposed bench and pilot tests will be undertaken simultaneously with each other within different areas of the MTBE plume. It is anticipated that these tests can be performed, and the results can be obtained, within four months of implementation. The timeline for implementation of the five pilot tests are presented in Table 2.

6.0 CLOSURE

This report has been prepared for the exclusive use of Avis Rent A Car System and Payless Allstate Rent A Car. The scope of services performed in execution of this investigation may not be appropriate to satisfy the needs of other users, and any use of this document or the findings, conclusions, or recommendations presented herein is at the sole risk of said third party. The findings presented in this report are based upon observations of field personnel, points of investigation, and results of laboratory tests performed by qualified laboratories. They are intended exclusively for the purpose outlined herein and the proposed site location and project indicated.

These consulting services were performed in accordance with the generally accepted standard of practice at the time this document was written. No warranty, expressed or implied, is intended. Opinions and recommendations presented herein apply to the conditions that existed at the time of our investigation and cannot necessarily apply to site changes of which we are unaware and have not had the opportunity to evaluate. It is possible that variations in the soil or ground-water conditions could exist beyond the points presented in this document. Changes in site conditions could also occur at some time in the future due to variations in rainfall, temperature, regional water usage, or other factors. Changes in applicable standards and regulations may also occur as a result of legislation or the broadening of knowledge. Consequently, the findings of this document may be invalidated, wholly or in part, by changes that are unforeseen and beyond our control.

7.0 JURAT

The Nevada Division of Environmental Protection requires (NRS 459.500) the following statement for Environmental Managers who practice in Nevada:

> *I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulations and ordinances.*

URS Corporation

Scott Ball, C.E.M. #1316,
Expires 10/15/01
Geoscience Division Manager

BROADBENT & ASSOCIATES, INC

Kirk J. Stowers, C.E.M #1549
Expires 10/11/02
Senior Geologist

TABLES

Table 1
Comparative Projected Cost Chart for Remediation Options
AVIS/Payless Co-Mingled Hydrocarbon Plume

	Pump-and-Treat	Air Sparge/Vapor Extraction with Hydrogen Peroxide Injection	Ground-Water Circulation Wells (GCW)
Fixed Costs			
Equipment	$99,500	$28,000	$350,000
Construction	$375,000	$300,000	$280,000
Building Utility	$13,500	$5,000	$10,000
Permits	$10,000	$7,000	$10,000
Engineering Design	$11,250	$7,500	$10,000
Start-Up	$8,000	$3,000	$5,000
Total Fixed Costs	$517,250	$350,500	$665,000
Operations and Maintenance Costs			
Labor	$147,660	$116,760	$135,000
Material	$7,725	$15,725	$15,000
Auxiliary Power	$12,960	$12,000	$15,000
Sampling/Analysis	$19,800	$16,200	$20,000
Administrative/Reporting	$13,750	$11,000	$12,000
Total O&M Costs	$201,895	$171,685	$197,000
Closure/Demobilization Costs			
Labor	$21,330	$18,380	$13,000
Laboratory	$4,500	$4,500	$3,000
Well Abandonment	$17,500	$27,500	$20,000
System Removal	$20,000	$21,236	$15,000
Reporting/Closure Request	$7,675	$6,736	$8,000
Total Closure Costs	$71,005	$78,352	$59,000
Total Project Costs (Two years of O&M/1 year of closure mon.)	$790,150	$600,537	$921,000

Table 2:

PROJECTED TIMELINE

For:

Avis / Payless Co-Mingled Plume
Las Vegas, Nevada

BTEX / MTBE Impacted Ground-Water Area Corrective Action Plan

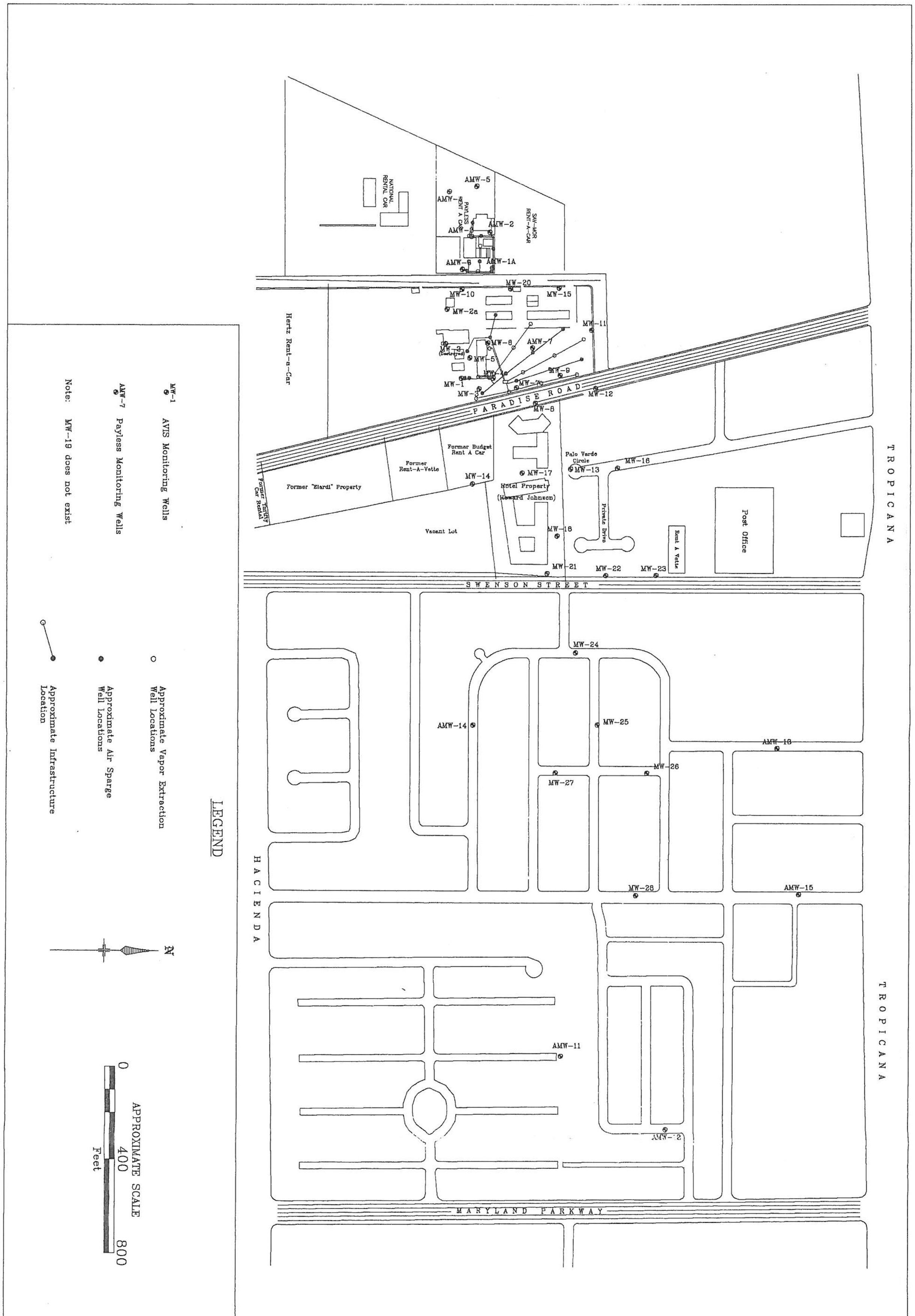
CURRENT TIMELINE	2000							2001												2002				2003			
TASKS	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Design/Permitting																											
Contractor Bidding																											
System Installation																											
Start-up Operations																											
O&M Activities																											
Closure Monitoring																											

MTBE Impacted Ground-Water Area Pilot Testing

CURRENT TIMELINE	2000							2001												2002				2003			
TASKS	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Pilot Test Workplan																											
ISO-GEN Pilot Test*																											
C-Sparge Pilot Test																											
Hydrogen Peroxide Pilot Test																											
Fenton's Reagent Bench Test																											
Potassium Permanganate B.T.																											

