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UTAH DIVISION OF
SOLID & HAZARDOUS WASTE

Part I. Facility General Information

***Part I* General Information**	APPLICANT: PLEASE COMPLETE ALL SECTIONS.				
***I.* Landfill Type**	☐ Class I	***II.* Application Type**	☐ New Application X Renewal Application	☐ Facility Expansion ☐ Modification	
For Renewal Applications, Facility Expansion Applications and Modifications Enter Current Permit Number	9410R1				
***III.* Facility Name and Location**					
Legal Name of Facility: Washington County Landfill Facility					
Site Address (street or directions to site): 325 North Landfill Road				County: Washington County	
City: Washington City	State: Ut	Zip Code: 84780	Telephone: 435-628-2821		
Township: 42S	Range: 14W	Section(s): 8, 9, 17	Quarter/Quarter Section: N/A	Quarter Section: N/A	
Main Gate Latitude: Degrees 37	Minutes 8	Seconds 17	Longitude: Degrees 113	Minutes 27	Seconds 5
***IV.* Facility Owner(s) Information**					
Legal Name of Facility Owner: Washington County Solid Waste Special Service District #1					
Address (mailing): 325 North Landfill Road					
City: Washington	State: Ut	Zip Code: 84780	Telephone: 435-673-2813		
***V.* Facility Operator(s) Information**					
Legal Name of Facility Operator: Red Rock Waste Services					
Address (mailing): 557 North Industrial Road					
City: St. George	State: Ut	Zip Code: 84770	Telephone: 435-628-2821		
***VI.* Property Owner(s) Information**					
Legal Name of Property Owner: Washington County					
Address (mailing): 178 North 200 East					
City: St. George	State: Ut	Zip Code: 84770	Telephone: (435) 634-5723		
***VII.* Contact Information**					
Owner Contact: Susie Holt		Title: District Manager			
Address (mailing): 325 North Landfill Road					
City: Washington	State: Ut	Zip Code: 84780	Telephone: (435) 673-2813		
Email Address: wcsw@infowest.com		Alternative Telephone (cell or other): (435) 619-8808			
Operator Contact: Tracy Watts		Title: General Manager			

Address (mailing) 557 North Industrial Road			
City St. George	State Ut	Zip Code 84770	Telephone (435) 628-2821
Email Address wcsw@inforwest.com		Alternative Telephone (cell or other)	(435) 619-8808
Property Owner Contact John Willie		Title Administrator	
Address (mailing) 197 East Tabernacle			
City St. George	State Ut	Zip Code 84770	Telephone (435) 634-5700
Email Address johnw@washco.state.ut.us		Alternative Telephone (cell or other)	(435) 467-4769

Part I General Information

VIII. Waste Types (check all that apply)

	Waste Type	Combined Disposal Unit	Monofill Unit
X	Municipal Waste	X	☐
X	Construction & Demolition	☐	X
X	Industrial	X	☐
X	Incinerator Ash	X	☐
X	Animals	X	☐
☐	Asbestos	X	☐
☐	PCB's (R315-315-7(3) only)	X	☐
☐	Other _____	☐	☐

IX. Facility Area

Facility Area	500	acres
Disposal Area	45	acres
Design Capacity		
Years	40	
Cubic Yards	24,709,000	
Tons	18,531,750	

X. Fee and Application Documents

Indicate Documents Attached To This Application ☐ Application Fee: Amount $

X *Facility Map or Maps*	X *Facility Legal Description*	X *Plan of Operation*	X Waste Description
X Ground Water Report	X Closure Design	X Cost Estimates	X Financial Assurance

I HEREBY CERTIFY THAT THIS INFORMATION AND ALL ATTACHED PAGES ARE CORRECT AND COMPLETE.

Signature of Authorized Owner Representative Walter Cox Walter Cox Name typed or printed	Title: Chairman of Board	Date: 6/9/2004
	Address: 325 N. Landfill Rd. Washington, UT	
Signature of Authorized Land Owner Representative (if applicable) Name typed or printed	Title	Date
	Address	
Signature of Authorized Operator Representative (if applicable) Tracy Watts Tracy G. Watts Name typed or printed	Title: General Manager	Date: 7-9-04
	Address: 557 W. Industrial Rd. St. George Ut. 84770	

Part II. Application Checklist

I. **Facility General Information**	
Description of Item	Location In Document
Completed Part I General information	Page 1
General description of the facility (R315-310-3(1)(b))	Page 7
Legal description of property (R315-310-3(1)(c))	Page 8
Proof of ownership, lease agreement, or other mechanism (R315-310-3(1)(c))	Page 8
Area served by the facility including population (R315-310-3(1)(d))	Page 8
If the permit application is for a class I landfill a demonstration that the landfill is not a commercial facility	Page 8
Waste type and anticipated daily volume (R315-310-3(1)(d))	Page 9
Intended schedule of construction (R315-302-2(2)(a))	Page 9
Demonstration That The Facility Meets The Location Standards (R315-302-1)	
Land use compatibility	Page 10
Maps showing the existing land use, topography, residences, parks, monuments, recreation areas or wilderness areas within 1000 feet of the site boundary	Page 10
Certifications that no ecologically or scientifically significant areas or endangered species are present in site area	Page 10
List of airports within five miles of facility and distance to each	Page 10
Geology	Page 10
Geologic maps showing significant geologic features, faults, and unstable areas	Page 10
Maps showing site soils	Page 10
Surface water	Page 10
Magnitude of 24 hour 25 year and 100 year storm events	Page 10
Average annual rainfall	Page 10
Maximum elevation of flood waters proximate to the facility	Page 10
Maximum elevation of flood water from 100 year flood for waters proximate to the facility	Page 10
Wetlands	Page 10
Ground water	Page 10
Plan of Operations (R315-310-3(1)(e) and R315-302-2(2))	
Forms and other information as required in R3315-302-2(3) including a description of on-site waste handling procedures and an example of the form that will be used to record the weights or volumes of waste received (R315-302-2(2)(b) And R315-310-3(1)(f))	Page 11

I. **Facility General Information**	
Description of Item	Location In Document
Schedule for conducting inspections and monitoring, and examples of the forms that will be used to record the results of the inspections and monitoring (R315-302-2(2)(c), R315-302-2(5)(a), and R315-310-3(1)(g))	Page 15
Contingency plans in the event of a fire or explosion (R315-302-2(2)(d))	Page 16
Corrective action programs to be initiated if ground water is contaminated (R315-302-2(2)(e))	Page 17
Contingency plans for other releases, e.g. explosive gases or failure of run-off collection system (R315-302-2(2)(f))	Page 17
Plan to control fugitive dust generated from roads, construction, general operations, and covering the waste (R315-302-2(2)(g))	Page 19
Plan for letter control and collection (R315-302-2(2)(h))	Page 19
Description of maintenance of installed equipment (R315-302-2(2)(i))	Page 19
Procedures for excluding the receipt of prohibited hazardous or PCB containing wastes (R315-302-2(2)(j))	Page 20
Procedures for controlling disease vectors (R315-302-2(2)(k))	Page 21
A plan for alternative waste handling (R315-302-2(2)(l))	Page 21
A general training and safety plan for site operations (R315-302-2(2)(o))	Page 22
Any recycling programs planned at the facility (R315-303-4(6))	Page 23
Closure and post-closure care Plan (R315-302-2(2)(m))	Page 23
Procedures for the handling of special wastes (R315-315)	Page 23
Plans and operation procedures to minimize liquids (R315-303-3(1)(a) and (b))	Page 24
Plans and procedures to address the requirements of R315-303-3(7)(c) through (i) and R315-303-4	Page 24
Any other site specific information pertaining to the plan of operation required by the Executive Secretary (R315-302-2(2)(p))	Page 25

// Facility Technical Information	
Description of Item	Location In Document
Maps	
Topographic map drawn to the required scale with contours showing the boundaries of the landfill unit, ground water monitoring well locations, gas monitoring points, and the borrow and fill areas (R315-310-4(2)(a)(i))	Page 25
Most recent U.S. Geological Survey topographic map, 7-1/2 minute series, showing the waste facility boundary; the property boundary; surface drainage channels; any existing utilities and structures within one-fourth mile of the site; and the direction of the prevailing winds (R315-310-4(2)(a)(ii))	Page 25
Geohydrological Assessment (R315-310-4(2)(b))	
Local and regional geology and hydrology including faults, unstable slopes and subsidence areas on site (R315-310-4(2)(b)(i))	Page 26
Evaluation of bedrock and soil types and properties including permeability rates (R315-310-4(2)(b)(ii))	Page 26
Depth to ground water (R315-310-4(2)(b)(iii))	Page 26
Direction and flow rate of ground water (R315-310-4(2)(b)(iv))	Page 26
Quantity, location, and construction of any private or public wells on-site or within 2,000 feet of the facility boundary (R315-310-4(2)(b)(v))	Page 27
Tabulation of all water rights for ground water and surface water on-site and within 2,000 feet of the facility boundary (R315-310-4(2)(b)(vi))	Page 27
Identification and description of all surface waters on-site and within one mile of the facility boundary (R315-310-4(2)(b)(vii))	Page 28
Background ground water and surface water quality assessment and, for an existing facility, identification of impacts upon the ground water and surface water from leachate discharges (R315-310-4(2)(b)(viii))	Page 28
Ground Water Monitoring (R315-303-3(7)(b) and R315-308)	Page 28
Statistical method to be used (R315-308-2(7))	Page 28
Calculation of site water balance (R315-310-4(2)(b)(ix))	Page 29
ENGINEERING REPORT - PLANS, SPECIFICATIONS, AND CALCULATIONS	
Documentation that the facility will meet all of the performance standards of R315-303-2	Page 29
Engineering reports required to meet the location standards of R315-302-1 including documentation of any demonstration or exemption made for any location standard (R315-310-4(2)(c)(i))	Page 29
Anticipated facility life and the basis for calculating the facility's life (R315-310-4(2)(c)(ii))	Page 29

// Facility Technical Information	
Description of Item	Location In Document
Cell design to include liner design, cover design, fill methods, elevation of final cover including plans and drawings signed and sealed by a professional engineer registered in the State of Utah (R315-303-3(3), R315-303-3(6) and (7)(a), R315-310-3(1)(b) and R315-310-4(2)(c)(iii))	Page 30
Leachate collection system design and calculations showing system meets the requirements of R315-303-3(2)	Page 30
Equipment requirements and availability (R315-310-4(2)(c)(iii))	Page 37
Identification of borrow sources for daily and final cover and for soil liners (R315-310-4(2)(c)(iv))	Page 38
Run-On and run-off diversion designs (R315-303-3(1)(c), (d) and (e))	Page 38
Leachate collection, treatment, and disposal and documentation to show that any treatment system is being or has been reviewed by the Division of Water Quality (R315-310-4(2)(c)(v) and R315-310-3(1)(i))	Page 38
Ground water monitoring plan that meets the requirements of Rule R315-308 including well locations, design, and construction (R315-310-4(2)(b)(x) and R315-310-4(2)(c)(vi))	Page 39
Landfill gas monitoring and control plan that meets the requirements of Subsection R315-303-3(5) (R315-310-4(2)(c)(vii))	Page 39
Slope stability analysis for static and under the anticipated seismic event for the facility (R315-310-4(2)(b)(i) and R315-302-1(2)(b)(ii))	Page 39
Design and location of run-on and run-off control systems (R315-310-4(2)(c)(viii))	Page 39
CLOSURE PLAN (R315-310-3(1)(h))	
Closure Plan (R315-302-3(2) and (3))	Page 40
Post-Closure Plan (R315-302-3(5) and (6))	Page 41
Closure schedule (R315-310-4(2)(d)(i))	Page 40
Design of final cover (R315-303-3(4) and R315-310-4(2)(c)(iii))	Page 40
Capacity of site in volume and tonnage (R315-310-4(2)(d)(ii))	Page 40
Final inspection by regulatory agencies (R315-310-4(2)(d)(iii))	Page 40
POST-CLOSURE CARE PLAN (R315-310-3(1)(h))	
Site monitoring of landfill gases, ground water, and surface water, if required (R315-310-4(2)(e)(i))	Page 41
Changes to record of title, land use, and zoning restrictions (R315-310-4(2)(e)(ii))	Page 42
Maintenance activities to maintain cover and run-on/run-off control systems (R315-310-4(2)(e)(iii))	Page 42
List the name, address, and telephone number of the person or office to contact about the facility during the post-closure care period (R315-310-4(2)(e)(vi))	Page 43
FINANCIAL ASSURANCE (R315-310-3(1)(j))	
Identification of closure costs including cost calculations (R315-310-4(2)(d)(iv)) and (R315-302-2(2)(n))	Page 43

// Facility Technical Information	
Description of Item	Location In Document
Identification of post-closure care costs including cost calculations (R315-310-4(2)(e)(iv))	Page 43
Identification of the financial assurance mechanism that meets the requirements of Rule R315-309 and the date that the mechanism will become effective (R315-309-1(1))	Page 44

General description of the facility (R315-310-3(1)(b)):

Since 1980 Washington County has been operating a sanitary landfill through the Washington County Solid Waste Special Service District #1. This landfill is located in the south central portion of Washington County just east and south of the Washington City limits in an isolated drainage known as Purgatory Flat.

In the original sitting of the landfill, extensive geologic data were used. The data had been previously developed by the U.S. Bureau of Reclamation on the proposed Laverkin Springs Desalinization Ponds; which were proposed to be located just north of the landfill site. The work which has been completed, then and now recently, indicates that the present landfill site can be designed and operated so as to meet all subtitle "D" criteria as administered by the state of Utah.

Since the beginning of landfill operations at the site, the landfill waste stream has consisted of municipal solid waste and other non-hazardous municipal and industrial wastes, including green wastes and construction and demolition materials. This general waste stream will continue through the upcoming permit period.

Prior to the opening and operation of the Washington County Landfill Facility, many of the local communities operated their own landfills for their citizens which often included open burning of solid waste materials. In order to consolidate efforts, conserve resources, and minimize environmental impacts, the Washington County Solid Waste Special Service District #1 was created. The District's Board, which consists of at least one representative from every community within Washington County, oversees the operation of the Washington County Landfill Facility. Since the onset of operation of this facility, all of the landfills throughout Washington County have been closed. This has proven to be a substantial improvement in the handling of solid waste generated by the citizens of Washington County.

The landfill facility is currently operated by Red Rock Waste Services as a result of a contract with the Washington County Solid Waste Special Service District #1. The landfill facility is situated on ground owned by Washington County. The County has leased 500 acres of land to the Washington County Special Service District #1, a special service district organized and existing under the laws of the State of Utah, for the express purpose of construction and operation of a landfill facility. The lease agreement between Washington County and the Washington County Special Service District #1 is provided in Attachment A of this permit application.

Legal description of property (R315-310-3(1)(c)):

The legal description of the landfill facility is as follows:

Salt Lake Meridian, Utah
T. 42 S., R. 14 W.,
sec. 8, SE1/4SE1/4NE1/4, SE1/4SE1/4 SW1/4, NE1/4SE1/4,
S1/2SE1/4, SE1/4NW1/4SE1/4;
sec. 9, SE1/4NW1/4NW1/4, SW1/4NW1/4, NW1/4SW1/4,
N1/2SW1/4SW1/4, SW1/4SW1/4SW1/4;
sec. 17, N1/2NE1/4NE1/4, SW1/4NE1/4NE1/4, NW1/4NE1/4,
NW1/4SW1/4NE1/4, E1/2NW1/4, E1/2W1/2NW1/4,
SW1/4NW1/4NW1/4, W1/2SW1/4NW1/4.
Containing 500.00 acres

Proof of ownership, lease agreement, or other mechanism (R315-310-3(1)(c)):

The proof of ownership by Washington County is contained in Attachment B of this permit application. The lease agreement is contained in Attachment A of this permit application.

Area served by the facility including population (R315-310-3(1)(d)):

The Washington County Sanitary Landfill Facility serves Washington County, Utah. Located within Washington County are several communities, a national park, and a national forest. Each of these has access to this landfill facility.

A demonstration that the landfill is not a commercial facility:

The Washington County Sanitary Landfill Facility complies with subsection R315-301-2(7) of the Solid Waste Permitting and Management Rules. The landfill is operated as a Class I landfill.

Waste type and anticipated daily volume (R315-310-3(1)(d)):

The Washington County Sanitary Landfill Facility accepts municipal solid waste (MSW), construction and demolition debris (C&D) and various special wastes, furniture, industrial waste, non hazardous or exempt petroleum contaminated soils, exempt wastes under The Resource Conservation and Recovery Act (RCRA), and water or waste water treatment sludges. The landfill does not accept radioactive waste, hazardous waste, asbestos, or waste which must be managed as PCBs under the Toxic Substances and Control Act.

The Washington County Sanitary Landfill Facility receives an average of 527 tons/day of waste. This equates to an average daily volume of 1,035 cubic yards. This volume is anticipated to continue and to increase in the future. The anticipated volume includes waste and daily cover material.

Intended schedule of construction (R315-302-2(2)(a)):

The landfill cell presently in use was initially constructed in 1980. At present, the foot print of this cell covers 45 acres and is expected to meet the needs of Washington County through the year of 2005. The existing unit is approximately 700 feet wide and 2800 feet long and extends from County Access Road on the south and northeasterly along the westerly side of Purgatory Flat.

Upon completion of the existing cell, three successive units, each comprised of sub-units designed with four to five year service lives, will be constructed incorporating the existing unit and extending northeasterly along the westerly side of Purgatory Flat to the northeast property line, approximately 5800 feet. The first, and most southerly sub-unit, will contain approximately 1,399,000 cubic yards, which includes 15% for daily cover material, and is expected to meet the needs of Washington County through the year of 2010. The second sub-unit will contain approximately 1,679,000 cubic yards and is expected to meet the needs of Washington County through the year of 2016. The third and most northerly of the westerly sub-units will contain approximately 1,557,000 cubic yards and is expected to meet the needs of Washington County through the year of 2019.

Upon completion of the westerly unit, three additional sub-units designed with three to four year service lives will be constructed along the easterly side of Purgatory Flat between the landfill units on the west and the Harrisburg Dome on the east. These sub-units will also extend from County Access Road on the south, northeasterly to the northeast property line, approximately 5800 feet. The fourth, and most northerly sub-unit, will contain approximately 1,715,000 cubic yards and is expected to meet the needs of Washington County through the year of 2023. The fifth sub-unit will contain

approximately 1,871,000 cubic yards and is expected to meet the needs of Washington County through the year of 2026. The sixth and most southerly of the easterly sub-units will contain approximately 1,537,000 cubic yards and is expected to meet the needs of Washington County through the year of 2028.

Upon completion of the easterly sub-units, five final sub-units designed with four to five year service lives will be constructed down the center of Purgatory Flat between the previously constructed units on the west and the east. These sub-units will extend from the northeast property line southwesterly to the existing county access road. The seventh, and most northerly sub-unit, will contain approximately 2,258,000 cubic yards and is expected to meet the needs of Washington County through the year 2030. The eighth sub-unit will contain approximately 2,252,000 cubic yards and is expected to meet the needs of Washington County through the year of 2033. The ninth sub-unit will contain approximately 2,816,000 cubic yards and is expected to meet the needs of Washington County through the year of 2035. The tenth sub-unit will contain approximately 3,145,000 cubic yards and is expected to meet the needs of Washington County through the year of 2038. The eleventh, most southerly, and final sub-unit will contain approximately 4,480,000 cubic yards and is expected to meet the needs of Washington County through the year of 2041.

Red Rock Waste Services will submit detailed construction plans for each construction phase prior to the planned construction. These plans will be submitted to the Executive Secretary for approval.

Attachment C of this document provides a table addressing the demographics of Washington County with population and solid waste projections upon which the landfill layout was based. Current population and population projections were taken from the U.S. Bureau of the Census; Utah Population Estimates Committee; 2002 Baseline Projections, Governor's Office of Planning and Budget, UTED Model System. The amount of MSW produced by each person is estimated by the EPA to be 4.5 pounds per day. This number was used in creating the table.

Demonstration the facility meets the location standards (R315-302-1)

1. Airport

   The site is approximately seven miles west of the Hurricane City airport, approximately seven miles northwest from a private air strip just south of the Hurricane City airport, seven and a half miles northeast of the St. George City airport, and 6 miles north of an abandoned landing field now used only for sanctioned auto drag racing.

2. Flood Plains

   Not Applicable

3. Wetlands

   Not Applicable

4. Fault Areas and Seismic Impact Zones

   Not Applicable

5. Unstable Areas

   Not Applicable

6. Closure of Existing Municipal Solid Waste Landfill Units

   Not Applicable

Plan of operations (R315-310-3(1)(e) and R315-302-2(2))

Description of on-site waste handling procedures and an example of the form that will be used to record the weights or volumes of waste received (R315-302-2(2)(b) And R315-310-3(1)(f)):

All solid wastes deposited in the landfill will first cross a truck scale located adjacent to the scale house at the front gate. Haulers of the solid waste are divided into two categories by Red Rock Waste Services as being either licensed or unlicensed. Commercial solid waste haulers are considered licensed haulers as they must obtain a license from Washington County Solid Waste Special Service District #1 to operate commercially in the landfill. The application that will be used by Washington County Solid Waste Special Service District #1 is contained in Attachment D this permit application. Along with the application each licensed hauler must submit proof of insurance with certification to Washington County, a copy of their current city or county business license, and their truck(s) number, serial number, body capacity, weight, and date of manufacture. Licensing is required of each commercial hauler annually.

All other solid waste haulers are classified as unlicensed. Included as unlicensed haulers are general contractors hauling construction and demolition materials and private citizens who haul their own trash and yard wastes.

Regardless of whether a solid waste hauler is classified as licensed or unlicensed, they are required to stop at the scale house and be weighed. Attachment E of this permit application contains a copy of a weigh ticket each hauler receives which is the basis for the assessment of the tipping fees.

A copy of the form used by Red Rock Waste Services to track those loads hauled into the landfill by licensed and unlicensed haulers is presently contained in Attachment F of this permit application. When tires are brought to the landfill for disposal, the appropriate information is logged on a form for tracking and billing purposes. This form is contained in Attachment F of this permit application.

After the initial stop at the scale house, the haulers of solid waste then proceed to the landfill site, and are directed to the active face by way of signing. As the haulers approach the working face of the landfill, they are further directed by the landfill spotter to a specific unloading location. As the waste material is off loaded, it is the spotter's responsibility to visually inspect the waste to determine the specific composition of the load being deposited. Provided at the landfill are 6 drop boxes to be used by residents of the district. These drop boxes are taken to the active face and off loaded. A camera is installed to monitor the activity at the drop boxes.

All waste material placed in the landfill cell is compacted to minimize air space usage and maximize unit weight. Waste is spread in lifts and compacted with a Cat D7 dozer and Cat 826 compactor to achieve maximum compaction.

At the end of each production day the solid waste placed in the landfill is covered with six inches of soil cover material or an Alternative Daily Cover (ADC). Following are the three ADC's that may be utilized.

1. <u>Tarpaulins</u>

The tarpaulins will be TR-1 Tarpaulins and will be provided by Western Ag Enterprises. The specifications are as follows:

Fiber	Polypropylene
Finish	Tendered & Calendered
Construction	Warp: 60
	Fill: 50
Thickness Mils	20
Weight	7.6 oz/sq yd
Abrasion Resistance	Warp: 190 lbs
	Fill: 250 lbs
Tensile Strength	Warp: 440 lbs
	Fill: 365 lbs
Tear Strength	Warp: 185 lbs
	Fill: 190 lbs
Burst Strength	710 lbs/sq inch

Puncture Strength	165 lbs
UV Resistance	90% ASTM D-3787, % retained after 5,000 hrs
Air Flow	230 cfm

2. Hydromulch

Hydromulch is a cellulose fiber product manufactured using fiber stock. It is provided in easy-to-handle bags. Pre-measured, water soluble dye packets are inserted into each bag, which provide a consistent dying of the material. The material mixes rapidly with water to form a homogeneous slurry. The specifications are as follows:

Moisture Content	7.1%
Organic Matter	94.6%
Moisture Holding Capacity	1,107%
pH	6.1

3. Compost

Compost will be used as an ADC when required.

The current daily cover needs are met by Alternative Daily Covers (ADCs) or the soil excavated from on-site. When either of these sources become inadequate, the importation of soil cover material from a nearby gravel crushing operation will be utilized. This operation procedure will continue through the next permit period.

The following special handling procedures apply for certain waste streams:

1. Odoriferous Wastes - All odoriferous wastes placed in the landfill cell are covered with six inches of cover material and/or ADC within the current work period or day's end.

2. Ash- All ash which presents a blowing concern will be covered with six inches of material and/or ADC within four hours after disposal of the waste in the unit before day's end. Water may be sprayed on the ash if required to control dust emissions during covering activities.

3. Bulky Wastes - The landfill is not utilized as an appliance or automobile junkyard. If these items are delivered to the landfill, they are removed and taken to a recycler.

4. Water Treatment or Wastewater Treatment Sludges, Non-Hazardous or Exempt Petroleum Contaminated Soils - Sludges including exempt petroleum contaminated soils, grease trap materials, oily water, and sand trap wastes that fail the Paint Filter Liquids Test method will be solidified prior to their disposal in the landfill unit. Solidification methods include

the addition of absorbent materials, after which the solidified wastes must pass the Paint Filter Liquids Test method before disposal. These solidified wastes are then placed on the working face and covered with other solid wastes or cover material. Sludges consisting of exempt petroleum contaminated soils may be used as daily cover. Sludges which are brought into the landfill shall be certified as non-hazardous by the generator. Analytical data may be required to certify waste as non-hazardous.

Generators/haulers of non-hazardous or exempt petroleum contaminated soils, water treatment or wastewater treatment sludges will be encouraged to solidify their sludges to ensure passage of the Paint Filter Liquids test prior to their placement in the landfill. However, the generator/hauler of these sludges may bring sludges which do not pass the Paint Filter Liquids test to the landfill for solidification and disposal. Upon arrival at the scale house, the gate keeper will verify certification as non-hazardous and direct the hauler to the Sludge Solidification Site. At this point a landfill spotter will visually inspect the load prior to unloading to verify content. If it does not appear that the sludge will then pass the Paint Filter Liquids test, it will be distributed on the ground at the Sludge Solidification Site. The sludge will be placed on the solidification site by means of a tremie or flexible metal spout to allow for even distribution. As the sludge is being unloaded, the hauler will proceed under the direction of the spotter at a speed which will ***ensure no ponding*** of the liquids. Upon completion of unloading, all valves and external openings of the hauler's vehicle will be stopped prior to the hauler's departure from the Sludge Solidification Site. The sludge at the solidification site will be blended with native absorbent material until the sludge passes the Paint Filter Liquids test. The solidified sludges will then be placed at the landfill working face for disposal. Sludges which do not pass the Paint Filter Liquids test will not be accepted at the landfill facility during inclement weather.

As liquids in delivered sludges are evaporated or absorbed into the surrounding soils, the dikes will be leveled. The impacted soils which made up the dikes and floor will be blended with other native absorbent material until the soil passes the Paint Filter Liquids test. The soils which pass this test may be stockpiled and used as a source of daily cover material.

5. Tires - It is the policy of Red Rock Waste Services to have the landfill stockpile all tires brought into the landfill. Tires are removed from the site and delivered to a commercial recycler of tires.

6. Dead Animals - Animal carcasses received at the facility will be deposited onto the working face at or near the bottom of the cell with other solid waste, or into a separate disposal trench where they will be covered daily with a minimum of six inches of earth to prevent odors and the propagation and harborage of rodents and insects.

Schedule for conducting inspections and monitoring, and examples of the forms that will be used to record the results of the inspections and monitoring (R315-302-2(2)(c), R315-302-2(5)(a), and R315-310-3(1)(g)):

Inspections of the facility will be conducted quarterly by Red Rock Waste Services or its representative. The purpose of these inspections is to prevent any problems with the facility and to identify any deterioration of the facility and operator errors or malfunctions which may cause a release of wastes to the environment or threaten human health. The inspection logs will be kept at the facility in the scale house. Attachment G of this permit application is an example of the inspection log. All inspections will conform to subsection R315-302-2(5)(a) of the Solid Waste Permitting and Management Rules. The Red Rock Waste Services inspection log program will consist of a summary of the following information:

1. Total Containment Evaporation Pond - Inspection of inlet and overflow structures for blockage, failure, and erosion. Inspection of rock-lined dikes and rock-lined drainage channel around the pond for potential erosion and washout. Inspection of lining systems for possible damage from men, equipment, root systems of surrounding vegetation, and burrowing animals will be conducted. Inspection of fence line and gates to ensure security of the total containment evaporation pond facility will be conducted. Inspection of containment dikes that lie below the pond will occur.

2. 18" Diameter Leachate Outfall Line - Inspection of manholes and outfall line for signs of blockage, leakage, or infiltration.

3. 12" Diameter Leachate Collection Line - Inspection of cleanouts and collection line for signs of blockage and failure. Should it be suspected that either has occurred to the collection line, a mandrel will be pulled through the suspected section to determine the extent and location of the damage.

4. Run-off Drainage Channel - Inspection of the lined channel and culverts for erosion and blockage.

5. Run-on Drainage Channel - Inspection of the rock-lined channel and culverts for erosion and blockage.

6. Perimeter Fencing and Access Gates - Inspection of fencing for breach of security and litter accumulation. Inspection of gates and other points of access for security and restriction of unauthorized access will be conducted.

7. Landfill Cell - Inspection of the active landfill face for placement and compaction of imported waste stream. Inspection of the access roads for settlement and stability and inspection of covered portions of the landfill cell for erosion and excessive settlement.

Contingency plans in the event of a fire or explosion (R315-302-2(2)(d)):

Red Rock Waste Services will implement various procedures to minimize and control fire, explosion, and release of explosive gases. Training for facility operations personnel will be provided. The procedures will include:

1. Red Rock Waste Services will provide training to all facility employees regarding fire prevention and fire fighting at the facility.

2. All supervisory personnel will maintain radio communication with personnel in the scale house and the Red Rock Waste Services office. If required, the Red Rock Waste Services office will contact the Washington City Fire Department for emergency assistance.

3. Dozers will be available to spread burning materials in the landfill so that water can be applied, to smother the burning material with non-ignitable material, or to build berms to contain the fire.

4. Stockpiled soil cover materials will be available in the vicinity to spread on burning materials.

5. All facility vehicles will contain a portable fire extinguisher which can be utilized to extinguish small fires.

6. A fire hydrant is located within 300 feet of the scale house. The hydrant is connected to a 36" water transmission line running through the landfill property. Water from this hydrant will be used to suppress fires.

7. In case off-site fire fighting assistance is needed, the Washington City Fire Department will respond. The Washington City Fire Department should be able to respond to a fire within 15 minutes.

Corrective action programs to be initiated if ground water is contaminated (R315-302-2(2)(e)):

In the event ground water contamination is detected, an appropriate remediation plan will be developed. Depending on specific conduits, pumps will be placed in monitoring Well 1 and monitoring Well 2 with the intent of removing the perched water from the ground, therefore stopping transmission of the release. Water pumped from the monitoring wells will be land applied within the boundaries of the landfill facility where it will be evaporated. In the event that the perched aquifer is too large to practically draw down, pumping will continue until all constituents being analyzed are shown to be at or below established background values.

This plan may be modified upon completion of investigations related to ground water contamination.

Contingency plans for other releases, e.g. explosive gases or failure of run-off collection system (R315-302-2(2)(f)):

In the event of a run-off containment system failure, the procedures for taking corrective action will include:

1. During the Month of March, Red Rock Waste Services will provide necessary training to facility employees regarding landfill emergency procedures.

2. All supervisory personnel will maintain radio communication with personnel in the scale house and the Red Rock Waste Services office. The Red Rock Waste Services office would then be able to contact the Washington County Emergency Management Personnel as required.

3. Dozers and compactors and other earth-moving equipment will be available to move earth material as necessary to seal off any breach to the run-off containment system until other permanent corrective measures can be taken.

In the event of a gas explosion, the procedures for taking corrective action will include:

1. During the Month of March, Red Rock Waste Services will provide necessary training to facility employees regarding landfill emergency procedures.

2. All supervisory personnel will maintain radio communication with personnel in the scale house and the Red Rock Waste Services office. The Red Rock Waste Services office would then be able to contact the Washington County Emergency Management Personnel as required.

3. Dozers and compactors and other earth-moving equipment will be available to move earth material as necessary to contain an emergency.

In the event of an overflow in the Total Containment Evaporation Pond, the procedures for taking corrective action will include:

1. During the Month of March, Red Rock Waste Services will provide necessary training to facility employees regarding landfill emergency procedures.

2. All supervisory personnel will maintain radio communication with personnel in the scale house and the Red Rock Waste Services office. The Red Rock Waste Services office would then be able to contact the Washington County Emergency Management Personnel as required.

3. Dozers and compactors and other earth-moving equipment will be available to move earth material as necessary to seal off any breach to the run-off containment system until other permanent corrective measures can be taken.

4. Contained waste water will be pumped into a water truck and returned to the Total Containment Evaporation Pond, solidified with on-site material and hauled to the landfill and used as daily cover, or taken to the local sewer district for disposal. Upon removal of the captured waste water, the affected native soil material will be removed and used for daily cover on the landfill cell.

5. Any damage to the Total Containment Evaporation Pond caused by the overflow will be repaired and the area will be restored to its original condition.

6. If the Total Containment Evaporation Pond overflows, the water will then be contained in the newly constructed overflow pond. The overflow pond lies below the Total Containment Evaporation Pond. There are no improvements planned for the overflow pond. If improvements to the overflow pond are necessary, they will be performed by on-site operators and equipment.

Plan to control fugitive dust generated from roads, construction, general operations, and covering the waste (R315-302-2(2)(g)):

It is Red Rock Waste Services policy that all unpaved traveled roadways within the landfill facility are sprayed with water and that waste material be wetted or covered as necessary to control dust. Also, any solid waste material, such as ash, which presents a blowing concern, is covered with six inches of material or an ADC by the end of he day of disposal or water is sprayed on the waste material to control dust emissions. Air emissions will fall within state Air Quality Standards.

Plan for litter control and collection (R315-302-2(2)(h)):

Wind-blown litter control will be performed by use of fencing, daily cover, and ADC. Litter collection will be performed by the Spotter at the active face and other landfill personnel as required. Fencing will be inspected for wind-blown litter as required to ensure containment and disposal of the litter materials.

Description of maintenance of installed equipment (R315-302-2(2)(i)):

Ground water monitoring equipment will be maintained in accordance.

The leachate collection system consists mainly of an open ditch which will also handle run-off water from those open portions of the landfill unit. The leachates and run-off water are channeled and piped to the Total Containment Evaporation Pond for containment until evaporation is complete. The Total Containment Evaporation Pond is lined with a membrane liner to prevent seepage of the leachates into the surrounding ground. Maintenance of the channel system and the Total Containment Evaporation Pond will consist mainly of weed control. In conjunction with the channeling system, each landfill unit will be designed with a leachate/run-off water collection pipe. The leachate collection and run-off water piping system is fitted with cleanouts at 500' intervals for ease of maintenance.

Methane gas monitoring is performed quarterly using a hand-held probe. The hand-held probe is calibrated prior to each use by the gas sample collector. This will be done in conformance with the manufacturer's recommendations. The calibration of the probe will then be documented on the landfill gas quarterly monitoring results form. (See Attachment H of this permit application). Any required maintenance or repair, other than calibration, will be performed by the manufacturer of the probe or a licensed representative of the manufacturer.

Procedures for excluding the receipt of prohibited hazardous or PCB containing wastes (R315-302-2(2)(j)):

Inspections of wastes for hazardous materials or waste containing PCBs will be performed quarterly or as deemed necessary by Red Rock Waste Services. A copy of the Random Load Inspection Record form is provided in Attachment I of this permit application. Although private individuals who haul only their personal solid waste are exempt, any load, private or commercial, suspected of containing hazardous materials or wastes containing PCBs will be subject to inspection.

The randomly inspected loads, as well as loads suspected of containing hazardous materials or wastes containing PCBs, will be off loaded at a predetermined inspection site. This inspection site will always be located away from the current working face of the landfill. Upon completion of the inspection Red Rock Waste Services will remove the solid wastes passing inspection and place them at the working face of the landfill for burial. If inspection reveals that the load contains suspected hazardous materials or wastes containing PCBs the following measures will be taken by landfill personnel:

1. Immediately notify the Generator

2. Notify the Executive Secretary of the Department of Environmental Quality within 24 hours

3. Restrict the area from public access and from facility personnel

4. Assure proper cleanup, transport and disposal of the waste as per DEQ recommendations

Inspection training of the landfill personnel will be performed by a qualified person from Allied Waste.

Extensive documentation will be maintained on special waste received. Individual files will be maintained for each generator. Each file will typically contain the following information:

1. Profile sheet

2. Appropriate analytical data

3. Correspondence with the generator.

Procedures for controlling disease vectors (R315-302-2(2)(k)):

Various procedures are incorporated into the operation of the landfill to prevent, as much as possible, the transmittal of disease through disease vector control. Red Rock Waste Services landfill operating procedures are intended to control disease vectors such as rodents, insects, and air borne particulates.

It is Red Rock Waste Services policy to keep the working face exposure to a minimum. In so doing, compaction efforts are maximized. Proper compacting procedures will help ensure not only the most effective use of available landfill space, but also reduces the likelihood of a rodent infestation.

To prevent an infestation of insects at the landfill, it is the policy of Red Rock Waste Services to cover all odoriferous wastes with 6 inches of soil cover weekly.

A plan for alternative waste handling (R315-302-2(2)(l)):

In the event that normal land filling operations are impeded or all together terminated through equipment breakdown or other unforeseen event, then an alternative location within the landfill boundaries will be designated as a temporary handling and stockpiling facility. This alternative location will be as nearly adjacent to the existing working face as possible but maintaining sufficient distance for public safety. It is intended to use the ground which is currently approved for disposal of solid waste as a temporary stockpiling area first. However, should it become necessary to move off the approved site for the safety and general welfare of the public, the temporary stockpiling facility would then be located on ground which is proposed for the next unit to be constructed. As there are 500 acres within the sanitary landfill boundaries, it is unlikely that the occasion would arise that would require the complete closure of the landfill facility. In the event that the entire landfill facility was closed to public access due to a major catastrophe, then an alternative landfill site would need to be located for the temporary solid waste handling and stockpile facility as an emergency measure.

A temporary solid waste handling and stockpile facility would of necessity have to be versatile and mobile yet be conducive to securing the temporarily stockpiled solid waste from wind, salvagers, and animal scavengers. To construct such a facility, temporary fencing would be constructed along the perimeter of the proposed temporary stockpiling area. These fenced in areas could easily be enlarged or reduced in size as necessary to accommodate the expanding or reducing stockpile size. Sizing each individual stockpile area would be important in combating the effects of wind. In addition to securing the stockpiling area with fencing, it would also be necessary to channel and berm completely around the solid waste stockpiling area to protect the facility and surrounding area from run-on/run-off water and leachate.

After the working face of the existing landfill unit was re-established and was deemed safe to resume standard landfill operating practices, the solid waste which had previously been stockpiled at the temporary solid waste handling and stockpiling facility would then be transported to the landfill unit and deposited at the working face for compaction and burial. Upon completion of the removal of all the solid waste from the temporary stockpiling facility, the fencing would then be removed. Any impacted native soil would be removed and used as daily cover in the Washington County Landfill Facility. All run-on/run-off waters and leachate collected in the stockpiling area perimeter channel would then be pumped out and used as dust control at the landfill site. All channels would then be backfilled, all berms would be leveled, and the entire temporary stockpiling area would be scarified and contoured to its original condition.

A general training and safety plan for site operations (R315-302-2(2)(o)):

The manager of Red Rock Waste Services will ensure that the required safety and training programs are conducted for the employees of the Washington County Landfill Facility. These topics will be taught from the Allied Waste Services Safety and Training Manual. A copy of the safety and training manual will be on file in the office of Red Rock Waste Services. The order of training may change to suit the needs of the facility. All safety meetings and training will be documented by indicating the topic covered and main points discussed. Employees will be required to sign and date the appropriate forms.

Following is a list of the required and recommended safety and training topics.

MONTH	REQUIRED	RECOMMENDED
January	Employee Right to Know	Operating Excavators
February	Respirator Training	Operating Dozers
March	Emergency Response and Spill Procedures, Company Work/Safety Rules	Hot loads and fires
April	Identification of Unacceptable/Hazardous Waste; Load Inspection	Proper Lifting Techniques
May	Lock-out/Tag-out	Slips, Trips, and Falls
June	Forklift Training	Heat Stress
July	Confined Spaces	Fire Extinguisher Use

August	Asbestos Management	Pre-Operational Inspections
September	Blood Borne Pathogens	Operating Loaders
October	Electrical Safety	Landfill Gas Safety
November	Drug and Alcohol Awareness	Cold Weather Precautions for Personnel and Equipment
December	Personal Protective Equipment	Operating Equipment on slopes

Any recycling programs planned at the facility (R315-303-4(6)):

Currently the Washington County Landfill Facility has programs to recycle metal and tires. An individual will remove the metal from the working face and place it into large containers. The containers are then picked up by a contracted individual for recycling. Tires are removed from the working face, placed in a container, and a contracted commercial recycler of tires removes them from the landfill property.

A composting program has also been implemented at the landfill. The compost is produced by landfill personnel and sold to the public. If a surplus of compost is produced, the extra material may be used as an ADC.

The landfill is now providing to the local communities a paint exchange program. Surplus paint is brought to the landfill by the public and exchanged for other paint. The public is not required to take paint with them when they drop off unwanted paint.

Closure and post-closure care Plan (R315-302-2(2)(m)):

The closure and post-closure care plan for the Washington County Landfill Facility will be as cited in **Closure Plan (R315-310-3(1)(h))** and the **Post-Closure Care Plan (R315-310-3(1)(h))** contained in this permit application. (See pages 39 and 40)

Procedures for the handling of special wastes (R315-315):

The procedures for handling special wastes is as cited in *Procedures for excluding the receipt of prohibited hazardous or PCB containing wastes (R315-302-2(2)(j))* of this permit application. (See page 19)

Plans and operation procedures to minimize liquids (R315-303-3(1)(a) and (b)):

The plans and operation procedures to minimize liquids will be as cited in *Description of on-site waste handling procedures and an example of the form that will be used to record the weights or volumes of waste received (R315-302-2(2)(b) And R315-310-3(1)(f)):* of this permit application. (See page 11)

Plans and procedures to address the requirements of R315-303-3(7)(c):

The plans and procedures to address these requirements will be as cited in *Description of on-site waste handling procedures and an example of the form that will be used to record the weights or volumes of waste received (R315-302-2(2)(b) And R315-310-3(1)(f)):* of this permit application. (See page 11)

Plans and procedures to address the requirements of R315-303-3(7)(d):

The Washington County Landfill Facility has erected signs at the entrance of the facility. The signs explain the hours during which the facility is open, what the acceptable wastes are, emergency phone numbers, and the name of the facility.

Plans and procedures to address the requirements of R315-303-3(7)(e):

The plans and procedures to address these requirements will be as cited in *Contingency plans in the event of a fire or explosion (R315-302-2(2)(d)):* of this permit application. (See page 16)

Plans and procedures to address the requirements of R315-303-3(7)(f):

The plans and procedures to address these requirements will be as cited in *Procedures for controlling disease vectors (R315-302-2(2)(k)):* of this permit application. (See page 20)

Plans and procedures to address the requirements of R315-303-3(7)(g):

The Washington County Landfill Facility is operated in a manner that minimizes the active face area. Traffic is managed with safety of operators, equipment, and personnel as the guiding factor.