** The ISO-GEN Pilot Test is being performed by SECOR International Incorporated at another location in Las Vegas. Results are anticipated in December of 2000*

DRAWINGS



Project Area Map
Avis/Payless Co-Mingled Plume
Las Vegas, Nevada

Drawing No. 1

Project No. 95150

Prepared by: TSR/JHL
Approved by: KJS/SB Date: 9/14/00

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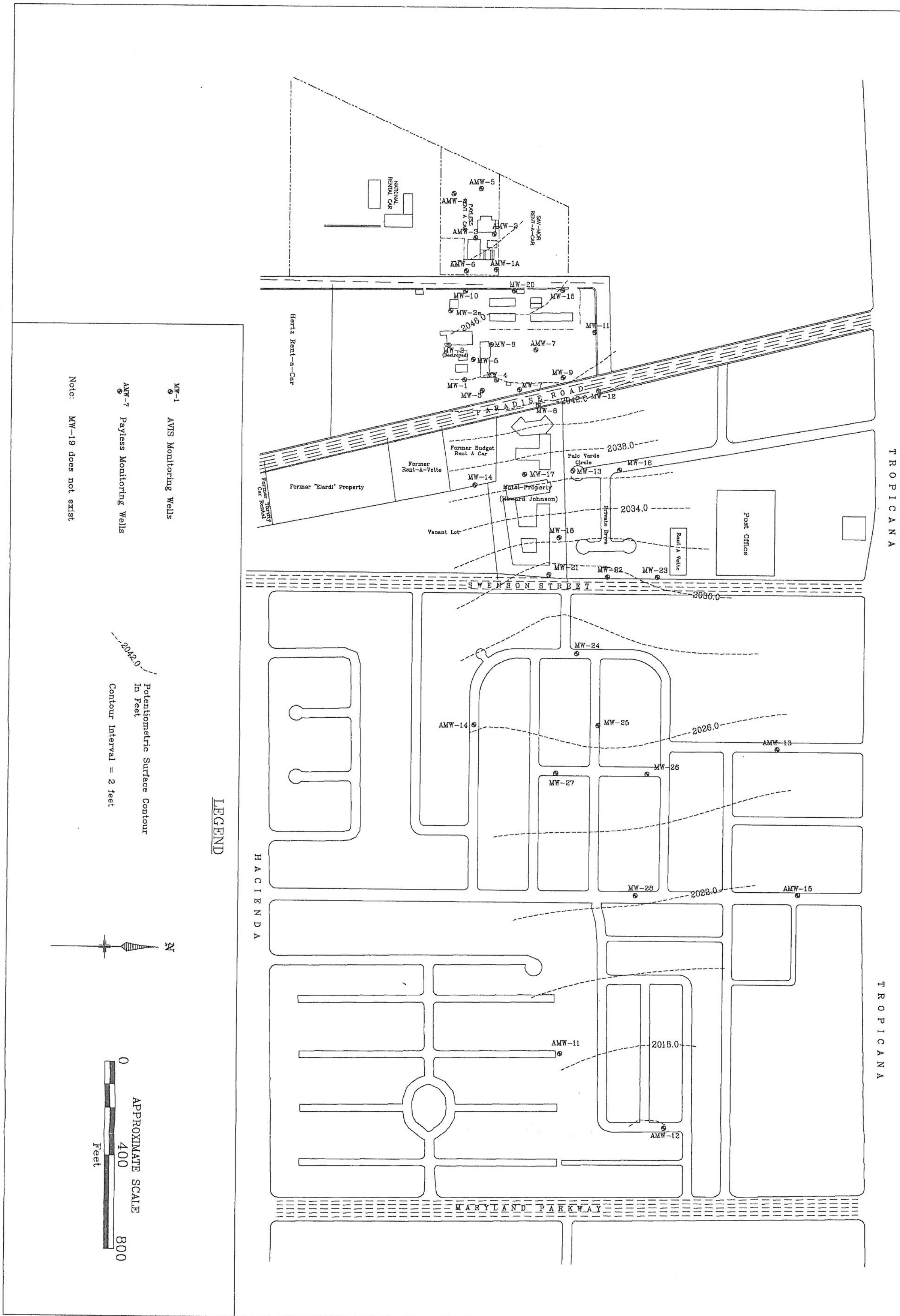

Potentiometric Surface Contour Map (June, 2000)
Avis/Payless Co-Mingled Plume
Las Vegas, Nevada