Plans and procedures to address the requirements of R315-303-3(7)(h):

The traffic at the Washington County Landfill Facility is managed to preclude tracking of waste materials outside of the landfill area. Also, traffic is managed to facilitate safety of operators, equipment, and personnel.

Plans and procedures to address the requirements of R315-303-3(7)(i):

The Washington County Landfill Facility personnel have access to radio, telephones, and vehicles to handle emergencies at the facility.

Plans and procedures to address the requirements of R315-303-4:

The plans and procedures to address these requirements will be as cited in various sections and of this permit application.

Any other site specific information pertaining to the plan of operation required by the Executive Secretary (R315-302-2(2)(p)):

Information for this section will be provided upon request by the Executive Secretary.

II. Facility Technical Information

Topographic map drawn to the required scale with contours showing the boundaries of the landfill unit, ground water monitoring well locations, gas monitoring points, and the borrow and fill areas (R315-310-4(2)(a)(i)):

The required map is located in Attachment J of this permit application. The 200-foot scale topographical map is located in Attachment S of this permit application.

Most recent U.S. Geological Survey topographic map, 7-1/2 minute series, showing the waste facility boundary; the property boundary; surface drainage channels; any existing utilities and structures within one-fourth mile of the site; and the direction of the prevailing winds (R315-310-4(2)(a)(ii)):

The required map is located in Attachment J of this permit application.

Geohydrological Assessment (R315-310-4(2)(b))

Local and regional geology and hydrology including faults, unstable slopes and subsidence areas on site (R315-310-4(2)(b)(i)):

This section has been adequately addressed in Mr. Bryce Montgomery's August 23, 1993 geologic report and his subsequent January 10, 1994 letter. These documents are contained in Attachment K of this permit application.

Evaluation of bedrock and soil types and properties including permeability rates (R315-310-4(2)(b)(ii)):

This section has been adequately addressed using the above-referenced geologic reports and the current regulatory approval of using the two down gradient wells as the only monitoring wells. These documents are contained in Attachment K of this permit application.

Depth to ground water (R315-310-4(2)(b)(iii)):

This section has been adequately addressed as detailed in the hydrogeologic evaluation provided by S. Bryce Montgomery. This document is contained in Attachment K of this permit application.

Direction and flow rate of ground water (R315-310-4(2)(b)(iv))

As referenced in the geologic reports, regional groundwater appears to flow near the facility at a depth of approximately 800 feet. Based on studies conducted in the area by the U.S. Bureau of Reclamation, the rate and direction of groundwater flow in this "regional" system are probably highly affected by the geologic structure of the Harrisburg Dome and associated anticline. These data suggest that the flow of groundwater in the "regional" aquifer is to the southwest.

However, faulting and fracturing in vicinity of the site has created localized zones of flow from nearby recharge areas. As discussed in the above-referenced reports, groundwater appears to flow from the outcrop of the Purgatory Buff Member of the Moenkopi formation to the southeast through a mapped fault towards MW-1. The aquifer which contains this groundwater appears to be perched and of local areal extent, with depths to groundwater of 15 to 20 feet.

There are insufficient data to make quantitative estimates of groundwater flow rate. However, based on interpretive geology in the above-referenced reports, the rate of groundwater flow appears to be extremely slow within the small perched aquifer near the site.

Quantity, location, and construction of any private or public wells on-site or within 2,000 feet of the facility boundary (R315-310-4(2)(b)(v)):

Other than two monitor wells which have been installed near the southwest end of the existing landfill cell, there are no on-site wells within the facility boundary. In addition, a search of records on file with the Utah Division of Water Rights indicates that only the following permitted well is located within 2,000 feet of the facility boundary:

1. No. 81-1211, a well water right for 12.0 acre-feet issued to Dixie Basin Smelters, Inc. The diversion is stated for use as domestic and mining. The referenced point of diversion is approximately 2000 feet north of the northeast corner of the landfill cell. A copy of the water right is found in Attachment L of this permit application. The location of this water right is shown on the map provided in Attachment J of this permit application.

There are no applications for new wells on record within 2,000 feet of the facility boundary.

Tabulation of all water rights for ground water and surface water on-site and within 2,000 feet of the facility boundary (R315-310-4(2)(b)(vi)):

A water right search was performed for Sections 8, 9, 17, 18, 20 and 21 in T. 42S, R14W. In addition to the above-mentioned well, the following are the water rights that were found on record within 2,000 feet of the facility boundary:

1. No. 81-415, a surface water right for 2.06 acre-feet issued to the United States Bureau of Land Management. The diversion is on an "unnamed wash" with the stated use as stock watering. The referenced point of diversion is approximately 700 feet southwest of the northwest corner of the landfill cell. A copy of the water right is found in Attachment L of this permit application. Location of this water right is shown on the map provided in Attachment J of this permit application.

2. No. 81-2827, a surface water right for 0.20 acre-feet issued to the United States Bureau of Land Management. The diversion is on an "unnamed wash" with the stated use as stock watering. The referenced point of diversion is approximately 1800 feet northwest of the northwest corner of the landfill cell. A copy of the water right is found in Attachment L of this permit application. Location of this water right is shown on the map provided in Attachment J of this permit application.

3. No. 81-2828, a surface water right for 0.20 acre-feet issued to the United States Bureau of Land Management. The diversion is on an "unnamed wash" with the stated use as stock watering. The referenced point of diversion is approximately 1700 feet northwest of the northwest corner of the landfill cell. A copy of the water right is found in Attachment L of this permit application. Location of this water right is shown on the map provided in Attachment J of this permit application.

Identification and description of all surface waters on-site and within one mile of the facility boundary (R315-310-4(2)(b)(vii)):

There are no surface water bodies within one mile of the facility boundary other than the Total Containment Evaporation Pond contained within the facility boundary. Water right 81-415, referenced above, apparently contains enough water on a seasonal basis to justify issuance of the right. Review of the file for this right indicates that a structure was constructed to catch run-off from the unnamed wash during periods of heavy rainfall. The file contains a detail of the resulting reservoir/impoundment and the associated control structures.

Background ground water and surface water quality assessment and, for an existing facility, identification of impacts upon the ground water and surface water from leachate discharges (R315-310-4(2)(b)(viii)):

The applicable document, Background Ground and Surface Water Document, is contained in Attachment M of this permit application.

Ground Water Monitoring (R315-303-3(7)(b) and R315-308):

Groundwater Sampling and Analysis plan is contained in Attachment N of this permit application.

Statistical method to be used (R315-308-2(7):

Statistical method to be used is addressed in section *Background ground water and surface water quality assessment and, for an existing facility, identification of impacts upon the ground water and surface water from leachate discharges (R315-310-4(2)(b)(viii)):* of this permit application. (See page 28)

Calculation of site water balance (R315-310-4(2)(b)(ix)):

A negative water balance, where evaporation and transpiration greatly exceed precipitation, exists in the area and will minimize the production of leachate. Calculation of the site water balance is as follows: The average annual precipitation received in this area is approximately 8 inches while the average pan evaporation is approximately 80 inches making for a substantial negative water balance of approximately 72 inches.

ENGINEERING REPORT - PLANS, SPECIFICATIONS, AND CALCULATIONS

Documentation that the facility will meet all of the performance standards of R315-303-2:

All documents that are required for this section are contained in this permit application or are available upon request of the Executive Secretary.

Engineering reports required to meet the location standards of R315-302-1 including documentation of any demonstration or exemption made for any location standard (R315-310-4(2)(c)(i)):

This section does not apply to the Washington County Landfill Facility because it is an existing facility (R315-302-1(1)(b)(i)).

Anticipated facility life and the basis for calculating the facility's life (R315-310-4(2)(c)(ii)):

The existing landfill cell and property was topographically surveyed in June 2003 and the information was used to determine the life of the facility. Using computer-generated maps and contours, it was determined that the existing landfill cell has 535,961 cubic yards of air space left. It has been calculated, through use of projected population growth rates provided that the existing unit will meet the needs of Washington County through the year 2006. It is estimated that approximately 535,961 cubic yards or 322,000 tons of solid waste and daily cover material (15% by volume) will be placed on the existing unit between now and 2006.

It is presently planned that there will be 11 successive landfill sub-units constructed, each having a life expectancy of three to five years and contain anywhere from 1.3 million to 4.5 million cubic yards each. It is the intent of the Washington County Special Service District #1 to operate each of the successive landfill sub-units separately. At the end of each of the predetermined three to five year operational periods, each sub-unit will be closed with the previously discussed protective cap system.

It is estimated that upon the closure of the last landfill unit at Washington County Landfill Facility in 2045 there will have been disposed of approximately 25,859,000 cubic yards or 15,515,400 tons of solid waste and daily cover.

Cell design to include liner design, if liner is to be used; cover design; fill methods; and elevation of final cover including plans and drawings signed and sealed by a professional engineer registered in the State of Utah, when required (R315-310-3(1)(b) and R315-310-4(2)(c)(iii)):

The current cell design including liner design, cover design, fill methods, elevation of final cover including plans and drawings are contained in Attachment R of this permit application. Red Rock Waste Services will submit detailed construction plans for each construction phase prior to the planned construction. These plans will be submitted to the Executive Secretary for approval.

Leachate collection system design and calculations showing system meets the requirements of R315-303-3(2) if a liner is to be used:

A leachate collection system will be designed for future cell development to comply with subsection R315-303-3(2) of the Solid Waste Permitting and Management Rules and subject to approval by the Executive Secretary prior to construction. Designs will submitted to Executive Secretary for approval 6 months prior to work taking place.

The current design of the leachate collection system and the contaminated run-off waters collection system operate in conjunction with one another as neither system will produce substantial amounts of liquid wastes due to the arid climate in which the landfill facility is operated. Recently an overflow pond was constructed below the Total Containment Evaporation Pond. The overflow pond was constructed to contain any overflow of the Total Containment Evaporation Pond. The overflow water will be handled as discussed in *Contingency plans for other releases, e.g. explosive gases or failure of run-off collection system (R315-302-2(2)(f)):* section. Considering the arid climate and the quantity of land available for use by the District, the construction of a treatment system designed to totally contain the leachate and contaminated run-off waters for the largest open unit anticipated is most practical.

P.17

The present layout design of the expected future landfill operation indicates that the largest landfill unit which will ever be open at any given time will be the existing landfill unit. It is estimated that the foot print of the existing unit covers approximately 45 acres. Future sub-units are presently designed at 26 to 28 acres.

With this in mind, the contaminated run-off waters channel/pipeline system and the Total Containment Evaporation Pond has been designed to handle a 25 year/24 hour precipitation event and to handle the run-off as well as subsequent leachates from the existing landfill unit.

The following calculations are the basis for the design of the contaminated run-off waters and leachate collection system and the Total Containment Evaporation Pond, which are based upon the Utah Department of Transportations (UD0T) small area run-off method. The small area method is effectively used for drainage areas of less than two square miles. The following equation gives the relation used:

$$Q_f = Q_c \times LF \times FF$$

Where: Q_f = Design Discharge in CFS

Q_c = Discharge Taken from UDOT Charts

LF = Land Terrain Factor Taken from UDOT Tables

FF = Frequency Factor

First the 25-year rainfall intensity was determined to be 1.10 in./hr. After determining the topography of the area a K-Factor of 0.19 corresponding to the intensity was determined. Q_c was determined to be 26 cfs for the existing 45 acre unit and 18 cfs for the future 28 acre sub-units by using UDOT charts and the K-Factor. By using the UDOT tables a land factor was estimated to be 0.6. The frequency factor is determined by dividing the design frequency (i_d) by the 25-year intensity (i_{25}).

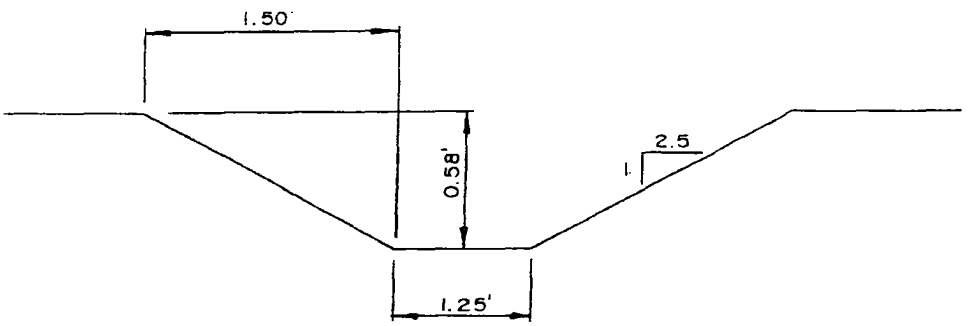
$$i_{25} = 1.10 \text{ in./hr.}$$

Hence: Q_{25} = (26 cfs) (0.6) (1.10/1.10) = 16 cfs (existing 45 acre unit)
Q_{25} = (18 cfs) (0.6) (1.10/1.10) = 11 cfs (future 28 acre sub-units)

The 16 cfs flow of the 25 year storm for the largest potential unit, the existing 45 acre unit, requires a 18" diameter outfall line to handle the contaminated run-off water and leachates. The sizing of the outfall line was determined by using Manning's formula for flow in pipes. The following equation gives the relation used:

$$Q = 1.486/n \, AR^{2/3} S^{1/2}$$

Where: Q = Discharge in cfs
A = Cross-Sectional Area of the Pipe
R = Hydraulic Radius
S = Slope of the Hydraulic Grade Line
n = Manning's Roughness Coefficient
(Concrete Pipe = 0.012)



$Q = 1.486/0.012\ (1.77)\ (1.77/4.71)^{2/3}\ (0.020)^{1/2}$
$Q = 16$ cfs

Upon determination of the flow of the 25 year storm, for both the existing unit of 45 acres and the future sub-units of 28 acres, it appears that a combination drainage channel/pipeline system would best meet the demands of the existing unit while a pipeline "only" system could meet the demands of the future sub-units. As the pipeline installed in conjunction with the drainage channel/pipeline system for the existing unit is to be extended for use at the future sub-units, this pipeline need only to be sized to handle the run-off from a 25 year storm from the future 28 acre unit which was previously determined to be 11 cfs. Also, as the collection pipelines will be installed along the perimeters of the existing land fill unit and future sub-units the run-off flows from the units will be split in two requiring the collection pipeline to handle 5.5 cfs. Using the Manning formula previously described, collection lines of 12 inches in diameter are adequate to pass the required flows.

To handle the total run-off flow demand for a 25 year storm for the existing unit a drainage channel system will be incorporated with the 12" diameter collection pipeline. As the drainage channel/pipeline system will completely surround the existing unit the run-off flows will be split in two requiring the drainage channel/pipeline system to handle 8 cfs.

With the 12" diameter pipeline carrying 5.5 of the 8 cfs, the remaining 3.5 cfs will be carried in a drainage channel above the pipeline to a junction manhole where all flows will be collected in the 18" diameter outfan line. The drainage channel/pipeline

collection system will be underlain by 3' of re-compacted earthen material with a permeability of 1 x 10^{-7} cm/sec.

As each sub-unit is closed run-off water will cease to flow into the collection lines allowing room in the leachate/run-off collection system for expansion into the next sub-unit constructed. Enlarging of the leachate/run-off collection system as it is extended into subsequent sub-units will not be required as the piping system is adequately sized to handle run-off of future sub-units. As the next sub-unit is developed the previous sub-unit will be closed changing the point of run-off water collection, not adding to it. Leachate collection of each closed sub-units will be negligible due to closure methods and the areas arid climate. Hence, there will be no need to enlarge the capacity of the leachate/run-off collection system but to extend the piping system only as the landfill facility expands.

The Program SAMM was used to determine the class of concrete pipe required to withstand the expected loading on the 12" pipe. Program SAMM computes earth loads on concrete pipe in accordance with the methods presented in the concrete pipe design manual (March 1990) and the Concrete Pipe Association. The following constitutes input pipe data and results:

PROGRAM SAMM
D-LOAD REQUIREMENTS FOR A 12 IN. DIAMETER CIRCULAR PIPE

PIPE DATA	
DIAMETER (in.)	12.00
WALL B, THICKNESS (in.)	2.000
INSTALLATION CONDITIONS	
MINIMUM DEPTH OF FILL (ft.)	2.000
MAXIMUM DEPTH OF FILL (ft.)	150.00
SOIL DENSITY (tb/eu. ft.)	100.00
BEDDING CLASS	B
INSTALLATION TYPE	TRENCH
TRENCH WIDTH (ft.)	3.00
SOIL LATERAL PRESSURE/FRICTION TERM (KMU)	0.1650
PARAMETERS TO COMPUTE TRANSITION WIDTH	
POSITIVE PROJECTION RATIO	1.00
POSITIVE SETTLEMENT RATIO	0.50
SOIL LATERAL PRESURE/FRICTION TERM (KMU)	0.1924
SOIL LATERAL PRESSURE COEFFICIENT	0.33

ADDITIONAL LOADS

LIVE LOADS

ASSHTO HS-20

NO SURCHARGE LOAD

FACTORS OF SAFETY

FACTOR OF SAFETY ON 0.01 INCH CRACK
D-LOAD (EARTH, LIVE) 1.00/1.00

FACTOR OF SAFETY ON ULTIMATE LOAD (EARTH, LIVE)
ACCORDANCE WITH ASTM C-76

DL.01 LESS THAN 2000 lbs/ft/ft	1.5
DL.01 GRATER THAN 3000 lbs/ft/ft	1.25
DL.01 BETWEEN 2000 – 3000 lbs/ft/ft	INTERPOLATED

RESULTS OF ANALYSIS

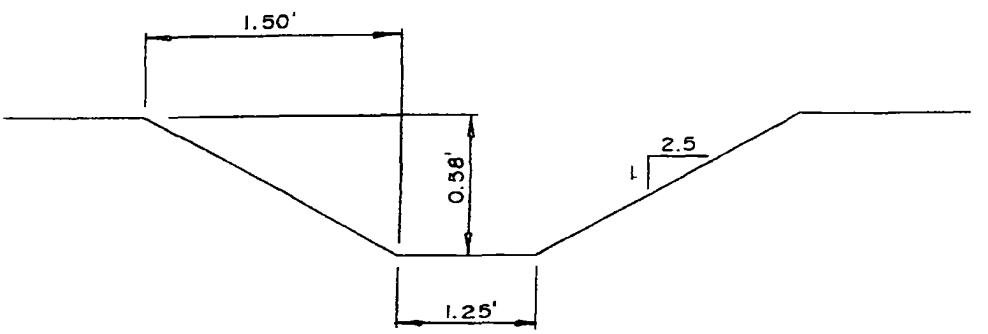
PIPE DEPTH (ft.)	-EARTH LOAD- ARCHING FACTOR	>TRANS	LOAD (lb/ft)	LIVE LOAD (lb/ft)	SURCH LOAD (lb/ft)	TOTAL LOAD (lb/ft)	BED FACT	REQ D-LOAD 0.01 IN. (lb/ft/FT)	ULT.
2.0	1.25	Y	416	1275	0	1691	3.01	449	674
12.0	1.02	N	1999	83	0	2081	2.10	791	1187
22.0	0.07	N	2485	29	0	2513	2.01	998	1497
32.0	0.51	N	2647	14	0	2661	1.98	1073	1609
42.0	0.40	N	2700	9	0	2709	1.97	1101	1652
52.0	0.32	N	2718	6	0	2724	1.96	1113	1670
62.0	0.27	N	2724	4	0	2728	1.95	1119	1678
72.0	0.23	N	2726	3	0	2729	1.95	1122	1683
82.0	0.20	N	2727	2	0	2729	1.94	1125	1687
92.0	0.18	N	2727	2	0	2729	1.94	1126	1689
102.0	0.16	N	2727	2	0	2729	1.94	1128	1692
112.0	0.15	N	2727	1	0	2729	1.93	1129	1693
122.0	0.14	N	2727	1	0	2728	1.93	1130	1695
132.0	0.13	N	2727	1	0	2728	1.93	1131	1696
142.0	0.12	N	2727	1	0	2728	1.93	1131	1697
150.0	0.11	N	2727	1	0	2728	1.93	1132	1698

As shown, the load on the pipe at 150 feet in depth is 1132 lb/ft.lft. Class III reinforced concrete pipe is capable of withstanding 1350 lb/ft.lft. which is adequate for this application.

The channel to handle the excess 3.5 of contaminated run-off water and leachates was designed using Mannings formula for an open channel. The following equation gives the relation used:

$$Q = 1.486/n\ AR^{2/3}\ S^{1/2}$$

Where Q = Discharge in cfs
A = Cross-Sectional Area of the Channel
R = Hydraulic Radius
S = Slope of the Hydraulic Grade Line
n = Mannings Roughness Coefficient (Rock Lined Channel = 0.035)



$$Q = 1.486/0.035\ (1.60)\ (1.604.47)^{2/3}\ (0.020)^{1/2}$$

$$Q = 5\ cfs$$

The proposed channel design will adequately handle the design flow of 3.5 cfs with additional capacity.

The capacity of the total containment pond is computed by obtaining the amount of precipitation expected to fall during the 25-year/24 hour precipitation event over the 45 acre site of the existing landfill unit.

The amount of precipitation expected during the 25 year/24 hour precipitation event at the landfill site is 2.18 inches as determined by E. Arlo Richardson, NOAA Climatologist, Utah State University, Logan.

The following equation gives time relation used:

$$V = AP_{25} LF$$

Where: V = Volume of Water Collected
A = Area of Collection Surface
P = 25 year/24 hour Precipitation Event
LF = Land Terrain Factor

Hence: V = (45 acres) (2.18 in. [1 ft/12 in.]) (.60) = 4.9 acre ft.

Other considerations which are essential to the design of the 4.9 ac./ft. total containment pond are the pond liner system, emergency overflow spillway, adequate pond free board, and rock lined bank protection.

The total containment pond will be designed with side slopes no greater than three horizontal to one vertical. The interior side slopes and the bottom of the pond will be designed to include, beginning with the lowest component, the following:

1. A two ft. layer of recompacted earthen material placed in six inch lifts with a permeability of 1 x 10^{-7} cm/sec. The maximum laboratory density shall be determined in accordance with AASHTO Designation T -99 Method D and infield compaction and moisture testing shall be performed for every 500 cubic yards of material placed. An in field single ring infiltrometer permeability test shall be performed for every 1,000 cubic yards of material placed.

2. A synthetic membrane 40 mils in thickness installed in direct and uniform contact with the compacted earthen component.

3. A 12" thick layer of soil to give adequate protection to the synthetic membrane. The membrane liner and protective soil cover will then be protected from wave action on the side slopes by the placement of riprap. Also, to protect the integrity of the pond from wave action a minimum free board of at least two and one half feet will be provided. In the event the capacity of the pond is exceeded by incoming flows an emergency overflow or spillway will be designed to safely release flood waters which could damage or destroy the pond.

The Washington County Landfill is located in an arid area that has a water balance of -72 inches annually. Under these conditions, assuming run-on flows are collected on the perimeter of the landfill unit, very little, if any, leachate will be generated. The flows collected and transported to the leachate pond will be mainly run-off collected from the face and sides of the unit. The pond sizing has been defined previously.

Upon the occurrence of the 25 yr., 24 hour precipitation event, the leachate pond would be filled to near capacity. The planned water depth is 4.0 feet when at the capacity of five acre feet. With a water balance of -72 inches, assuming no seepage, the pond would be empty at year's end. The average water depth for the year would be 2 ft. Utilizing the seepage formula of Q = KiA with K being the seepage coefficient, i being average water/depth shown above divided by the proposed section thickness, and A as the area of the pond bottom, the quantity of seepage annually can be calculated. The calculations will be conservative because it assumes the subgrade material to be free draining. In reality, the subgrade materials are fairly impervious.

Calculations made show that the placement of a 40 mil synthetic liner alone restricts the seepage to a mere 18.25 cubic feet annually. Averaged across the pond bottom, this quantity is less than 0.003 of an inch. To provide an added safety factor, the proposed design calls for the placement of 2.0 ft. of clay ($1x10^{-7}$) placed directly under a 40 mil synthetic liner ($1x10^{-13}$).

The conditions under which the volumes of seepage were calculated are near the worst case scenerio. Weather conditions are unpredictable and worst case may be substantially more severe. However, average and normal years will generate substantially less seepage.

Equipment requirements and availability (R315-310-4(2)(c)(iii)):

The equipment list may change as a result of a change in the operational requirements. The following equipment is presently being used at the landfill site in the landfilling operations and cover operations:

1 - Caterpillar 826 Compactor
1 - Caterpillar D7 Dozer
1 - Caterpillar D250E Dump Truck
1 - Ford LN9000 Water Truck
1 - IHC Roll Off Truck
1 - Caterpillar 140G Grader
1 - Caterpillar 950F Front End Loader
1 - Caterpillar IT24 Front End Loader

1 - Chevrolet S-14 SV
1 - Ford SV
1 - Ford F600 SV
1 - Case 590 Rubber Tire Backhoe

Identification of borrow sources for daily and final cover and for soil liners (R315-310-4(2)(c)(iv)):

The current daily cover needs are met by Alternative Daily Covers (ADCs) or the soil excavated from on-site. When either of these sources becomes inadequate, the importation of soil cover material from a nearby gravel crushing operation will be utilized. This operation procedure will continue through the next permit period. The natural material at the site is a very stable material and averages 10 feet thick. This material will be used as daily cover material during construction of the units as well as part of the final closure cap system. During the course of landfill operation, native soil may be excavated to provide for added solid waste volume as well as to provide for daily cover material. Upon closure of the existing landfill unit, native soil material will be excavated from on-site and deposited on the landfill units as native cover soil.

The ADC used at the landfill is hydromulch. The hydromulch is a cellulose fiber product manufactured using fiber stock. It is provided in easy-to-handle bags. Pre-measured, water soluble dye packets are inserted into each bag, which provide a consistent dying of the material. The material mixes rapidly with water to form a homogeneous slurry. The specifications are as follows:

Moisture Content	7.1%
Organic Matter	94.6%
Moisture Holding Capacity	1,107%
pH	6.1

The Washington County Landfill Facility reserves the right to change the ADC used upon approval from the Executive Secretary.

Run-off or leachate collection, treatment, and disposal and documentation to show that any treatment system is being or has been reviewed by the Division of Water Quality (R315-310-4(2)(c)(v) and R315-310-3(1)(i)):

It has been determined that there exists no potable water source in the Purgatory Flat area which would require extensive monitoring. Therefore, there will be no permanent ground water monitoring equipment installed which will require maintenance.

The leachate collection system consists mainly of an open ditch channelizing system which will also handle run-off water from those open portions of the landfill unit. The leachates and run-off water is channeled and piped to an open pond for containment until evaporation is complete. The containment pond is lined with a membrane liner to prevent seepage of the leachates into the surrounding ground. Maintenance of the channel system and containment pond will consist mainly of weed control. The leachate collection and run-off water piping system is fitted with cleanouts at 500' intervals permitting for the ease of maintenance. In conjunction with the channeling system, each landfill unit will be designed with a leachate/run-off water collection pipe.

Ground water monitoring plan that meets the requirements of Rule R315-308 including well locations, design, and construction (R315-310-4(2)(b)(x) and R315-310-4(2)(c)(vi)):

The Groundwater Sampling and Analysis Plan is included in Attachment N of this permit application.

Landfill gas monitoring and control plan that meets the requirements of Subsection R315-303-3(5) (R315-310-4(2)(c)(vii)):

Methane gas monitoring will be performed quarterly using a hand-held probe. The hand-held probe is to be calibrated prior to each use by the District's gas sample collector. This is to be done in conformance with the manufacturer's recommendations. The calibration of the probe will then be documented on the landfill gas quarterly monitoring results form, see Attachment O. Any required maintenance or repair, other than calibration, will be performed by the manufacturer of the probe or a licensed representative of the manufacturer. 2004 Tier II results show a gas collection and control system is not needed until at least 2009 at which time another Tier II will be performed.

Slope stability analysis for static and under the anticipated seismic event for the facility (R315-310-4(2)(b)(i) and R315-302-1(2)(b)(ii)):

This section has been adequately addressed in Mr. Bryce Montgomery's August 23, 1993 geologic report and his subsequent January 10, 1994 letter. These documents are contained in Attachment K of this permit application.

Design and location of run-on and run-off control systems (R315-310-4(2)(c)(viii)):

The run-on/run-off collection system consists mainly of an open ditch channelizing system which will also handle run-off water from those open portions of the landfill unit. The leachates and run-off water will be channeled and piped to an open pond for containment until evaporation is complete. The containment pond is lined with

a membrane liner to prevent seepage of the leachates into the surrounding ground. Maintenance of the channel system and containment pond will consist mainly of weed control. In conjunction with the channeling system each landfill unit will be designed with a leachate/run-off water collection pipe. The leachate collection and run-off water piping system is fitted with cleanouts at 500' intervals permitting for the ease of maintaining.

Refer to the previous section, *Leachate collection system design and calculations showing system meets the requirements of R315-303-3(2) if a liner is to be used* for additional information on run-on/run-off systems. (See page 30)

Closure Plan (R315-310-3(1)(h))

Closure schedule (R315-310-4(2)(d)(i)):

The closure schedule of the Washington County Landfill Facility will be as cited in section *Anticipated facility life and the basis for calculating the facility's life (R315-310-4(2)(c)(ii))* of this permit application. (See page 29)

Design of final cover (R315-310-4(2)(c)(iii)):

The cell design including liner design, cover design, fill methods, elevation of final cover including plans and drawings are contained in this permit application in Attachment R. The applicable documents are contained in the referenced permit.. Landfill design drawings will be submitted prior to any future construction to the Executive Secretary for approval.

Capacity of site in volume and tonnage (R315-310-4(2)(d)(ii)):

The capacity of the site in volume and tonnage has been determined using computer-generated maps. The site has been recently surveyed as discussed above. The existing landfill cell has 535,961 cubic yards of air space remaining which equates to 322,000 tons of solid waste and daily cover material. The total remaining volume and tonnage of the site is 25,244,961 cubic yards and 15,147,400 tons respectively.

Final inspection by regulatory agencies (R315-310-4(2)(d)(iii)):

All items of closure work performed by the contractor will be subject to inspection by the District, its representatives or representatives of regulatory agencies having jurisdiction over the operation of the landfill. To ensure compliance with all rules and regulations that apply to the landfill, a final closure plan will be submitted prior to any closure construction to the Executive Secretary for approval.

Prior to the existing landfill unit closure construction, the District will notify the regulatory agency responsible for the operations of the landfill facility in order that inspection trips may be planned.

All test results for all phases of closure construction will be kept on file as part of the landfill record.

Post-Closure Care Plan (R315-310-3(1)(h))

Site monitoring of landfill gases, ground water, and surface water, if required (R315-310-4(2)(e)(i)):

Ground water monitoring will continue during the post-closure care period as it is apparent that there is a perched water aquifer requiring the installation of ground water monitoring equipment. Maintenance of water monitoring equipment during this period consists of protection and maintaining of the monitoring well heads.

As there are no surface water sources on the landfill property, it will not be required of the District to conduct surface water monitoring as part of the post-closure care activities.

Upon closure of the landfill facility, leachate will be collected and treated as needed. During the years of operation prior to closure, a de-watering/run-off system has been and will be constructed to collect and remove all contaminated water from unclosed units and deposit the water in a total containment evaporation pond. After all units are covered with a protective cap system, the de-watering systems will remain in-place and continue to drain any moisture within the units. Post-closure maintenance of this system will consist of maintaining the integrity of the evaporation pond membrane lining system through weed and erosion control. It is expected that the facility will be entirely capped. There will be little, if any, leachate collected in the evaporation pond during the actual post-closure care period.

Gas monitoring will continue after closure of the landfill facility during the post-closure care period. Maintenance of gas monitoring equipment during this period consists of regular calibrations, and occasional repair or replacement of the actual gas equipment as per manufactures recommendations.

Withdrawals from the selected financial assurance instrument for the costs incurred by the District for performing the regularly scheduled quarterly inspections and methane gas monitoring will be requested at the end of each quarter that the inspections are made. Withdrawals for any required additional inspection trips and maintenance work performed will also be made at the as needed in which it was performed.

Changes to record of title, land use, and zoning restrictions (R315-310-4(2)(e)(ii)):

Change of ownership of the property has occurred. On January 21, 1994, the United States of America gave and granted the property that contains the Washington County Landfill Facility to Washington County. Washington County then leased the property to the Washington County Solid Waste Special Service District #1. Red Rock Waste Services operates the landfill facility. A copy of the deed and the lease agreement are contained in Attachments A and B of this permit application. There have been no additional changes to the zoning and land use restrictions.

Maintenance activities to maintain cover and run-on/run-off control systems (R315-310-4(2)(e)(iii)):

There are no surface water sources on the landfill property. As a result, Red Rock Waste Services will not conduct surface water monitoring as part of the post-closure care activities.

The water balance indicates that, upon closure of the landfill facility, there will be no leachate collection or associated treatment. During the years of operation prior to closure, a de-watering/run-off system has been and will be constructed to collect and remove all contaminated water from unclosed units and deposit the water in a Total Containment Evaporation Pond. After all units are covered with a protective cap system, the de-watering systems will remain in-place and continue to drain any moisture within the units. Post-closure maintenance of this system will consist of maintaining the integrity of the evaporation pond membrane lining system through weed and erosion control. It is expected that the facility will be entirely capped, there will be little, if any, leachate collected in the evaporation pond during the actual post-closure care period.

Maintenance of the leachate evaporation pond as discussed previously will consist of weed and erosion control to ensure that any collected leachate is contained. Quarterly inspections will be made to determine the integrity of the pond and volume of collected leachates if any.

The run-off water channels along the perimeter of the closed landfill unit will require quarterly inspections and cleaning to ensure that obstructions do not occur. In conjunction with the routine inspection of the run-off water channels, inspection of the protective cap system will be performed to ensure that the vegetation continues to protect the cover soil from erosion.

Quarterly inspections will be made to ensure the integrity of the protective cap system and the run-on/run-off systems. It is understood that erosion can have an adverse effect upon the landfill facility, and, if left unchecked or not maintained, could become a

public health hazard. It is Red Rock Waste Services' intention to implement a maintenance program to ensure the integrity of the landfill facility and remaining structures during the post-closure period, thus protecting the public and the environment.

It is anticipated that weed control in the run-off water channels and evaporation pond will require maintenance annually. This post-closure maintenance should be performed mid to late winter prior to the germination of the seeds in the spring.

List the name, address, and telephone number of the person or office to contact about the facility during the post-closure care period (R315-310-4(2)(e)(vi)):

The names, address, and telephone number of the person or office to contact about the facility during the post-closure care period is as follows:

Name:	Washington County Special Services District #1 Susie Holt, District Manager
Address:	325 North Landfill Road Washington, Utah 84780
Phone #:	(435) 673-2813

FINANCIAL ASSURANCE (R315-310-3(1)(j))

Identification of closure costs including cost calculations (R315-310-4(2)(d)(iv)):

The closure costs associated with closing the existing landfill as modified through the year 2004 are contained in Attachment P of this permit application.

Identification of post-closure care costs including cost calculations (R315-310-4(2)(e)(iv)):

The costs associated with post-closure care of the existing landfill cell, as modified through the year 2035, are contained in Attachment P of this permit application.

Identification of the financial assurance mechanism that meets the requirements of Rule R315-309 and the date that the mechanism will become effective (R315-309-1(1)):

The Washington County Solid Waste Special Service District entered into an escrow agreement with the State of Utah as a financial assurance mechanism to provide funding for closure of its existing cells. The Utah State Treasurer is acting as the escrow agent. The terms of the agreement include the Washington County Special Service District #1 making monthly payments into the escrow account such that the funds would be available to complete the closure and post closure requirements. The balance of the fund as of March 31, 2004 is $2,185,282.30. The average net earnings rate to-date is 1.4508%. There will be adequate funds in the account to cover closure and post-closure care costs of the existing landfill cell. A copy of the Statement of Account is provided in Attachment Q of this permit application. Funds could be withdrawn for payment of closure and post closure expenses upon authorization by both the Washington County Special Service District #1 and the Executive Secretary of the Solid and Hazardous Waste Control Board.

Attachment P of this permit application contains a table showing the cost calculations for post-closure care costs for the next 30 years.

LEASE AGREEMENT

This LEASE AGREEMENT is made on this 17th day of February, 1994, by and between WASHINGTON COUNTY SPECIAL SERVICE DISTRICT NO. 1, a special service district organized and existing under the laws of the State of Utah, hereinafter referred as the "District", and WASHINGTON COUNTY, UTAH, a body politic of the State of Utah, hereinafter referred to as the "County."

RECITALS

1. The District was created by resolution of the Washington County Commission for the purpose of providing solid waste collection and disposal services to the residents of the County.

2. The District is responsible for operation and maintenance of a sanitary landfill on certain real property located in the County, said property being more particularly described in Exhibit A, a copy of which is attached hereto and by this reference incorporated herein.

3. From the period of time since the organization of the District to approximately the present time, the sanitary landfill site was owned by the Bureau of Land Management, who leased said site to the County for use as a sanitary landfill.

4. The Bureau of Land Management has recently conveyed title to the landfill site to the County, who now desires to lease said site to the District for continued use as a sanitary landfill.

5. The District and the County desire to enter into a formal lease agreement, specifying the terms and conditions upon which said property shall continue to be used as a landfill site.

NOW, THEREFORE, IN CONSIDERATION of the mutual covenants and obligations contained herein, the parties hereto agree as follows:

1. The County hereby leases to the District that certain real property described in Exhibit A, a copy of which is attached hereto and incorporated herein as if fully set forth.

2. As consideration for said lease, the parties acknowledge that the District has paid all accrued rent owed by the County to the Bureau of Land Management for the period of time that said property has been used as a sanitary landfill. In addition, the District hereby agrees to pay to the County the sum of one dollar ($1.00) per year for rent during the period of this agreement, for a total of fifty dollars ($50.00), payable in advance at the time of execution of this agreement.

3. The term of the lease shall be for a period of fifty (50) years, commencing on January 1, 1994 and ending on December 31, 2044, or until such time as the District ceases to exist, whichever first occurs.

4. The County covenants and warrants that it has fee title to said real property, free and clear of all encumbrances, restrictions or reservations which would in any way impair the validity of this lease agreement or the right of the District to

utilize said property for disposal of solid waste.

5. The parties hereto agree that said real property shall be utilized solely for continued operation and maintenance of a sanitary landfill site, and that District shall be solely responsible for operation, maintenance and control of said landfill in accordance with all state and federal statutes, rules and regulations, as well as any rules or regulations adopted by resolution of said District's Administrative Control Board.

6. The parties hereto agree that, as between the District and the County, all responsibility and liability in connection with the use of the property as a sanitary landfill site shall be borne solely by the District. The District further agrees to indemnify and hold the County harmless from and against any and all claims, demands or causes of action that may be asserted against the County by any other person or entity in connection with the use of said property as a sanitary landfill site, and to procure and maintain public liability and property damage insurance, with the County named as an additional insured, in such amounts as may be established from time to time by resolution of the Board of Washington County Commissioners. The parties acknowledge and agree that as of the date hereof, the amount of such insurance shall be the sum of not less than Five Hundred Thousand Dollars ($500,000.00) for each occurrence, and One Million Dollars ($1,000,000.00) for property damage and liability per one year, and that the insurance required hereby shall remain at said amounts until such time that the County shall send the District written notice of any change.

7. This lease shall be binding upon and shall inure to the benefit of the parties hereto, their successors and assigns.

8. This lease, or any right hereunder, shall not be assigned to any other person or entity except upon written consent of both parties hereto.

9. This lease shall be governed by and construed under the laws of the State of Utah.

10. This lease agreement constitutes the entire agreement of the parties, all negotiations and representations having been included herein, and shall not be modified except upon written agreement duly executed by the parties hereto.

IN WITNESS WHEREOF the parties have executed this agreement on the date first above written.

WASHINGTON COUNTY

Gayle Aldred, Chairman
Washington County Commission

Attest:

Carolyn Sutterfield, Deputy Clerk

WASHINGTON COUNTY SPECIAL SERVICE DISTRICT NO. 1

Barbara Beckstrom, Chariman
Administrative Control Board

Attest:

Joan Bills, Secretary

Form 1860-9
(January 1988)

The United States of America

To all to whom these presents shall come, Greeting:

Serial: Utah 40541

WHEREAS,

Washington County

is entitled to a land patent pursuant to the Recreation and Public Purposes Act of June 14, 1926 (44 Stat. 741), as amended and supplemented (43 U.S.C. 869; et. seq.), for the following described land:

Salt Lake Meridian, Utah

T. 42 S., R. 14 W.,
sec. 8, SE¼SE¼NE¼, SE¼SE¼SW¼, NE¼SE¼, S½SE¼, SE¼NW¼SE¼;
sec. 9, SE¼NW¼NW¼, SW¼NW¼, NW¼SW¼, N½SW¼SW¼, SW¼SW¼SW¼;
sec. 17, N½NE¼NE¼, SW¼NE¼NE¼, NW¼NE¼, NW¼SW¼NE¼, E½NW¼, E½W½NW¼, SW¼NW¼NW¼, W½SW¼NW¼.

containing 500.00 acres

NOW KNOW YE, that the UNITED STATES OF AMERICA, in consideration of the premises, and in conformity with said Act of Congress, HAS GIVEN AND GRANTED, and by these presents DOES GIVE AND GRANT unto the said Washington County, the land above described, for use as a solid waste sanitary landfill: TO HAVE AND TO HOLD the same, together with all rights, privileges, immunities, and appurtenances, of whatsoever nature, thereunto belonging, unto the same Washington County, forever; and

EXCEPTING AND RESERVING TO THE UNITED STATES:

1. A right-of-way thereon for ditches or canals constructed by the authority of the United States. Act of August 30, 1890 (43 U.S.C. 945); and

2. All mineral deposits in the lands so patented, and the right of the United States, or persons authorized by the United States, to prospect for, mine, and remove such deposits from the same under applicable laws and regulations as the Secretary of the Interior may prescribe; and

Washington County, its successors or assigns, assumes all liability for and shall defend, indemnify, and save harmless the United States and its officers, agents, representatives, and employees, from all claims, loss, damage, actions, causes of action, expense, and liability (hereinafter referred to in this clause as claims) resulting from, brought for, or on account of, any personal injury, threat of personal injury, or property damage received or sustained by any person or persons (including the patentee's employees) or property growing out of, occurring, or attributable directly or indirectly, to the disposal of solid waste on, or the release of

Patent Number 43-94-0009

00458194 Bk0795 Pg0379
RUSSELL SHIRTS * WASHINGTON CO RECORDER
1994 FEB 15 11:33 AM FEE $.00 BY RS

Form 1860-10
(April 1988)

Serial: Utah 40541

hazardous substances from the land described above, regardless of whether such claims shall be attributable to: (1) the concurrent, contributory, or partial fault, failure, or negligence of the United States, or (2) the sole fault, failure, or negligence of the United States.

The above described land has been used for solid waste disposal. Solid waste commonly includes small quantities of commercial hazardous waste and household hazardous waste as determined in the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6901), and defined in 40 CFR 261.4 and 261.5. Although there is no indication these materials pose any significant risk to human health or the environment, future land uses should be limited to those which do not penetrate the liner or final cover of the landfill unless excavation is conducted subject to applicable State and Federal requirements.