Drawing No. 2

Project No. 95150

Prepared by: TSR/JHL
Approved by: KJS/SB Date: 9/14/00

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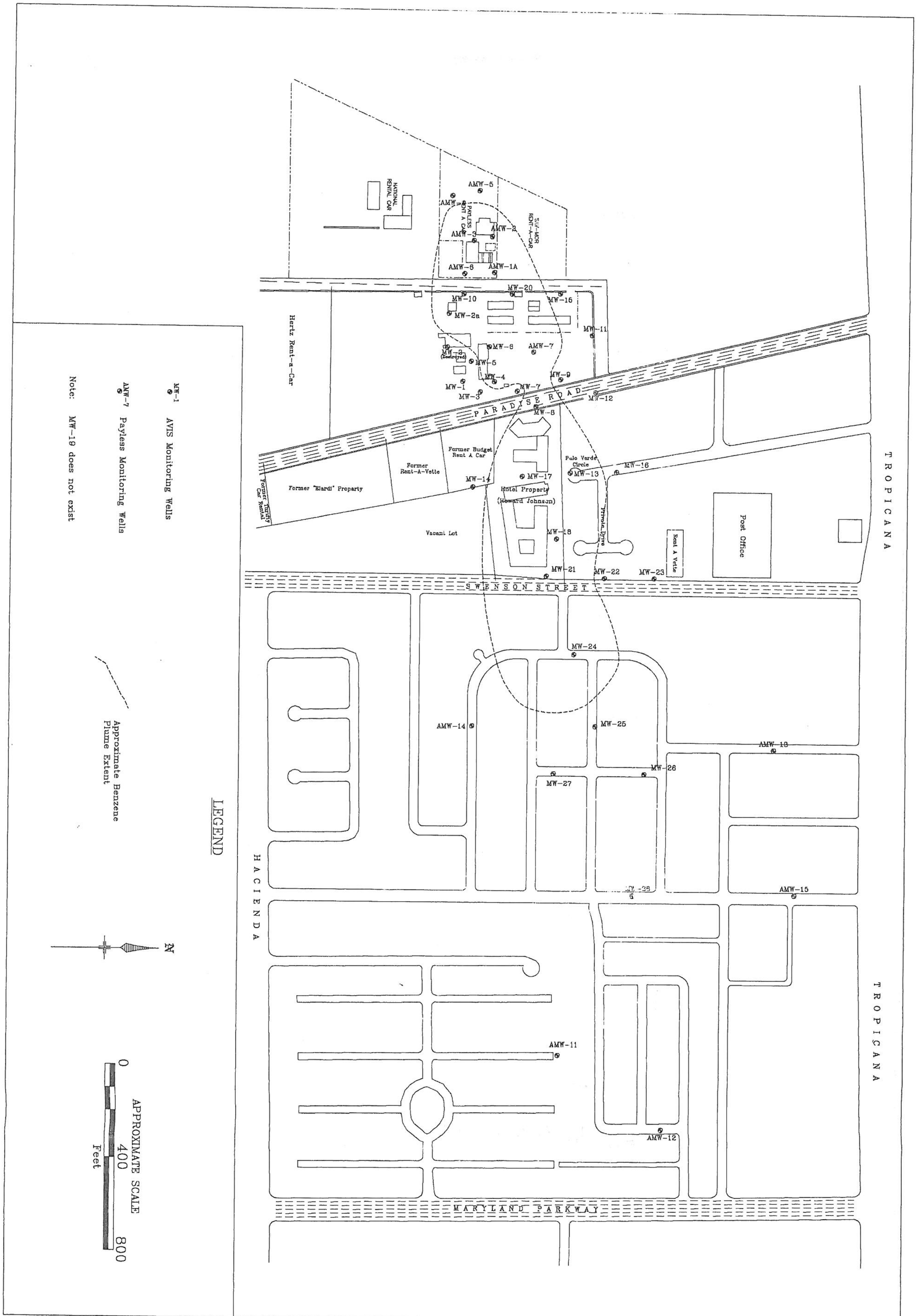