SUBJECT TO:

1. Those rights for an oil and gas pipeline granted to Mountain Fuel Supply Company, its successors or assigns, by right-of-way number UTU-62308, pursuant to the Act of February 25, 1920 (41 Stat. 437; 30 U.S.C. 185, Section 28).

2. Those rights for a water pipeline granted to St. George City, its successors or assigns, by right-of-way number UTU-60051, pursuant to the Act of February 25, 1920 (41 Stat. 449; 30 U.S.C. 185, Sec. 28).

3. Those rights for a water pipeline granted to Washington County Special Service District #1, its successors or assigns, by right-of-way number UTU-66221, pursuant to the Act of October 21, 1976 (90 Stat. 2776; 43 U.S.C. 1761).

4. Those rights for power transmission line granted to Pacificorp dba UPL, its successors or assigns, by right-of-way number UTU-43523, pursuant to the Act of October 21, 1976 (90 Stat. 2776; 43 U.S.C 1761).

IN TESTIMONY WHEREOF, the undersigned authorized officer of the Bureau of Land Management, in accordance with the provisions of the Act of June 17, 1948 (62 Stat. 476), has, in the name of the United States, caused these letters to be made Patent, and the Seal of the Bureau to be hereunto affixed.

GIVEN under my hand, in Salt Lake City, Utah
the twenty-first day of January
in the year of our Lord one thousand nine hundred and
ninety-four and of the Independence of the
United States the two hundred and eighteenth.

By _____
Chief, Branch of Lands and Minerals, Operations

Patent Number 43-94-0009

00458194 Bk0795 Pg0380

POPULATION/SOLID WASTE PROJECTIONS

Year	Population	Waste Generation	Waste Volume	Cover Material	Total Volume
2005	109,776	1,645	150,480	22,573	173,053
2006	114,197	1,645	156,541	23,482	180,022
2007	118,617	1,645	162,601	24,391	186,991
2008	123,038	1,645	168,661	25,300	193,961
2009	127,459	1,645	174,721	26,209	200,930
2010	131,880	1,645	180,780	27,118	207,898
2011	136,715	1,645	187,408	28,112	215,521
2012	141,550	1,645	194,036	29,106	223,143
2013	146,385	1,645	200,664	30,100	230,765
2014	151,220	1,645	207,282	31,095	238,387
2015	156,055	1,645	213,920	32,089	246,009
2016	160,315	1,645	219,759	32,965	252,724
2017	164,575	1,645	225,599	33,841	259,439
2018	168,834	1,645	231,438	34,717	266,154
2019	173,094	1,645	237,277	35,592	272,870
2020	177,354	1,645	243,117	36,468	279,585
2021	181,503	1,645	248,803	27,321	286,125
2022	185,651	1,645	254,490	38,175	292,665
2023	189,800	1,645	260,177	39,028	299,205
2024	193,948	1,645	265,864	39,881	305,745
2025	198,097	1,645	271,551	40,734	312,285
2026	202,246	1,645	277,238	41,587	318,825
2027	206,394	1,645	282,925	42,440	325,365
2028	210,543	1,645	288,612	43,293	331,904
2029	214,691	1,645	294,299	44,146	338,444
2030	218,840	1,645	299,985	44,999	344,984

2031	225,383	1,645	308,955	46,344	355,299
2032	232,122	1,645	318,193	47,730	365,923
2033	239,063	1,645	327,707	49,157	376,864
2034	246,211	1,645	337,505	50,627	388,132
2035	253,572	1,645	347,596	52,141	399,737
2036	261,154	1,645	357,990	53,700	411,690
2037	268,963	1,645	368,694	55,305	423,999
2038	277,005	1,645	379,718	56,959	436,677
2039	285,287	1,645	391,071	58,662	449,733
2040	293,817	1,645	402,764	60,416	463,180
2041	302,602	1,645	414,807	62,223	477,029
2042	311,650	1,645	427,209	64,083	491,292
2043	320,969	1,645	439,983	65,999	505,982
2044	330,565	1,645	453,139	67,972	521,111
2045	340,449	1,645	466,687	70,005	536,692
2046	350,629	1,645	480,641	72,098	552,739
2047	361,113	1,645	495,012	74,254	569,266

Administrative Control Board
WASHINGTON COUNTY SOLID WASTE
Special Service District Number 1
197 East Tabernacle - St. George, Utah 84770

APPLICATION FOR LICENSE AS COMMERCIAL HAULER

All commercial haulers of solid waste operating within the boundaries of Washington County Special Service District No. 1 are required by resolution of said District to obtain an annual license therefor by completing the following application and submitting it to the office District at 197 East Tabernacle, St. George, Utah 84770 prior to December 31 of each year.

****

APPLICATION

DATE: _____

NAME OF BUSINESS: _____

BUSINESS ADDRESS: _____

_____

BUSINESS MAILING ADDRESS: _____

TELEPHONE: _____

NAME AND ADDRESSES OF ALL OWNERS, PARTNERS OR CORPORATE OFFICERS:

NAME(S): _____

_____

_____

ADDRESS(ES): _____

_____

_____

_____

_____

_____

_____

TELEPHONE: _____

ORGANIZATION:

Individual_____ Partnership_____ Corporation_____

****

In consideration of the granting of this license, applicant hereby understands and agrees:

1. To submit to District at the end of each calendar month books and records showing the volume of solid waste disposed of at the sanitary landfill site during the prior month.
2. To pay commercial fees, as fixed from time to time by resolution of District, for each calendar month within fifteen (15) days of the end of said calendar month.
3. That all commercial fees not paid within 15 days of the end of the calendar month shall bear interest at the rate of 12% per annum until paid.
4. To pay all costs of collection incurred by District in enforcing payment of commercial fees, including court costs and a reasonable attorney's fee.
5. To be responsible for maintaining at all times a policy of general liability insurance in an amount of not less than $1 million ($1,000,000.00), covering applicant's commercial hauling activities during the term of any license granted; and to indemnify and hold District harmless from and against any and all claims, causes of action or demands resulting or arising from Applicant's commercial hauling activities pursuant to said license.
6. To abide by all rules and regulations of District now in effect or which may hereafter be adopted from time to time by resolution of District.
7. That any license granted pursuant to this application may be denied or revoked for violation of any of the terms of this agreement or any other rules or regulations of the District as adopted from time to time by resolution.

DATED this _____ day of _____, 199___.

_____
APPLICANT/TITLE

_____

(for office use only)

New or renewal license: _____
Date Application Reviewed: _____
Application: Granted _____
Denied _____
Expiration Date _____

_____
District's Signature

SITE	TICKET	GRID

WEIGHMASTER	
DATE IN	TIME IN
DATE OUT	TIME OUT
VEHICLE	ROLL OFF
REFERENCE	ORIGIN

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	FEE	TOTAL

NET AMOUNT
TENDERED
CHANGE
CHECK NO.

SIGNATURE _____

WASTE INSPECTION REPORT

DATE ______ **INSPECTORS** ______________________

TIRE REPORT

$1.50	$2.00	$4.00	BY WEIGHT	LOCATION	NIGHT CANS	COUNTY CLEAN UP

LOCATION	HAULER	LIC-TRUCK	VEHICLE TYPE	WASTE COMPOSITION

INSPECTION LOG

Washington County Landfill Facility

Name of Area Inspected	OK	Needs Repair	Comments
Total Containment Evaporation Pond			
18" Leachate Outfall Line			
12" Leachate Collection Line			
Run-off Drainage Channel			
Run-on Drainage Channel			
Perimeter Fencing and Access Gates			
Landfill Cell			
TIME:	**DATE:**	**INSPECTOR:**	**SIGNATURE:**

WASHINGTON COUNTY
SOLID WASTE SPECIAL SERVICE DISTRICT NO. 1
LANDFILL GAS QUARTERLY MONTORING RESULTS
YEAR ____ QUARTER ____

Date: _____ Time: _____

Name of Gas Sample Collector_____

Temperature_____ Weather_____

Monitoring device should be calibrated prior to initiating sampling.
Accomplished? Yes No

Methane Monitoring Location		Measured %LEL	Internal Action Limit: Half of Regulatory Limit (%LEL)	Regulatory Action Limit (%LEL)
1. NW Corner of the Scale House	Outside		12	25
	Inside		12	25
2. North Boundary			50	100
3. South Boundary			50	100
4. NW Corner of Treatment Pond			12	25
5. SW Corner of Composting Area			12	25

- **Gas Sample Collector:** If measured % LEL equals or exceeds internal action limit, contact the facility manager.
- **Facility Manager:** If measured % LEL equals or exceeds regulatory action limit, notify the State Director in compliance with 40 CFR 258.23(c).

Comments:

_____

_____

_____

_____

_____

_____

_____
Gas Sample Collector

WASHINGTON COUNTY SANITARY LANDFILL
Random Load Inspection Record

INSPECTION INFORMATION

Inspector's Name: _____
Date of Inspection: _____
Time of Inspection: _____
Facility Name: _____

TRANSPORTATION COMPANY INFORMATION

Name: _____
Address: _____

_____

Phone Number: _____

VEHICLE INFORMATION

Driver's Name: _____
Vehicle Type: _____
Vehicle License Number: _____
Vehicle's Last Stop: _____
Vehicle Contents: _____

OBSERVATIONS AND ACTIONS TAKEN

_____
_____
_____
_____

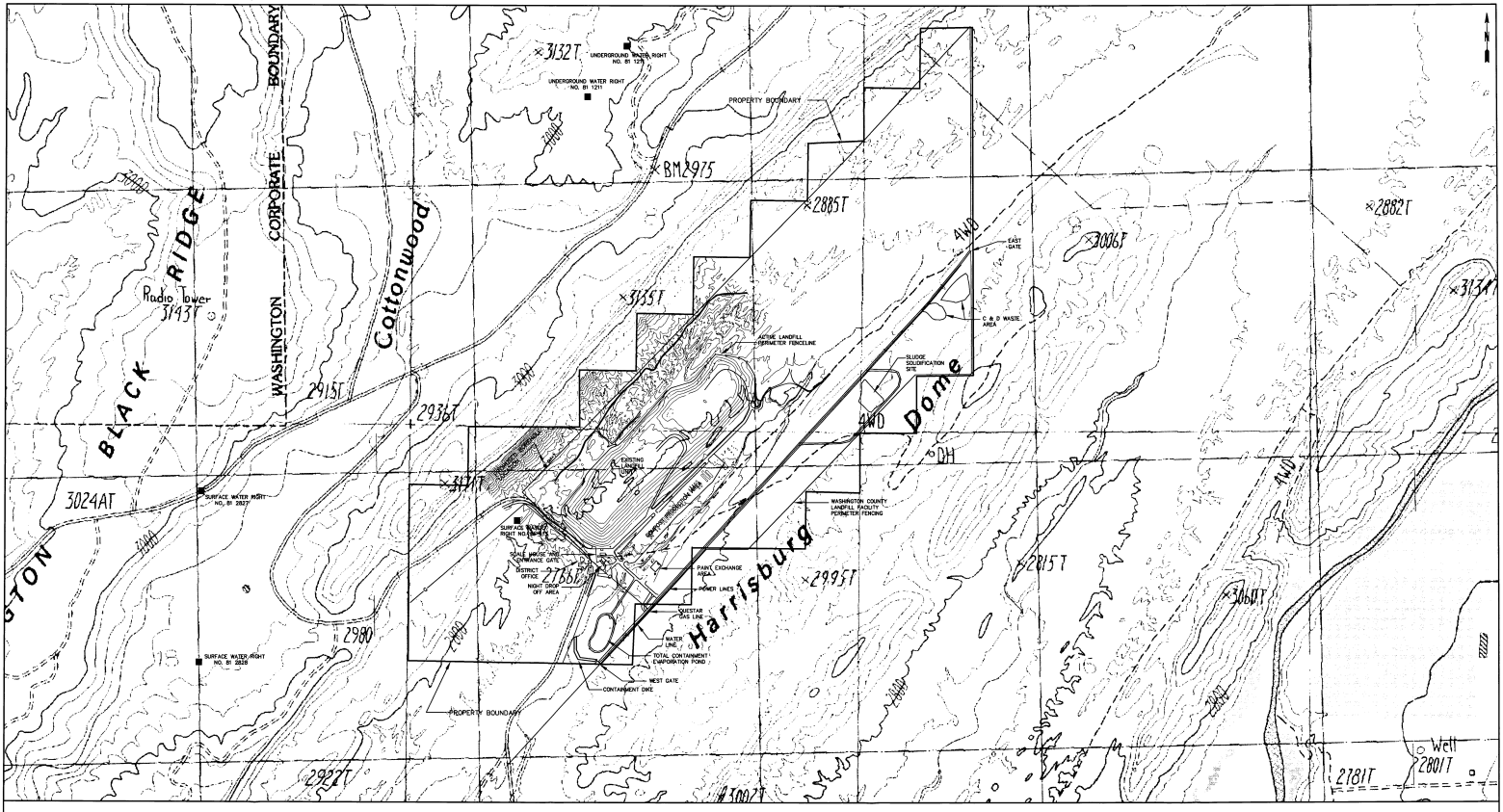
Photo Documentation: ___ Yes ___ No

Driver's Signature*: _____ Date: _____

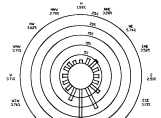
Inspector's Signature: _____ Date: _____

* Driver's signature hereon denotes: His presence during the inspection and does not admit, confirm or identify liability.

ALL DISTRICT EMPLOYEES PRESENT MUST SIGN BOTTOM OF FORM



MAP TAKEN FROM USGS 7.5 MINUTE MAP
HARRISBURG JUNCTION, UTAH
PROVISIONAL EDITION 1986



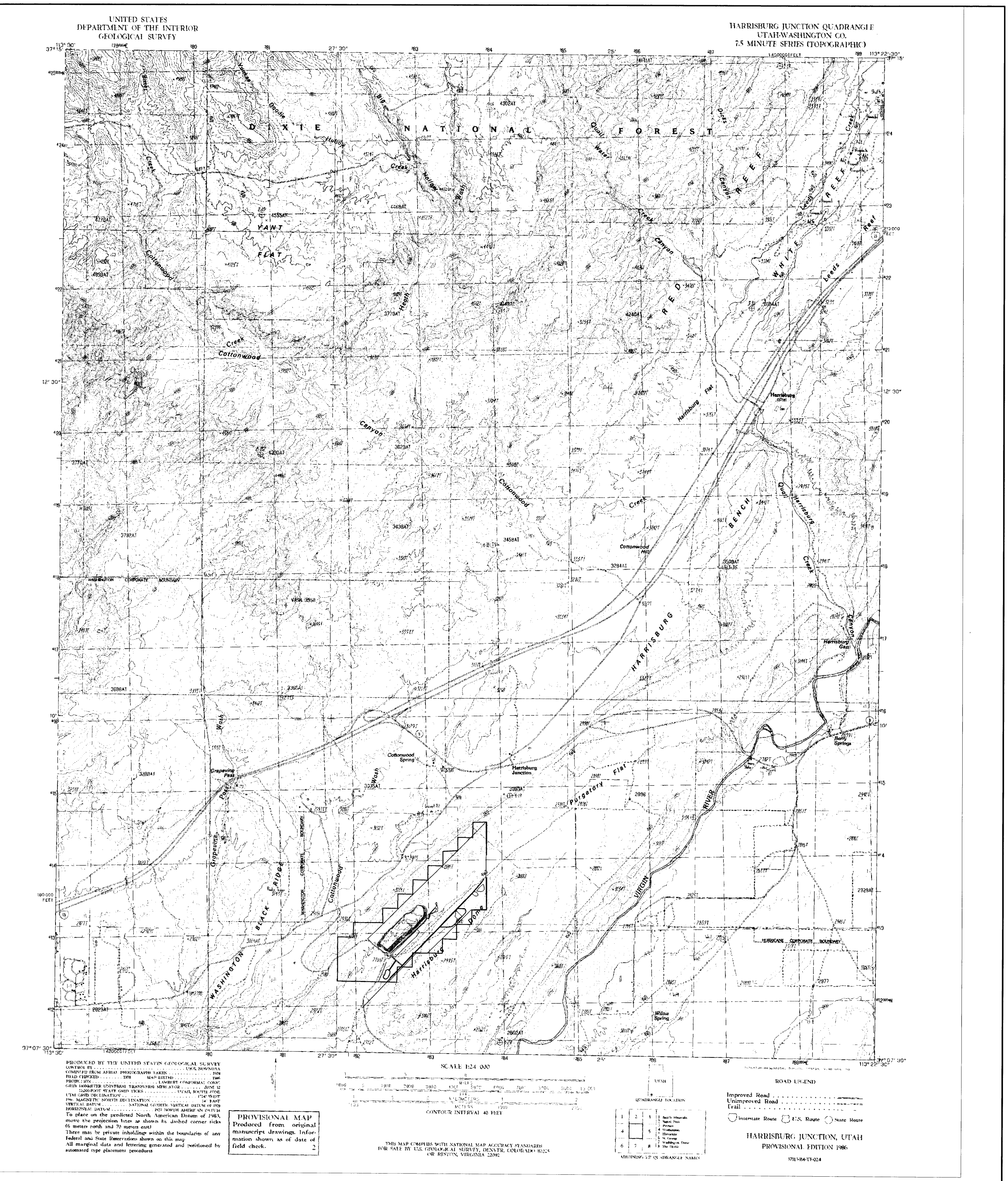
REVISION	
DATE	BY
9/13/99	GHP

EarthFax Engineering, Inc.
Engineers/Scientists

WASHINGTON COUNTY
LANDFILL FACILITY

ALLIED WASTE SERVICES

DRAWN BY: KHB	CHECKED BY: GHP	DATE: 7/28/99
APPROVED BY: GHP	PROJECT NUMBER: UC-680-02	



0' 2000'

REVISION	
DATE	BY
5/10/04	GHP

EarthFax Engineering, Inc.
Engineers/Scientists
EarthFax

WASHINGTON COUNTY LANDFILL FACILITY SITE LOCATION MAP

ALLIED WASTE SERVICES

DRAWN BY: KHB	CHECKED BY: GHP	DATE: 7/26/99
APPROVED BY: GHP	PROJECT NUMBER: UC-680-02	

REGISTERED PROFESSIONAL ENGINEER
No. 186210
GENE H. PLAYER
May 2004
STATE OF UTAH

August 23, 1993

Mr. Reed Noble
Mr. Steven E. Layton
Creamer & Noble Engineers
P. O. Box 1094
St. George, Utah 84770

RE: Washington County Landfill Site geologic study and report

Gentlemen:

In response to your request of July 7, 1993, I have completed my geologic study of the Washington County Landfill Site and submit to you the following report. See the attached geologic map and section, with other supplemental maps and diagram, in reference to the following analysis, conclusions and recommendations.

In addition to my recent field examinations on July 26-28, 1993, and previous work in the region I have researched the following references:

Adair, J. W., and others, 1975, Guide for Planning and Preliminary Design of earth Dams in Seismically Active Areas: Engineering and Watershed Planning Unit No. 45, U. S. Soil Conservation Service, South Technical Service Center, Fort Worth, Texas;

Algermissen, S. T., 1980, The Wasatch Fault Zone, The Earthquake Ground Shaking Hazard and Estimation of Damage: presentation at Earthquake Engineering Research Institute Seminar Fundamentals of Intra-Plate Earthquakes, Salt Lake City, Utah;

Arabasz, W. J. and others, 1992, Observational Seismology and the Evaluation of Earthquake Hazards and Risk in the Wasatch Front Area, Utah: in U. S. Geol. Sur. Prof. Paper 1500-A-J, Assessment of Regional Earthquake Hazards and Risk Along the Wasatch Front, Utah, P. L. Gori and W.W. Hays, editors, p. D1-D36;

Black, B. D. and Christenson, G. E., 1993, M 5.8 St. George Earthquake, September 2, 1992: Utah Geological Survey, Survey Notes Vol. 25, Number 3-4, p. 25-29;

Cook, E. F., 1960, Geologic Atlas of Washington County, Utah: Utah Geol. and Min. Survey Bulletin 70;

Cordova, R. M., and others, 1972, Ground-water Conditions in

the Central Virgin River Basin, Utah: Utah Dept. of Nat. Resources, Div. of Water Rights Tech. Pub. No. 40, prepared by the U. S. Geol. Survey;

Cordova, R. M., 1978,Ground-water Conditions in the Navajo Sandstone in the Central Virgin River Basin, Utah: Utah Dept. of Nat. Res., Division of Water Rights Tech. Pub. No. 61, prepared by the U. S. Geol. Survey;

Gourley, C., 1992, Geologic Aspects of the Quail Creek Dike Failure: in Engineering and Environmental Geology of Southwestern Utah, Utah Geol. Assoc. Pub. 21, edited by K. M. Harty, p. 17-38;

Hansen, G. H. and Scoville, H. C., 1955, Drilling Records for Oil and Gas in Utah: Utah Geol. and Min. Survey Bulletin 50;

James, R. L., and others, 1989, Investigation of the Cause of Quail Creek Dike Failure: Independent Review Team;

Mortensen, V. L. and others, 1977, Soil Survey of Washington County Area, Utah: U. S. Soil Conservation Service,Dept. of Agriculture in cooperation with others;

Mulvey, W. E., 1992, Engineering Geologic Problems Caused by Soil and Rock in Southwestern Utah: in Engineering and Environmental Geology of Southwestern Utah, Utah Geol. Assoc. Pub. 21, edited by K. M. Harty, p. 139-144;

Payton, C. C., 1992, Geotechnical Investigation and Foundation Design for the Reconstruction of Quail Creek Dike: in Engineering and Environmental Geology of Southwestern Utah, Utah Geol. Assoc. Pub. 21, edited by K. M. Harty, p. 39-51;

Smith, R. B., 1982, Earthquakes, Seismic Geology and Earthquake-Hazards of the Wasatch Front and Intermountain Region: Earthquake Engineering Research Institute Regional Seminar, Salt Lake City, Utah;

Stearns, C. E., 1974, Seismic Risk Evaluations: Geologist-Design Engineers Workshop in Portland, Oregon;

Taylor, C. L. and Cluff, L. S., 1977, Fault Displacement and Ground Deformation Associated with Surface Faulting: Proceedings of Current State of Knowledge of Lifeline Earthquake Engineering, ASCE, Los Angeles, Calif.;

U. S. Bureau of Reclamation, 1969, Definite Plan Report on Dixie Project: Utah, Region 3, Appendix B-Geology, Boulder City, Nevada:

U. S. Bureau of Reclamation, 1979, Preliminary LaVerkin Springs Unit, Utah, Colorado River Water Quality Improvement Program, Point Source Division: Appendices A-B; and

Ward, P. L. and others, 1990, The Loma Prieta Earthquake of October 17, 1989, and Earthquake Map of the United States: U. S. Geological Survey pamphlet.

The existing and proposed landfill site is mainly underlain with the Shnabkaib Member of the Triassic-age Moenkopi Formation which is part of the northwest limb of the Harrisburg Dome-Virgin Anticline. The Shnabkaib Member, including the Middle Red Member, comprises about 1300 feet of an approximate total Moenkopi thickness of 2200 feet. It consists of gray, white, light green-gray, pink and light rust-maroon, gypsiferous, silty and sandy shale, dolomitic siltstone, gypsum, and silty dolomite. Bedding of differential hardness produces a low-relief erosion surface of small, narrow hogback ridges and strike valleys, striking northeastward, cut normally by small ravines, and having the depressions filled partially with residual soil. The eroded surface and residual soil presents a dry, fluffy, popcorn surface of powdery, gypsiferous, fine-grained soil consisting of silt, silty clay and fine-grained sand (ML, Unified Soil Classification System).

Included within the lower part of the mapped Shnabkaib Member is the Middle Red Member of the Moenkopi Formation. It consists of approximately 350 feet (of the total 1300 feet previously stated) of rust-red-brown, gypsiferous, soft, shaley, fine-grained sandstone, inpart-clayey siltstone, and gypsum, which produces and erosion slope. The produced residual soil is more sandy and clayey (ML-SM) than that yielded by the Shnabkaib Member.

Underlying the Shnabkaib-Middle Red Members, and forming a sharp, narrow, conspicuous hogback ridge with its hardest limestone unit, is the Virgin Limestone Member of the Moenkopi Formation. The dirt road trending northeasterly through Purgatory Flat and through the eastern portion of the Washington County Landfill property, parallels this narrow hogback ridge. The Virgin Limestone Member consists of 100-150 feet of light brown-gray, fine crystalline limestone which is inpart sandy and silty. The limestone is sandwiched between interbedded, purple and maroon-red-brown and light green, gypsiferous, silty shale and white-light gray gypsum. The resistant limestone unit is approximately 30-50 feet thick and is well jointed and permeable thereby, with the intersecting joints striking N 20-45 degrees E, dipping 26-45 degrees SE, spaced 2-24 inches apart and open to a half inch at the weathered surface; and N 38-57 degrees

W, dipping 59-79 degrees SW, spaced 4-36 inches apart and open to a half inch at the weathered surface.

The Virgin Limestone Member is underlain by the Lower Rid Member of the Moenkopi Formation which is approximately 300-400 feet thick. It consists of a slope-forming, gypsiferous, reddish-brown siltstone and mudstone with some thin-bedded dolomite, which unconformably overlies the Kiabab Limestone.

The underlying Permian-age Kiabab Limestone is exposed within the core and crest of the Harrisburg Dome. It consists of at least 600 feet of well jointed, vuggy, light brown-gray, fine-crystalline, medium-bedded limestone containing an abundance of brown weathering chert blebs up to 8-inch size. It weathers-out as an angular gravel. Abundant jointing strikes N 11-84 degrees west, dipping 75-77 degrees NE and some 15 degrees SW; and intersecting with N 20-88 degrees E, dipping 72-85 degrees SE. These joints are spaced 2-36 inches apart and are open from a quarter inch to 4 inches at the weathered surface. Thus, because of these joints and bedding planes, the formation is pervious.

Overlying the Shnabkaib Member of the Moenkopi Formation is the Upper Red Member of that formation. It is exposed in the lower to upper slope of the prominent, high hogback ridge immediately west of the subject landfill property. It consists of 400 feet of well-jointed, rust-red to maroon-rust brown, very fine to fine grained sandstone which is in thin to thick beds with siltstone and lesser, maroon and brown silty shale and shaley siltstone. A prominent yellow-brown weathering, cliff-forming, fine grained, jointed sandstone of variable thickness comprises its base. However, due to an overthrust fault and possibly, but not likely, inpart due to lack of deposition or alteration, this sandstone unit is missing or only is a very broken remnant, and generally smeared-out throughout the SE/4 Sec. 8, T 42 S, R 14 W.

The Moenkopi Formation is capped unconformably by the Triassic-age Shinarump Sandstone, about 200 feet thick, on the high prominent hogback ridge at the west edge of the landfill property. It is a hard, inpart silica-cemented, fine-coarse, subangular and lenticular, yellow-gray-brown sandstone. It contains a conspicuous, intersecting set of joints which provides for the formation to weather-out in angular gravel, cobbles, boulders and large blocks up to 12 feet in size. Because of overthrust faulting through it within the ridge immediately southwest and west of the present landfill, where the paved road transects it, segments of the formation have been thrust over other

CENTER UNIT				
Station	End Area (SQ.')	Ave. End Area (SQ.')	Int. (FT.)	Vol (CY)
29+50	0	0	0	0
30+00	4,250	2,125	50	3,935
32+00	23,000	13,625	200	100,926
36+00	74,150	48,575	400	719,630
40+00	83,800	78,975	400	1,170,000
44+00	77,250	80,525	400	1,192,963
48+00	90,500	83,875	400	1,242,593
52+00	85,800	88,150	400	1,305,926
56+00	98,850	92,325	400	1,367,778
60+00	83,150	91,000	400	1,348,148
64+00	80,050	81,600	400	1,208,889
68+00	83,250	81,650	400	1,209,630
72+00	73,850	78,550	400	1,163,704
76+00	75,800	74,825	400	1,108,519
80+00	77,950	76,875	400	1,138,889
84+00	42,150	60,050	400	889,630
88+00	0	21,075	400	312,222
TOTAL:				**15,483,382**

segments of the formation and over its top, including a small amount of the younger Chinle Shale. The sandstone within the upper overthrust plates is very broken and shattered. Where measurable, the thrust faulting planes are dipping about 35 degrees to the northwest, north and northeast.

Prominent joints within the sandstone strike N 10-65 degrees W, having dips 69-88 degrees SW and some 66 degrees E, spaced 2-12 feet apart and open to an inch at the weathered surface; intersecting with less prominent joints striking N 20-37 degrees E, and dipping 63-70 degrees SE.
The Shinarump Sandstone is overlain by the Triassic-age Chinle shale which has been either greatly eroded or mantled with alluvium is approximately 800 feet thick, some of which is probably thickening due to overthrusting. It consists generally of gray, purple and maroon siltstone and bentonitic shale, with lesser interbeds of sandstone and conglomeratic sandstone. It is generally easily eroded and underlies strike valleys that are commonly covered with alluvium, but is exposed within ravines and roadcuts. Because of the massive erosion of the Virgin Anticline (including the Harrisburg Dome) there is none of it remaining within the Purgatory Flat and landfill property area.

The Chinle Shale is overlain by the Triassic-age Moenave, exposed about a mile west of the landfill property. It consists of about 500 feet of gray-dark-brown, maroon, rust-red and purple shale, fine-grained sandstone, and siltstone, being capped with the Springdale (Silver Reef) Sandstone member. It is a lavender, buff to white weathering, fine-medium grained sandstone which is about 150 feet thick and forms a conspicuous hogback from differential erosion.

Overlying the Moenave Formation is the rust-red-brown, interbedded siltstone, shale and sandstone, of the Triassic-Jurassic age Kayenta Formation, which is about 700 feet thick.

The well-known, Jurassic-age Navajo Sandstone which is a massive, cross-bedded, yellow-orange-reddish brown, fine grained sandstone, overlies the Kayenta Formation, and is a regional aquifer. It is at least 2000 feet thick in the region, where not reduced by erosion.

A conspicuous Quaternary-age, curved tongue of well jointed basalt caps the Washington Black Ridge, within 1-1 1/2 miles west of the landfill property. It is the erosion-resistant flow of lava that once filled an ancient erosion channel, which is now elevated above the less-resistant-to-erosion

bedrock formations on either side of it.

Quaternary-age deposits of alluvium occur on the high bench, west of the landfill property as sand and clay colluvium and capping terrace gravels and sand, of variable thickness.

On the landfill property, the alluvial cover is thin, probably less than 10 feet thick, with the thickest deposits being aprons along the edges of the Purgatory Flats and at the toes of the steeper slopes. The soil generally is a clayey, sandy silt with a high content of calcium sulfate (gypsum powder) (ML), but becomes gravelly and more sandy within the alluvial aprons. Test pits need to be dug in the various areas to more adequately determine the composition and thickness of the deposits. It is possible that the land strip between the outcrop of the Virgin Limestone Member and the steeper, northwest slope of the Harrisburg Dome, west of the Kiabab Limestone outcrop may contain at depth sufficient clay content to make it an adequate, impervious blanketing material. On the surface it is gravelly, sandy silt (ML-SC).

The alluvial apron within the west edge of the landfill property is composed of silty sand and sandy silt that is gravelly with larger clasts next to the steep slope contain blocks up to 12 feet in size, mainly from the Shinarump Sandstone, let down by erosion. Although zones of it may be clayey, because of the large clasts included, such would be difficult to compact properly as an impervious blanket, unless the coarser fraction is first removed.

All of the rock strata except the Quaternary deposits have been involved in overthrust folding and faulting, with resultant shearing and jointing. The Virgin Anticline (Harrisburg Dome) is a result of it. Subsequent tensional forces exerted regionally has resulted in further jointing, and to the east 7 miles, normal faulting. No normal faulting was detected beneath or adjacent to the landfill property, but a prominent thrust fault surfaces within the northwest edge of the property, having a slippage plane extending to the northwest and north, with some local short segments to the east. Associated with this thrusting are small shear faults detected within the floor of Purgatory Flats beneath the main landfill property. Some beds of the upper part of the Shnabkaib Member within the west edge of the landfill property, near the overthrust fault, have been tilted to vertical and even over-turned to dip steeply southeastward, as shown on the geologic map. Generally the bedding beneath the landfill property is dipping northwestward 54-75 degrees, with the lesser dips in the southeast edge of the property.

The U. S. Bureau of Reclamation (1969) drilled three test

holes (DH-1P, DH-2P and DH-3P) along the axis of a proposed dike in Purgatory Flat, within the S/2 Sec. 3, T 42 S,R 14 W, approximately a mile northeast of the landfill property. Total depths were 103, 204 and 153 feet, respectively. Water percolation test were also conducted in these holes at successive intervals of penetration. See attached log copies. Permeability or hydraulic conductivity of the Shnabkaib Member was nil in all three holes except for the interval from 12.2-22.2 feet in DH-2P which took 6-11 gpm with water pressure of 15-25 p.s.i. over a 20 minute period. Since water was injected into the tight holes both during drilling and water testing, water level measurements in the holes included such injected standing water. However, in DH-3P, upon completion of the drilling to a depth of 153 feet, the water in the hole was bailed down to 148 feet depth on March 14, 1966, and then the water level was measured in the hole three days later on March 17, 1966, and found to be at a depth of 139 feet. This may represent a perched aquifer level, the principal "aquifer" level, or just drill water that seeped back into the drill hole out of the sidewalls after sitting three days.

The U. S.Bureau of Reclamation (1969) also shows a reported water level elevation 2158 feet in an abandoned oil test drilled on the crest of the Harrisburg Dome. This old oil test hole within the NE/4 NW/4 NW/4 Sec. 16, T 42 S, R 14 W, and another located about 700 feet northeast of it also on the ridge crest, both had junk in them when I examined them, which prevented getting any kind of measurement of water level. The reported water level of 2158 feet elevation would be at a depth of approximately 680 feet below the land surface at the landfill property. The oil test well was commenced in the top of the Kiabab Limestone at an approximate elevation of 2950 feet, and drilled to a reported depth of 3508 feet. This depth would have penetrated the Callville Limestone of Pennsylvanian age. A reported water elevation of 2158 feet would project to be at a depth of about 800 feet from land surface at the well.

It is my opinion at this point of available data that the Shnabkaib Member beneath the landfill property is not serving nor will serve as an aquifer, and any water contained therein is far from potable in its natural state. Any such water contained therein would probably drain towards the Virgin River to the south and exit from the subsurface at an elevation of 2650 feet. Projecting a gentle potentiometric surface from this elevation back to a surface elevation of 2840 feet at the landfill property would mean that any ground water present here would be encountered within a depth of 190 feet or higher.

Because of the close proximity of the landfill property to

the major Hurricane Fault with related parallel Washington Fault, and the fact that these faults are of late geologic occurrence, the potential exists for a major earthquake in the area, resulting from movement on either or both of them. The Hurricane Fault extends southward into Arizona for 100 miles and northward past Cedar City and farther north for at least 50 miles. The Washington Fault located within three miles west of the land fill property, is approximately 100 miles long.

The subject property is located within the southeast edge of the Intermountain Seismic Belt where historic earthquakes as large as Richter Magnitude 7 have occurred (Yellowstone Park area). See attached seismic maps. The latest of those nearest to the project site was of Richter Magnitude 5.8 with its epicenter near the Quaternary-age Washington Fault, about 4 miles to the SSW. See attached location map. This occurred on September 2, 1992, which caused some liquefaction and landsliding with some structural damage to buildings within the region. The project site falls into Seismic Risk Zone 2 of moderate damage corresponding to Modified Mercalli Intensity VII of Moderate Damage, corresponding to Richter Magnitude 5.5 (Algermissen, 1969). Based upon the geologic recency and amount of displacement of the Hurricane Fault, on-going historical earthquakes in the region, the length of the Hurricane Fault, and empirically obtained data of world-wide faulting and earthquakes, I estimate the potential of a future earthquake in the project vicinity of a maximum Richter Magnitude 6.5, Mercalli Intensity IX, and maximum horizontal rock acceleration of 0.3 g (gravity of 32 ft/squared second). However, there is no way of knowing or predicting when such potential earthquake will occur in the area.

The foundation of the landfill property is stable, and under the existing dry conditions, or similar in the future, it will remain so. There are no underlying potable aquifers, and it is not a recharge area to any potable aquifer. Therefore, it is my conclusion that the proposed use of the landfill property for refuse disposal is practical and feasible. However, to maintain the stability of the foundation, any appreciable water flow into the foundation, beyond that amount of existing natural conditions, should be prevented. Since the Virgin Limestone Member is pervious, its outcrop band should be excluded from the placement of landfill on it. Furthermore, there is both a water pipeline and a natural gas pipeline that parallel this Virgin Limestone outcrop within a couple hundred feet of it, which should obviously not be covered with landfill. The overthrust fault bounding the northwestern edge of the landfill property should also be avoided for landfill burial, as the fault plane may inpart be permeable.

Proven experience with the foundation of the Quail Creek Dike, which has a foundation almost entirely on the Shnabkaib Member, has shown that not all joints or shear planes within the formation are tight, which can allow water to enter into the formation. If such amount of water is sufficient to circulate, it can dissolve existing gypsum in both beds and joints, and permit piping of overlying, fine-grained sediments into any existing or enlarged and created openings.

Thus, it is my recommendation to dig sufficient test pits to a depth of at least 12 feet over the subject property area that contains alluvial cover to quantify the amount and composition of potential borrow material that could be used for an impervious blanket to be placed beneath the future refuse landfill. Some of these same test pits could be used to conduct water percolation tests to determine permeabilities for the soil zone. The preferred area for such borrow is probably within the southeastern edge of the property on both sides of the Virgin Limestone outcrop, with obvious avoidance of the two pipelines buried through this area. If possible, test pits should also be dug around the northeast end and southeast flank of the Harrisburg Dome, on both sides of the Virgin Limestone outcrop to quantify the amount and composition of potentially usable, clayey soil, that might also be borrowed from there.

An alternative source of known plastic clayey soil is the weathered Chinle Shale formation that is present on the bench to the west of the landfill area, within the SE/4 Sec. 7 and the N/2 Sec. 8, T 42 S, R 14 W. This will require a haulage of about 2 miles via the existing roadways.

In placing the impervious clayey blanket as a bottom seal to the future landfill placement, I recommend that the fluffy topsoil be first removed (perhaps to a depth of 3-4 feet) and stockpiled to be later used as a covering over the landfill. The clayey soil foundation blanket should be compacted in lifts with optimum moisture content over the underlying, exposed and smoothed-out, naturally compacted material (both alluvium and bedrock).

The final top of the deposited refuse landfill should also be blanketed to prevent or minimize the infiltration of water into the compacted landfill mass.

At least two initial test holes, which could also be used as on-going monitoring wells, should be drilled to depths of 200 feet, one near the southwest end of the existing landfill and another about a mile to the northeast near the center of the proposed landfill, about 600 feet west of the

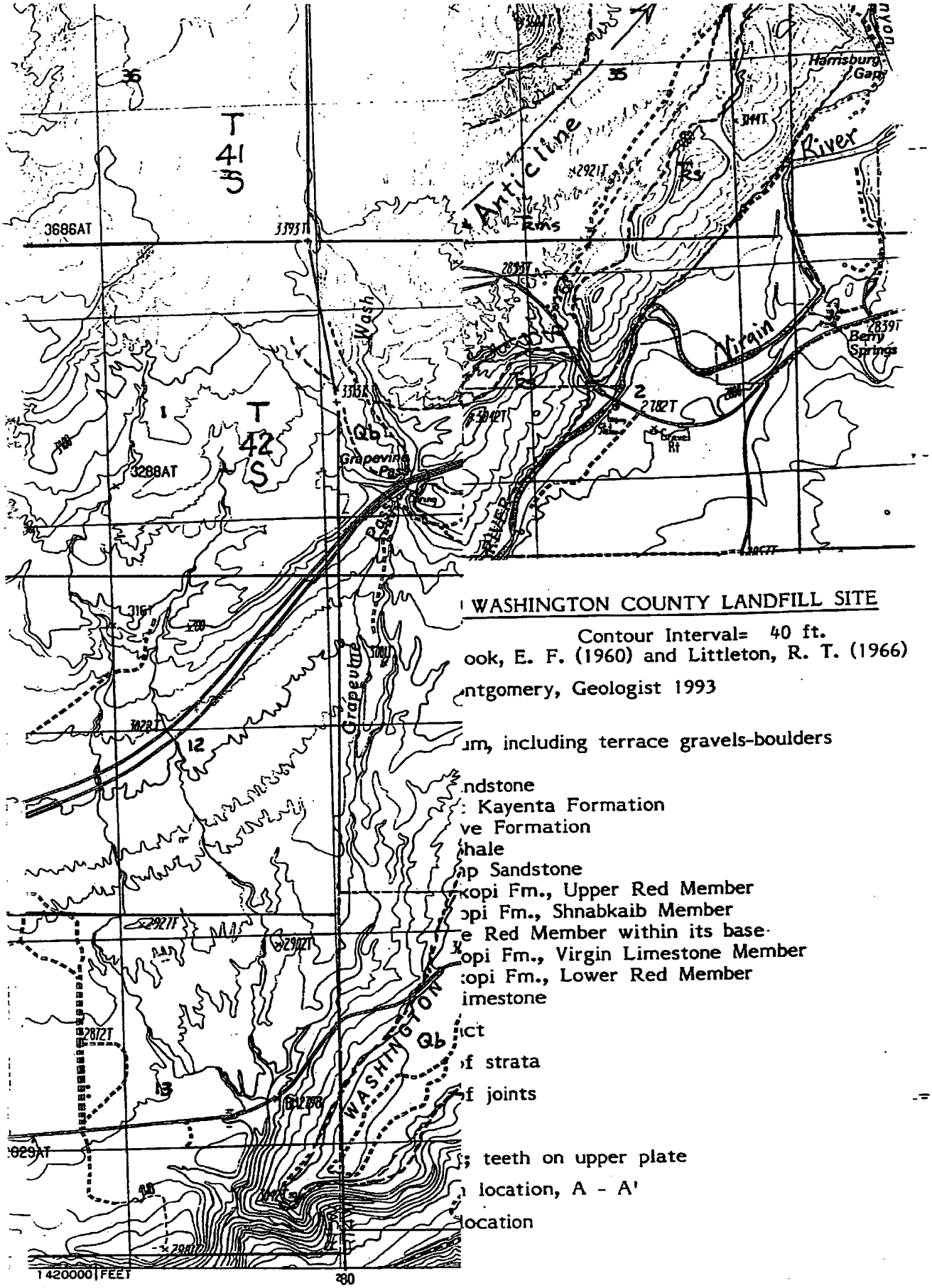
roadway near the existing pipelines. These holes should be drilled first with dry, air-rotary method to detect any water-table and collect samples of any encountered water, followed by water pressure testing by the use of inflatable rubber packers to isolate various zones and determine hydraulic conductivity of the underlying Shnabkaib Member. This would be followed by the insertion of plastic casing, slot perforated near the bottom, and sealed around it at the top, to gather any available water levels and samples in the future.

I also recommend that permeability tests be conducted on optimally compacted soil samples collected over the proposed landfill area and potential borrow area to be used for impervious blanketing material, in addition to the percolation tests conducted in selected test pits under natural conditions.

Respectfully submitted,

S. Bryce Montgomery
Professional Geologist
3512 South 100 East
Bountiful, Utah 84010 Telephone 295-8592

Attachments



WASHINGTON COUNTY LANDFILL SITE

Contour Interval= 40 ft.

ook, E. F. (1960) and Littleton, R. T. (1966)

ntgomery, Geologist 1993

ım, including terrace gravels-boulders

ndstone
: Kayenta Formation
ve Formation
hale
ap Sandstone
kopi Fm., Upper Red Member
opi Fm., Shnabkaib Member
e Red Member within its base
opi Fm., Virgin Limestone Member
opi Fm., Lower Red Member
imestone

ict

f strata

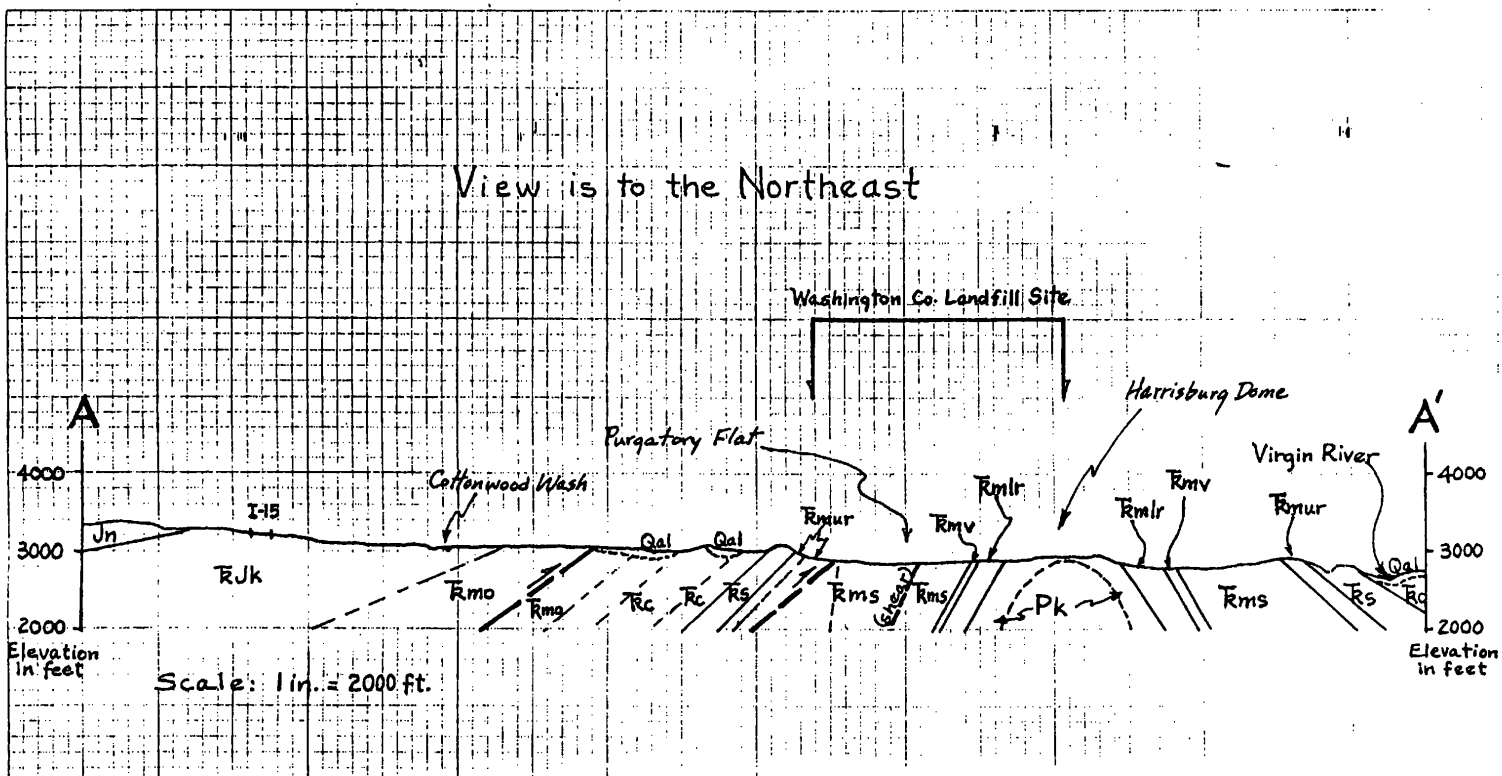
f joints

; teeth on upper plate

location, A - A'

location

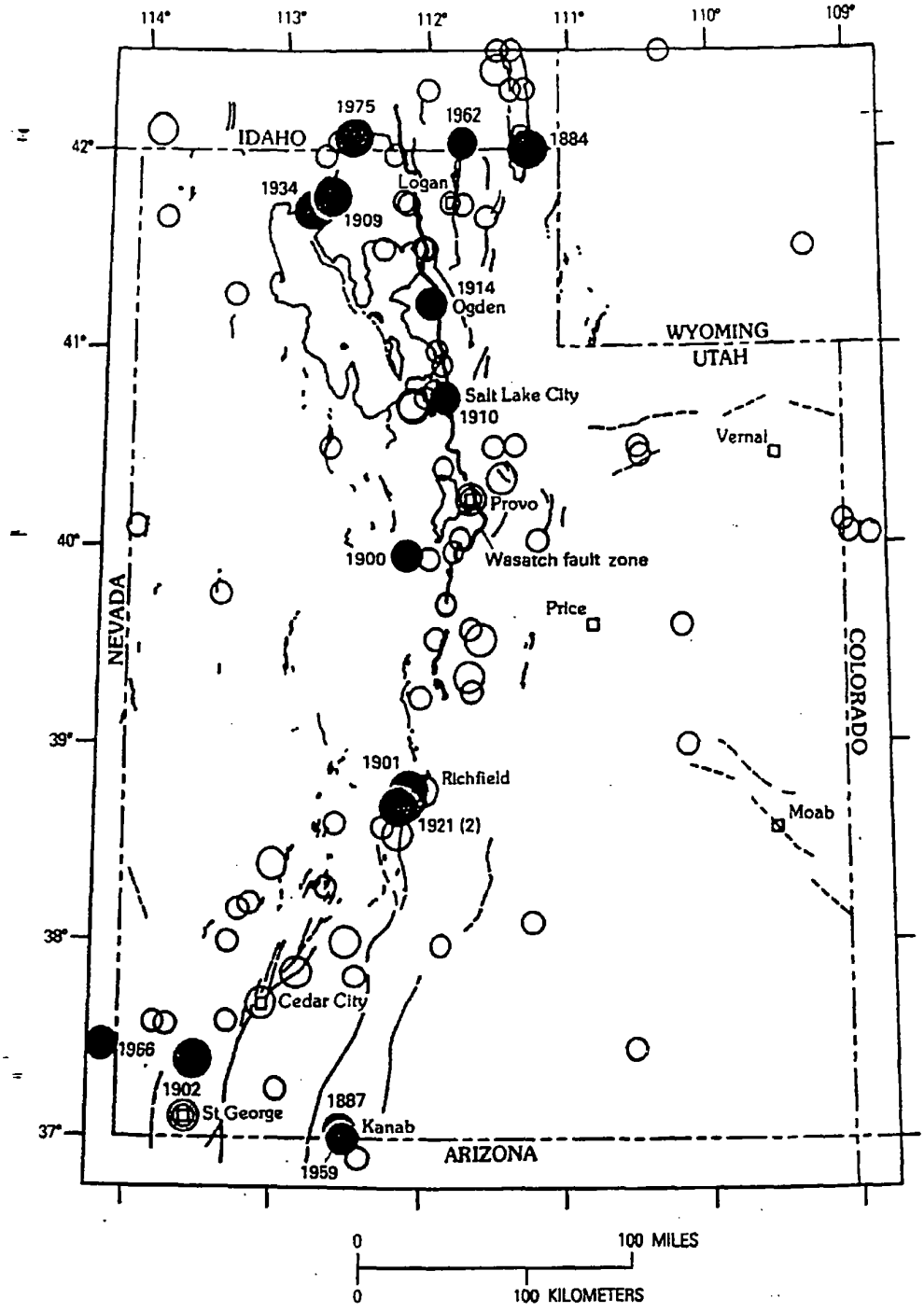
BY THE UNITED STATES GEOLOGICAL SURVEY
USGS, NOS/NOAA
AERIAL PHOTOGRAPHS TAKEN 1978



GEOLOGIC SECTION THROUGH WASHINGTON COUNTY LANDFILL SITE

(See attached geologic map for location, position of landfill, and geologic symbols)

S. Bryce Montgomery, Geologist 1993



–Epicenters of all independent main shocks of M_L 4.0 or greater (or Modified Mercalli intensity V or greater) in the Utah region, 1850–1986, and Quaternary faults. Earthquakes of estimated M_L 5.5 or greater are indicated by solid circles, labeled with date. Data from University of Utah Seismograph Stations.

from- Arabasz, W. J. and others, 1992

Modified Mercalli Intensity Scale, Horizontal Acceleration,

and Richter Magnitude Scale Relationships

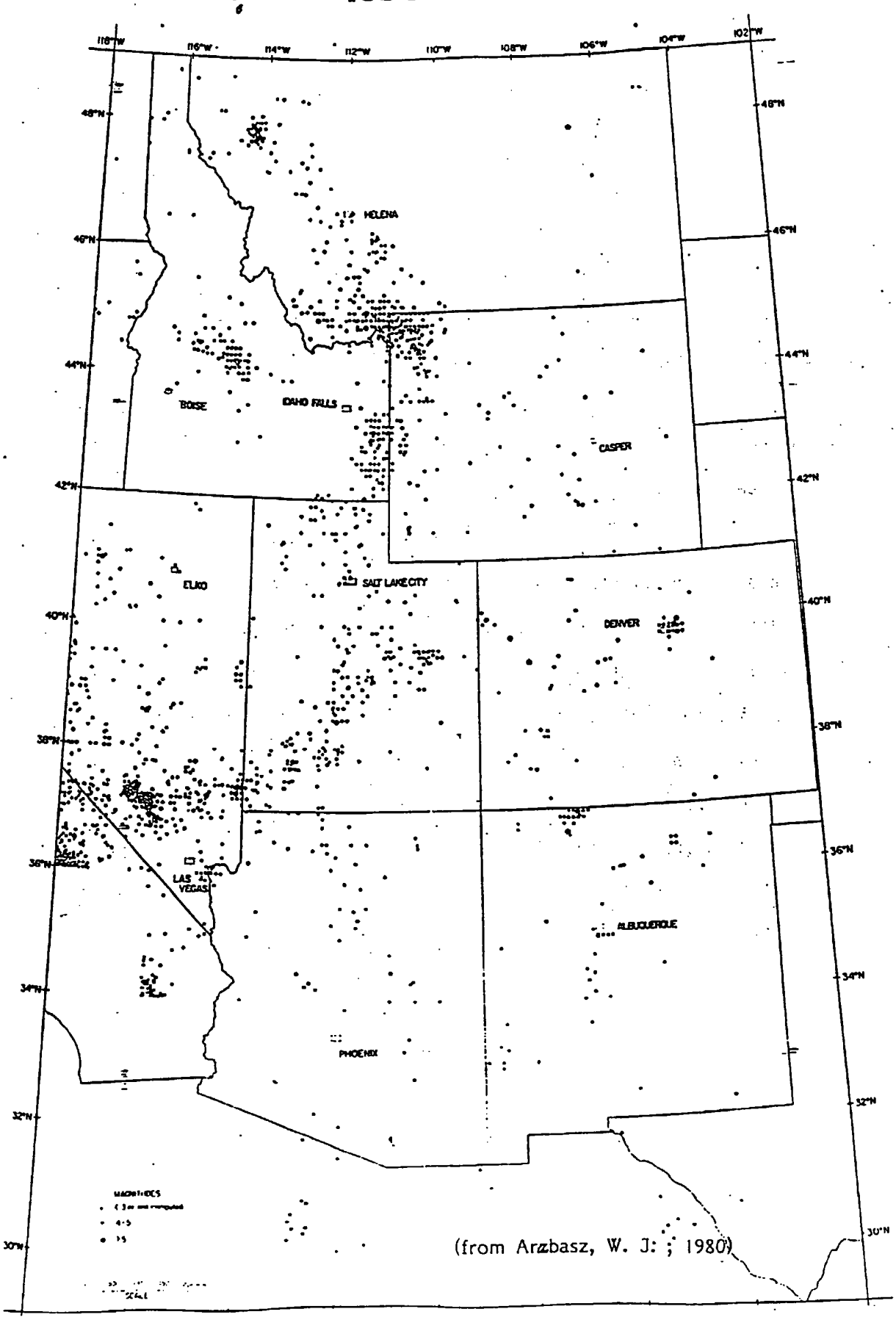
from- Adair, J. W., etal (1975)

Modified Mercalli Intensity Scale (1931, Wood and Neumann)	Horizontal Acceleration ($g=32ft/sec^2$)	Magnitude (Richter Scale)	Approx. Dist. Felt (miles)
I. Detected only by sensitive instruments.		2	
II. Felt by few persons at rest, especially on upper floors; delicately suspended objects may swing			15
III. Felt noticeably indoors, but not always recognized as earthquake; standing autos rock slightly; vibration like passing truck	0.01g	3	
IV. Felt indoors by many, outdoors by few; at night some awaken; dishes, windows, doors disturbed; motor cars rock noticeably		4	30
V. Felt by most people, some breakage of dishes, windows, and plaster; disturbance of tall objects.			
VI. Felt by all; many frightened and run outdoors; falling plaster and chimneys; damage small	0.05g	5	70
VII. Everybody runs outdoors; damage to buildings varied depending on quality of construction; noticed by drivers of automobiles.	0.1g		125
VIII. Panel walls thrown out of frames; fall of walls, monuments, chimneys; sand and mud ejected; drivers of autos disturbed		6	
IX. Buildings shifted off foundations, cracked, thrown out of plumb; ground cracked; underground pipes broken.	0.2g		250
X. Most masonry and frame structures destroyed; ground cracked; rails bent; landslides.	0.5g	7	
XI. Few structures remain standing, bridges destroyed; fissures in ground;pipes broken, landslides, rails bent.		8	450
XII. Damage total, waves seen on ground surface, lines of sight and level distorted, objects thrown up into air.	1.0g		

Note: The correlations shown above are for illustration only, as they are not based on statistical data, and do not include other important considerations.

INTERMOUNTAIN SEISMIC BELT

~1850-1974

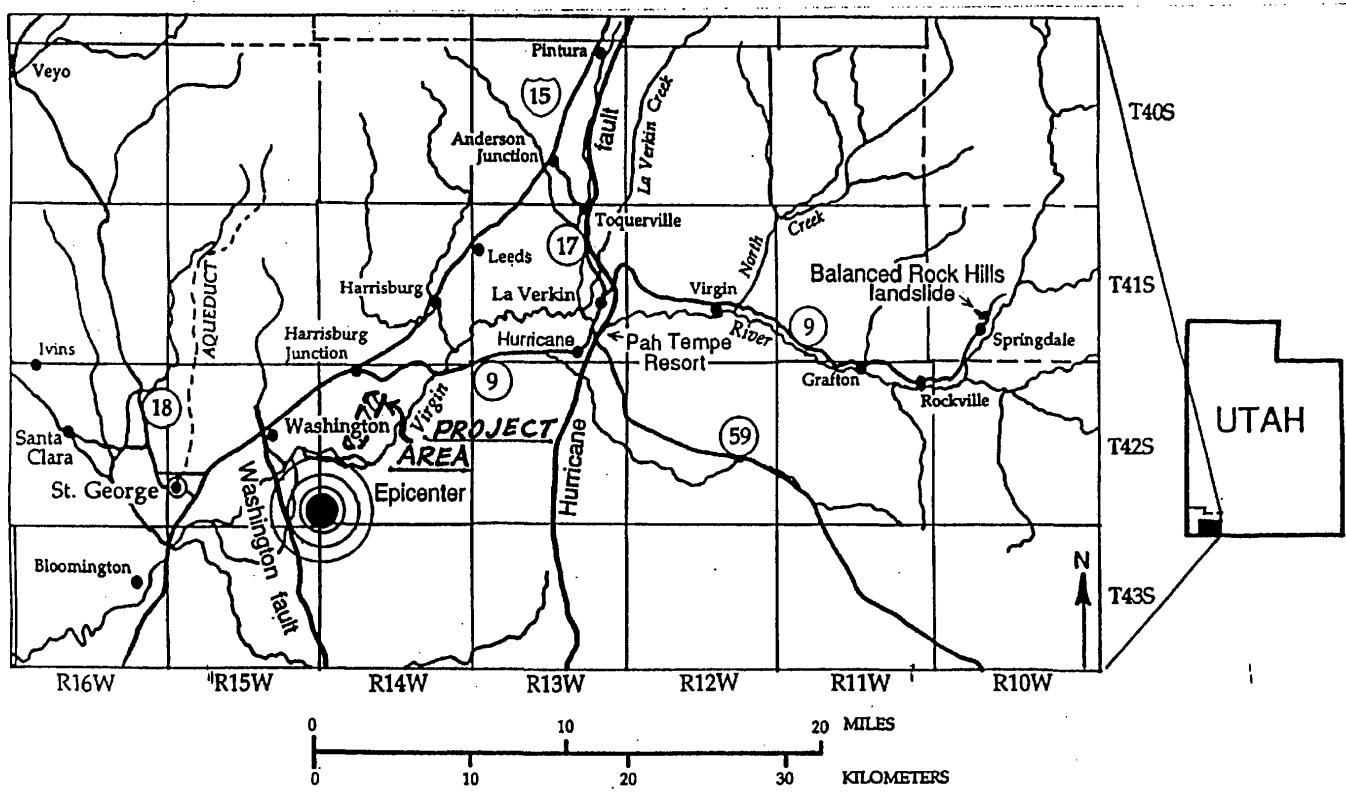


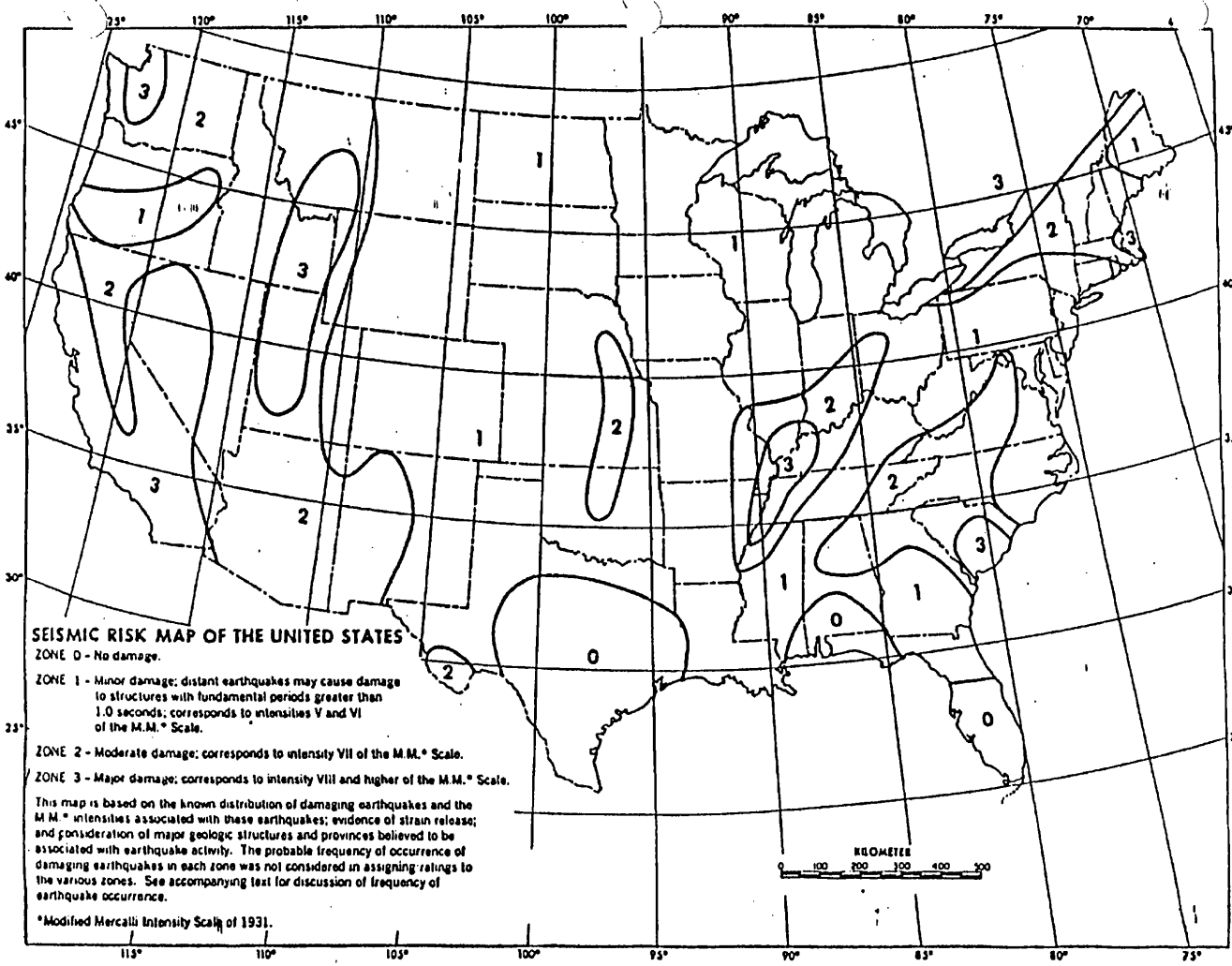
(from Arabasz, W. J: ; 1980)

LOCATION MAP OF M 5.8 ST. GEORGE EARTHQUAKE, SEPTEMBER 2, 1992

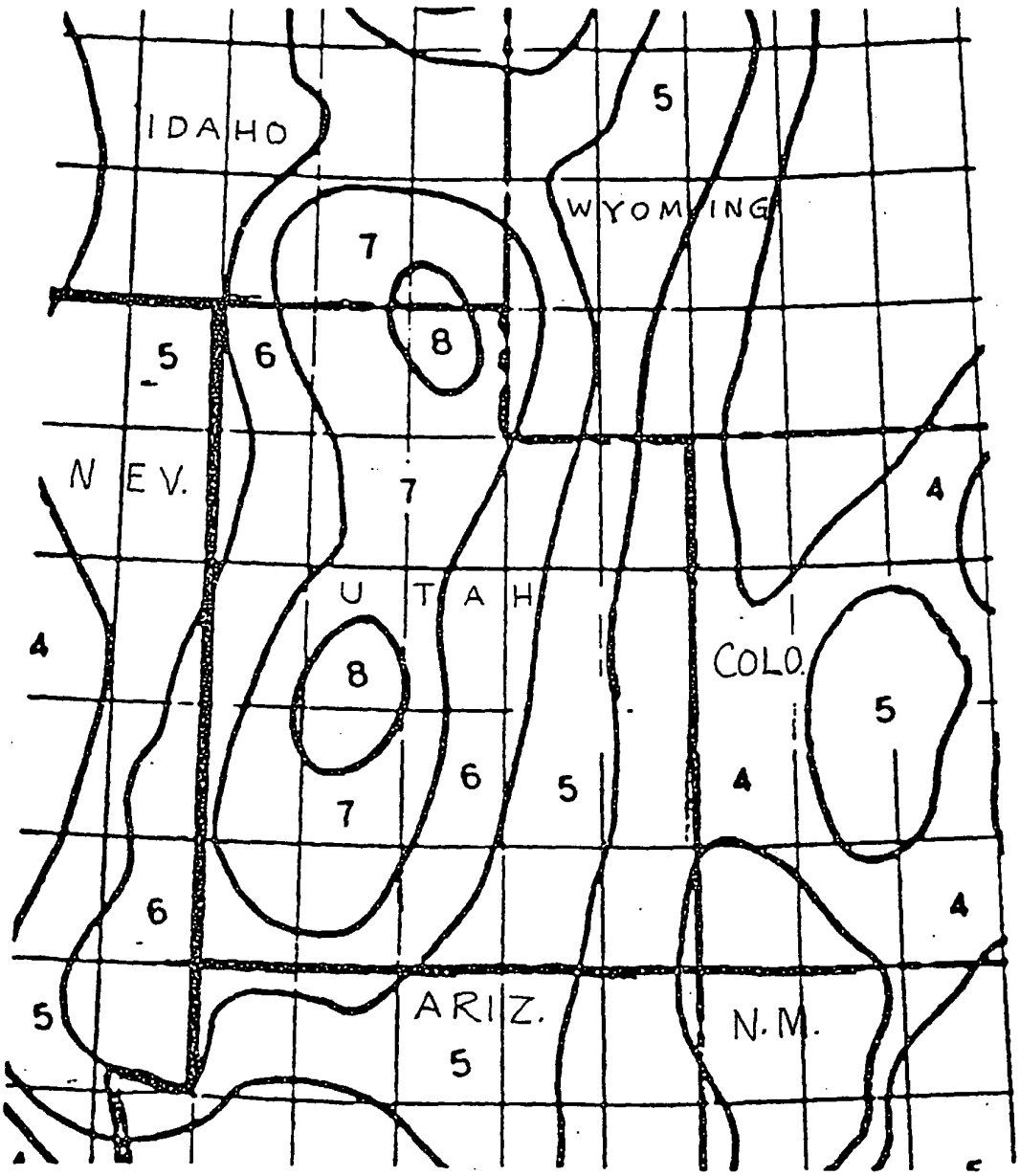
relative to Washington County Landfill Site

base map from Black, B. D. and Christensen, G. E., 1993



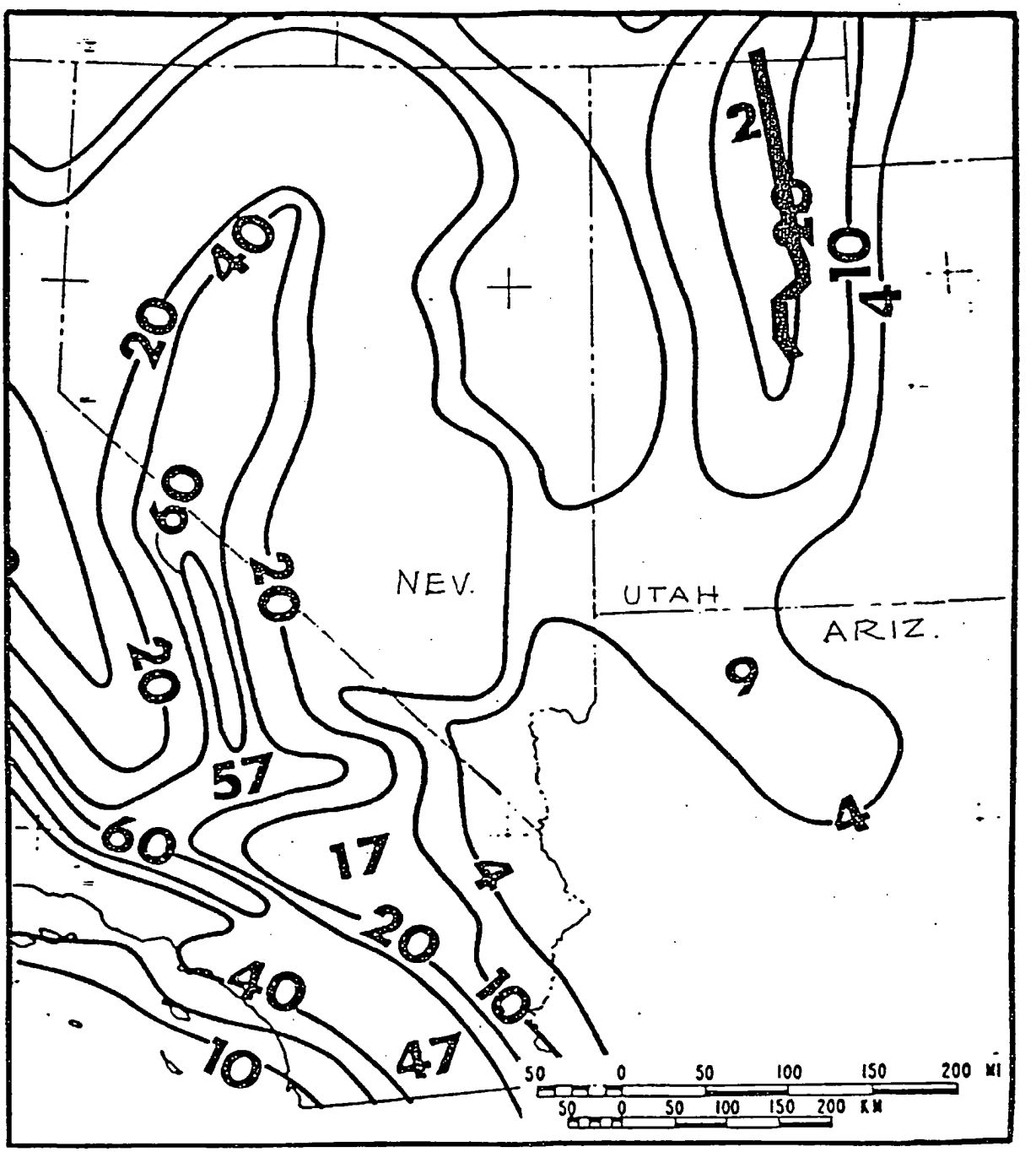


Algermissen, 1969



Probabilistic intensity hazard map, 100 year return period, 99 percent extreme probability (after Liu and de Capua, 1975).

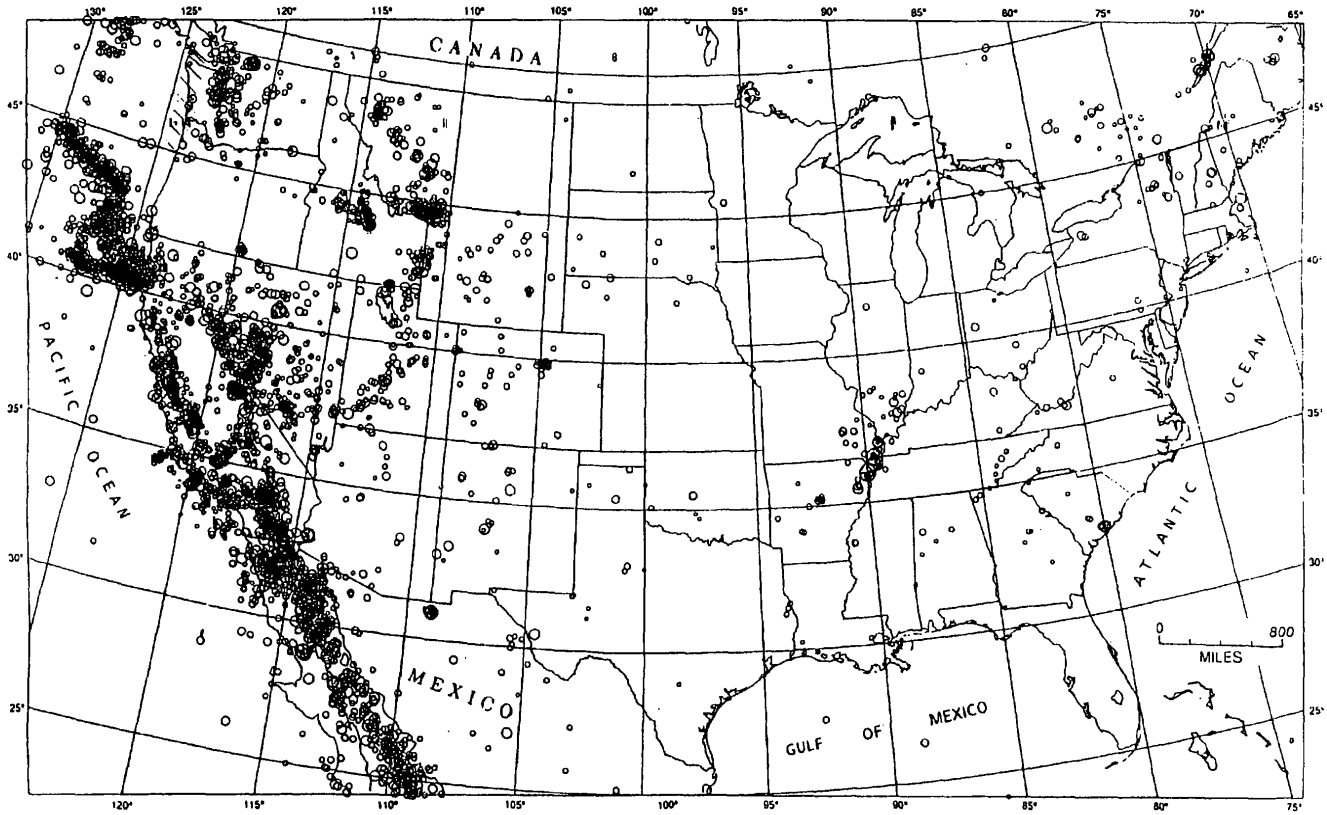
from- Algermissen, S. T. (1980)



-Acceleration in rock (percent of g) for an exposure time of 50 years at the 90 percent probability level (after Algermissen and Perkins, 1976).

from- Algermissen, S. T. (1980)

EARTHQUAKES OCCUR THROUGHOUT THE UNITED STATES.



Although earthquakes are most common in California and Alaska, they have shaken all States. Earthquakes as large or larger than the Loma Prieta event (red dots) have occurred in Alaska, California, Hawaii, Idaho, Missouri/Tennessee, Montana, Nevada, South Carolina, Washington, and in Quebec, just northwest of Maine; also, prehistorical evidence (red pattern) indicates that events of this size have occurred in Oregon, Washington, and Utah. This map shows the locations of all historical earthquakes of magnitude 5.5 or larger (largest circles), all earthquakes of magnitude 5 to 5.4 since 1925 (smaller circles), all recorded earthquakes of magnitude 4 to 4.9 since 1962 (still smaller circles), and all recorded earthquakes of magnitude 3.5 to 3.9 since 1975 (smallest circles). Clearly, earthquakes are a nationwide problem.

This U.S. Geological Survey pamphlet was written by Peter L. Ward and Robert A. Page and edited by Laurie D. Hodgen and Jeffrey A. Troll. Graphics by T.R. Alpha, R.D. Borcherdt, L.E. Buchholz, M.E. Coveau, L.D. Dietz, E.R. Engdahl, Tim Hitchcock, J.C. Lahr, F.W. Lester, S.E. Mayfield, M.J. Rymer, D. Tsoi, and J.F. Vigil.

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from- Ward, P. L., and others, 1990, U. S. Geological Survey

7-1337
(1-55)
BUREAU OF RECLAMATION

GEOLOGIC LOG OF DRILL HOLE

FEATURE Purgatory Dike Virgin River Dunsite PROJECT Dixie STATE Utah

HOLE NO. DH-1P LOCATION (C-42-14) 3cad GROUND ELEVATION 287.8 ANGLE FROM VERTICAL None

COORDINATES N. 185,144.3; E. 1,442,329.7 TOTAL

BEGUN 1/19/66 FINISHED 1/24/66 DEPTH OF OVERBURDEN 8.3 DEPTH 102.9 BEARING OF ANGLE HOLE None

DEPTH OR ELEV. OF WATER TABLE See Note Below HOLE LOGGED BY C. Swapp FOREMAN O. Hopkin

NOTES
On water table levels, water return, character of drilling etc.

Drilling Equipment
Joy Rotary Model 22

Drilling Fluid
Water: 0.0 to 102.9

Casing
4" casing set at 21 feet but not cemented.

100% water return from 0-102.9.

Water level at 12.9 after standing overnight with a hole depth of 34.9.

Water level at 33.0 feet after standing overnight with the hole at a depth of 72.7 feet.

Hole caved before the water table could be established.

TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS: DEPTH (FT) FROM (P, Cs or Cm)	DEPTH (FT) TO	LOSS IN (G.P.M.)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	ELEVATION	DEPTH	LOG / SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
RB 5 5/8"		Bedrock at 8.3 feet in Middle Red member of the Moenkopi formation.					287.5	8.3		0-8.3 Alluvium; silt, sand, and clay.
D NX	0							10		
RB 5 5/8"										8.3-21.1 Shale; reddish brown with some gray streaks. Generally weathered and soft with clay streaks. Formation too soft for core recovery. Gypsiferous with selenite crystals comprising over 25% of sample. Very slightly calcareous.
D NX	100	P 24.9	34.9	0 0	15 25	5 5	265.7	21.1		
	62							30		21.1-50.0 Shale; reddish brown. Contains some interbedded silt and claystone. Gypsum beds 1/8 to 1/4 inch thick comprise 5 to 20% of the core. Strata dipping about 28°. Recovered core generally soft and breaks easily by hand. Pieces range from 1/2 to 6 inches in length.
		P 34.0	44.0	0 0	15 25	5 5		40		
	100	P 43.0	53.0	0 0	15 25	5 5	237.8	50		50.0-55.0 Claystone; reddish brown. Silty and slightly gypsiferous with most gypsum being bedded. Core breaks easily by hand. Core recovered as pieces 1/2 to 6 inches in length. Core crumbles as it dries on exposure to air.
		P 52.7	62.7	0 0	15 25	5 5	232.8	55.0		
	95	F 62.7	72.7	0 0	15 25	10 10		60		55.0-102.9 Shale; reddish brown with gray from 58.0 to 63.0 feet. This interval is gradational with some zones being silty and clayey. Gypsum beds (selenite) 1/16 to 1/4 inch thick comprise 5 to 25% of core. Some high angle fracturing from 64.0 to 65.0 feet. All fractures are well healed with gypsum. Zone from 97.5 to 98.5 feet contains irregular shaped inclusions of alabaster gypsum ranging in size from pinpoint up to 1/2 inch in diameter. Core recovered as pieces 1/2 to 6 inches long and can be broken by hand or with a light hammer tap.
	99	P 72.9	82.9	0 0	15 25	10 10		70		
		P 82.9	92.9	0 0	15 25	10 10		80		
	100	P 92.9	102.9	0 0	15 25	10 10		90		
		Bottom of hole					184.9	102.9		

RB = Rock roller bit

CORE LOSS
CORE RECOVERY

ANGLE HOLE ☐
VERTICAL HOLE ⊡

Type of hole ... D=Diamond, H=Hydrostellite, S=Shot, C=Churn
Hole sealed ... P=Packer, Cm=Cemented, Cs=Bottom of casing
Approximate size of hole (X-series) Ex = 1 1/2", Ax = 1 7/8", Bx = 2 3/8", Nx = 3"
Approximate size of core (X-series) Ex = 1", Ax = 1 1/8", Bx = 1 5/8", Nx = 2 1/8"
Outside diameter of casing (X-series) Ex = 1 15/16", Ax = 2 3/16", Bx = 2 7/8", Nx = 3 1/2"
Inside diameter of casing (X-series) Ex = 1 1/2", Ax = 1 7/8", Bx = 2 3/8", Nx = 3"

HOLE NO. DH-1P

7-1337
(1-55)
BUREAU OF RECLAMATION

GEOLOGIC LOG OF DRILL HOLE

Virgin River Impsite

FEATURE Purgatory Dike PROJECT Dixie STATE Utah

HOLE NO. DH-2P LOCATION (C-42-14) 3dcb GROUND ELEVATION 2902.1 ANGLE FROM VERTICAL None

COORDINATES N. 184,521.7; E. 1,443,208.9 TOTAL DEPTH 203.5 BEARING OF ANGLE HOLE None

BEGUN 2/24/66 FINISHED 3/3/66 DEPTH OF OVERBURDEN 3.0 HOLE LOGGED BY C. Swapp FOREMAN O. Hopkin

DEPTH OR ELEV. OF WATER TABLE See Notes Below

NOTES
On water table levels, water return, character of drilling etc.

Drilling Equipment
Joy Rotary Model 22

Drilling Medium
Water: 0.0 to 203.5 feet

Casing
Set 10.0 feet of 4" while drilling and removed on completion.

About 90% water return during drilling from 0 to total depth. (Drilling day shift only.)

Water Table Data

Date	CS Depth At start of shift	Hole Depth	Depth to Water
2-28-66	10.0	74.2	68.0
3- 1-66	10.0	103.2	60.5
3- 2-66	10.0	134.2	63.8 (over weekend)
3- 3-66	10.0	173.8	60.7
3-16-66	0.0	203.5	68.4
3-17-66	0.0	203.5	68.6

TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS: DEPTH (FT.) FROM (P, Cs or Cm)	TO	LOSS IN (G.P.M.)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)
RB 7 7/8		Bedrock at 3.0 feet in Shnabkaib member of Moenkopi formation.				
D HX	38					
	100					
	98	P 12.6	22.6	6 11	15 25	10 10
		P 22.6	32.6	0 0	15 25	10 10
		P 31.6	41.6	0 0	15 25	10 10
	100	P 39.2	54.2	0 0	15 25	10 10
		P 54.2	64.2	0 0	15 25	10 10
		P 64.2	74.2	0 0	15 25	10 10
		P 73.2	84.2	0 0	15 25	10 10
	98	P 82.3	93.3	0 0	15 25	10 10
	98	P 92.2	103.2	0 0	15 25	10 10
	100					

ELEVATION	DEPTH
2899.1	3.0
2879.5	22.6
2876.1	26.0
2874.9	27.8
2873.7	28.8
2819.3	82.8
2817.3	84.8

LOG — SAMPLES FOR TESTING

CLASSIFICATION AND PHYSICAL CONDITION

0.0-3.0 Alluvium; silty, gypsiferous, gray weathered Shnabkaib surface zone.

3.0-22.6 Siltstone; medium gray. Contains gypsum in the form of disseminated crystals, veinlets, fracture fillings and lenses up to 1/4 inch thick. Fractures occur at random angles and are well healed with gypsum from 17.0 to 18.0. The interval from 6.0 to 10.5 feet was recovered in shattered pieces from 1/4 to 3.0 inches in diameter. The zone from 10.0 to 11.0 feet is slightly fissile. The core is weak to moderately strong and is recovered in pieces 1/4 inch to 8.0 inches long. It has medium density.

22.6-26.0 Claystone; light green to medium gray and silty. Beds of satin spar gypsum, 1/8 to 1/4 inch thick parallel the bedding. (Average about 1 zone per foot interval) This zone very weak and can be broken easily by hand. Pieces as recovered are 1/2 to 4.0 inches long. Density is medium to high.

26.0-27.2 Siltstone; medium gray and thin bedded. Bands of gypsum 1/16 to 1/2 inch thick lie parallel to bedding and comprise 5 to 15% of interval. Some minor fracturing at random angles but all well healed with gypsum. Core moderately strong and has medium density. May be broken by hand or with light hammer tap.

27.2-28.4 Gypsum; medium gray with irregular shaped inclusions of siltstone. Core weak to moderately strong and has medium density. May be broken with light to medium hammer tap. Recovered pieces 1.0 to 8.0 inches long.

28.4-82.8 Siltstone; medium to light gray with some zones having a brown or light green cast. Intervals up to 10.0 inches thick grade into a clayey siltstone with some being slightly fissile. Gypsum occurs disseminated and as irregular lenses and beds up to 1.0 inch thick. Percentage of gypsum in core is about 5-20%. Core is generally weak to moderately strong and can be broken by hand or with light to medium hammer tap. The zone has medium density and some minor fracturing at random angles. All fractures are well healed with gypsum. Core recovered in pieces averaging 2.0 to 6.0 inches long.

82.8-84.8 Gypsum; light gray to white with irregular shaped inclusions of siltstone. Core has medium density and is moderately strong. May be broken with medium hammer tap. Recovered pieces 2.0 to 12.0 inches long.