Drawing No. 3

Benzene Plume Map
Avis/Payless Co-Mingled Plume
Las Vegas, Nevada

Project No. 95150

Prepared by: TSR/JHL
Approved by: KJS/SB Date: 9/14/00

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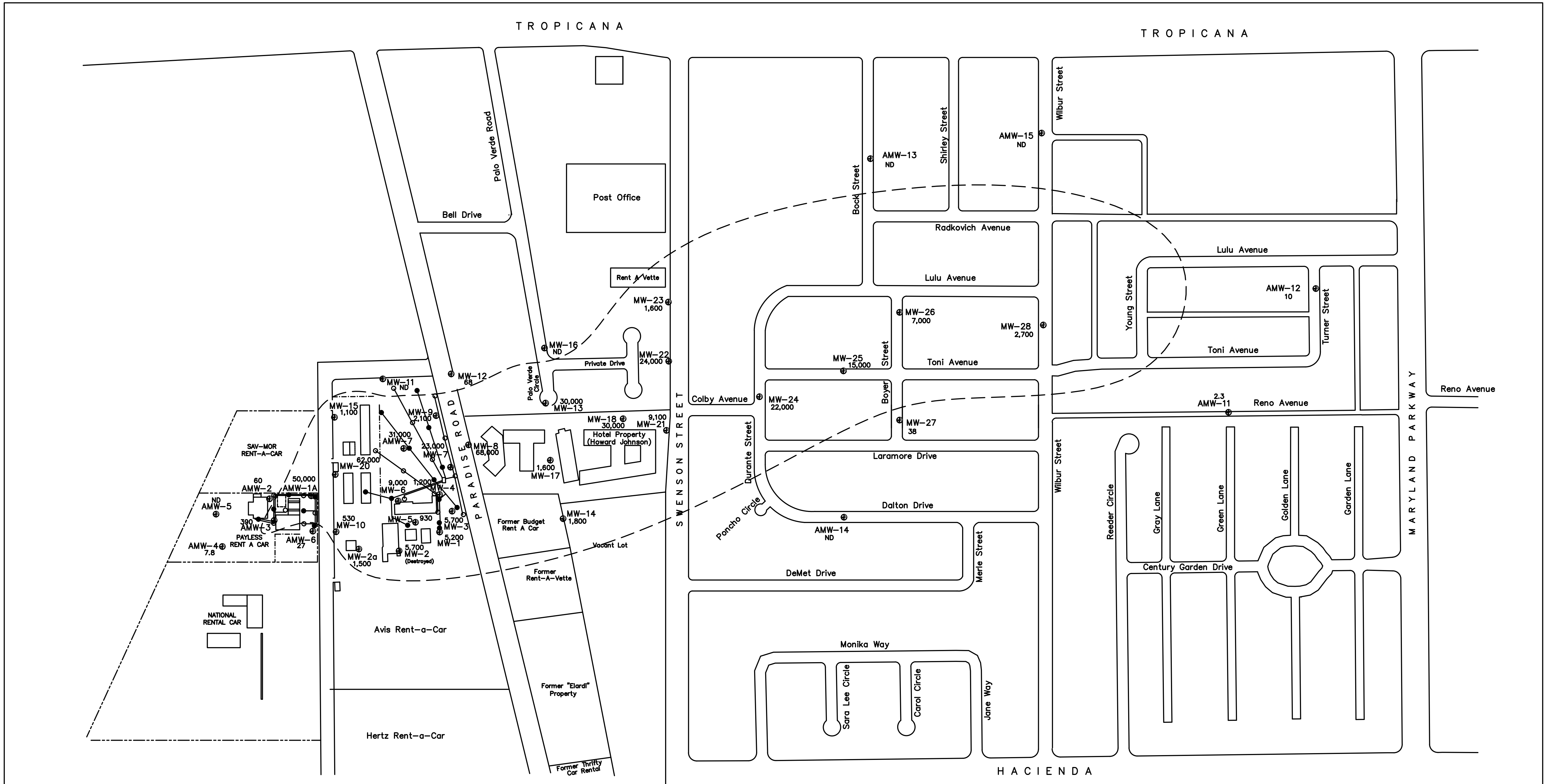


LEGEND

MW-1	AVIS Monitoring Wells
AMW-7	Payless Monitoring Wells
(dashed line)	Approximate Extent of MTBE Plume (Above Nevada Interim Action Level of 200 ug/L)
ND	Not Detected
530	MTBE Concentration in ug/L

Note: Monitoring Well MW-19 does not exist

N

APPROXIMATE SCALE

0 400 800

Feet

MTBE Plume Map
Avis/Payless Co-Mingled Plume
Las Vegas, Nevada

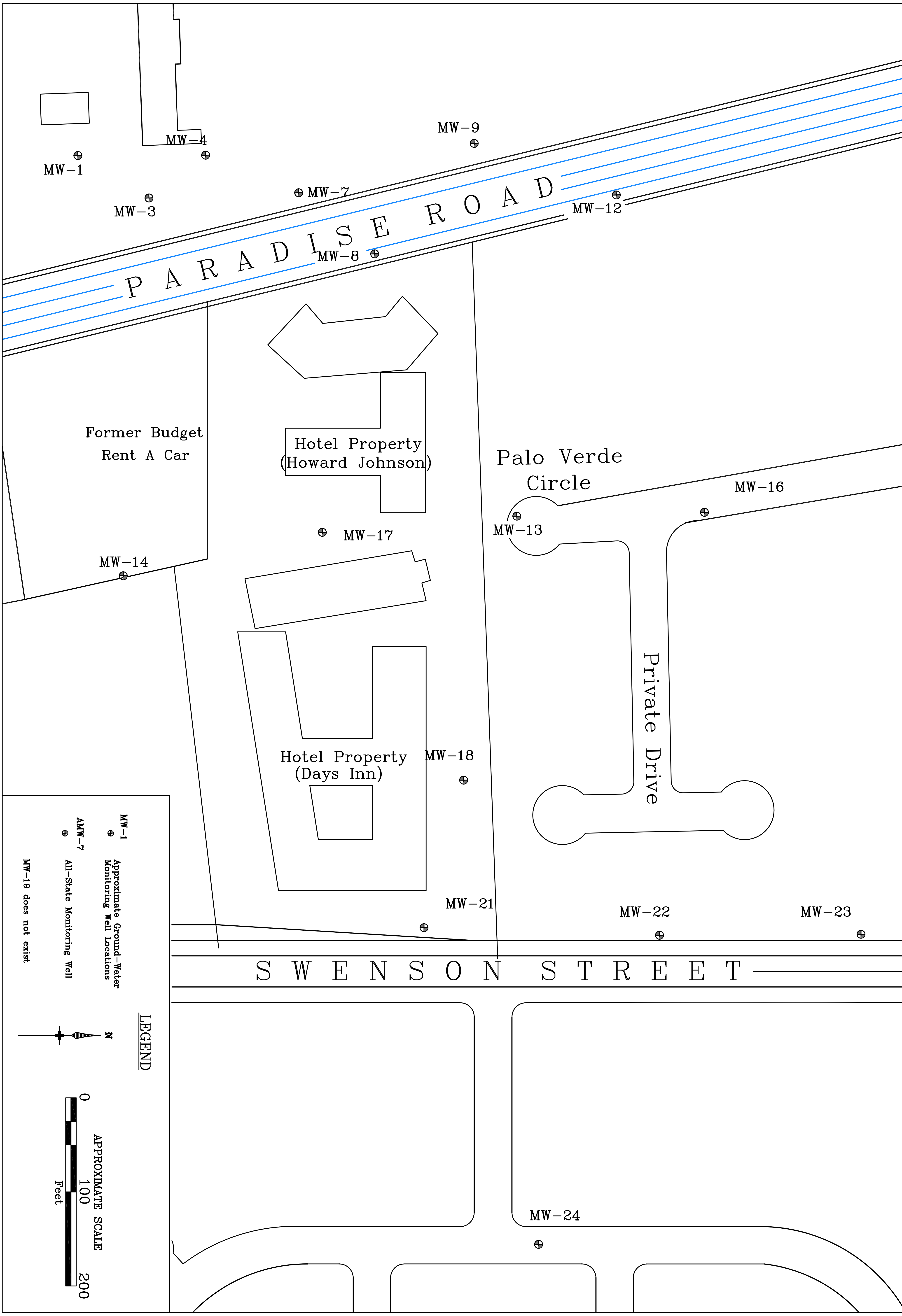
Figure No. 4

URS Project No. 38257-004-169

Broadbent Project No. 95150

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL

Prepared by: BEC/DDD
Approved by: KJS/SB
Date: 11/01/00



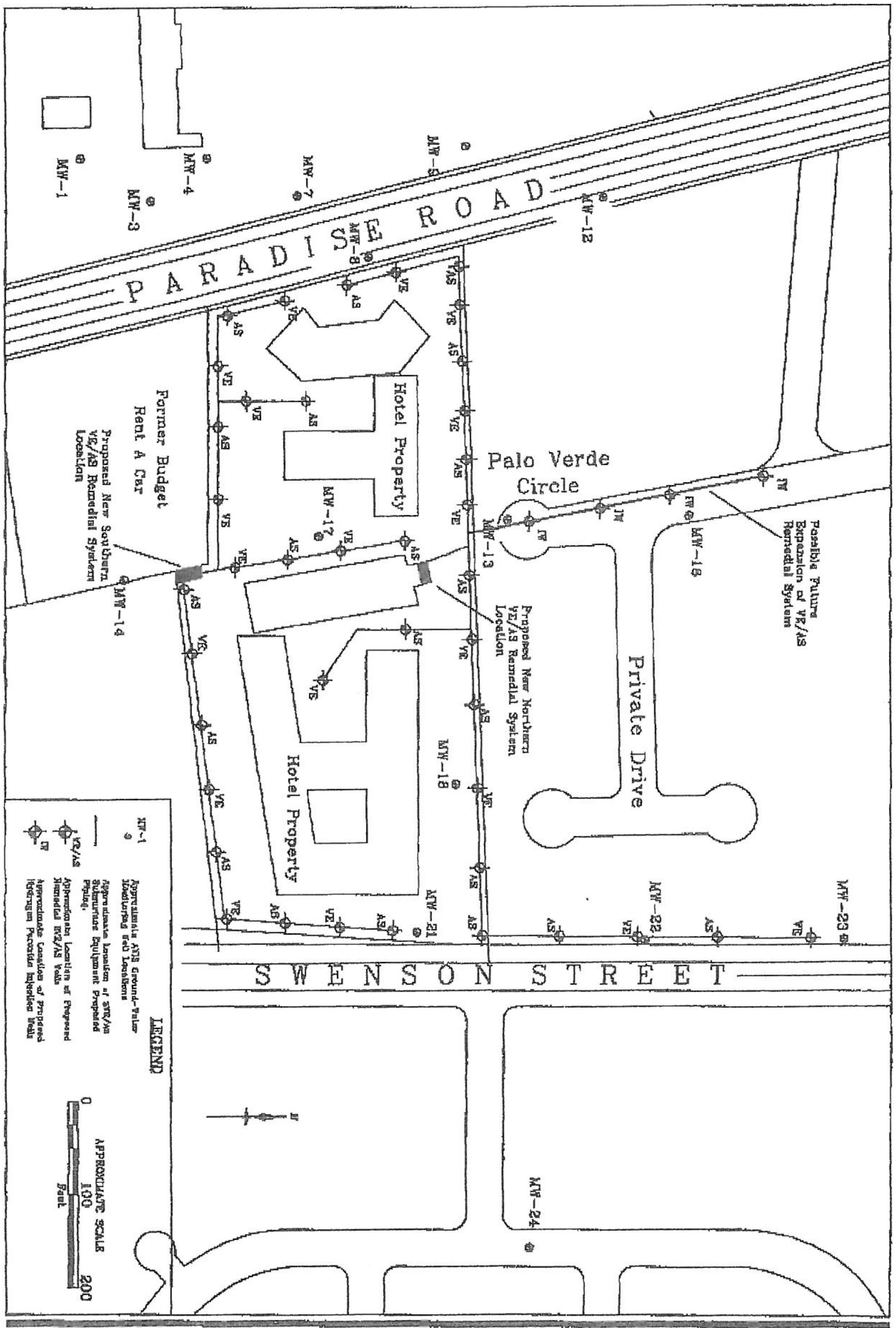
Offsite Map
Avis Rent A Car System, Inc.
Las Vegas, Nevada

Drawing No. 5

Project No. 95150

Prepared by: TSR Approved by: KJS Date: 9/11/00

BROADBENT & ASSOCIATES, INC.
ENGINEERING, WATER RESOURCES & ENVIRONMENTAL



Revised Proposal for AS/SVE Remedial Systems BTEX/MTBE Area
Avis/Payless Comingled Plume
Las Vegas, Nevada

Drawing No. 6

Project No. 95150

Prepared by: BEC/DDD

by: KJS/SB Date: 9/11/00