CORE LOSS
CORE RECOVERY

EXPLANATION RB = Rock roller bit

Type of hole ..... D = Diamond, H = Hayslellite, S = Shot, C = Churn

Hole sealed ..... P = Packer, Cm = Cemented, Cs = Bottom of casing

Approximate size of hole (X-series) ..... Ex = 1 1/2", Ax = 1 7/8", Bx = 2 3/8", Nx = 3"

Approximate size of core (X-series) ..... Ex = 7/8", Ax = 1 1/8", Bx = 1 5/8", Nx = 2 1/8"

Outside diameter of casing (X-series) ..... Ex = 1 13/16", Ax = 2 1/4", Bx = 2 7/8", Nx = 3 1/2"

Inside diameter of casing (X-series) ..... Ex = 1 1/2", Ax = 1 15/16", Bx = 2 3/8", Nx = 3"

ANGLE HOLE ☐
VERTICAL HOLE ☒

7-1337
(1-55)
BUREAU OF RECLAMATION

Virgin River Dunsite

GEOLOGIC LOG OF DRILL HOLE

FEATURE Purgatory Dike PROJECT Dixie STATE Utah

HOLE NO. DH-2P LOCATION (C-42-14) 34cb GROUND ELEVATION 2902.1 ANGLE FROM VERTICAL None

COORDINATES N. 184,521.7; E. 1,443,204.9 TOTAL DEPTH 203.5 BEARING OF ANGLE HOLE None

BEGUN 2/24/66 FINISHED 3/3/66 DEPTH OF OVERBURDEN 3.0 FOREMAN O. Hopkin

DEPTH OR ELEV. OF WATER TABLE See Notes Below HOLE LOGGED BY C. Bragg

NOTES
On water table levels, water return, character of drilling etc.

After completing hole at a total depth of 203.5 on 3/3/66, water level was bailed down from 60.3 to 90.0 feet from surface.

3/4/66
After standing overnight the water level had raised from 90.0 to 68.2 feet (probably due to drilling water returning from formation.)

Bailed water level on down to 199.0 feet from surface on 3/4/66.

Pulled the 10.0 feet of 4" casing and installed 204.0 feet of 1-1/4" observation pipe with bottom 42.0 feet perforated.

TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS: DEPTH (FT.) FROM (P, Cs or Cm)	TO	LOSS IN (G.P.M.)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	ELEVATION	DEPTH	LOG
Rx	100								
	98	P 102.2	113.2	0 0	15 25	10 10		110	
		P 113.2	124.2	0 0	15 25	10 10		120	
		P 124.2	134.2	0 0	15 25	10 10	2767.7	130 134	
		P 134.2	144.2	0 0	15 25	10 10	2765.2	136 140	
		P 144.0	154.0	0 0	15 25	10 10	2765.0 2754.3	147 147 150	
	100	P 154.0	164.0	0 0	15 25	10 10		160	
		P 163.8	173.8	0 0	15 25	10 10		170	
		P 173.7	183.7	0 0	15 25	10 10		180	
		P 183.7	193.7	0 0	15 25	10 10	2715.1	187 190	
		Transitional top of Middle Red member of Moenkopi at 187.0 feet.							
		P 193.5	203.5	0 0	15 25	10 10			
		Bottom of hole					2698.6	203.5	

SAMPLES FOR TESTING

CLASSIFICATION AND PHYSICAL CONDITION

84.8-134.4 Siltstone; medium to light gray. Some zones (2.0-12.0 inches thick) are slightly clayey and fissile. Gypsum as satin spar occurs in lenses, veinlets, and beds up to 1/2 inch thick. Gypsum content of core about 5 to 20 percent. Some light shows of sulfur associated with gypsum. Core is weak to moderately strong and has medium density. Fractures at random angles averaging 2 to 3 per foot interval. These are all well healed with gypsum. Recovered core pieces average 2.0 to 6.0 inches long.

134.4-136.9 Gypsum; light gray to white. Generally a granular medium to low density variety. Core breaks by hand or with light hammer tap. Recovered in pieces 1/2 to 5.0 inches long.

136.9-147.1 Siltstone; light to medium gray. Gypsum present as lenses, bedded and as fracture fillings in thicknesses up to 1.0 inch. Some disseminated crystals. Total gypsum percent not over 15 percent. The fracturing is very limited and all well healed with gypsum. The zone from 146.6 to 147.1 has a mottled breccia appearance but has medium density with no unhealed fractures. Core is moderately strong and may be broken with light hammer tap. Recovered pieces are 1/2 to 6.0 inches in length.

147.1-147.8 Gypsum; medium gray to white with irregular-shaped inclusions of siltstone. The gypsum is generally silty. The interval has medium density and is moderately strong.

147.8-203.5 Siltstone; generally light to medium gray down to about 187.0 feet. From this point to the bottom, there is considerable brown and tan coloring with some gray zones interbedded. Gypsum occurs as beds, lenses, fracture fillings, and is disseminated. The fractures occur at random angles and average about two per foot interval. All are well healed with gypsum. The core is recovered in pieces 1/2 inch to 1.5 feet long. The entire interval has medium density with the core being weak to moderately strong. Core requires light to medium hammer tap to break.

CORE LOSS
CORE RECOVERY

RB = Rock roller bit

Type of hole ..... D=Diamond, H=Haystellite, S=Shot, C=Churn

Hole sealed ..... P=Packer, Cm=Cemented, Cs=Bottom of casing

Approximate size of hole (X-series) ..... Ex = 1 1/2", Ax = 1 7/8", Bx = 2 3/8", Nx = 3"

Approximate size of core (X-series) ..... Ex = 7/8", Ax = 1 1/8", Bx = 1 5/8", Nx = 2 1/8"

Outside diameter of casing (X-series) ..... Ex = 1 13/16", Ax = 2 1/4", Bx = 2 7/8", Nx = 3 1/2"

Inside diameter of casing (X-series) ..... Ex = 1 1/2", Ax = 1 29/32", Bx = 2 3/8", Nx = 3"

ANGLE HOLE ☐
VERTICAL HOLE ☒

7-1337
(1-55)
BUREAU OF RECLAMATION

Virgin River Damsite **GEOLOGIC LOG OF DRILL HOLE**

FEATURE Purgatory Dike PROJECT Dixie STATE Utah

HOLE NO. DH-3P LOCATION (C-42-14) 3ca GROUND ELEVATION 2901.0 ANGLE FROM VERTICAL None

COORDINATES N. 185,548.0; E. 1,441,388.6 TOTAL

BEGUN 3/7/66 FINISHED 3/14/66 DEPTH OF OVERBURDEN 3.5 DEPTH 152.8 BEARING OF ANGLE HOLE None.

DEPTH OR ELEV. OF WATER TABLE See Notes Below HOLE LOGGED BY C. Svapp FOREMAN O. Hopkin

NOTES On water table levels, water return, character of drilling etc.

Drilling Equipment
Joy Rotary Model 22

Drilling Medium:
Water: 0.0 to 152.8

Casing
Set 3.5 feet of 4" loose in top of hole.

About 95-100% water return during drilling from 0 to total depth. (Drilling day shift only)

Water Table Data	CS Depth	Hole Depth	Depth Water
Date	start of shift		
3-8-66	3.5	24.5	9.4
3-9-66	3.5	64.5	40.7
3-10-66	3.5	104.2	35.6
3-14-66	3.5	133.2	41.5
3-17-66	3.5	152.8	139.2

Upon completion of hole on 3/14/66, the water was bailed down to 148.0-foot depth.

TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS DEPTH (FT.) FROM (P, Cs or Cm)	TO	LOSS IN (G.P.M.)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	ELEVATION	DEPTH	LOG	SAMPLES FOR TESTING
RB 5 7/8"		Bedrock at 3.5 feet in Middle Red member of Moenkopi formation.					2897.5	3.5		
D NX	0									
	64									
	98	P 9.5	24.5	0 0	15 25	10 10	2886.5	14.5		
	100	P 23.6	33.6	0 0	15 25	10 10				
		P 33.6	43.6	0 0	15 25	10 10	2858.7	42.3		
	97	P 43.6	53.6	0 0	15 25	10 10	2855.5	45.5		
		P 52.5	64.5	0 0	15 25	10 10				
	100	P 64.3	47.3	0 0	15 25	5 5	2834.2	66.8		
		P 74.3	84.3	0 0	15 25	5 5	2827.0	74.0		
		P 84.2	94.2	0 0	15 25	5 5				
		P 94.2	104.2	0 0	15 25	5 5				

0-3.5 Alluvium; silt and fine-grained sand with some weathered gypsum. No sample taken.

3.5-14.5 Alluvium; weathered gypsiferous siltstone and claystone. Core generally very soft and can be broken or crumbled by hand.

14.5-42.3 Siltstone; medium gray to brown or red. Contains gypsum as disseminated crystals and as thin (up to 1/4 inch thick) beds and fracture fillings. Core is generally argillaceous with some clay zones up to 8.0 inches thick. Fractures are at random angles (average 2 to 3 per 1 foot interval) and are all well healed with gypsum. Core is weak and friable. Bedding in core dipping at 55° from horizontal.

42.3-45.5 Shale; medium gray with some brown. Contains beds and stringers of gypsum up to 1/2 inch thick. Gypsum comprises 5-10% of core. Core is weak to moderately strong and can be broken by hand or with light hammer tap. Recovered pieces 1.0 to 8.0 inches long.

45.5-66.8 Siltstone; dark brown to red. Contains satin spar gypsum as beds and stringers up to 1/2 inch thick. Gypsum comprises about 5-10% of core. Core is weak to moderately strong and has medium density. Recovered pieces are from 1.0 to 12.0 inches long.

66.8-74.0 Claystone; medium gray and silty. Slightly fissile or shaley. Core is weak and may be broken by hand. Breaks up on loss of moisture. Highly fractured at random angles but fractures fit tight together and are well healed. Recovered pieces are 1/2 to 6.0 inches in length.

EXPLANATION RB = Rock roller bit

Type of hole ..... D = Diamond, H = Hoystellite, S = Shot, C = Churn

Hole sealed ..... P = Packer, Cm = Cemented, Cs = Bottom of casing

Approximate size of hole (X-series) ..... Ex = 1 1/2", Ax = 1 7/8", Bx = 2 3/8", Nx = 3"

Approximate size of core (X-series) ..... Ex = 1 5/8", Ax = 1 1/8", Bx = 1 5/8", Nx = 2 1/8"

Outside diameter of casing (X-series) ..... Ex = 1 13/16", Ax = 2 1/2", Bx = 2 7/8", Nx = 3 1/2"

Inside diameter of casing (X-series) ..... Ex = 1 1/2", Ax = 1 57/64", Bx = 2 3/8", Nx = 3"

CORE LOSS

CORE RECOVERY

ANGLE HOLE ☐

VERTICAL HOLE ☒

7-1337
(1-55)
BUREAU OF RECLAMATION

GEOLOGIC LOG OF DRILL HOLE

FEATURE Virgin River Damsite Purgatory Dike PROJECT Dixie STATE Utah
HOLE NO. DH-3P LOCATION (C-42-14) 3ca GROUND ELEVATION 2901.0 ANGLE FROM VERTICAL None
COORDINATES N. 185,548.0; E. 1,441,588.6 TOTAL
BEGUN 3/7/66 FINISHED 3/14/66 DEPTH OF OVERBURDEN 3.5 DEPTH 152.8 BEARING OF ANGLE HOLE None
DEPTH OR ELEV. OF WATER TABLE See Notes Below HOLE LOGGED BY C. Swapp FOREMAN Q. Hopkin

NOTES On water table levels, water return, character of drilling etc.	TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS: DEPTH (FT.) FROM (P, Cs or Cm)	DEPTH (FT.) TO	LOSS IN (G.P.M.)	PRESSURE (P.S.I.)	LENGTH OF TEST (min)	ELEVATION	DEPTH	LOG: SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
	D NX										
			P 104.2	114.2	0	15	5				
					0	25	5				
		100	P 114.2	124.2	0	15	5				
					0	25	5				
			P 123.2	133.2	0	15	5				
					0	25	5				
		99	P 132.4	143.4	0	15	10				
					0	25	10				
		100	P 142.8	152.8	0	15	10				
					0	25	10				
			Bottom of hole					2748.2	152.8		

74.0-152.8 Siltstone; dark brown to red with gray streaks up to 1.0 inch thick. Slightly clayey with some zones 6.0 inches to 3.0 feet thick being fissile. Stringers of satin spar gypsum up to 1.0 inch thick and running at random angles make up 5 to 15% of the core. Bedding planes dipping about 50° from horizontal. Fractures averaging 1 to 2 per 1.0 foot interval are at random angles and all wall healed with gypsum. Core weak to moderately strong and has medium to high density. Recovered pieces are 1.0 to 12.0 inches long.

CORE LOSS
CORE RECOVERY

EXPLANATION RB = Rock roller bit

Type of hole	D = Diamond, H = Hayesteliite, S = Shot, C = Churn
Hole sealed	P = Packer, Cm = Cemented, Cs = Bottom of casing
Approximate size of hole (X-series)	Ex = 1 1/2", Ax = 1 7/8", Bx = 2 3/8", Nx = 3"
Approximate size of core (X-series)	Ex = 7/8", Ax = 1 1/8", Bx = 1 5/8", Nx = 2 1/8"
Outside diameter of casing (X-series)	Ex = 1 13/16", Ax = 2 1/4", Bx = 2 7/8", Nx = 3 1/2"
Inside diameter of casing (X-series)	Ex = 1 1/2", Ax = 1 29/32", Bx = 2 3/8", Nx = 3"

ANGLE HOLE
VERTICAL HOLE

January 10, 1994

Mr. Steven E. Layton
Mr. Reed Noble
Creamer & Noble Engineers
P. O. Box 37
St. George, Utah 84771

RE: Washington County Landfill hydrogeologic evaluation, your letter of December 29, 1993.

Gentlemen:

As per our previous conversations, my study-report of August 23, 1993, subsequent test drilling results, and your letter of December 29, 1993, regarding the Washington County landfill site, I submit the following.

Attached to this letter is a copy of a hydrogeologic map which I have prepared on the base of your prepared topographic map of the site, upon which are shown the locations of the test wells (drill holes abbreviated DH) and their data. Also, attached are the driller's records of the five subsequent test wells drilled along with copies of the chemical analysis of ground water from test wells Nos. 1 and 4.

As I had concluded in my previous report, the test drilling has shown that there are no potable aquifers underlying the existing and projected landfill site. Test wells Nos. 2, 3 and 5 located directly under the projected landfill extension were dry to total depths of 200 feet. However, test wells Nos. 1 and 4 located at the very south and southeast end of the existing landfill unit did encounter small yields of ground water with high total dissolved mineral contents of 12,000 mg/l and 4,000 mg/l respectively.

In test well No. 4, the encountered ground water is most probably originating from spillage into a southwesterly trending fracture system within the underlying bedrock of the Middle Red Member siltstone-shale of the Moenkopi Formation, from the steeply dipping (54-60 degrees NW), well jointed Virgin Limestone Member of the Moenkopi Formation. This limestone unit is confined by silty-shaley beds to the northwest and southeast. As this ground water moves within and along the fracture system present in the limestone unit, it is also able to move at a much slower rate through the cross, diagonally fracture system that is present, into the silty Middle Red Sandstone Member and on into the shaley, gyppy, dolomitic siltstone of the Shnabkaib Member of the Moenkopi Formation. The Shnabkaib Member contains a much higher

content (near 10-20 percent) of gypsum and other salts such as magnesium sulfate, sodium sulfate, and sodium chloride, than the Middle Red or Virgin Limestone Members.

The Virgin Limestone Member is less than 100 feet thick and outcrops as a prominent, narrow hogsback or cockscomb along the east side of Purgatory Flat, in which the landfill site is located. Precipitation and runoff has been able to partially infiltrate the fractures and joints, along with upward tilted bedding planes of the limestone unit, allowing limited groundwater to be stored and slowly recharged over the historic past. Successively, this limited ground water of poor quality degrades further in quality as it moves slowly from the Virgin Limestone Member into the Middle Red and Shnabkaib Members.

The Purgatory or buff-yellow sandstone unit near the base of the silty, Upper Red Member of the Moenkopi Formation is also well jointed and fractured, and contains intergranular porosity and permeability, and thus is pervious, similar to the Virgin Limestone Member. This sandstone also outcrops upgradient to test well No. 1, as a prominent, narrow hogback (about 100 feet wide) within the southwest edge of the Purgatory Flat area of the landfill site, where it dips steeply northwestward 60-83 degrees. It is sheared-off by overthrust faulting, farther northward along the westward side of Purgatory Flat and the projected landfill area. It too acts as a thin aquifer similar to the Virgin Limestone, and is apparently, slowly spilling poor quality ground water into the adjacent Shnabkaib Member, by the same fracture trend, where its quality is rapidly degraded further. This is evidenced by the high total dissolved mineral solids content found in the ground water encountered in test well No. 1.

Thus, the intermittent surface drainage located adjacent to test well No. 4 and immediately east of test well No. 1, is apparently near the low gradient position of the shallow ground water encountered within the fracture system of these two drill holes. This small flow of ground water has historically moved slowly, down-gradient to the southwest towards the Virgin River, through the existing Moenkopi Formation bedrock, beneath any shallow, perched alluvial aquifer within the floodplain of the Virgin River valley, more than a mile away.

The encountered ground water of high mineral content in test wells Nos. 1 and 4 is from a very limited, small-yielding aquifer which is not useable for potable purposes, and does not supply recharge to an aquifer located down-gradient that is being or could be used for potable purposes. To maintain this natural, existing condition, it is my recommendation to avoid or minimize the introduction of water into the landfill site, so as to prevent the circulation and movement of it into the existing bedrock fracture system and upward-tilted bedding planes. This will prevent its dissolving of gypsum and other salts, without

xxx ECXX ENROUTE COLJCT - BARRY xxx

03 30 0641

GENERAL INQUIRY REPORT SENT FROM TCS SERVICE CENTER
GENERAL INQUIRY TYPE- DY REPETITIVE INQUIRY - 12919
RESPONSIBILITY AREA GRP UW813

CONSIGNEE	EQUIPMT-ID INT NUMBER	L E	CURRENT LOCATION					ETA DA	HR
YARD UW813 COLJCT	UT								
ECDC ENVIRONM	UPCX 96109	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96099	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96106	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96051	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96075	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96114	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96091	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96086	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96066	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96120	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96067	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96118	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96055	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96031	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96003	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96036	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96112	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96007	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	UPCX 96039	L	DP	MCHNP	29	CORTLAND	IL	03 30	0612 05 19
ECDC ENVIRONM	ECXX 96115	L	TA	LUH144	29	HELPER	UT	03 29	2000 30 18
ECDC ENVIRONM	UPCX 96027	L	TA	MESNP	27	NPLTWEST	NE	03 29	1347 03 19

SUB-TOT 00021 LOADS 00000 MTYS 00000 UNKNOWNS

TOTALS 00021 LOADS 00000 MTYS 00000 UNKNOWNS

THE ABOVE GENERAL INQUIRY REPORT IS FROM THE FOLLOWING INPUT
S/D-D,L/E-A
CT-CAR TYPE MOP-K,AAR-T,MACRO-M
N G5
CS-CONSIGNEE NAME
ECDC;
EQ-EQUIP OWNER-O,INITIAL-I,SERIES-S
S ECXX 096000 096999 UPCX 096000 096999
SW-SORT/SUMMARY/WT
N CS CL
FM-FORMAT
CS EQD LE CL TME

aquifer.

Sincerely,

S. Bryce Montgomery
Professional Geologist
3512 South 100 East
Bountiful, Utah 84010 Telephone 295-8592

Utah Division of Water Rights

Water Right Listing

Water Right 81-1211

Click here to view documents

[WRPRINT] ***WR#: 81 1211 has been PRINTED!!
CD: 19990726
(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN
DATE: 19990726 Page 1
WRNUM: 81-1211 APPLICATION/CLAIM NO.: A40615 CERT. NO.:

OWNERSHIP**********

NAME: Dixie Basin Smelters Inc. OWNER MISC:
ADDR: P.O. Box 280
CITY: Hurricane STATE: UT ZIP: 84737 INTEREST:
LAND OWNED BY APPLICANT? No

DATES,
ETC.**********

FILING: 04/28/1971|PRIORITY: 04/28/1971|ADV BEGAN: 06/03/1971|ADV ENDED: / / |NEWSPAPER:
PROTST END: / / |PROTESTED: [Hea] |APPR/REJ: [ ]|APPR/REJ: / / |PROOF DUE: / /
|EXTENSION: / /
ELEC/PROOF:[ ]|ELEC/PROOF: / / |CERT/WUC: / / |LAP, ETC: / / |PROV LETR: / /
|RENOVATE: / /
PD Book No. Type of Right: APPL Status: UNAP Source of Info: WUC Map: Date Verified:

04/20/1988 Initials: LER

LOCATION OF WATER RIGHT**********

FLOW: 1.0 cfs SOURCE: Underground Water Well
COUNTY: Washington COMMON DESCRIPTION:

POINTS OF DIVERSION -- UNDERGROUND:
(1) S 100 ft E 2300 ft from NW cor, Sec 8, T 42S, R 14W, SLBM DIAM: 12 ins. DEPTH: 150 to ft. YEAR DRILLED: WELL LOG?
Comment:
(2) S 620 ft E 2500 ft from NW cor, Sec 8, T 42S, R 14W, SLBM DIAM: 12 ins. DEPTH: 150 to ft. YEAR DRILLED: WELL LOG?
Comment:
(3) S 1200 ft E 2040 ft from NW cor, Sec 8, T 42S, R 14W, SLBM DIAM: 12 ins. DEPTH: 150 to ft. YEAR DRILLED: WELL LOG?
Comment:

PLACE OF USE OF WATER RIGHT**********

NORTH-WEST4 NORTH-EAST4 SOUTH-WEST4 SOUTH-EAST4

FLOW: 1.0 cfs SOURCE: Underground Water Well
COUNTY: Washington COMMON DESCRIPTION:

POINTS OF DIVERSION -- UNDERGROUND:
(1) S 100 ft E 2300 ft from NW cor, Sec 8, T 42S, R 14W, SLBM DIAM: 12 ins. DEPTH: 150 to ft. YEAR DRILLED: WELL LOG?
Comment:
(2) S 620 ft E 2500 ft from NW cor, Sec 8, T 42S, R 14W, SLBM DIAM: 12 ins. DEPTH: 150 to ft. YEAR DRILLED: WELL LOG?
Comment:
(3) S 1200 ft E 2040 ft from NW cor, Sec 8, T 42S, R 14W, SLBM DIAM: 12 ins. DEPTH: 150 to ft. YEAR

DRILLED: WELL LOG?
Comment:

PLACE OF USE OF WATER RIGHT**********

	NORTH-WEST4 NW NE SW SE	NORTH-EAST4 NW NE SW SE	SOUTH-WEST4 NW NE SW SE	SOUTH-EAST4 NW NE SW SE
Sec 8 T 42S R 14W SLBM	* X: X: X: X*	* X: X: X: X*	* X: X: X: X*	* X: X: X: X*

USES OF WATER RIGHT**********

CLAIMS USED FOR PURPOSE DESCRIBED: 1211
Referenced To: Claims Groups: Type of Reference -- Claims:
Purpose: Remarks:

.....

###DOMESTIC: 30 Persons Diversion Limit: acft.
PERIOD OF USE: 01/01 TO 12/31

.....

###MINING: DISTRICT: Harrisburg NAME: Burg Property
PERIOD OF USE: 01/01 TO 12/31
ORES: Copper,Silver,Uranium

OTHER COMMENTS**********

The area is now held by State of Utah and the Bureau of Land Management.
Application protested by the Bureau of Land Management.
This application is not to be approved or rejected until it is determined if t

Utah Division of Water Rights

Water Right Listing

Water Right 81-415

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```
 ***WR#: 81  415 has been PRINTED!!
                          (WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN
DATE: 07/19/99    Page 1
WRNUM: 81-415       APPLICATION/CLAIM NO.: A32060       CERT. NO.: 7190
-------------------------------------------------------------------------------------------------------------
-------------------------
OWNERSHIP*************************************************************************************************
************************
-------------------------------------------------------------------------------------------------------------
-------------------------
NAME: USA Bureau of Land Management (Cedar City District)       OWNER MISC:
ADDR: 176 East DL Sargent Drive
CITY: Cedar City                      STATE: UT  ZIP: 84720      INTEREST:
LAND OWNED BY APPLICANT?
-------------------------------------------------------------------------------------------------------------
-------------------------
DATES,
ETC.*****************************************************************************************************
******************
-------------------------------------------------------------------------------------------------------------
-------------------------
FILING:    06/17/1960|PRIORITY:  06/17/1960|ADV BEGAN:   /  /    |ADV ENDED:   /  /    |NEWSPAPER:
PROTST END:  /  /    |PROTESTED: [   ]     |APPR/REJ:  {        }|APPR/REJ:  09/20/1960|PROOF DUE:   /  /
|EXTENSION:    /  /
ELEC/PROOF:[        ]|ELEC/PROOF:  /  /    |CERT/WUC:    /  /    |LAP, ETC:    /  /    |PROV LETR:   /  /
|RENOVATE:     /  /
PD Book No.  3  Type of Right: APPL  Status: CERT  Source of Info: WUC   Map: 135      Date Verified:   /
/      Initials:
```

LOCATION OF WATER RIGHT***

FLOW: 2.061 acre-feet SOURCE: Unnamed Wash
COUNTY: Washington COMMON DESCRIPTION:

POINT OF DIVERSION -- SURFACE:
(1) S 1101 ft W 4001 ft from NE cor, Sec 17, T 42S, R 14W, SLBM
Diverting Works: Source:

USES OF WATER RIGHT***

CLAIMS USED FOR PURPOSE DESCRIBED: 415,808,2827/2830
Referenced To: Claims Groups: Type of Reference -- Claims:
Purpose: Remarks:

....

###STOCKWATERING: 250 Cattle or Equivalent Diversion Limit: acft.
PERIOD OF USE: 01/01 TO 12/31
Red Cliff Allotment

Storage from 01/01 to 12/31, inclusive, in Sullivan Stockwater with a maximum capacity of 2.061 acre-feet, located in:

		NORTH-WEST4	NORTH-EAST4	SOUTH-WEST4	SOUTH-EAST4
Height of Dam:	13				
Area Inundated:		NW NE SW SE	NW NE SW SE	NW NE SW SE	NW NE SW SE
Sec 17 T 42S R 14W SLBM		* X: : : *	* : : : *	* : : : *	* : : : *

IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII E N D O F D A T A
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO E N D O F D A T A
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO

Utah Division of Water Rights

Water Right Listing

Water Right 81-2827

Click here to view documents

[WRPRINT] ***WR#: 81 2827 has been PRINTED!!
CD: 19990726
(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN
DATE: 19990726 Page 1
WRNUM: 81-2827 APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP**********

NAME: USA Bureau of Land Management (Cedar City District) OWNER MISC:
ADDR: 176 East DL Sargent Drive
CITY: Cedar City STATE: UT ZIP: 84720 INTEREST:
LAND OWNED BY APPLICANT?

DATES,
ETC.**********

FILING: / / |PRIORITY: 00/00/1856|ADV BEGAN: / / |ADV ENDED: / / |NEWSPAPER:
PROTST END: / / |PROTESTED: [ ] |APPR/REJ: [ ]|APPR/REJ: / / |PROOF DUE: / /
|EXTENSION: / /
ELEC/PROOF:[ ]|ELEC/PROOF: / / |CERT/WUC: 10/15/1986|LAP, ETC: / / |PROV LETR: / /
|RENOVATE: / /
PD Book No. 3 Type of Right: DIL Status: Source of Info: WUC Map: 135 Date Verified: /

/ Initials:

LOCATION OF WATER RIGHT**

FLOW: 0.2 acre-feet SOURCE: Unnamed Wash
COUNTY: Washington COMMON DESCRIPTION:
POINT OF DIVERSION: (1)Stockwatering directly on reservoir located in NWNE Sec 18, T42S, R14W, SLBM.
Source:

USES OF WATER RIGHT**

CLAIMS USED FOR PURPOSE DESCRIBED: 2827,415,808,2828/2830
Referenced To: Claims Groups: Type of Reference -- Claims:
Purpose: Remarks:

....

###STOCKWATERING: 250 Cattle or Equivalent Diversion Limit: acft.
PERIOD OF USE: 01/01 TO 12/31
Red Cliff Allotment

Storage from 01/01 to 12/31, inclusive, in Unnamed with a maximum capacity of 0.200 acre-feet, located in:
Height of Dam: 3 NORTH-WEST4 NORTH-EAST4 SOUTH-WEST4 SOUTH-EAST4
Area Inundated: NW NE SW SE NW NE SW SE NW NE SW SE NW NE SW SE

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Utah Division of Water Rights

Water Right Listing

Water Right 81-2828

Click here to view documents

[WRPRINT] ***WR#: 81 2828 has been PRINTED!!
CD: 19990726
(WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN
DATE: 19990726 Page 1
WRNUM: 81-2828 APPLICATION/CLAIM NO.: CERT. NO.:

OWNERSHIP**********

NAME: USA Bureau of Land Management (Cedar City District) OWNER MISC:
ADDR: 176 East DL Sargent Drive
CITY: Cedar City STATE: UT ZIP: 84720 INTEREST:
LAND OWNED BY APPLICANT?

DATES,
ETC.**********

FILING: / / |PRIORITY: 00/00/1856|ADV BEGAN: / / |ADV ENDED: / / |NEWSPAPER:
PROTST END: / / |PROTESTED: [ ] |APPR/REJ: [ ]|APPR/REJ: / / |PROOF DUE: / /
|EXTENSION: / /
ELEC/PROOF:[ ]|ELEC/PROOF: / / |CERT/WUC: 10/16/1986|LAP, ETC: / / |PROV LETR: / /
|RENOVATE: / /
PD Book No. 3 Type of Right: DIL Status: Source of Info: WUC Map: 135 Date Verified: /

/ Initials:

LOCATION OF WATER
RIGHT**

FLOW: 0.2 acre-feet SOURCE: Unnamed Wash
COUNTY: Washington COMMON DESCRIPTION:
POINT OF DIVERSION: (1)Stockwatering directly on reservoir located in SWNE Sec 18, T42S, R14W, SLBM.
Source:

USES OF WATER
RIGHT**

CLAIMS USED FOR PURPOSE DESCRIBED: 2828,415,808,2827,2829,2830
Referenced To: Claims Groups: Type of Reference -- Claims:
Purpose: Remarks:

....

###STOCKWATERING: 250 Cattle or Equivalent Diversion Limit: acft.
PERIOD OF USE: 01/01 TO 12/31
Red Cliff Allotment

Storage from 01/01 to 12/31, inclusive, in Unnamed with a maximum capacity of 0.200 acre-feet, located in:
Height of Dam: 2 NORTH-WEST4 NORTH-EAST4 SOUTH-WEST4 SOUTH-EAST4
Area Inundated: NW NE SW SE NW NE SW SE NW NE SW SE NW NE SW SE
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII E N D O F D A T A
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1 BACKGROUND GROUND AND SURFACE WATER QUALITY

1.1 Site Geology

The Washington County Landfill is situated on an outcrop the Shnabkaib Member of the Triassic-age Moenkopi Formation, which is a part of the northwest limb of the Harrisburg Dome-Virgin Anticline (Montgomery, 1993).

The Shnabkaib Member is about 1,300 feet thick. It consists of gray, white, light green-gray, pink and light rust-maroon, gypsiferous, silty and sandy shale, dolomitic siltstone, gypsum, and silty dolomite. The eroded surface and residual soil presents a dry, fluffy, popcorn surface of powdery, gypsiferous, fine-grained soil consisting of silt, silty clay and fine-grained sand (Montgomery, 1993). Included within the lower part of the mapped Shnabkaib Member is the Middle Red Member of the Moenkopi Formation. It consists of approximately 350 feet of rust-red-brown, gypsiferous, soft, shaley, fine-grained sandstone, impart-clayey siltstone, and gypsum, which produces an erosion slope. The produced residual soil is more sandy and clayey than that yielded by the Shnabkaib Member (Montgomery, 1993).

Monitor wells W-1 and W-2 are located in the southern portion of the facility and are reported to yield small quantities of groundwater with high dissolved mineral content. Precipitation and runoff are thought to infiltrate the fractures and joints, along with tilted bedding planes, allowing limited groundwater to be stored and slowly recharged over time. Monitor well W-1 is completed in the light to dark brown shales of the Moenkopi Formation. Monitor well W-2 is completed in dipping, interbedded white sandstone and Moenkopi Formation brown shale. Permeability is low for both rock types. Both wells are drilled to depths of 100 feet. Screen intervals are from 20 to 100 feet for each well.

1.2 Groundwater Quality

Groundwater monitoring was initiated in August 1995 at the site. The groundwater monitoring parameters consist of 15 inorganic indicator parameters, 16 heavy metals, and 47 volatile organic compounds in accordance with UAC R315-308-4. Table 1 provides a summary of the inorganic parameters, Table 2 provides a summary of the heavy metals, and the detected VOCs are summarized in Table 3. Each table contains Maximum Contaminant Levels (MCL) established by the USEPA and those concentrations exceeding their respective MCL are designated in bold. Time-series plots of the inorganic constituents, heavy metals, and multiple detected VOCs are provided in Appendix A. Wells W-1 and W-2 are currently undergoing assessment monitoring as per Utah Department of Environmental Quality (UDEQ) correspondence dated March 13, 2003.

The extent of groundwater underlying the Washington County facility is limited in nature, slow moving, and of poor natural quality (high TDS) (Montgomery, 1993; Montgomery, 1994). No upgradient water source has been found to a depth of 200 feet below ground surface (bgs) (EarthFax, 1999). The Montgomery reports indicate shallow groundwater does not provide a potable or otherwise usable water source, and does not contact any regional aquifer system. Minor recharge appears to be occurring from the well-jointed Virgin Limestone Member of the Moenkopi formation to the southwesterly trending fracture system of the Middle Red Member siltstone and shale of the Moenkopi Formation and eventually into fracture systems of the shaley, gypsiferous, dolomitic siltstone of the Shnabkaib Member of the same formation. All formations are steeply dipping. The groundwater quality appears to naturally degrade through interaction with the variable lithologies during migration.

1.3 Inorganic Parameters

Groundwater can be classified by its major ion compositions. Analysis of the major ion chemistry in W-1 and W-2 indicates that sulfate is the dominant anion in both W-1 and W-2 followed by chloride. The dominant cation in W-1 is magnesium followed by sodium and potassium; whereas, the dominant cation in W-2 is calcium followed by magnesium. The calcium, magnesium, sulfate and general water chemistry appear to be indicative of the gypsiferous ($CaSO_4 \cdot 2H_2O$), dolomitic ($CaMg(CO_3)_2$) siltstone of the Shnabkaib Member. As the groundwater flows through this siltstone, gypsum and dolomite are dissolved into their respective ions: calcium, magnesium, sulfate and carbonate.

Nitrate is the only inorganic indicator parameter with a MCL established by the USEPA. The nitrate concentrations in both wells typically exceed the MCL of 10 mg/L. Nitrate has exhibited elevated concentrations throughout the monitoring history of both wells. Potential nitrate sources include an adjacent composting operation that uses sewage sludge in the composting process, prior agricultural activities, and leaching of natural strata. Based on the nature of the groundwater system underlying the Washington County landfill area, conditions are favorable for the occurrence of nitrate at elevated concentrations. Nitrate is an easily-mobilized compound that can remain mobile in the absence of significant denitrifying conditions and/or biota. The semi-arid conditions and limited extent of the shallow water-bearing zone may allow for elevated concentrations of nitrate within the groundwater. It is noted that other inorganic constituents (e.g. TDS, calcium, magnesium, sulfate, potassium, sodium, chloride, etc.) naturally exhibit elevated concentrations in the groundwater at the site.

1.4 Heavy Metals

Most of the heavy metal concentrations have been below reporting limits. A few random, low level detections of antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, thallium and zinc have occurred since monitoring began in 1995. The random nature of these low level concentrations suggests that they are false positives, possibly field or laboratory artifacts.

Low concentrations of nickel, silver and vanadium have been occasionally detected during the monitoring period. Moderate concentrations of selenium have been detected throughout the monitoring history in both wells. The selenium concentrations in W-1 typically exceed the MCL of 0.05 mg/L. Selenium can naturally occur at significant concentrations within soils of semi-arid regions (Fairbridge, 1972). Freeze and Cherry (1979) note that selenium is of interest primarily because of natural sources rather than human-derived sources.

1.5 Volatile Organic Compounds

1.5.1 Historical VOC Detections

Carbon disulfide, dibromochloromethane, methyl bromide, and toluene have each had a single detection in W-1 since 1995. Chloroform has shown minor detections, in W-1, since June 2000; however, all concentrations have been below the laboratory PQL and the GWPS. 1,1 Dichloroethane (1,1-DCA) has not been detected in W-1 since December 1998. Methylene chloride has not been detected in W-1 since May 1999. Tetrachloroethylene (PCE) has not been detected in W-1 since November 1999.

Acetone, bromodichloromethane, carbon disulfide, dibromochloromethane, and toluene have each had a single detection in W-2 since 1995. Chloroform has shown minor detections, in W-2, since December 1998; however, all concentrations have been below the GWPS and have not exceeded the laboratory PQL since February 2001. Methylene chloride has not been detected in W-2 since September 2001.

1.5.2 Current VOC Detections

Chloroform was the only VOC detected during the December 2003 event. Chloroform occurred in W-1 and W-2 at concentrations of 1.2 µg/L and 2.5 µg/L, respectively, during the December 2003 event. Both reported chloroform concentrations were below the laboratory PQL of 5 µg/L. The Groundwater Protection Standard (GWPS) for chloroform, provided in UAC R315-308-4, is 100 µg/L. Current chloroform concentrations occur well below the UAC R315-308-4 GWPS. Chloroform does not have a primary EPA maximum contaminant level (MCL).

1.6 Statistical Analysis of Groundwater Data

Data collected during the most recent groundwater monitoring event (December 2003) were statistically evaluated using either Shewhart-CUSUM Control Charts or 95-Percent Lower Confidence Limits. Details are provided below.

1.6.1 Shewhart-CUSUM Control Charts

Inorganic and heavy metal constituents without a UAC R315-308-4 GWPS were statistically evaluated using combined Shewhart-CUSUM control charts and Sen's Slope/Mann Kendall trend analyses for informational purposes. Shewhart-CUSUM control charts allow detection of both major and gradual changes in groundwater quality independent of the spatial variation. This procedure is specifically recommended in the USEPA document *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities* (April 1989). A few constituents could not be statistically evaluated by control charts due to greater than 50 percent non-detections in the background pool. These constituents were statistically evaluated using a non-parametric prediction limit. The initial eight background concentrations were updated with the first four detection monitoring results following procedures discussed in Gibbons (1994), prior to the June 2000 monitoring event. The background pool now includes samples collected from January 1996 through November 1999. Sen's Slope/Mann Kendall trend analyses were also performed to evaluate the significance of potential trends. A summary of the constituents that exceeded control limits is as follows:

Well	Constituent	Result	CUSUM Value	h	SCL	NP Prediction Limit	Significant Upward Trend ?	Slope (mg/L/yr)
W-1	Alkalinity	114	204.6	184.31	176.76	127	Yes	5.331
	COD	90.9	n/a	n/a	n/a	50	Yes	9.636
	Chloride	2330	6219	3127.05	2930.27	1830	No	106.471
	Nitrate	516	191.5	613.30	577.06	330	Yes	41.939
W-2	Alkalinity	94	501.7	171.85	159.02	112	Yes	6.431
	Bicarbonate	94	202.8	177.18	167.79	134	Yes	5.873
	Nitrate	44.1	124.1	112.52	103.53	69	Yes	5.785

Notes: CUSUM - Cumulative Sum
h - CUSUM Limit
SCL - Shewhart Control Limit
n/a - Method not used

Non-UAC R315-308-4 GWPS parameters exceeding statistical limits during the December 2003 event include alkalinity, chemical oxygen demand (COD), chloride, nitrate, selenium, and silver in W-1, and alkalinity, bicarbonate, nitrate, selenium, silver and thallium in W-2. The statistical analysis results appear to be reflective of poor natural groundwater quality in the shallow water-bearing zone underlying the site as previously discussed.

1.6.2 95-Percent Lower Confidence Limits

Analytical results for W-1 and W-2 were also statistically evaluated by comparing lower 95 percent confidence limits (LCL) to GWPS provided in UAC R315-308-4 and by the USEPA. This procedure is typically applied to monitor wells in assessment monitoring. Results in which the LCL exceeds the GWPS indicate statistically significant evidence that a constituent occurs at a

concentration greater than the GWPS. For LCL analyses, data older than two years preceding the subject monitoring event was not used in order to better reflect current conditions. Data collected from November 2001 through November 2003 was used to calculate the LCLs during this event.

A summary of results for detected VOCs and other constituents with a GWPS in UAC R315-308-4 is provided on the following table:

Constituent	Well	November 2003 Result	95% LCL	GWPS	Exceeds?
Chloroform (ug/l)	W-1	1.2 J	1.273222	100	No
Barium Total (mg/l)	W-1	0.0097 J	0.003297	2	No
Nitrate (mg/l)	W-1	516	448.07994	10	Yes
Selenium Total (mg/l)	W-1	0.14 J	0.12198	0.05	Yes
Silver Total (mg/l)	W-1	0.0061 J	0.001676	0.1	No
Vanadium Total (mg/l)	W-1	0.0162	0.017043	0.3	No
Chloroform (ug/l)	W-2	2.5 J	2.790024	100	No
Barium Total (mg/l)	W-2	0.0099 J	0.003729	2	No
Nitrate (mg/l)	W-2	44.1	42.394286	10	Yes
Silver Total (mg/l)	W-2	0.0061 J	0.002347	0.1	No
Thallium Total (mg/l)	W-2	0.22 J	0.0001	2	No
Vanadium Total (mg/l)	W-2	0.014 J	0.0075	0.3	No

Notes: J - Laboratory Qualifier (constituent detected below PQL)
LCL – Lower Confidence Limit
GWPS – UAC R315-308-4 Groundwater Protection Standard
* - EPA Primary Maximum Contaminant Level

The 95 percent LCL for selenium in well W-1 exceeded its UAC R315-308-4 GWPS. It is noted that the concentration in selenium in W-1 is below the laboratory PQL of 0.25 mg/L. Nitrate does not have a UAC R315-308-4 GWPS, but does have a primary MCL of 10 mg/L, established by the USEPA. Nitrate concentrations reported in both W-1 and W-2 exceed the MCL at concentrations of 516 mg/L and 44.1 mg/L, respectively. No other parameter's 95 percent LCL exceeded a GWPS during the December 2003 groundwater monitoring event.

1.7 Surface Water Quality

There are no surface water bodies of any substance in the vicinity of the landfill. Drainage from the landfill is controlled by engineered site drainage.

1.8 Groundwater Monitoring (UAC R315-308):

Groundwater monitoring and report procedures are addressed in the attached Groundwater Sampling and Analysis Plan which meets the requirements of UAC R315-308 of this permit application.

1.9 Statistical method to be used (R315-308-2(7)):

Statistical method to be used is addressed in Appendix A of the Groundwater Sampling and Analysis Plan.

2 REFERENCES

Earthfax Engineering, Inc. 1999. Water Data Collection Quality Assurance Plan for the Washington County Landfill Facility.

Fairbridge, R. W. (ed.). 1972. The Encyclopedia of Geochemistry and Environmental Sciences. Van Nostrand Reinhold Company. New York. 1321 p.

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Gibbons, Robert D. 1994. Statistical Methods for Groundwater Monitoring. John Wiley and Sons, Inc.

Kerfoot, H. B. Landfill Gas Effects on Groundwater Samples at a Municipal Solid Waste Facility. Journal of Air and Waste Management Association. 44. 1293-1298.

Montgomery, S. Bryce. 1993. August 23, Letter regarding geologic study of proposed landfill site.

Montgomery, S. Bryce. 1994. January 10, Letter regarding hydrogeologic evaluation of proposed landfill site.

Smith, Roy-Keith. 2000. Interpretation of Organic Data. Genium Publishing. Schenectady, NY.

TABLES

Table 1 - Washington County Landfill
Historic Inorganic Parameters

Well	Date	pH [Field] (su)	pH [Lab] (su)	TOC	COD	Iron	Manganese	Magnesium	Calcium	Potassium	Sodium	Ammonia, as N	Bicarbonate	Carbonate as CaCO3	Chloride	Sulfate	Nitrate	TDS
	MCL	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	10	none
W-1	8/14/1995	n/a	7.86	3.21	n/a	1.02	0.2	1030	416	30.5	3730	2.1	74	<1	1830	9700	**102**	18200
	11/27/1995	n/a	7.94	3.01	n/a	<0.5	0.23	874	423	30.9	3640	1.1	74	<1	1830	9310	**171**	17500
	1/25/1996	7.67	6.9	5	<50	<0.5	<0.3	1490	482	41	1170	0.59	85	<10	1270	7100	**310**	11900
	5/9/1996	7.1	6.8	7	<50	<0.6	<0.3	1400	509	43	1170	<0.3	90	<10	1180	7300	**302**	12000
	7/31/1996	7.1	7.2	5	<50	<0.6	<0.3	1380	468	40	1160	<0.3	93	<10	1170	7300	**316**	11900
	11/1/1996	7.3	7.3	5	<50	<0.5	<0.3	1520	536	44	1260	<0.3	96	<10	1280	7500	**280**	12500
	1/21/1997	7.31	7.6	<5	<50	<0.6	<0.3	1420	494	42	1210	<0.3	115	<10	1220	7010	**230**	11500
	4/24/1997	7.19	7.2	<5	<50	<0.6	<0.3	1590	538	46	1410	0.25	108	<10	1200	7010	**279**	12100
	7/31/1997	7.1	7.4	6	<50	<0.6	<0.3	1510	510	47	1300	<0.3	119	<10	<100	8380	**271**	12000
	10/31/1997	7.21	7.3	18	<50	0.08	<0.03	987	549	34	1020	0.62	121	<10	1030	4960	**113**	9160
	5/12/1998	7	7.4	5	<50	<0.6	<0.3	1360	547	44	1280	<0.3	121	<10	960	7230	**258**	12600
	12/31/1998	7.15	6.9	5	<50	<0.5	<0.3	1510	527	45	1220	0.58	122	<10	1020	7360	**290**	13000
	5/18/1999	7.21	7.4	5	<50	<0.3	<0.1	1670	525	48	1330	<0.3	127	<10	1210	7210	**260**	13200
	11/16/1999	7.01	7.2	2	n/a	<0.02	<0.01	1500	420	48	1200	<0.2	156	<1	1180	6590	**330**	14200
	6/12/2000	7.08	7.22	2.55	72.1	<1	0.016	1420	638	50.2	2080	<1	158	<10	2160	6280	**550**	14500
	9/11/2000	7.11	7.14	2.38	90.6	<1	<0.015	1350	554	54.7	2060	<1	150	<10	<1120	5570	**480**	15900
	2/28/2001	7.05	7.2	2.11	96.5	n/a	<0.015	1310	553	44	2070	<1	138	<10	2390	6720	**680**	12000
	6/13/2001	7.06	7.14	2.33	86.4	n/a	<0.015	1380	548	53.1	2120	<0.5	137	<10	2170	6720	**526**	15500
	9/20/2001	n/a	7.2	3.64	110	n/a	<0.015	1400	581	48.1	2160	<0.5	140	<10	2290	7020	**510**	18700
	5/16/2002	n/a	7.28	n/a	80.7	<5	0.0066	1370	566	46.6	2040	<0.5	132	<10	2300	5990	**423**	16200
	11/5/2002	n/a	7.07	1.4 (J)	101	<0.5	0.0051 (J)	1330	570	49	2050	<0.5	120	<10	2040	6150	**469**	15100
	6/16/2003	n/a	7.49	1.4 (J)	72.3	0.11	0.006 (J)	1290	543	48.7	1910	<1	122	<10	2410	6270	**521**	15700
	11/17/2003	n/a	7.22	1.89	90.9	<0.5	0.0073 (B)	1400	600 (B)	51.7	2100	<1	114	<10	2330	5960	**516**	13900
W-2	8/14/1995	n/a	7.51	0.72	n/a	<0.5	0.03	208	485	11.5	473	<0.5	76	<1	162	2920	4.64	4600
	11/27/1995	n/a	7.55	0.89	n/a	<0.5	0.06	205	510	11.9	445	<0.5	76	<1	160	2510	0.39	4360
	1/25/1996	7.7	6.8	<5	<50	<0.1	<0.05	163	549	11.9	219	1.33	67	<10	126	2240	**28**	3380
	5/9/1996	7.37	6.8	<5	<50	<0.1	<0.06	188	507	12	389	<0.3	79	<10	190	2900	**16.1**	4250
	7/31/1996	7.2	7.3	<5	<50	<0.6	<0.3	205	519	12.8	466	<0.3	80	<10	150	2740	**16.9**	4180
	11/1/1996	7.1	7.4	<5	<50	<0.2	<0.1	174	575	12	313	<0.3	74	<10	182	2510	**17.8**	3810
	1/21/1997	7.73	7.9	<5	<50	<0.2	<0.08	217	483	12.5	506	<0.3	90	<10	74	2840	**16.5**	4000
	4/24/1997	7.31	7.2	<5	<50	<0.3	0.05	207	525	12.6	548	<0.3	78	<10	155	2820	**14.6**	4330
	7/31/1997	7.21	7.5	<5	<50	<0.1	<0.06	157	553	13.1	226	<0.3	67	<10	98	2020	**17**	3180
	10/31/1997	7.1	7.4	<5	<50	0.08	<0.03	158	566	13.1	215	<0.3	70	<10	92	2010	**21.4**	3190
	5/12/1998	7.41	7.4	<5	<50	<0.1	<0.06	175	638	12.9	236	<0.3	72	<10	270	2110	**49**	3700
	12/31/1998	7.37	7.2	<5	<50	<0.1	<0.06	216	697	15	274	<0.3	91	<10	380	2250	**69**	4190
	5/18/1999	7.25	7.5	<5	<50	<0.1	<0.06	200	588	13.1	264	<0.3	112	<10	230	2160	**36**	3680
	11/16/1999	7.27	7.3	<1	n/a	<0.02	<0.01	200	460	13	550	<0.2	134	<1	213	2590	**13**	4640
	6/12/2000	7.26	7.54	1.65	78.2	<1	<0.015	252	606	14	269	<1	128	<10	315	2210	**82**	4040
	2/28/2001	7.28	7.52	1.5	<55	n/a	<0.015	202	560	12.4	215	<1	130	<10	215	2270	**60**	<6500
	6/13/2001	7.12	7.36	<1.5	<55	n/a	<0.015	203	565	12.7	218	<0.5	128	<10	194	2200	**47.8**	4540
	9/20/2001	n/a	7.49	<1.5	<40	n/a	<0.015	209	595	13.2	224	<0.5	120	<10	205	2250	**53.6**	4020
	5/16/2002	n/a	7.48	0.8	<35	<5	<0.015	202	593	13	225	<0.5	114	<10	600	2150	**44.2**	3670
	11/5/2002	n/a	7.45	0.54 (J)	8.6 (J)	0.22 (J)	<0.015	202	601	14.2	229	<0.5	104	<10	195	2060	**52.6**	3610
	6/16/2003	n/a	7.55	0.38 (J)	13 (J)	0.23 (J)	<0.015	195	557	12.6	219	<1	118	<10	178	2220	**42.5**	3910
	11/17/2003	n/a	7.53	0.56 (J)	28 (J)	0.15 (J)	0.003 (B)	204	595 (B)	13.4	246	0.34 (J)	94	<10	186	2060	**44.1**	3740

Notes: All units in mg/L except for pH; n/a = not available
COD = Chemical Oxygen Demand; (B) = Detected in Blank
TDS = Total Dissolved Solids; (J) = Concentration Estimated
MCL = Maximum Contaminant Level

Table 2 - Washington County Landfill
Historic Heavy Metal Parameters

		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
	MCL	0.006	0.01	2.0	0.004	0.005	0.1	none	none	none	0.002	none	0.05	none	0.002	none	10
Well	Date																
W-1	8/14/1995	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.06	<0.05	n/a	n/a	<0.01	n/a
	11/27/1995	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.06	<0.2	n/a	n/a	<0.01	n/a
	1/25/1996	<0.01	<0.006	<0.1	<0.003	<0.2	<0.5	<0.5	<0.5	<0.006	<0.001	<0.5	**0.08**	<0.3	<0.01	<0.3	<0.5
	5/9/1996	<0.01	<0.006	<0.1	<0.006	<0.01	<0.01	<0.6	<0.6	<0.01	<0.001	0.055	**0.086**	<0.006	<0.006	0.025	<0.6
	7/31/1996	<0.01	<0.03	<0.1	<0.006	<0.01	<0.01	<0.6	<0.6	<0.01	<0.001	<0.03	**0.077**	<0.006	<0.006	0.017	<0.6
	11/1/1996	<0.002	<0.03	<0.01	<0.001	<0.002	0.0038	<0.5	<0.5	<0.002	<0.001	0.03	**0.074**	<0.001	<0.001	<0.002	<0.5
	1/21/1997	<0.02	<0.006	<0.1	<0.01	<0.02	<0.02	<0.6	<0.6	<0.02	<0.001	0.2	**0.078**	<0.01	<0.01	0.3	<0.6
	4/24/1997	<0.002	0.004	<0.1	<0.001	<0.002	0.0087	<0.6	<0.6	<0.01	<0.001	0.061	**0.071**	<0.001	<0.006	0.0181	<0.6
	7/31/1997	<0.02	<0.03	<0.1	<0.03	<0.02	<0.02	<0.6	<0.6	<0.02	<0.001	<0.07	**0.083**	<0.01	<0.01	0.02	<0.6
	10/31/1997	<0.002	<0.006	0.011	<0.001	<0.002	<0.002	<0.06	<0.06	<0.002	<0.001	0.019	**0.068**	<0.001	<0.001	0.0155	0.11
	5/12/1998	<0.02	<0.005	<0.1	<0.01	<0.02	0.023	<0.6	<0.6	<0.02	<0.001	0.07	**0.07**	<0.01	<0.01	0.023	<0.6
	12/31/1998	<0.02	<0.006	<0.1	<0.01	<0.02	<0.02	<0.6	<0.6	<0.02	<0.001	<0.07	**0.077**	<0.01	<0.01	0.025	<0.6
	5/18/1999	<0.01	<0.005	<0.06	<0.006	<0.01	<0.01	<0.3	<0.3	<0.01	<0.001	<0.03	**0.079**	<0.006	<0.006	0.016	<0.3
	11/16/1999	<0.0005	<0.005	0.005	<0.001	<0.001	0.028	0.02	<0.01	<0.005	0.0002	<0.01	**0.122**	<0.0005	<0.0005	<0.01	0.04
	6/12/2000	<.030	<0.1	<0.015	<0.001	<0.015	<0.05	<0.015	<0.05	<0.020	<0.0005	<0.025	**0.219**	<0.02	<0.04	0.0386	<0.25
	9/11/2000	n/a	<0.1	<0.015	<0.001	<0.015	<0.05	<0.015	<0.05	0.001	<0.0005	<0.025	**0.181**	<0.02	<0.0005	0.0315	<0.25
	2/28/2001	<0.001	<0.1	<0.015	0.00215	<0.015	<0.05	<0.005	<0.05	<0.0005	<0.0005	<0.05	**0.179**	<0.025	<0.0003	0.029	<0.25
	6/13/2001	<0.001	<0.1	<0.015	<0.001	<0.015	<0.05	<0.005	<0.05	<0.0006	<0.0005	<0.05	**0.175**	<0.025	<0.0003	0.0286	<0.25
	9/20/2001	<0.001	<0.1	<0.015	<0.001	<0.015	<0.05	<0.025	<0.05	<0.001	n/a	<0.05	**0.171**	<0.025	<0.0005	0.0308	<0.25
	5/16/2002	<0.002	<0.15	0.0085	0.00021	<0.015	<0.05	<0.015	<0.05	<0.001	<0.0005	0.032	**0.12**	0.0084	0.0004	0.021	0.068
	11/5/2002	0.0004	<0.15	0.0089 (J)	0.0004 (J)	<0.015	<0.05	<0.015	<0.05	0.00024 (J)	<0.0005	0.055 (J)	**0.13 (J)**	0.0031 (J)	<0.000278	0.0238	<0.25
	6/16/2003	<0.00222	<0.15	0.0085	<0.001	<0.015	<0.05	<0.015	<0.05	<0.00222	<0.0005	0.023 (J)	**0.14 (J)**	0.01 (J)	0.00028 (J)	0.0196 (J)	0.063 (J)
	11/17/2003	<0.00222	<0.15	0.0097 (J)	<0.001	<0.015	<0.05	<0.015	<0.05	<0.00222	<0.001	<0.1	**0.14 (J)**	0.0061 (J)	<0.000556	0.0162	<0.25
W-2																	
	1/25/1996	<0.01	<0.03	<0.02	<0.003	<0.03	<0.1	<0.1	<0.1	<0.03	<0.001	<0.1	0.015	<0.05	<0.06	<0.05	<0.1
	5/9/1996	<0.002	<0.006	<0.02	<0.001	<0.002	<0.002	<0.1	<0.1	<0.002	<0.001	0.038	0.017	<0.001	<0.001	0.0058	<0.1
	7/31/1996	<0.01	<0.03	<0.1	<0.006	<0.01	<0.01	<0.6	<0.6	<0.01	<0.001	<0.03	0.015	<0.006	<0.006	<0.01	<0.6
	11/1/1996	<0.002	<0.006	<0.01	<0.001	<0.002	<0.002	<0.2	<0.2	<0.002	<0.001	0.021	0.016	<0.001	<0.001	0.0083	<0.2
	1/21/1997	<0.01	<0.06	<0.03	<0.005	<0.01	<0.01	<0.2	<0.2	<0.01	<0.001	0.08	0.017	<0.005	<0.005	<0.01	<0.2
	4/24/1997	<0.002	<0.01	<0.06	<0.001	0.0022	<0.002	<0.3	<0.3	<0.005	<0.001	0.058	0.016	<0.001	<0.003	<0.002	<0.3
	7/31/1997	<0.006	<0.006	<0.02	<0.006	<0.006	<0.006	<0.1	<0.1	<0.006	<0.001	<0.02	0.017	<0.003	<0.003	0.014	<0.1
	10/31/1997	<0.002	<0.03	0.01	<0.001	<0.002	<0.002	<0.06	0.53	<0.002	<0.001	0.028	0.013	<0.001	<0.001	0.0152	<0.006
	5/12/1998	<0.006	<0.005	<0.02	<0.003	<0.006	<0.006	<0.1	<0.1	<0.006	<0.001	0.069	0.039	<0.003	<0.003	0.015	<0.1
	12/31/1998	<0.006	<0.006	<0.02	<0.003	<0.006	<0.006	<0.1	<0.1	<0.006	<0.001	0.026	0.048	<0.003	<0.003	0.017	<0.1
	5/18/1999	<0.006	<0.03	<0.02	<0.003	<0.006	<0.006	<0.1	<0.1	<0.006	<0.001	<0.02	0.028	<0.003	<0.003	0.013	<0.1
	11/16/1999	<0.0005	<0.005	0.01	<0.001	<0.001	<0.005	<0.01	<0.01	<0.005	<0.0002	<0.01	<0.002	<0.0005	<0.0005	<0.01	0.02
	6/12/2000	<0.03	<0.1	<0.015	<0.001	<0.015	<0.05	<0.015	<0.05	<0.020	<0.0005	<0.025	<0.015	<0.02	<0.4	<0.02	<0.25
	2/28/2001	<0.001	<0.1	<0.015	0.00221	<0.015	<0.05	<0.025	<0.05	<0.0005	<0.0005	<0.05	<0.15	<0.025	<0.0003	<0.015	<0.25
	6/13/2001	<0.001	<0.1	<0.015	<0.001	<0.015	<0.05	<0.005	<0.05	<0.0006	<0.0005	<0.05	<0.15	<0.025	<0.0003	<0.015	<0.25
	9/20/2001	<0.001	<0.1	<0.015	<0.001	<0.015	<0.05	<0.025	<0.015	<0.0005	n/a	<0.05	<0.15	<0.025	<0.0003	<0.015	<0.25
	5/16/2002	<0.002	<0.15	0.01	<0.001	<0.015	<0.05	<0.015	<0.05	<0.001	<0.0005	0.033	0.045	0.0056	0.0001	0.0132	<0.25
	11/5/2002	0.00032 (J)	<0.15	0.011 (J)	0.00029 (J)	<0.015	<0.05	<0.015	<0.05	<0.00111	<0.0005	0.067 (J)	<0.2	0.0068 (J)	<0.000278	0.0126	<0.25
	6/16/2003	<0.00222	<0.15	0.0094	<0.001	<0.015	<0.05	<0.015	<0.05	<0.000222	0.00182	<0.1	<0.25	0.0081 (J)	<0.000556	0.014 (J)	<0.05
	11/17/2003	<0.00222	<0.15	0.0099 (J)	<0.001	<0.015	<0.05	<0.015	<0.05	<0.00222	<0.001	<0.1	<0.25	0.0061 (J)	**0.22 (J)**	0.014 (J)	<0.25

Notes:
All units in mg/L
MCL = Maximum Contaminant Level
n/a = not available
(J) = Concentration Estimated

Table 3 -- Washington County Landfill

Historic Volatile Organic Compound (VOC) Detections

Groundwater Well W-1

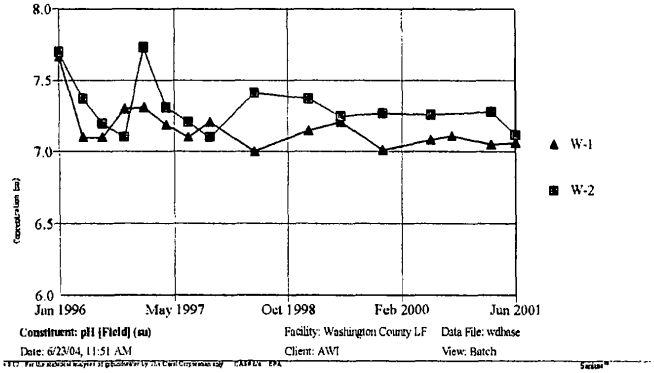
	1,1-DCA	Carbon disulfide	Chloroform	Dibromochloromethane	Methyl bromide	Methylene chloride	Tetrachloroethylene	Toluene
MCL	none	none	none	none	none	5	5	1000
Date								
8/14/1995	<5	n/a	<5	<5	n/a	**12**	<5	16
11/27/1995	<5	n/a	<1	<1	n/a	**26**	<5	<5
1/25/1996	<5	<5	<5	<5	<10	<5	<5	<5
5/9/1996	<5	<5	<5	<5	<10	<5	<5	<5
7/31/1996	1.8	<1	<1	<1	<2	<1	3.3	<1
11/1/1996	1.9	<1	<1	<1	<2	<1	3.2	<1
1/21/1997	<1	<1	<1	<1	<2	<1	**5.2**	<1
4/24/1997	2.3	<1	<1	<1	<2	<1	3.4	<1
7/31/1997	2.9	<1	<1	<1	<2	<1	3.8	<1
10/31/1997	<1	<1	<1	<1	<2	**8.2**	<1	<1
5/12/1998	2.2	<1	<1	<1	<2	<1	3	<1
12/31/1998	1.3	<1	<1	<1	<2	<1	2.1	<1
5/18/1999	<1	<1	<1	<1	<2	3.4	<1	<1
11/16/1999	<1	<1.2	<1.2	<1	<4	<2	1.21	<2
6/12/2000	<5	<5	3.1	<5	<5	<5	<5	<5
9/11/2000	<5	<5	3.2	0.97	<5	<5	<5	<5
2/28/2001	<5	<5	2.8	<5	<5	<5	<5	<5
6/13/2001	<5	<5	<0.3	<5	<5	<5	<5	<5
9/20/2001	<5	<5	2.1	<5	<5	<5	<5	<5
5/16/2002	<5	<5	1.9	<5	<5	<5	<5	<5
11/5/2002	<5	1.6 (J)	1.7 (J)	<5	5.92	<5	<5	<5
6/16/2003	<5	<5	1.3 (J)	<5	<5	<5	<5	<5
11/17/2003	<5	<5	1.2 (J)	<5	<5	<5	<5	<5

Notes:
All units in µg/L.
1,1-DCA = 1,1-Dichloroethane
n/a = not available
MCL = Maximum Contaminant Level
(J) = Concentration Estimated

Table 3 continued -- Washington County Landfill Historic Volatile Organic Compound (VOC) Detections Groundwater Well W-2							
	Acetone	Bromodichloromethane	Carbon disulfide	Chloroform	Dibromochloromethane	Methylene chloride	Toluene
MCL	none	none	none	none	none	5	1000
Date							
8/14/1995	n/a	<5	n/a	<5	<5	**11**	7
11/27/1995	n/a	<5	n/a	<5	<5	**13**	<5
1/25/1996	<10	<5	<5	<5	<5	<5	<5
5/9/1996	<10	<5	<5	<5	<5	<5	<5
7/31/1996	<2	<1	<1	<1	<1	<1	<1
11/1/1996	<2	<1	<1	<1	<1	<1	<1
1/21/1997	<3	<1	<1	<1	<1	<1	<1
4/24/1997	<2	<1	<1	<1	<1	<1	<1
7/31/1997	<2	<1	<1	<1	<1	<1	<1
10/31/1997	<2	<1	<1	<1	<1	2.4	<1
5/12/1998	<2	<1	<1	<1	<1	<1	<1
12/31/1998	<2	2.8	<1	3.1	2	<1	<1
5/18/1999	<2	<1	<1	<1	<1	2.7	<1
11/16/1999	<20	<1	<1.2	<1.2	<1	<2	<2
6/12/2000	<12.5	<5	<5	7.56	<5	<5	<5
9/11/2000	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2/28/2001	<12.5	<5	<5	6.27	<5	<5	<5
6/13/2001	<12.5	<5	<5	4.8	<5	<5	<5
9/20/2001	7.5	<5	<5	3.5	<5	4.8	<5
5/16/2002	<12.5	<5	<5	3.8	<5	<5	<5
11/5/2002	<12.5	<5	1.2 (J)	3.1 (J)	<5	<5	<5
8/16/2003	<12.5	<5	<5	3.4 (J)	<5	<5	<5
11/17/2003	<12.5	<5	<5	2.5 (J)	<5	<5	<5
Notes:	All units in µg/L.						
	n/a = not available						
	MCL = Maximum Contaminant Level						
	(J) = Concentration Estimated						

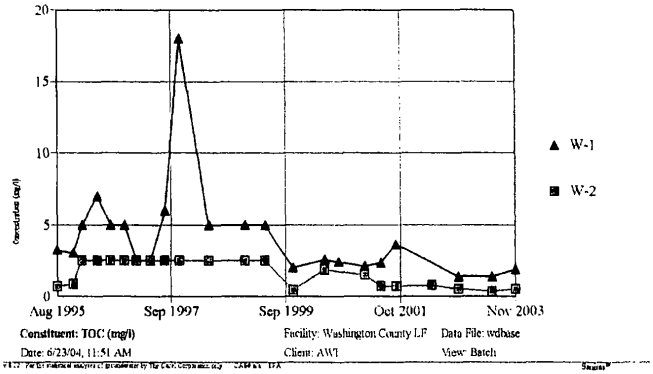
APPENDIX A

TIME SERIES



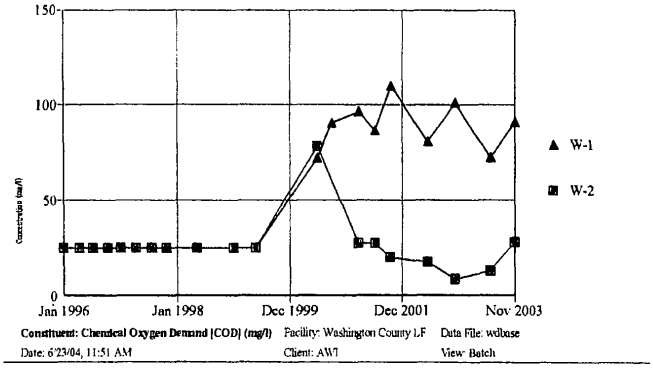
Constituent: pH (Field) (su) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 11:51 AM Client: AWI View: Batch

TIME SERIES



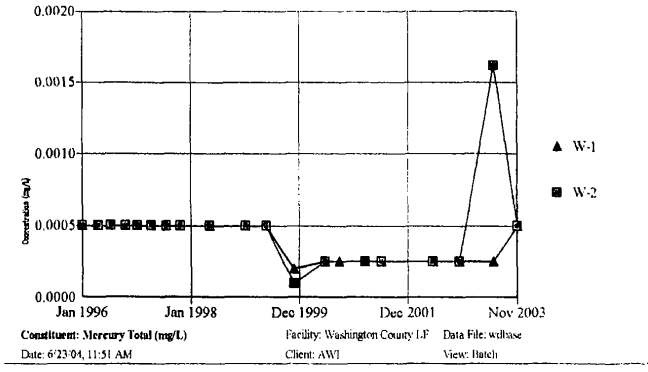
Constituent: TOC (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 11:51 AM Client: AWI View: Batch

TIME SERIES



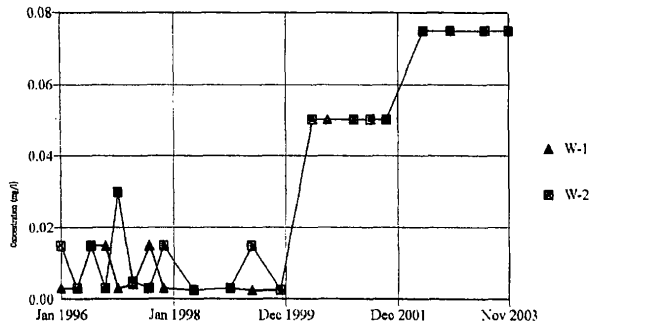
Constituent: Chemical Oxygen Demand (COD) (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 11:51 AM Client: AWI View: Batch

TIME SERIES



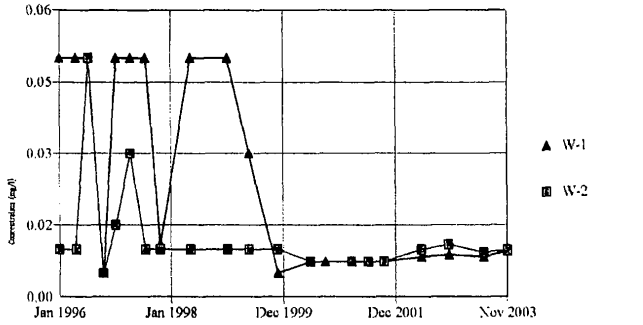
Constituent: Mercury Total (mg/L) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 11:51 AM Client: AWI View: Batch

TIME SERIES



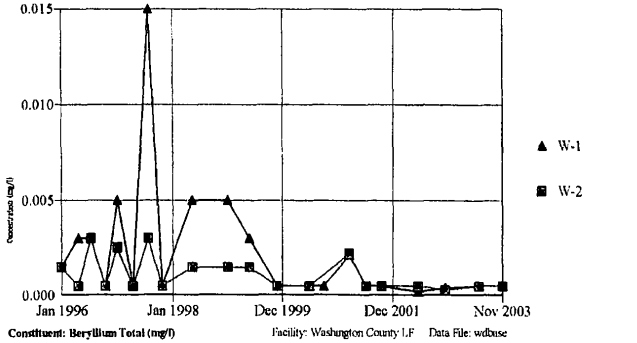
Constituent: Arsenic Total (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 9:24 AM Client: AWI View: _Batch_

TIME SERIES



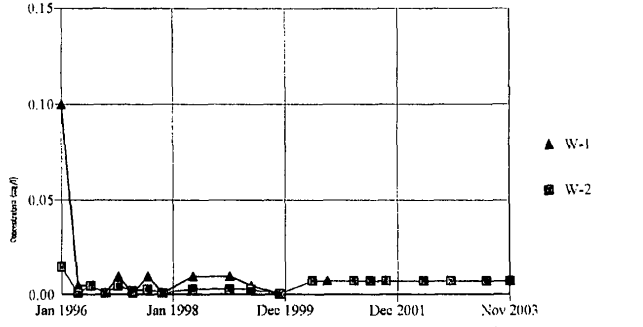
Constituent: Barium Total (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 9:26 AM Client: AWI View: _Batch_

TIME SERIES



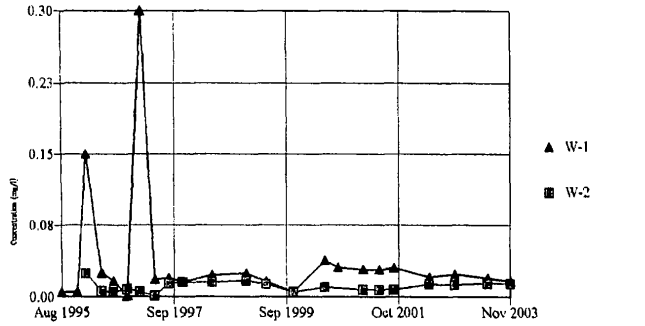
Constituent: Beryllium Total (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 9:29 AM Client: AWI View: _Batch_

TIME SERIES



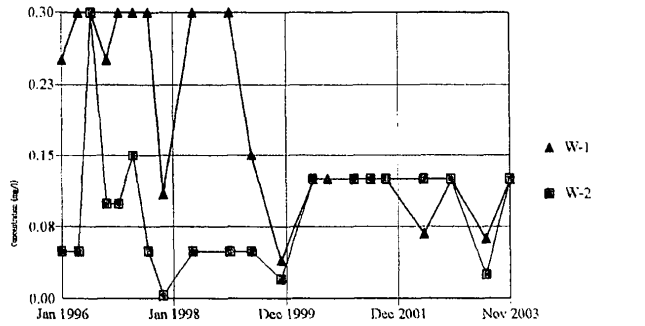
Constituent: Cadmium Total (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 9:31 AM Client: AWI View: _Batch_

TIME SERIES



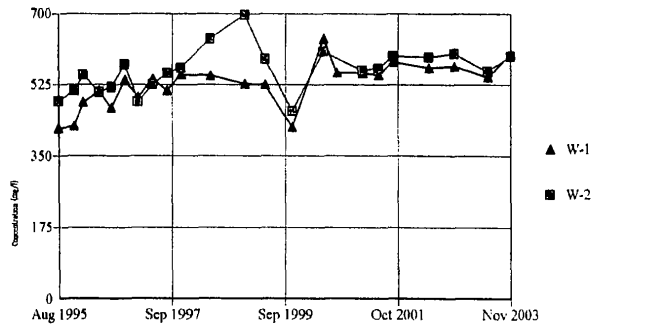
Constituent: Vanadium Total (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 9:49 AM Client: AWI View: _Batch_

TIME SERIES



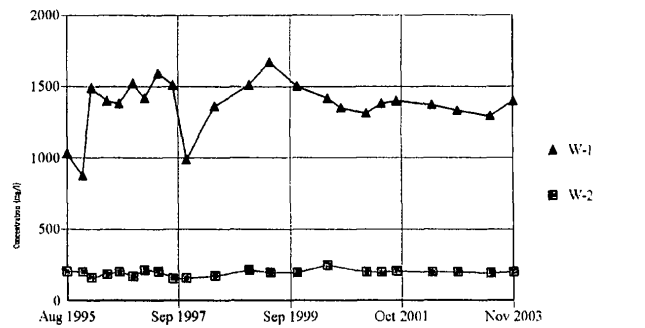
Constituent: Zinc Total (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 9:52 AM Client: AWI View: _Batch_

TIME SERIES



Constituent: Calcium Total (mg/l) Facility: Washington County LF Data File: wdbase
Date: 6/23/04, 9:54 AM Client: AWI View: _Batch_

TIME SERIES



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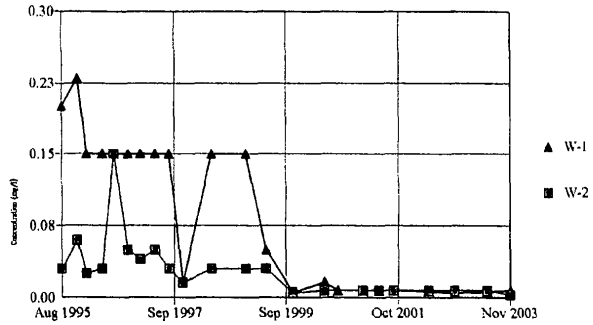

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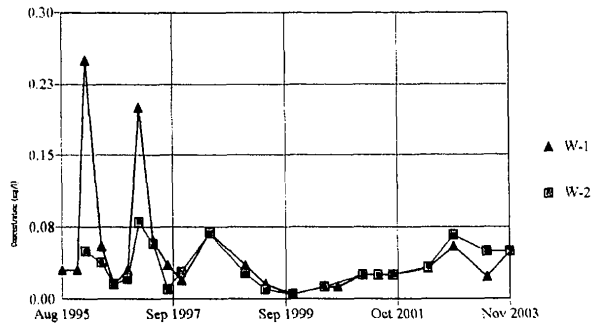

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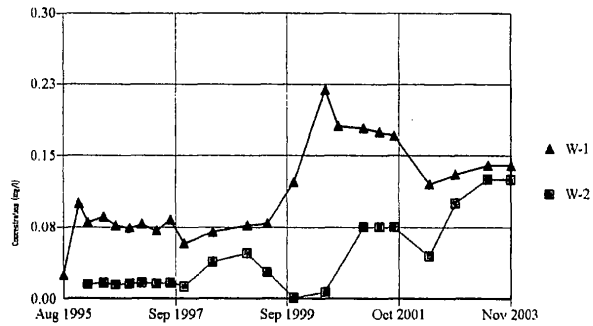

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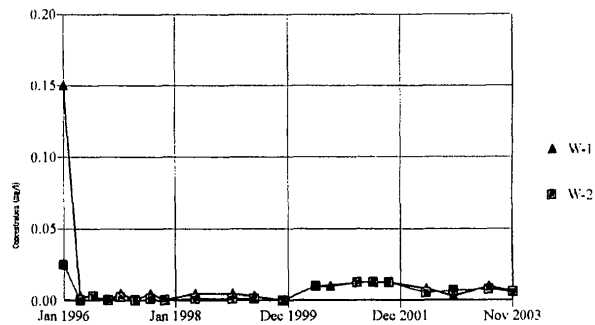

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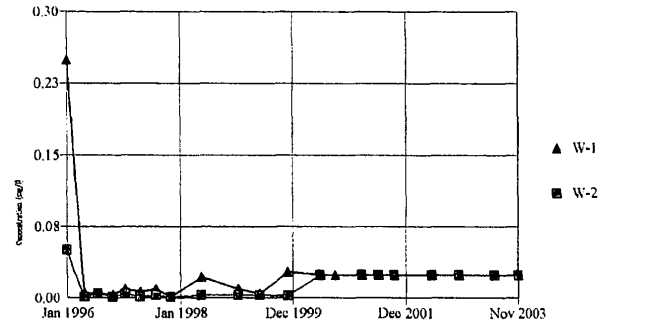

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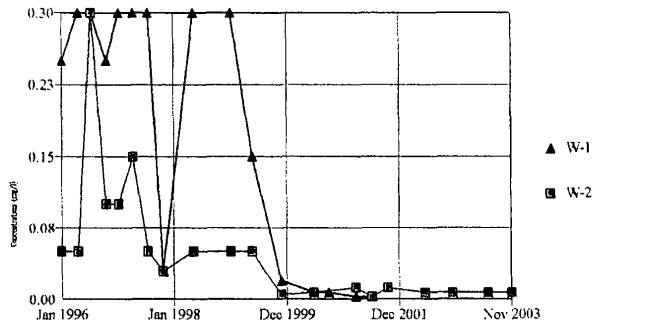

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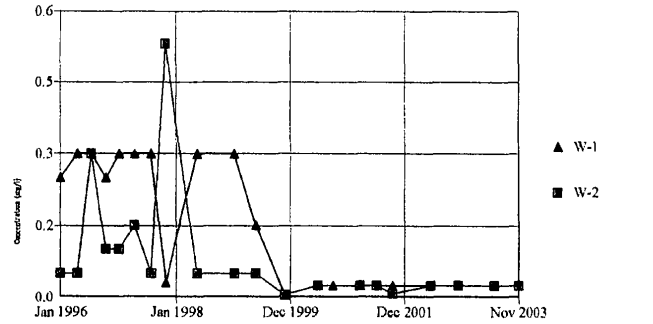

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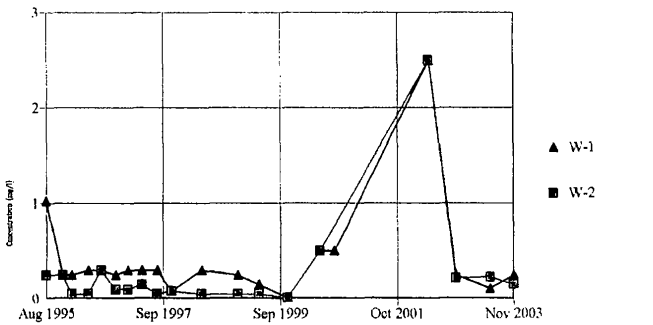

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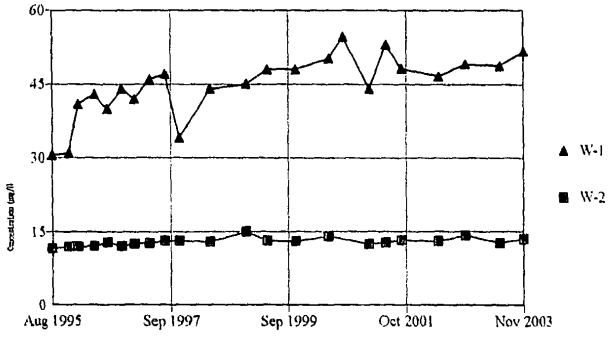

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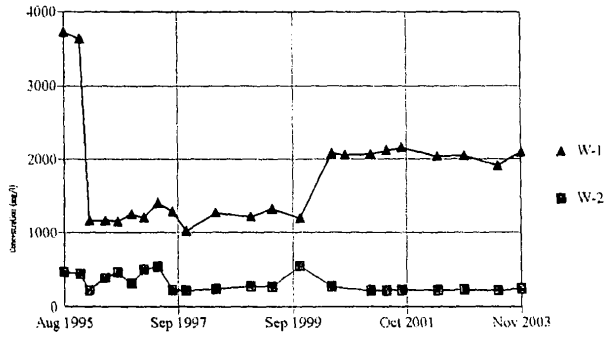

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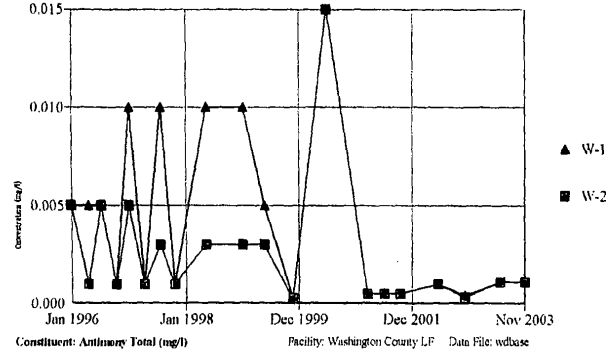

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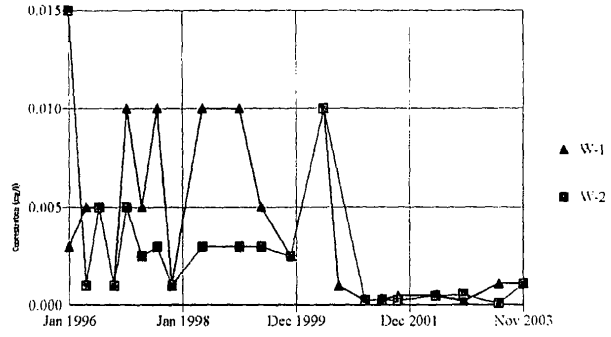

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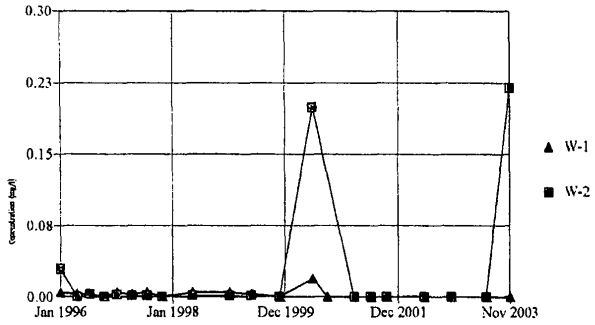

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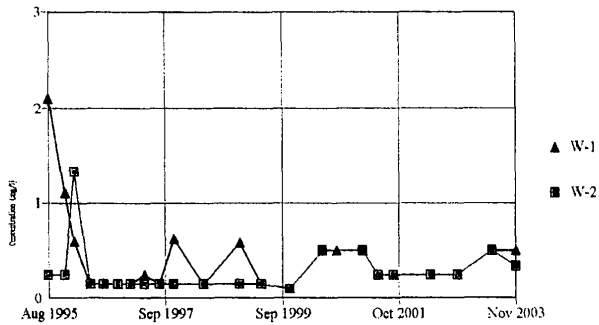

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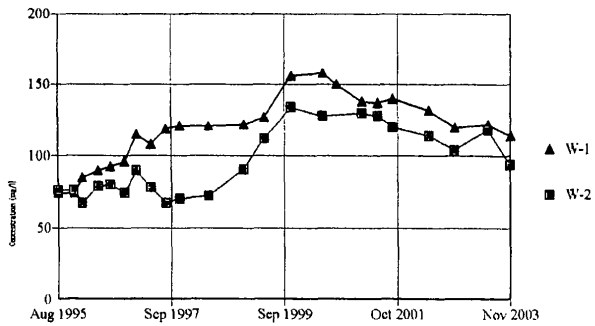

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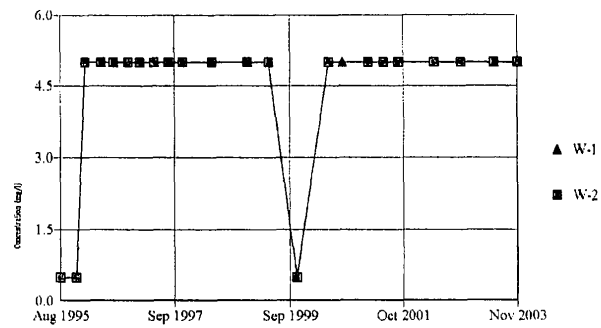

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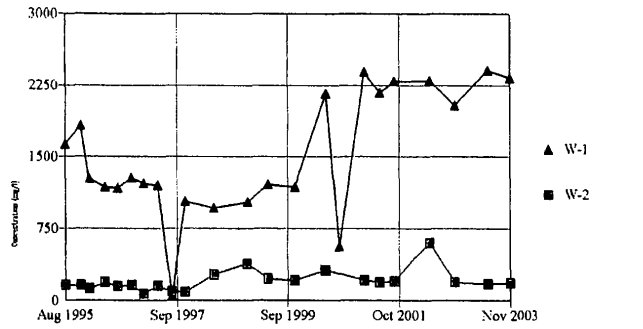

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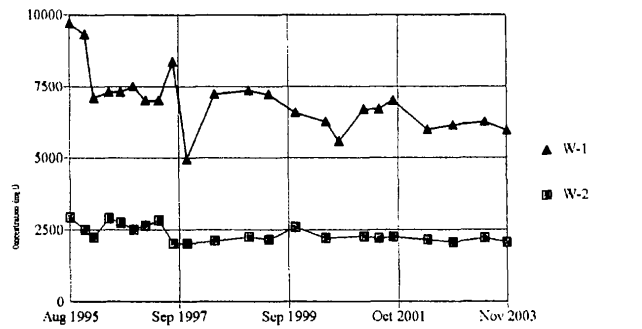

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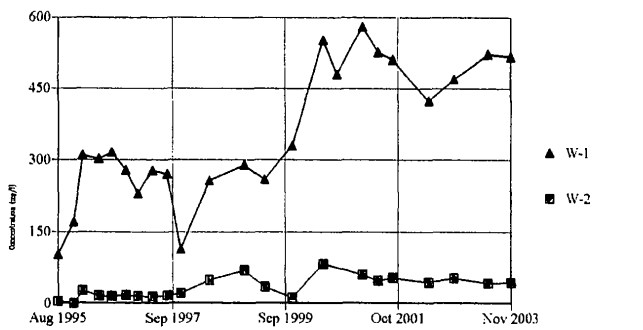

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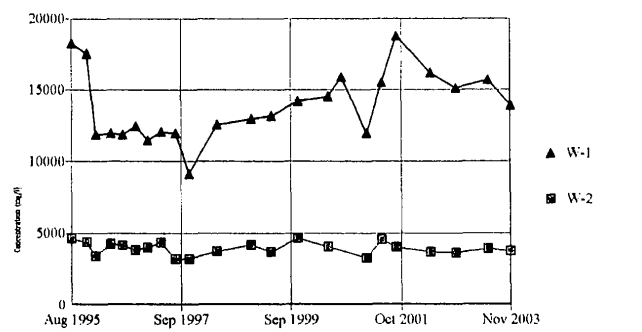

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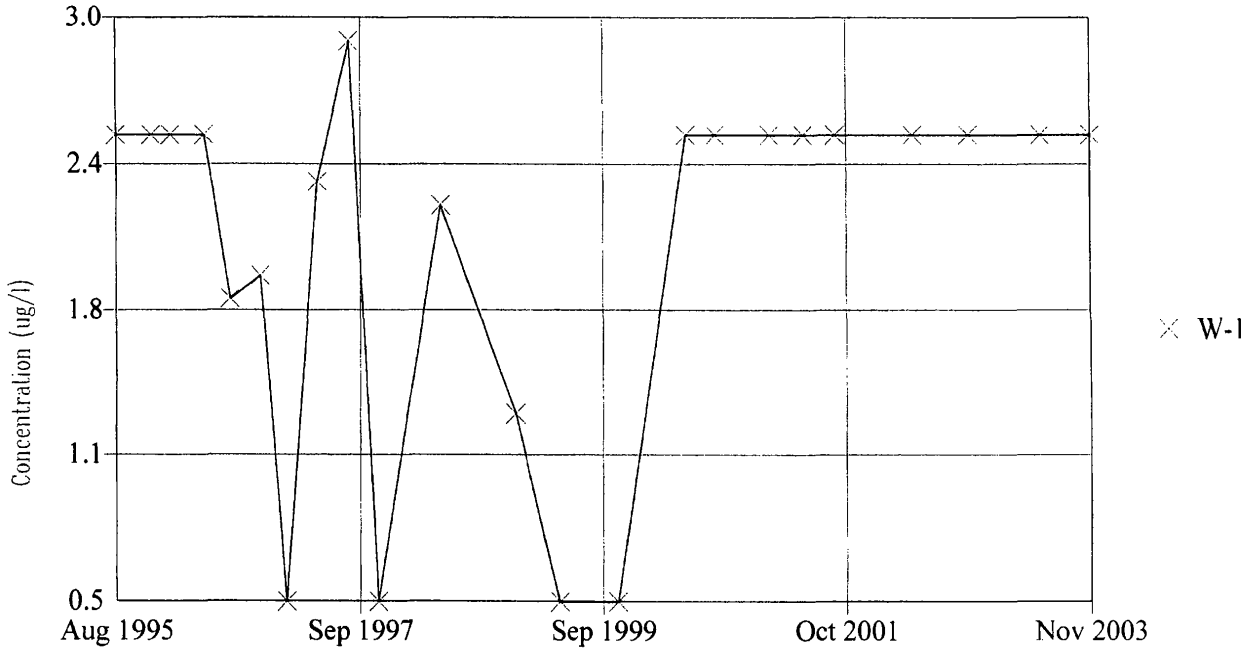

Constituent: 11-Dichloroethane (ug/l) Facility: Washington County LF Data File: wdbase

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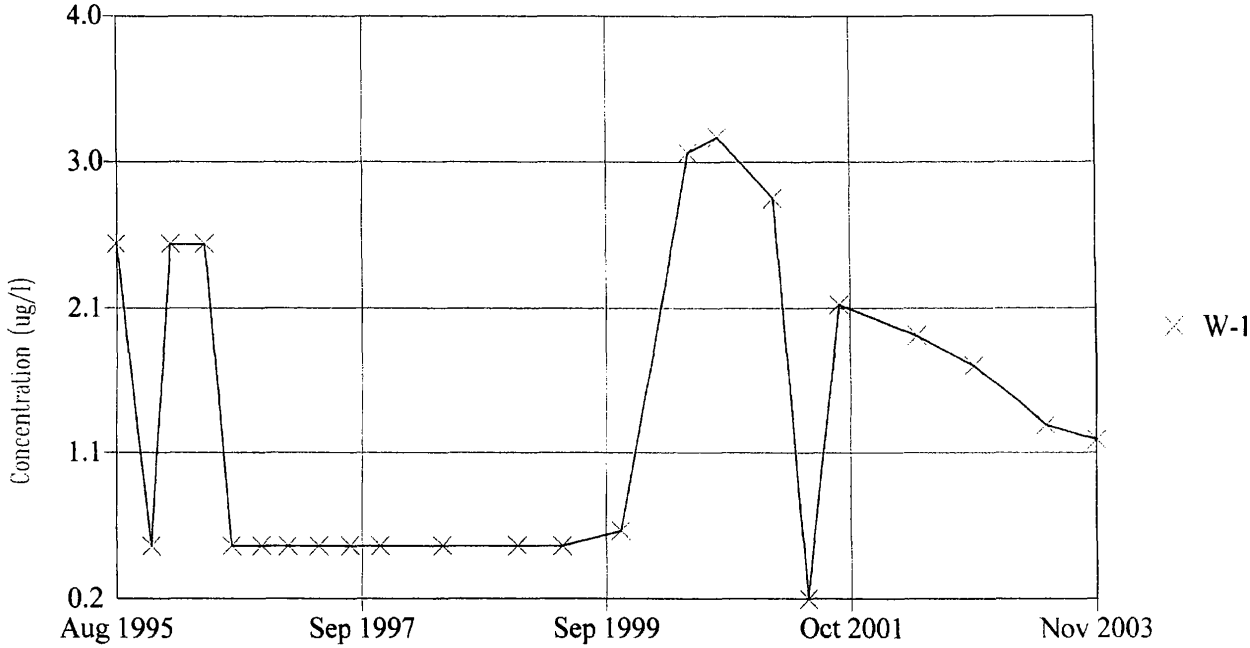
TIME SERIES



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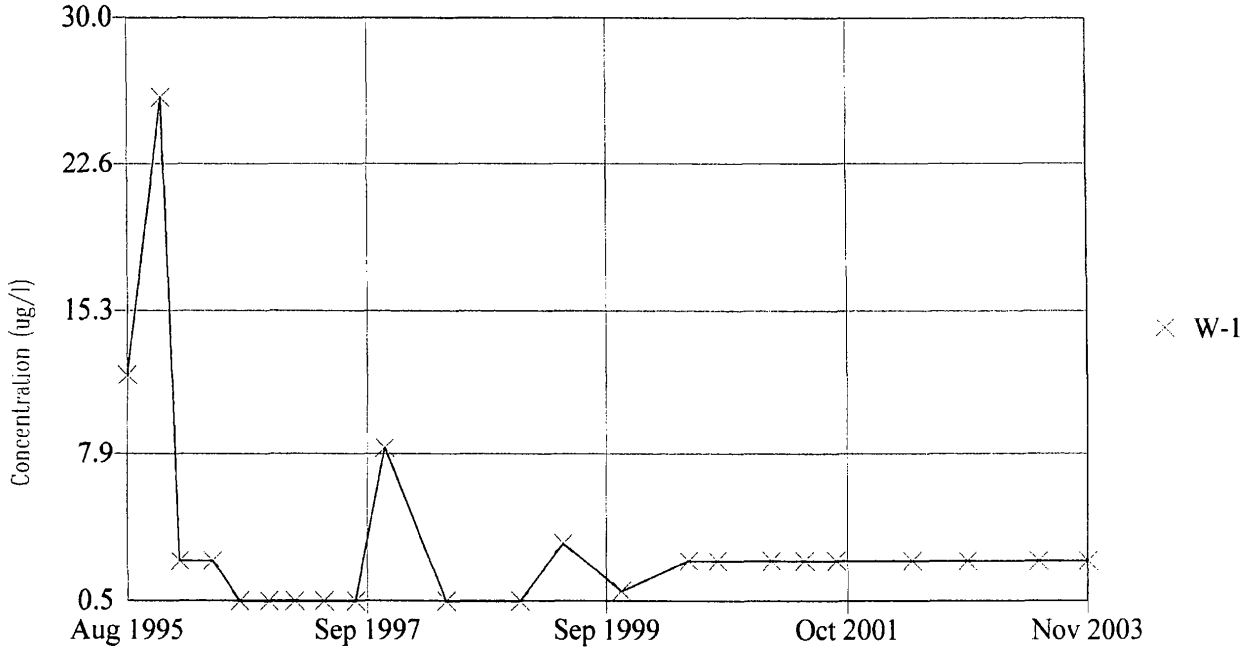

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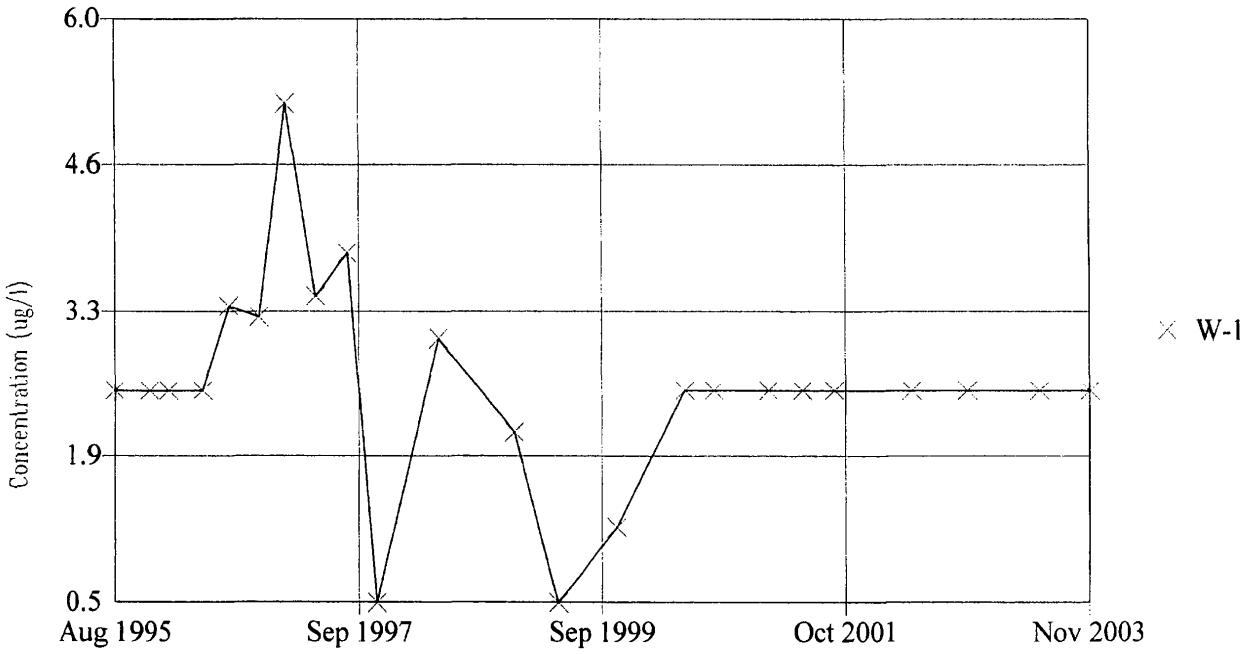

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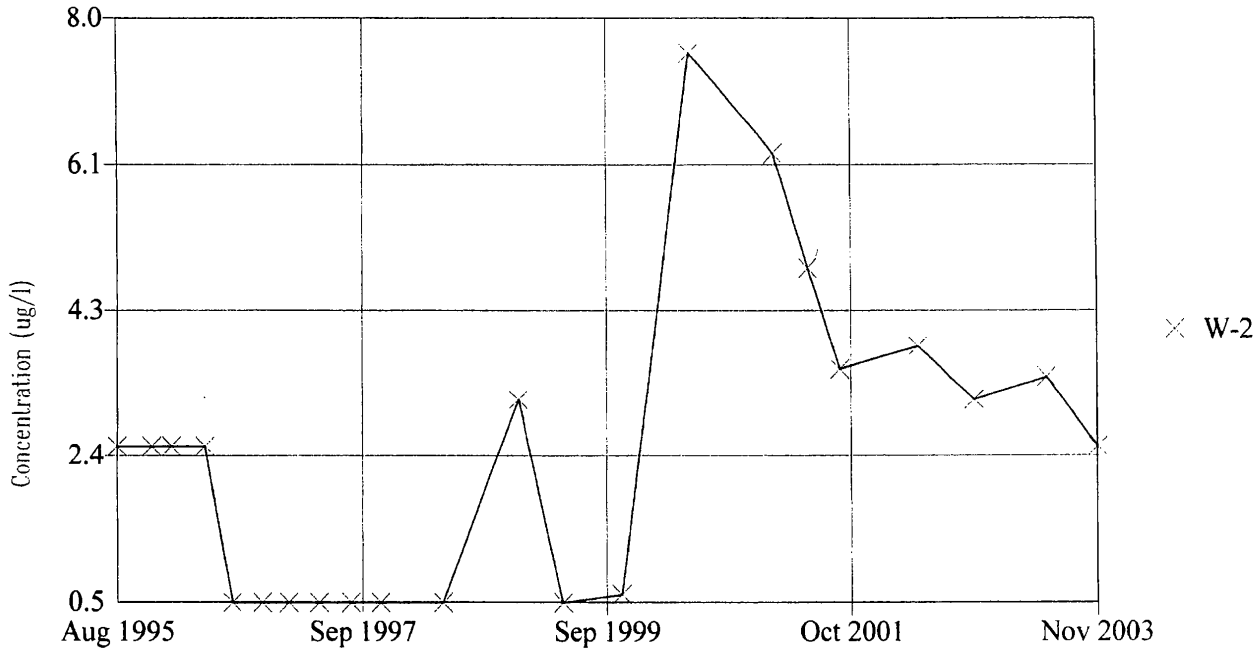
TIME SERIES



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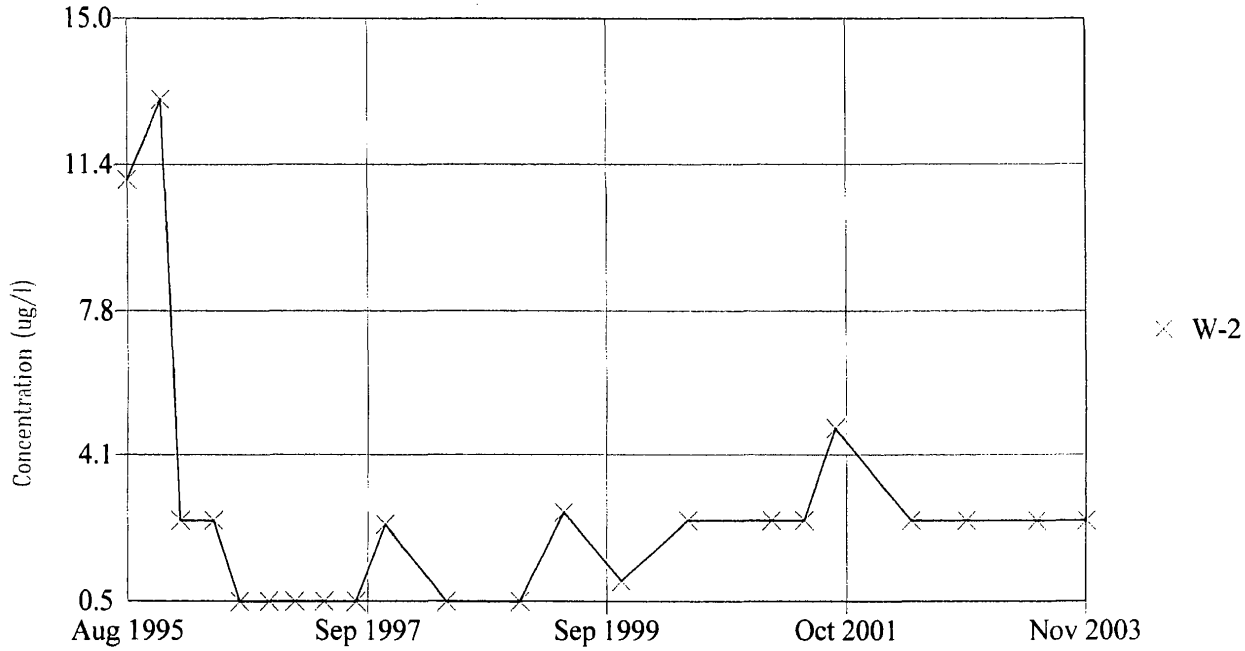

Constituent: Methylene chloride (ug/l) Facility: Washington County LF Data File: wdbase

Date: 6/24/04, 10:37 AM Client: AWI View: VOC

GROUNDWATER SAMPLING AND ANALYSIS PLAN (GWSAP)

WASHINGTON COUNTY LANDFILL
ST. GEORGE, UTAH

Project No: 05-09-21

Prepared for

Washington County Landfill

September 2005

Prepared by:

The Carel Corporation
136 Pecan Street
Keller, TX 76248

TABLE OF CONTENTS

1 INTRODUCTION

The following sampling and analysis plan covers the procedures for collecting representative samples from groundwater monitoring wells and the laboratory requirements for obtaining valid, defensible data. The scope is limited to sampling and analysis requirements and does not include monitor well placement, design and construction, or well development procedures.

The plan is a general requirement for groundwater monitoring sampling and analysis based primarily on the federal requirements in 40 CFR Part 258, current EPA guidance documents, and Utah Administrative Code (UAC) R315-308-2 Solid Waste Permitting and Management Rules.

2 FIELD PROCEDURES

2.1 Field Sampling Health and Safety Plan

A health and safety plan is required for all groundwater sampling events at the Washington County Landfill. Prior to monitoring well purging and sampling, the sampling contractor's Groundwater Sampling Health and Safety Plan must be in place. Designing the site Groundwater Sampling Health and Safety Plan will be the duty of the party performing the actual work.

In addition, each laboratory facility should have their own standard laboratory health and safety plan as required by current OSHA regulations.

2.2 Sample Event Preparation and QA/QC

2.2.1 General Event Preparation

The laboratory performing the groundwater analysis shall supply all necessary coolers, pre-cleaned containers, trip blanks, chemical preservatives, labels, custody seals, and chain-of-custody and shipping forms. All field data shall be entered on a Field Data Sheet (see example provided as Appendix A) or equivalent form. Adequate instructions to the laboratory must be given in advance of each monitoring event. Details concerning any changes to the monitoring plan and/or procedures need to be given to the laboratory prior to the field sampling personnel arriving on the site. A specific contact person shall be established at both the facility and contract laboratory for communication between the two (2) parties.

2.2.2 Sample Container Selection

Sample containers need to be constructed of a material compatible and non-reactive with the material it is to contain. Consult Appendix B, *Recommended Containerization and Preservation of Samples*, to determine the number, type and volume of appropriate containers. The contract laboratory performing the analysis shall supply all the required containers. In special circumstances when the facility must obtain its own containers,

these containers will be purchased from local container distributors with the exception of the septum vials and PTFE (e.g. Teflon®) lined caps required for organic analyses which are available from laboratory supply companies. Metal lids shall not be utilized for any sample containers.

2.2.3 Container Preparation

Sample containers will be purchased as a pre-cleaned product or cleaned in the laboratory in a manner consistent with EPA protocol.

2.2.4 Sample Equipment Preparation

This section outlines the equipment preparation prior to site arrival for a specific monitoring event. This equipment preparation includes minimum decontamination procedures for water level indicator(s), pH/temperature meter, specific conductivity meter, turbidity meter, and filtration device. Operation and calibration of equipment will be as per the manufacturer's instructions. All non-dedicated equipment will be thoroughly cleaned prior to arrival at the site and between sampling points as follows:

- Water Level Indicator(s) - Water level indicator(s) will be decontaminated prior to initial site arrival by hand washing the sensor probe and entire length of tape in a non-phosphate detergent followed by rinsing with deionized water. While the tape is reeled back onto the carrying spool, the tape and probe will be wiped down with a clean dry paper towel.

- Field Parameter (Temperature, pH, Specific Conductivity, Turbidity) Measuring Device(s) – Field parameter measuring device(s) will be decontaminated by hand washing the sample cells in a non-phosphate detergent followed by rinsing with deionized water. Meters will then be checked for proper calibration and operation as per the manufacturer's instructions. Field calibration results will be recorded on a Calibration Data Sheet (Appendix C). Any malfunctioning meters will be replaced prior to packing. Field parameter measuring device(s) will be rinsed with deionized water after each measurement.

- Sampling devices associated with groundwater sampling will be cleaned in non-phosphate detergent, followed by rinsing with deionized water.

Multiple-use equipment (e.g. water level indicators and filter chambers) must be thoroughly decontaminated and cleaned as described in this section to prevent cross contamination from prior use at other facilities. All field instruments must be properly checked and calibrated prior to arrival on-site at a sampling location.

2.2.5 Field QA/QC Samples

Field QA/QC samples consist of two (2) primary areas of quality control. The first part is the quality control of sample contamination, which may occur in the field and/or shipping procedures. This is monitored in the trip blank(s), field blank(s), and the equipment (rinsate) blank(s). A basic description of each is as follows:

- Trip Blank - These samples will be prepared in the laboratory by filling the appropriate clean sample containers with organic-free water and adding the applicable chemical preservative, if any, as indicated in Appendix B for each type of sample. These containers are to be labeled "Trip Blank", the analyses to be performed on each container indicated, and then shipped in the typical transportation cooler to the field and back to the laboratory along with the other sample set containers for a given event. This blank is tested for any contamination that may occur as a result of the containers, sample coolers, cleaning procedures, or chemical preservatives used. Trip blanks shall be taken and analyzed for each sampling event or a minimum of a one (1) in twenty (20) batch per monitoring event for volatile organic compounds (VOCs) only.

- Field Blank - Field blank containers will be prepared in the field at a routine sample collection point during a monitoring event by filling the appropriate sample containers from the field supply of deionized water. This field supply water shall be the same water used for cleaning and decontamination of all field purge and sample equipment. This blank is tested for any contamination that may occur as a result of site ambient air conditions and serves as an additional check for contamination in the containers, sample transport coolers, cleaning procedures, and any chemical preservatives. Field blanks shall be taken and analyzed for each sampling event or a minimum of one (1) per cooler per monitoring event for VOCs.

- Equipment (Rinsate) Blank - These blanks will be prepared in the field immediately following decontamination cleaning procedures on any non-dedicated equipment used for purging, sampling or sample filtration. Following decontamination, field supply organic-free water is passed through the non-dedicated equipment in the same procedure as a groundwater sample. This blank confirms proper field decontamination procedures on non-dedicated equipment utilized in the field. Equipment blanks shall be taken and analyzed for all applicable parameters anytime non-dedicated equipment is used or new equipment is being dedicated to a well at a batch minimum of one (1) in twenty (20) per monitoring event.

Other Field QA/QC Samples - A second area of standard field QA/QC samples are field duplicates.

- Field duplicates are an extra set of samples taken at a particular monitoring point and labeled "Field Duplicate". These are independent samples that are collected as close as possible to the same point in space and time. They are two (2) separate samples taken from the same source, stored in separate containers, and analyzed independently. Field duplicates are useful in documenting the precision of the sampling and analytical process. Samples shall be collected in proper alternating order for the sample point and field duplicate for each parameter (e.g. VOA - VOA, metals - metals, etc.) Field duplicates shall be taken and analyzed at a batch minimum of one (1) in twenty (20) per monitoring event.

Appropriate field QA/QC documentation should be recorded in the field notes (e.g. locations where the field blank or duplicate were collected).

2.3 Well Purge

2.3.1 General Well Purge Information

Purging a monitoring well is just as important as the subsequent sampling of the well. Water standing in a monitor well over a certain period of time may become unrepresentative of formation water because of chemical and biochemical changes which may cause water quality alterations. Prior to monitoring well purge, inspection of the monitoring well integrity will be performed utilizing the Field Data Sheet (Appendix A) or equivalent form.

2.3.2 Water Level Measurement

Prior to any purge or sampling activity at each monitoring well, a water level measurement is required to be taken. Measurement of the static water level is important in determining the hydrogeologic characteristics of the subsurface (e.g. upgradient and downgradient). The water level indicator will be an electronic sensor device, which signals by audio or light indicator when the probe contacts the water.

Water level indicator equipment will be constructed of chemically inert materials and, during mobilization preparation and following each monitoring point, be decontaminated with a non-phosphate detergent followed with multiple deionized water rinses. Water levels will be measured with a precision of +/- 0.01 foot. Water level indicator devices will be periodically checked for proper calibration. Calibration shall be performed at a frequency recommended by the manufacturer. Each monitor well shall have a reference elevation point located and properly marked at the top of the riser casing established by a licensed surveyor. This reference point elevation is measured in relation to Mean Sea Level (MSL).

Ground water elevations in wells that monitor the same waste management area must be measured within a forty-eight (48) hour period to avoid temporary variations in groundwater flow, which could preclude accurate determination of groundwater flow rate and direction.

2.3.3 Purge Equipment and Procedure

Well purging will take place from hydraulically upgradient wells to hydraulically downgradient wells. If known impacts exist, purging will take place from the least impacted well to the most impacted well. Prior to purge, the sample personnel will put on clean disposable nitrile gloves and an initial water level will be taken as described in Section 2.3.2.

Groundwater wells will be purged with dedicated bladder pumps. These pumps will remain dedicated to each respective well throughout monitoring unless replacement is necessary due to damage or wear, in which case repairs will be completed or a new pump will be dedicated. Purge procedures for dedicated equipment are described in Section 2.3.3.1. Pump intakes will be located as close as possible to the middle of the screened interval.

2.3.3.1 Dedicated Equipment

Low Flow Technique

Low-flow purging is the preferred purging and sampling technique and will be employed using dedicated bladder pumps if proper pump controller and field instruments are available to the sampling personnel. Well purging will be conducted at a rate of approximately 100 milliliters per minute until a minimum of two pump and tubing volumes have been removed and stabilization of field parameters is achieved. Field parameters include temperature, specific conductivity, pH, and turbidity.

Parameter stabilization is defined as:

- Temperature = ± 10% for three (3) consecutive measurements
- pH = ± 0.1 standard pH units for three (3) consecutive measurements
- Specific Conductivity = ± 3% for three (3) consecutive measurements
- Turbidity = ± 10% for three (3) consecutive measurements

Measurements will be recorded on the field data sheet every three to five minutes. Water level measurement will also be taken every three to five minutes and recorded on the field data sheet. An initial decrease in water level may be expected due to pump and tubing

evacuation, however, minimal subsequent continuous drawdown is to be expected. Should a well repeatedly not meet one or more criteria, alternate criteria may be implemented with UDEQ approval.

Fixed Volume Technique

If Low-Flow techniques are not used, wells will be purged a minimum of three (3) well casing volumes of water or until dryness if occurring prior to removal of three well casing volumes of water. Measurements of temperature, pH, conductivity, and turbidity will be recorded at intervals of approximately three (3) to five (5) minutes on a Field Data Sheet (see Appendix A) during purging.

A bladder pump will be used for both well purging and sample collection.

Equipment:

- Bladder pump
- Bladder pump controller
- Compressed air source
- New disposable gloves of appropriate material (nitrile)
- Graduated pail and/or cylinder
- Field parameter measurement device/s

Procedure:

- Appropriate disposable gloves are to be worn during installation.
- Connect the compressed air source to the pump fitting at the top of the well.
- Start the air compressor.
- Replace disposable gloves after handling the compressor.
- Turn on the pump controller and adjust the discharge and refill cycles to the appropriate settings.
- Press the start button on the controller, which begins the pumping action.
- Adjust the controller to the desired flow rate (approximately 100 milliliters per minute).

Continue pumping until the necessary volume of water has been purged from the well and field parameters have stabilized.

2.3.3.2 Non-Dedicated Equipment

In the event of a non-operative dedicated pump, the pump and tubing apparatus will be removed for repairs or replacement and the well will be purged by means of either a disposable bailer or a portable pump until such time the bladder pump is repaired/replaced and rededicated to the well. Purging will be performed by removing a minimum of three well-casing volumes of water from the well or until stabilization of field parameters (as defined in Section 2.3.3.1) occurs. Purging will be deemed complete if the well goes dry before three well-casing volumes of water have been removed. Field parameters will be measured after each well-casing volume of water removed.

Equipment:

- Non-dedicated pump/bailer
- Pump controller (if required)
- Generator or other power source/driving mechanism for pumps / appropriate disposable string or rope for bailer, downrigger (optional)
- New disposable tubing
- New disposable gloves of appropriate material (nitrile)
- Graduated pail or other appropriate container
- Field parameter measurement device(s)
- Container for laboratory grade, nonphosphate soap/reagent-grade deionized water solution
- Container for reagent-grade deionized water rinse

Procedure (Specific operating instructions vary depending on the type of portable pump used. The steps listed below are generalized procedures)

- Don a new pair of gloves.
- Cleanse portable pump/bailer with a non-phosphate, laboratory grade detergent solution followed by an reagent-grade deionized water rinse. Sufficient water should be passed through a non-dedicated pump to ensure proper cleansing.
- Remove gloves worn during cleaning and don a new pair of gloves.
- Attach new disposable tubing to pump or new disposable string to bailer.
- Insert pump and tubing/bailer into well.
- Start the portable pump by the appropriate method and adjust flow to desired rate / initiate removal of water from well with bailer. Ensure bailer and string do not touch ground during purging.

When purging with a bailer, introduce bailer into water column slowly (i.e. do not "drop" into water column) to avoid agitation of water in the well and immediate formation area.

Non-dedicated equipment will be constructed of chemically inert materials and will be decontaminated at each well with a non-phosphate detergent followed with a reagent-grade deionized water rinse. Additional cleaning procedures will be performed as deemed necessary.

Rate of discharge and volume purged will be checked periodically with a graduated bucket and/or timer. Field parameter (temperature, pH, specific conductivity, and turbidity) measurements will be recorded after each well volume of water is removed during purging.

2.3.4 Purge Water Management

If purge water is known to be historically contaminated or suspect due to prior analytical data, the water shall be stored in appropriate containers until analytical results are available. After review of these analyses, proper arrangements for disposal or treatment of the water shall be made. Otherwise, purge water will be discarded on the ground away from the monitor well area.

2.4 Monitoring Well Sample Collection

2.4.1 General Sample Collection Information

Sampling should take place as soon as purging is complete if the well has sufficient recharge. If the well was purged dry or significant drawdown of the water level exists immediately after purge, the monitor well should be sampled as soon as sufficient water is present for all analytes to be collected. The time interval between the completion of well purge and sample collection normally should not exceed forty-eight hours.

2.4.2 Sample Collection Order

Monitor well sampling at each event shall proceed from the point with the highest water level elevation to those with successively lower elevations unless contamination is known to be present. If contamination is known to be present, samples will be collected from the least to most contaminated wells, to minimize the potential for any cross-contamination. Samples will be collected and containerized according of the volatility of the requested analyses. A specific collection order is as follows:

- Field Parameters (Temperature, pH, Specific Conductivity, Turbidity)
- Volatile Organics
- Metals
- Inorganics

2.4.3 Sampling Equipment/Procedures

Groundwater wells will be sampled using dedicated bladder pumps. These are the same pumps used for well purging.

2.4.4 VOC Sample Collection

Filling VOC sample containers involves extra care. The water should be gently added to each vial until a positive meniscus is formed over the top of the container. This insures no headspace is present in the sample vial upon replacing the cap. After the cap has been placed on the vial and tightened, the vial should be checked for air bubbles by turning upside down and tapping with finger. If a bubble is seen rising to the top of the inverted vial, the process outlined above should be repeated. If no air bubbles are seen in each vial, the process is complete.

2.4.5 Sample Filtration

All efforts must be made to delete or minimize controllable factors to allow the collection of as representative and turbid-free sample as possible. Utah DEQ, UAC, Solid Waste Permitting and Management Rules does not currently allow for field sample filtration of constituents listed in R315-308-4 prior to laboratory analysis (R315-308-2 (4)(d)). The facility may collect samples for laboratory filtration and analysis of dissolved metals when deemed necessary. Otherwise, metal and inorganic indicator analyses will be for total concentrations.

2.4.6 Sample Preservation

All samples will be containerized and preserved according to Appendix B, *Recommended Containerization and Preservation of Samples.* In the goal to obtain the most representative sample possible, preserving the sample for transportation and storage to the laboratory is also important.

Methods of preservation are intended to retard biological action, retard hydrolysis of chemical compounds and complexes, and reduce the volatility of constituents. Samples

requiring refrigeration to four degrees Centigrade will be accomplished by placing the sample containers immediately into coolers containing wet ice and delivering to the analytical laboratory as soon as possible.

2.4.7 Field Measurements

Required field measurements include water levels, temperature, pH, specific conductivity, and turbidity. Each of these measurements is important in the documentation of properly collected groundwater samples.

All instruments shall be properly calibrated and checked with standards according to the manufacturer's instructions and/or the field crew's standard operating procedures. Any improper operating instruments must be replaced prior to continuing sample collection operations.

2.5 Record Keeping

2.5.1 Field Logs

All field notes must be completely and accurately documented to become part of the final report for a monitoring event. All field information will be entered on a Field Data Sheet (see Appendix A) or equivalent form.

All entries shall be legible and made in indelible ink. Entry errors will be crossed out with a single line, dated, and initialed by the person making the corrections.

2.5.2 Chain-of-Custody

Proper chain of custody records are required to insure the integrity of the samples and the conditions of the samples upon receipt at the laboratory, including the temperature of the samples at the time of log in. The sample collector shall fill in all applicable sections and forward the original, with the respective sample(s), to the laboratory performing the analysis. Upon receipt of the samples at the laboratory, the sample coordinator is to complete the chain of custody, make a copy for his/her files, and make the original documents part of the final analytical report (see example provided as Appendix D). All sample containers will be labeled to prevent misidentification. The following will be indicated on an adhesive label with a waterproof pen:

- Collector's name, date and time of sampling
- Sample source
- Sample identification number

- Sample preservatives
- Test(s) to be performed on the sample

Sample shuttle kits (coolers) will employ a tamper proof seal.

2.6 Sample Transport

Samples shall be shipped from the field back to the analytical laboratory either by hand delivery or utilizing an overnight courier service. Samples are to be shipped in sealed insulated shipping containers. Standard shipping containers must be a sturdy waterproof design (ice chests are commonly used) equipped with bottle dividers and cushion material to prevent breakage during shipment. Since wet ice is the most common means by which to refrigerate the samples, appropriate measures need to be taken to fully waterproof the contents from leakage. The field crew shall contact the laboratory each time samples are sent to identify the samples being sent and the transportation carrier along with the shipping identification number.

The laboratory shall provide a notification concerning the receipt of the groundwater samples as soon as practical after they have been received. The notification will include the date, temperature, and condition of sample bottles received.

3 LABORATORY PROCEDURES/ PERFORMANCE STANDARDS

3.1 Analytical Methods

Chemical analyses will be performed by a laboratory that is certified by the State of Utah to analyze each Table 1 constituent. Methods and reporting limits will conform to Table 1 and will be performed in accordance with test procedures presented in USEPA *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, September 1986 and any subsequent revisions or additions.

Alternative methods that provide equivalent or better performance than those listed in EPA publication SW-846 and analytical methods for constituents not listed in EPA publication SW-846 may be implemented with the approval of the Executive Secretary.

3.2 Deliverables (General and Supplemental QA/QC)

3.2.1 General Requirements

For general reporting of quantitative results for Subtitle D groundwater monitoring projects, the following reporting requirements apply:

- Methodology Summary - reporting of all the analytical test methods used in the analyses of the samples with a reference made for each to the method manual and the test method number to confirm compliance with Table 1.

- Summary of the analytical results, indicating appropriate unit, and reporting RL: and supervisor approval – concentration units must be consistently applied throughout report. Data cannot be method blank corrected. It must be appropriately flagged.

- Chain-of-Custody Form – As per Section 2.5.2.

- Field Data Sheets (see Appendix A) or equivalent form.

3.2.2 Supplemental QA/QC Reporting Requirements

- Laboratory Chronicles – must include date of sampling, sample receipt, preservation, preparation, analysis, and supervisor approval signature.

- Non-Conformance Summary for GC/MS Data Reports – must state if the following do not meet QA/QC requirements:

  GC/MS Tune Specifications
  GC/MS Tune Frequency
  Calibration Frequency
  Calibration Requirements – System Performance Check
  Compounds, Calibration Check Compounds
  Blank Contamination
  Surrogate Recoveries
  Sample Holding Times
  Minimum Detection Limits

3.2.3 Requirements for Organics: Volatiles

1. Quality Assurance (QA) Data Form – must include minimum detection limits, method blanks, field/trip blanks if specified in Sampling Plan, lab replicate. Quality Control (QC) samples may be other than project samples, but must be of same batch and similar matrix. A single QA Data Form should be used for a number of samples; however, pertinent sample numbers must be listed on the form.

2. Surrogate Compound Recovery Summary – for samples and blanks – as per most recent version of applicable SW-846 method 8260.

3. Other requirements per Laboratory Quality Assurance Plan and regulatory requirements.

3.2.4 Laboratory Requirements for Metals

At a minimum, method detection limits must be established and method blank results are mandatory.

3.2.5 Requirements for Inorganic - General Chemistry

Quality Assurance (QA) Data Form - must include minimum detection limits, method blanks, field/trip blanks as specified in Sampling Plan, lab replicate. Quality Control

(QC) samples may be other than project samples, but must be of same batch and similar matrix.

A single QA Data Form should be used for a number of samples; however, pertinent sample numbers must be listed on the form. In addition, spiked sample results must be included.

3.3 Data Quality Objectives

3.3.1 Required Reporting Limits

Data reported must be such that the method used shall achieve the nominal reporting limits (RLs) listed in Table 1 - Background/Detection Monitoring Parameters

3.3.2 Precision

Precision refers to the reproducibility of method results when a second aliquot of the same sample undergoes duplicate analysis. The degree of agreement is expressed as the Relative Percent Difference (RPD). Precision requirements shall be as per applicable method and laboratory standards.

3.3.3 Accuracy

Accuracy refers to the agreement between the amount of a constituent measured by a test method and the amount actually known to be present. Accuracy is usually expressed as a percent Recovery (R). Accuracy shall be as per applicable method and laboratory standards.

4 SAMPLING FREQUENCY AND REPORTING REQUIREMENTS

4.1 Background

As per UAC R315-308-2 (4)(a), a minimum of eight (8) independent samples will be collected and analyzed to establish background for the constituents listed in Table 1 to establish background concentrations. Each monitor well in the site groundwater monitoring program will be defined as background or detection.

4.2 Detection Monitoring Events

After establishment of background values, sampling and analysis for both upgradient and downgradient detection monitoring wells will be conducted on a semi-annual basis (every six (6) months) for constituents listed in Table 1.

4.3 Groundwater Analysis Result Submittals

Two (2) bound copies of a report of all groundwater sampling and analysis results will be submitted to the Executive Secretary. The report will be submitted in standard laboratory format and on any applicable state agency reporting forms. Within a reasonable period of time after completing sampling, the owner/operator must determine whether there has been a statistically significant increase (SSI) over background at each monitoring well as per UAC R315-308-2 (4) (f) (v).

If there has been a statistically significant increase over background of any tested constituent at any monitoring well, a notice in writing to the UDEQ will be submitted within fourteen (14) days after the finding.

5 STATISTICAL METHODOLOGY - GROUND WATER DATA ANALYSIS

Statistical comparisons will be performed using Sanitas™, a commercial software program developed by Intelligent Decision Technologies, Inc. or another comparable computer program. Statistical analyses of groundwater data will be performed in accordance with UAC R315-308-2 (7). A statistical analysis plan has been prepared and included as Appendix E. Appendix E Statistical Analysis Plan has been prepared using generally accepted statistical analysis principals and practices (IDT, 2002). However, it is not possible to predict all of the potential future circumstances. Therefore, alternative methods may be used that are more appropriate for the data distribution of the constituents being evaluated.

5.1 Statistically Significant Constituents and Verification Resampling

Statistical analysis of constituents in Table 1 will commence within six (6) months after completion of eight (8) quarterly background events for a particular well. An initial Statistically Significant Increase (SSI) will be based on any compound detected in any downgradient monitor well at a concentration above the specific constituent's statistical limit. If an initial SSI of any constituent is indicated at any downgradient monitoring well, a notice will be made to the Department in the form of a statistical analysis report as referenced in Section 4.3 of this plan.

Verification resampling is an integral part of the presented statistical methodology. In the event of an initial SSI, verification resampling may be conducted and the results provided to the Executive Secretary in accordance with UAC R315-308-2 (10) (b).

As per UAC R315-308-2 (10) (c), the owner/operator may demonstrate, to the satisfaction of the Executive Secretary, within 90 days of the finding that the SSI is the result of a source other than the Municipal Solid Waste Landfill (MSWLF), such as error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Otherwise, the owner/operator must initiate an assessment monitoring program under UAC R315-308-2 (11).

6 REFERENCES

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U.S. Environmental Protection Agency, 1991b. *Handbook - Groundwater, Volume II: Methodology.* EPA/625/6-90/0166.

U.S. Environmental Protection Agency, November 1986. *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, Third Edition (Revised),* SW-846. Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency, November 1993. *Solid Waste Disposal Facility Criteria Technical Manual.* EPA/530-R-93-017, NTIC #PB94-100-450, Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency, Federal Register, 40 CFR 258, October 9, 1991.

TABLES

Table 1
List of Analytical Parameters
Washington County Landfill

Inorganic Constituents	CAS	Method[1]	RL[2] (mg/L)
Ammonia as Nitrogen	7664-41-7	350.1	1
Carbonate/Bicarbonate		310.1	10
Calcium		6010 or 6020	0.6
Chemical Oxygen Demand (COD)		410.2	10
Chloride		300.0	10
Iron	7439-89-6	6010 or 6020	0.1
Magnesium		6010 or 6020	0.2
Manganese	7439-96-5	6010 or 6020	0.015
Nitrate as Nitrogen		300.0 or 353.2	5
pH		150.1	N/A
Potassium		6010 or 6020	5
Sodium		6010 or 6020	5
Sulfate		300.0 or 375.4	10
Total Dissolved Solids (TDS)		160.1	10
Total Organic Carbon (TOC)		415.1	2
Heavy Metals	**CAS**	**Method[1]**	**RL[2] (mg/L)**
Antimony	7440-36-0	6010 or 6020 or 200.8	0.005
Arsenic	7440-38-2	7041 or 6020	0.04
Barium	7440-39-3	6010 or 6020	0.02
Beryllium	7440-41-7	7091 or 6020	0.002
Cadmium	7440-43-9	6010 or 6020	0.001
Chromium		6010 or 6020	0.05
Cobalt	7440-48-4	6010 or 6020	0.07
Copper	7440-50-8	6010 or 6020	0.05
Lead		7421 or 6020 or 200.8	0.01
Mercury	7439-97-6	6020 or 7470	0.001
Nickel	7440-02-0	6010 or 6020	0.01
Selenium	7782-49-2	7740 or 6010 or 6020	0.02
Silver	7440-22-4	6010 or 6020	0.07
Thallium		7841 or 6020 or 200.8	0.002

Table 1 (Continued)

Heavy Metals	CAS	Method[1]	RL[2] (mg/L)
Vanadium	7440-62-2	6010 or 7911	0.02
Zinc	7440-66-6	6010 or 6020	0.01

Volatile Organic Compounds	CAS	Method[1]	RL[2] (µg/L)
Acetone	67-64-1	8260B	10
Acrylonitrile	107-13-1	8260B	50
Benzene	71-43-2	8260B	4
Bromochloromethane	74-97-5	8260B	4
Bromodichloromethane	75-27-4	8260B	4
Bromoform (tribromomethane)	75-25-2	8260B	4
Carbon disulfide	75-15-0	8260B	4
Carbon tetrachloride	56-23-5	8260B	4
Chlorobenzene	108-90-7	8260B	4
Chloroethane (ethyl chloride)	75-00-3	8260B	8
Chloroform (trichloromethane)	67-66-3	8260B	4
Dibromochloromethane (Chlorodibromomethane)	124-48-1	8260B	4
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	8260B	0.2
1,2-Dibromoethane (ethylene dibromide, EDB)	106-93-4	8260B	0.05
o-Dichlorobenzene (1,2-dichlorobenzene)	95-50-1	8260B	4
p-Dichlorobenzene (1,4 dichlorobenzene)	106-46-7	8260B	4
trans-1,4-Dichloro-2-butene	110-57-6	8260B	4
1,1-Dichloroethane (ethylidene chloride)	75-34-3	8260B	4
1,2-Dichloroethane (ethylene dichloride)	107-06-2	8260B	4
1,1-Dichloroethylene (1,1-dichloroethene)	75-35-4	8260B	4
cis-1,2-Dichloroethylene (1,1-dichloroethene)	156-59-2	8260B	4
trans-1,2-Dichloroethylene (trans-1,2-dichloroethene)	156-60-5	8260B	4
1,2-Dichloropropane (propylene dichloride)	78-87-5	8260B	4
cis-1,3-dichloropropene	10061-01-5	8260B	2
trans-1,3-dichloropropene	10061-02-6	8260B	2

Table 1 (Continued)

Heavy Metals	CAS	Method[1]	RL[2] (mg/L)
Vanadium	7440-62-2	6010 or 7911	0.02
Zinc	7440-66-6	6010 or 6020	0.01

Volatile Organic Compounds	CAS	Method[1]	RL[2] (µg/L)
Acetone	67-64-1	8260B	10
Acrylonitrile	107-13-1	8260B	50
Benzene	71-43-2	8260B	4
Bromochloromethane	74-97-5	8260B	4
Bromodichloromethane	75-27-4	8260B	4
Bromoform (tribromomethane)	75-25-2	8260B	4
Carbon disulfide	75-15-0	8260B	4
Carbon tetrachloride	56-23-5	8260B	4
Chlorobenzene	108-90-7	8260B	4
Chloroethane (ethyl chloride)	75-00-3	8260B	8
Chloroform (trichloromethane)	67-66-3	8260B	4
Dibromochloromethane (Chlorodibromomethane)	124-48-1	8260B	4
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	8011	0.2
1,2-Dibromoethane (ethylene dibromide, EDB)	106-93-4	8011	0.05
o-Dichlorobenzene (1,2-dichlorobenzene)	95-50-1	8260B	4
p-Dichlorobenzene (1,4 dichlorobenzene)	106-46-7	8260B	4
trans-1,4-Dichloro-2-butene	110-57-6	8260B	4
1,1-Dichloroethane (ethylidene chloride)	75-34-3	8260B	4
1,2-Dichloroethane (ethylene dichloride)	107-06-2	8260B	4
1,1-Dichloroethylene (1,1-dichloroethene)	75-35-4	8260B	4
cis-1,2-Dichloroethylene (1,1-dichloroethene)	156-59-2	8260B	4
trans-1,2-Dichloroethylene (trans-1,2-dichloroethene)	156-60-5	8260B	4
1,2-Dichloropropane (propylene dichloride)	78-87-5	8260B	4
cis-1,3-dichloropropene	10061-01-5	8260B	2
trans-1,3-dichloropropene	10060-02-6	8260B	2

10061-02-6

Table 1 (Continued)

Volatile Organic Compounds	CAS	Method[1]	RL[2](µg/L)
Ethylbenzene	100-41-4	8260B	4
2-Hexanone (methyl butyl ketone)	591-78-6	8260B	5
Methyl bromide (bromomethane)	74-83-9	8260B	5
Methyl chloride (chloromethane)	74-87-3	8260B	2
Methylene bromide (dibromomethane)	74-95-3	8260B	4
Methylene chloride (dichloromethane)	75-09-2	8260B	4
Methyl ethyl ketone (MEK, 2-butanone)	78-93-3	8260B	5
Methyl iodide (iodomethane)	74-88-4	8260B	4
4-Methyl-2-pentanone (methyl isobutyl ketone)	108-10-1	8260B	5
Styrene	100-42-5	8260B	4
1,1,1,2-Tetrachloroethane	630-20-6	8260B	4
1,1,2,2-Tetrachloroethane	79-34-5	8260B	4
Tetrachloroethylene (tetrachloroethene)	127-18-4	8260B	4
Toluene	108-88-3	8260B	4
1,1,1-Trichloroethane (methylchloroform)	71-55-6	8260B	4
1,1,2-Trichloroethane	79-00-5	8260B	4
Trichloroethylene (trichloroethene)	79-01-6	8260B	4
Trichlorofluoromethane (CFC-11)	75-69-4	8260B	4
1,2,3-Trichloropropane	96-18-4	8260B	4
Vinyl acetate	108-05-4	8260B	5
Vinyl chloride	75-01-4	8260B	2
Xylenes (total)	1330-20-7	8260B	4

1. Equivalent or better methods may be submitted as appropriate
2. Reporting Limits

For the compounds DBCP and EDB, any detectable amount between the RL and MCL will be estimated and flagged with an appropriate symbol.

APPENDIX A

Washington County Landfill

GROUNDWATER SAMPLING
FIELD DATA SHEET

Well Number: _____
Sample I.D.: _____ (if different from well no.)

Project: _____
Personnel: _____

Date: _____
Weather: _____ Air Temp: _____

WELL DATA:

Casing Diameter: _____ (in) ☐ PVC ☐ Other: _____
DEPTH TO: Static Water Level (WL): _____ (ft) Total Depth (TD): _____ (ft)
DATUM: ☐ Top of Well Casing ☐ Top of Protective Casing
CONDITION: Is well clearly labeled? ☐ Yes ☐ No
Is prot. casing in good cond.? (not bent or corroded) ☐ Yes ☐ No
Is concrete pad intact? (not cracked or frost heaved) ☐ Yes ☐ No
Is padlock functional? ☐ Yes ☐No Is inner casing intact? ☐ Yes ☐ No
Is inner casing properly capped and vented? ☐ Yes ☐ No
Comments: _____

PURGE DATA: One Casing Volume = (d/24)2 (23.5)(TD-WL)
METHOD: ☐ Bladder Pump ☐ Bailer ☐ Other: _____ Low-Flow Purging Used? ☐Yes ☐ No
MATERIALS: Type of Pump: _____
Tubing: ☐Teflon® ☐ Polyethylene ☐ Polypropylene ☐ Other: _____
PURGING EQUIPMENT: ☐ Dedicated ☐ Prepared Off-Site ☐ Field-Cleaned
PROCEDURES: Pump & Tubing Vol.: _____(ml) Pumping Rate: _____ (ml/min)
CALIBRATION: pH Meter Model: _____ Meter S/N: _____ Time: _____
Cond. Meter Model: _____ Meter S/N: _____ Time: _____
'sposition of Purge Water: _____

TIME SERIES DATA:

Time:							
Cum. Volume(ml)							
Temperature (®C)							
pH (s.u.):							
Spec. Cond. (µmhos/cm):							
Turbidity (NTU):							
Other							

SAMPLING DATA:

Sample Collection Time: _____
Water Level at Time of Sample: _____
METHOD: ☐ Bladder Pump ☐ Bailer ☐ Other: _____
SAMPLING EQUIPMENT: ☐ Dedicated ☐ Prepared Off-Site ☐Field-Cleaned
APPEARANCE: ☐ Clear Turbid (NTU): _____Color: _____ ☐ Contains Immiscible Liquid
FIELD DETERMINATIONS: Temp. (°C):_____pH (s.u.):_____Spec. Cond. (µmhos/cm): _____
General Remarks: _____

I certify that this sample was collected and handled in accordance with applicable regulatory and project protocols.

Signature: _____ Date: _____

APPENDIX B

RECOMMENDED CONTAINERIZATION AND PRESERVATION OF SAMPLES

Measurement	Volume (mL)	Container[a]	Preservative	Holding Times	Reference
Physical Properties					
Specific Cond. (Field)	100	P,G	None	Det. on Site	1
Specific Cond. (Lab)	100	P,G	Cool, 4 °C	28 Days	1
pH (Field)	50	P,G	None	Det. on Site	1,2
pH (Lab)	50	P,G	None	24 Hrs	1,2
Temperature	1000	P,G	None	Det. On Site	1
Turbidity	100	P,G	None	Det. On Site	1

Measurement	Volume (mL)	Container[a]	Preservative	Holding Times	Reference
Inorganics, Non-Metallics					
Ammonia as Nitrogen	1000	P,G	Cool, 4 °C H_2SO_4 to pH <2	28 days	2,3
Carbonate/Bicarbonate	200	P,G	Cool, 4 °C	14 days	1
Chemical Oxygen Demand (COD)	50	P,G	H_2SO_4 to pH <2	28 days	1
Chloride	200	P,G	None	28 Days	1,2
Nitrate plus Nitrite	200	P,G	Cool, 4 °C H_2SO_4 to pH <2	28 days	1,2
Sulfate	100	P,G	Cool, 4 °C	28 days	1,2
Total Dissolved Solids (TDS)	500	P,G	Cool, 4 °C	7 days	2,3
Total Organic Carbon (TOC)	250	P,G	Cool, 4 °C HCL or H_2SO_4 to pH <2	28 days	2,3

RECOMMENDED CONTAINERIZATION AND PRESERVATION OF SAMPLES

Measurement	Volume (mL)	Container[a]	Preservative	Holding Times	Reference
Metals (except mercury)					
Total	500	P,G	HNO_3 to pH <2	6 Mos	1,2
Dissolved	500	P,G	Filt. + HNO_3 to pH <2	6 Mos	1,2
Mercury – Total	500	P,G	HNO_3 to pH <2	28 days	1,2
Mercury – Dissolved	300	P,G	Filt. + HNO_3 to pH <2	28 days	1,2

Measurement	Volume (mL)	Container[a]	Preservative	Holding Times	Reference
Organics					
Volatile Organics by GC/MS	100 (2 vials @ 40ml)	G, Teflon septum cap	Cool, 4 °C HCL to pH <2	14 days	2,3
Herbicides	1000	Glass Only	Cool, 4 °C	7 days [b] 40 days [c]	2,3
Pesticides and PCB's	1000	Glass Only	Cool, 4 °C	7 days [b] 40 days [c]	2,3
Semi-Volatiles Acid and Base/Neutral Compounds	2000	Glass Only	Cool, 4 °C	7 days [b] 40 days [c]	2,3

NOTES:

a Plastic (P) or Glass (G). For metals, polyethylene with an all polypropylene cap is preferred.

b Maximum holding time from sampling to extraction.

c Maximum holding time from extraction to analysis.

REFERENCES:

1 Methods for Chemical Analysis of Water and Wastes, March, 1983, USEPA, 600/4-79-020 and additions thereto.

2 Test Methods for Evaluating Solid Waste, Physical/Chemical Method, November, 1986, Third Edition, USEPA, SW-846 and additions thereto.

3 "Guidelines Establishing Test Procedures for the Analysis of Pollutant Under the Clean Water Act", Environmental Protection Agency, Code of Federal Regulations (CFR), Title 40, Part 136.

APPENDIX C

Calibration Data Sheet

Project:_____
Calibrated By:_____
Date:_____ **Time:**_____

Calibration Solution Temperature:_____ C

pH Meter
Model _____
Serial Number _____
Calibration Solution _____
Instrument Reading _____
Known pH _____

Conductivity Meter
Model _____
Serial Number _____
Calibration Solution _____
Instrument Reading _____
Known Conductance _____

Turbidity Meter
Model _____
Serial Number _____
Calibration Solution _____
Instrument Reading _____
Known Turbidity _____

Date:_____ **Time:**_____

Calibration Solution Temperature:_____ C

pH Meter
Model _____
Serial Number _____
Calibration Solution _____
Instrument Reading _____
Known pH _____

Conductivity Meter
Model _____
Serial Number _____
Calibration Solution _____
Instrument Reading _____
Known Conductance _____

Turbidity Meter
Model _____
Serial Number _____
Calibration Solution _____
Instrument Reading _____
Known Turbidity _____

Comments:_____

APPENDIX D

ıain of
ıstody Record

SEVERN TRENT **STL**

Severn Trent Laboratories, Inc.

1124 (0901)

ınt	Project Manager	Date	Chain of Custody Number 165409
ress	Telephone Number (Area Code)/Fax Number	Lab Number	Page ____ of ____
State / Zip Code	Site Contact	Lab Contact	Analysis (Attach list if more space is needed)
ject Name and Location (State)	Carrier/Waybill Number		Special Instructions/ Conditions of Receipt
ntract/Purchase Order/Quote No.			

Sample I.D. No. and Description (ntainers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H_2SO_4	HNO_3	HCl	NaOH	ZnAcl NaOH

SAMPLE

ssible Hazard Identification

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)

rn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other ____

QC Requirements (Specify)

	Date	Time		Date	Time
Relinquished By			1. Received By		
Relinquished By			2. Received By		
Relinquished By			3. Received By		

ɔmments

APPENDIX E

CONTENTS

FIGURES

1 INTRODUCTION

This document provides a statistical methodology for groundwater monitoring at the Washington County Landfill. A tiered evaluation approach has been developed for detection monitoring wells. Intrawell comparisons of metals and inorganic indicator parameters will be conducted using Shewhart-CUSUM control charts. Non-parametric prediction limits combined with Sen's Slope/MannKendall trend analysis will be applied to those parameters with greater than 50 percent non-detections (25 percent under ASTM standards) in the background data set. Statistical limits for volatile organic compounds in detection monitoring wells will be based on reporting limits (RLs). Assessment monitoring constituents will be statistically evaluated using detection monitoring statisticis and 95 percent confidence interval analysis. Details of each method are provided in the following sections. Statistical comparisons will be performed using Sanitas™, a commercial software program developed by Intelligent Decision Technologies, Inc. or another comparable computer program.

This document has been prepared using generally accepted statistical analysis principals and practices. However, it is not possible to predict all of the potential future circumstances. Therefore, alternative methods may be used that are more appropriate for the data distribution of the constituents being evaluated.

2 DETECTION MONITORING STATISTICAL ANALYSES

2.1 Metals and Inorganic Indicator Constituents

2.1.1 Shewhart-CUSUM Control Charts

Metals and inorganic indicator constituents will be statistically evaluated using combined Shewhart-CUSUM Control Charts. This procedure assumes that the data are independent and normally distributed with a fixed mean and constant variance. The most important assumption is independence, therefore wells should be sampled no more frequently than quarterly (Gibbons, 1994). The assumption of normality is less of a concern and natural log or ladder of powers transformations are adequate for most applications. The analysis is only applied to constituents that have greater than 50 percent detections (25 percent under ASTM standards) in the background data. For those metals and inorganic indicator constituents with fewer than 50 percent detections in the background data set, a non-parametric prediction limit/Sen's Slope/Mann Kendall trend analysis will be used.

Shewhart-CUSUM control charts allow detection of both major and gradual releases from the facility independent of spatial variation. This procedure is specifically recommended in the USEPA document *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities* (April 1989).

2.1.2 Procedure

Control charts are a form of time-series graph, on which a parametric statistical representation of concentrations of a given constituent are plotted at intervals over time. The statistics are computed and plotted together with an upper and/or lower control limit on a chart where the x-axis represents time.

The Procedure for conducting the intrawell analysis using combined Shewhart-CUSUM Control Charts is provided below and a flow chart illustrating the decision making process is provided as Figure E-1.

Three parameters are selected prior to plotting:

h - The control limit to which the cumulative sum (CUSUM) values are compared. The EPA recommended value for **h** is 5 units of standard deviation.

k - A reference value that establishes the upper limit for the acceptable displacement of the standardized mean. The EPA recommended value for k is 1.

SCL - The upper Shewhart control limit to which the standardized mean will be compared. The EPA recommended value for **SCL** is 4.5.

For each time period, T_i, take n_i independent samples (n_i may be one), and calculate the mean, $\bar{x}_i$. Compute the standardized mean Z_i of the measured concentrations where only a single new measurement is obtained for each constituent at each event as :

$$Z_i = \left(X_i - \overline{X}\right)\sqrt{n_i} / S$$

Where:

x_i = value obtained for a constituent during monitoring event i.

s = The standard deviation obtained from prior monitoring data from the same well.

When applicable, for each time period, T_i, compute the cumulative sum, S_i, as:

$$S_i = \max\{0, (Z_i - k) + S_{i-1}\}$$

Where max {A,B} is the maximum of A and B, and $S_o = 0$.

Plot Z_i and S_i against Ti on the control chart. The results may be plotted in standardized units or converted to the concentration units of the constituents being evaluated. An "out-of-control" situation (potential contamination) occurs whenever $Z_i \geq$ SCL or $S_i \geq h$. Two different types of situation are controlled by the limits. Too large a standardized mean will occur if there is a rapid increase in concentration in the well. Too large a cumulative sum may also occur for a more gradual trend. A verified statistically significant change (SSC) will occur if both the initial result *and* a verification sample result consecutively exceed one of the above mentioned statistical limits. Upgradient wells will be monitored for informational purposes only and will not be part of the verification resampling program.

2.1.2.1 Verification Resamples

The Shewhart and CUSUM portions of the control chart are affected differently by initial statistically significant changes from background (SSCs). The Shewhart portion of the

control chart compares each individual new measurement to the control limit, therefore the next monitoring event constitutes an independent verification of the original result. However, the CUSUM procedure incorporates all historical values in the computation, therefore, the effect of the apparent SSC will be present in both the initial and verification sample. Hence, the statistical test will be invalid unless the verification sample value replaces the initial SSC value. Therefore, initial SSC values will be replaced by verification resample results in order to confirm a SSC (Gibbons, 1994).

2.1.2.2 Updating Control Charts

As monitoring continues, the background mean and variance will be updated periodically to incorporate new data. At a minimum of every two years all new data that are in control will be pooled with the initial eight background samples and the mean and variance will be recomputed and used in constructing future control charts. UDEQ (Utah Department of Environmental Quality) approval will be obtained prior to updating the background data pool.

2.1.2.3 Censored Data

If less than 15 percent of the background observations are nondetects, these will be replaced with one half of the laboratory reporting limit prior to running the analysis (U.S. EPA, April 1989).

If more than 15 percent but less than 50 percent of the background data are less than the detection limit, the data's sample mean and sample standard deviation are adjusted according to the method of Cohen or Aitchison.

If more than 50 percent of the background data are less than the detection limit, a nonparametric prediction limit will be computed.

2.1.3 Non-Parametric Prediction Limits and Sen's Slope/Mann Kendall Trend Analysis

For those metals and inorganic indicator constituents with fewer than 50-percent detections within the background pool, a combined non-parametric upper prediction limit/Sen's Slope/MannKendall trend ananlysis will be applied. Parameters will be initially tested using the non-parametric prediction limit analysis. Constituents exceeding the non-parametric prediction limit will then be tested using the Sen's Slope/Mann Kendall trend analysis. An initial statistical exceedence will be indicated if the measured concentration exceeds both the non-parametric prediction limit and exhibitis a significant upward trend. The combined methods provide a non-parametric control chart equivalent to allow detection of both major and gradual releases from the facility independent of spatial variation.

2.1.3.1 Non-Parametric Prediction Limit Analysis

An upper prediction limit is a statistical limit calculated to include one or more observations from the same population with a specified confidence. In groundwater monitoring, an upper prediction limit approach may be used to make comparisons between background and compliance well data. The limit is constructed to contain all **k** observations with stated confidence. Any observation exceeding the upper prediction limit provides statistically significant evidence that the observation is not representative of the background group. The number of observations, **k**, to be compared to the limit must be specified in advance. A flow chart illustrating the decision making process during the analysis is provided as Figure E-2.

The highest value from the background data is used to set the upper prediction limit. In the case of a two-tailed test, the lowest value from the background data is used to set the lower prediction limit. Under EPA Standards, the false positive rate is based upon the formula:

$$1-(n/(n+k))$$

Where:

n = The background sample size, and

k = The number of future values being compared to the limit.

2.1.3.2 Sen's Slope/Mann Kendall Trend Analysis

The Sen's Slope/Mann Kendall trend analysis procedure determines the significance of an apparent trend and evaluates the magnitude (slope) of that trend (IDT, 2002). The Mann Kendall test for temporal trend is a non-parametric procedure designed to test the null hypothesis, H_0:

H_0: No significant trend of a constituent exists over time.

And the alternative hypothesis, H_A:

H_A: A significant upward trend of a constituent concentration exists over time.

Wells for which less than 41 data points are available, the exact test is applied. For 41 or more data points, the Normal Approximation test is used.

The Sen's Slope estimator portion of the combined method provides an estimate of the true slope. The method is a non-parametric procedure not greatly affected by gross data errors or outliers, and can be computed when data are missing.

2.2 Statistical Evaluation of Volatile Organic Compounds

Volatile organic compounds (VOCs) will be routinely monitored during the detection monitoring program. The statistical limit for VOCs detected in wells under detection monitoring will be set equal to the laboratory reporting limit (RL). RLs are provided in Table 1 of the facility's Groundwater Sampling and Analysis Plan (GWSAP). As with the prediction limit statistical method, VOC detections will not be considered statistically significant unless confirmed by verification resampling. Verification resampling procedures are provided in Section 2.3 and in the GWSAP.

2.3 Verification Resampling

Results for constituents that exceed statistical limits will not be considered statistically significant unless they are confirmed through verification resampling.

If a statistically significant change (SSC) from background of any tested constituent at any monitor well has occurred (i.e. is confirmed) and there is reasonable cause that a source other than the landfill exists, then a report will be submitted documenting the source as per Section 5.1 of the GWSAP and UAC R315-308-2 (10)(c). Otherwise, assessment monitoring will be implemented in accordance with Section 5.1 of the GWSAP and UDEQ regulations.

3 ASSESSMENT MONITORING STATISTICAL ANALYSIS

For assessment wells, constituents exceeding detection monitoring statistical limits and that have a groundwater protection standard (GWPS) established by the USEPA or the UDEQ, and/or any VOC detections will be statistically compared to GWPS using one-sided 95-percent lower confidence limits (LCL). Evaluations are conducted per Gibbons and Coleman (2001). The method constructs a normal confidence interval on the mean concentration of a constituent incorporating, at a minimum, the four most recent semi-annual measurements. A separate interval is constructed for each constituent of interest in each well of interest. A confidence interval is generally used when downgradient samples are being compared to a GWPS. A flow chart depicting the decision making process during the analysis is provided as Figure E-3.

The lower 95-percent confidence limit on the mean will be compared to a GWPS to decide initially whether the mean concentration of a constituent of interest has exceeded a GWPS. If the lower 95-percent confidence limit on the mean exceeds the GWPS then there is statistically significant evidence that the mean concentration of that constituent exceeds the GWPS. Upper 95-percent confidence limit analyses may be applied to constituents in which it's 95 percent LCL has exceeded a GWPS. If the upper 95-percent confidence limit on the mean occurs lower that the GWPS then there is statistically significant evidence that the mean concentration of that constituent has returned to less than the GWPS.

3.1 Assumptions

The sample data used to construct the limits must be normally or transformed-normally distributed. In the case of a transformed-normal distribution, the confidence limit must be constructed on the transformed sample concentration values. In addition to the limit construction, the comparison must be made to the transformed GWPS value. When none of the transformed models can be justified, a nonparametric version of each limit may be utilized.

3.2 Distribution

The distribution of the data is evaluated by applying the Shapiro-Wilk or Shapiro-Francia test for normality to the raw data or, when applicable, to the Ladder of Powers (Helsel & Hirsch, 1992) transformed data. The null hypothesis, $\mathbf{H_O}$, to be tested is:

H_O: The population has a normal (or transformed-normal) distribution.

The alternative hypothesis, $\mathbf{H_A}$, is:

H_A: The population does not have a normal (or transformed-normal) distribution.

3.3 Censored Data

If less than 15 percent of the observations are non-dectects, these will be replaced with one half the method detection limit prior to running the normality test and constructing the confidence limit.

If more than 15 percent, but less than 50 percent, of the data are less than the detection limit, the data's sample mean and standard deviation are adjusted according to the method of Cohen or Aitchison (U.S. EPA, April 1989). This adjustment is made prior to construction of the confidence limit.

If more than 50 percent of the data are less than the detection limit, these values are replaced with one half the method detection limit and a nonparametric confidence limit is constructed.

3.4 Parametric Confidence Limit Procedures

A minimum of four sample values is required for the construction of the parametric confidence limit. The mean, **X**, and standard deviation, **S**, of the sample concentration values are calculated separately for each compliance well. For each well, the confidence limit is calculated as:

$$\overline{X} \pm t_{(1-a,\,n-1)} \frac{S}{\sqrt{n}}$$

Where:

S = The compliance point's standard deviation;

n = The number of observations for the compliance point; and

$t_{(1-\alpha,,n-1)}$ is obtained from the Student's t-Distribution (appendix B; U.S. EPA, April 1989) with (n-1) degrees of freedom.

The use of the 95th percentile of the t-Distribution is consistent with the 5 percent α - level of individual well comparisons. If the lower limit is above the compliance limit, there is statistically significant evidence that the constituent exceeds a GWPS.

3.5 Nonparametric Confidence Limit Procedure

The nonparametric confidence limit procedure requires at least seven observations in order to obtain a one-sided significance level of 1 percent. The observations are ordered from smallest to largest and ranks are assigned separately within each well. Average ranks are assigned to tied values. The critical values of the order statistics are determined as follows.

If the minimum seven observations are used, the critical values are the first and seventh values. Otherwise, the smallest integer, **M**, is found such that the cumulative binomial distribution with parameters **n** (sample size) and probability of success, p=0.5, is at least 0.99.

The exact confidence coefficient for sample sizes from 4 to 11 are given by the EPA (Table 6-3; U.S. EPA, April 1989). For larger samples, take as an approximation the nearest integer value to:

$$\mathbf{M} = \frac{n}{2} + 1 + \mathbf{Z}_{(1-\alpha)} \sqrt{\frac{n}{4}}$$

Where:

$\mathbf{Z}_{(1-\alpha)}$ = The 1-α percentile from the normal distribution found in Table 4 (appendix B; U.S. EPA, April 1989); and

n = The number of observations in the sample.

Once **M** has been determined, **(n+1-M)** is computed and the confidence limits are taken as the order statistics, **X(M)** and **X(n+1-M)**. These confidence limits are compared to the GWPS as discussed in Section 3.

4 REFERENCES

Davis, Charles B. and McNichols, R.J., 1993. Exploring Ideas of "Background" in Groundwater Monitoring. Waste Management Update

Gibbons, Robert, D. 1994. Statistical Methods for Groundwater Monitoring, John Wiley & Sons, Inc. New York

Horsey, Henry R., and Carosone-Link, P., 1995. Managing RCRA Statistical Requirements to Minimize Ground Water Monitoring Costs, Proceeding of the American Chemical Society's Eleventh Annual Waste Testing and Quality Assurance Symposium

Intelligent Decision Technologies, 2002. Sanitas Users Manual, Version 8, Longmont, Colorado

International Ground Water Modeling Center, 1995. Ground Water Statistics and Regulations, Colorado School of Mines, Golden, Colorado.

Lichaa, Ada. 1998. MSW Groundwater Monitoring Regulatory Procedures, Proceedings of the 1998 Environmental Trade Fair, Austin, Texas.

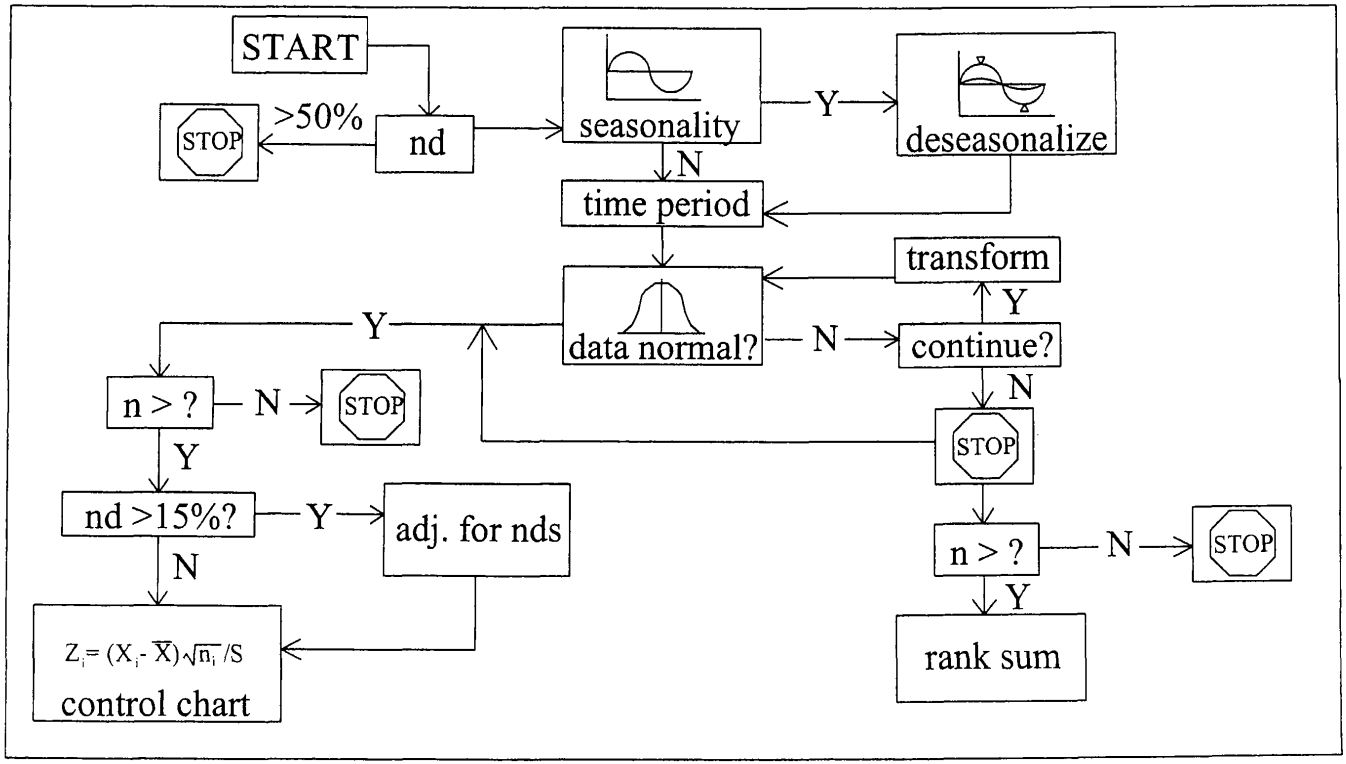
U.S. Environmental Protection Agency Office of Solid Waste, 1992. Statistical Training Course for Ground-Water Monitoring Data Analysis.

U.S. Environmental Protection Agency, 1989. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance, EPA/530/SW-89/026.

USEPA. 1992. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance (Draft).

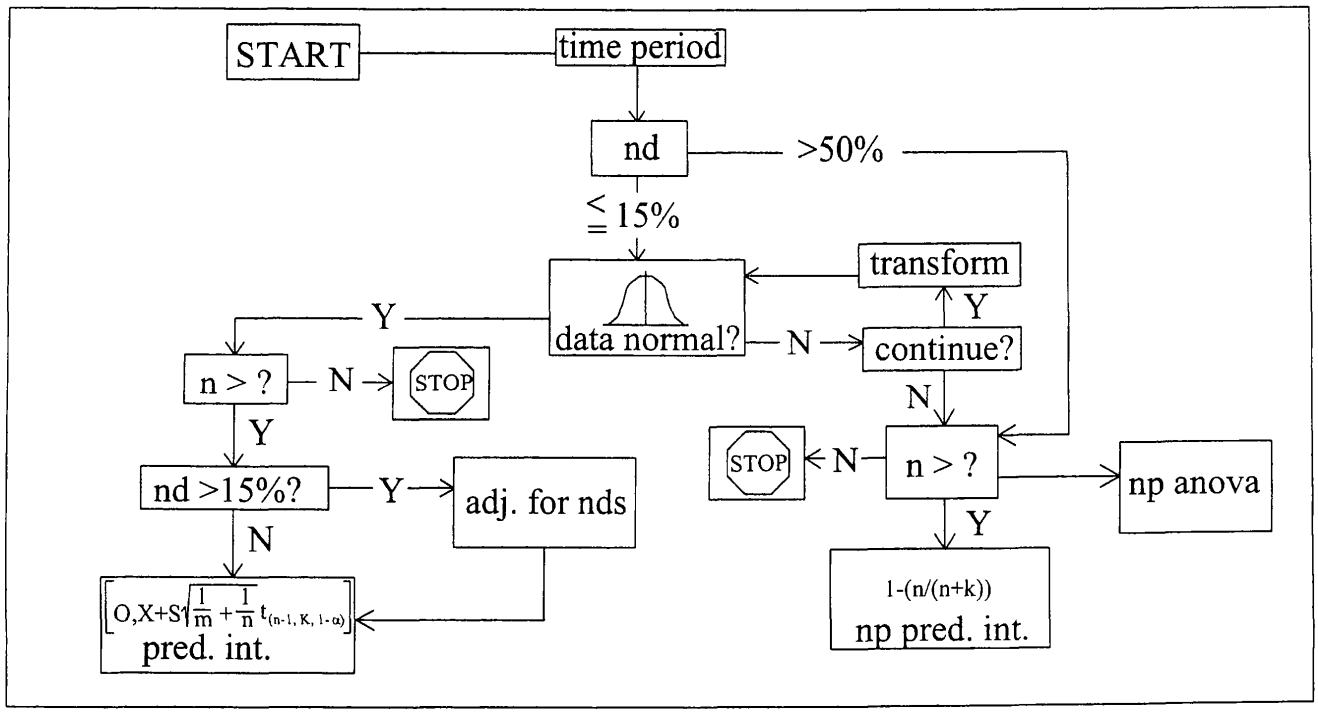
FIGURES

FIGURE E-1
CONTROL CHART FLOWCHART



Source: Sanitas™ version 7.5

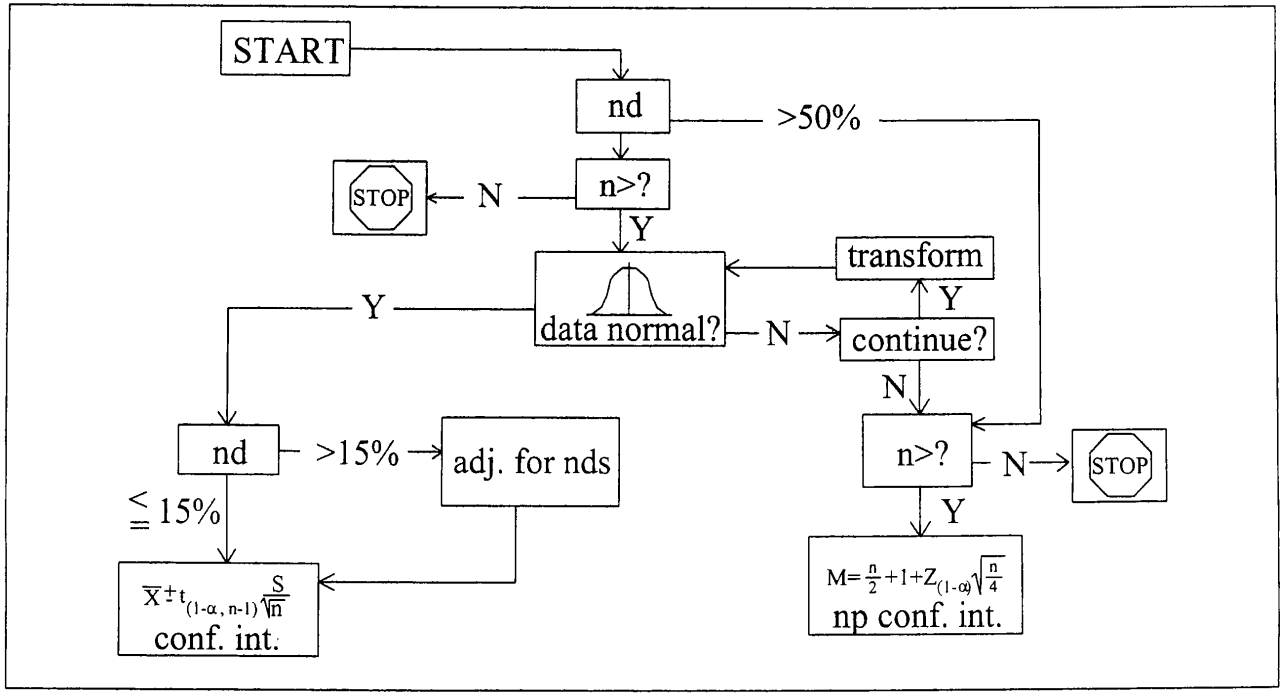
FIGURE E-2
PREDICTION LIMIT FLOWCHART



Source: Sanitas™ version 7.5

FIGURE E-3

95% CONFIDENCE INTERVAL FLOWCHART



Source: Sanitas™ version 8.0

WASHINGTON COUNTY
SOLID WASTE SPECIAL SERVICE DISTRICT NO. 1
LANDFILL GAS QUARTERLY MONTORING RESULTS
YEAR ____ QUARTER ____

Date: _____ Time: _____

Name of Gas Sample Collector_____

Temperature_____ Weather_____

Monitoring device should be calibrated prior to initiating sampling.
Accomplished? Yes No

Methane Monitoring Location		Measured %LEL	Internal Action Limit: Half of Regulatory Limit (%LEL)	Regulatory Action Limit (%LEL)
1. NW Corner of the Scale House	Outside		12	25
	Inside		12	25
2. North Boundary			50	100
3. South Boundary			50	100
4. NW Corner of Treatment Pond			12	25
5. SW Corner of Composting Area			12	25

- **Gas Sample Collector:** If measured % LEL equals or exceeds internal action limit, contact the facility manager.
- **Facility Manager:** If measured % LEL equals or exceeds regulatory action limit, notify the State Director in compliance with 40 CFR 258.23(c).

Comments:

_____

_____

_____

_____

_____

_____

_____
Gas Sample Collector

Player Consulting, L.C.
3071 West 8900 South
West Jordan, Utah 84088
801-554-2660

September 15, 2005

Mr. Darin Olson
Facility Engineer
ECDC Environmental, L.C.
1111 West Highway 123
East Carbon, Utah 84520

RE: 2005 Closure, Post-Closure, and Post-Closure Investment Costs for the Washington County Landfill Facility.

Mr. Olson:

As per your request, I have calculated the closure and post-closure costs for the Washington County Landfill Facility. I used survey information supplied to me by Talon Resources, Inc. from the past year. Using *AutoDesk Land Desktop* with the supplied data, I established the existing topography of the landfill facility. I used this topography information and information contained in the permit application to calculate the quantities needed for closure and post-closure. I used costs supplied to me by you, known costs of similar projects, and *RS Means Heavy Construction Cost Data, 2005 Edition* for references to establish costs for each closure and post-closure item contained in the attachments. Attached are the tables I used to calculate the total cost of closure and post-closure. Following is an explanation of each of the attachments.

Attachment 1 – 2005 Closure Costs

1. Engineering - Engineering shall take place to establish closure grades, run-on/run-off channels, and final closure elevations. Included in the engineering costs are, but is not limited to, surveying, data review, establishing existing topography, and calculating optimal closure grades, slopes, and channels. An aerial survey will take place each year to determine topography and densities. This survey will be used as part of the design. The cost of this survey will not be included in this cost because it will have already been performed. Any additional survey costs are included in this cost estimate.

2. Technical Specifications and Drawings - Technical specifications and drawings shall be produced. These items are required to bid the project and perform the work. Contract administration costs are included in this estimate.

3. Grading of Existing Waste to Acceptable Grades - The existing waste in landfill shall be graded to an acceptable slope. The slopes will be calculated at the time of closure. The waste material will be graded to form a base upon which the capping materials will be placed.

4. Low Permeability Material - Low permeability material shall be excavated from on-site, loaded, and hauled to the required area. The material shall then be placed to desired grades, moisture conditioned, and compacted. The thickness of this layer is 18 inches.

5. Purchase Common Earth Backfill - Common earth backfill shall be purchased from a local gravel pit. This material will be 6 inches thick and facilitate seeding for a vegetative cover.

6. Place Common Earth Backfill - The material shall be hauled and placed in the landfill facility. The materials shall be moisture-conditioned and compacted during placement. The material will placed 6 inches thick and complete the soil cap/cover for the landfill cell.

7. Seeding of Landfill Surface - Upon completion of the cap in landfill facility, the cell will be seeded for the production of a vegetative cover.

8. Excavate Drainage Channels - Drainage control for the landfill facility shall be excavated to specified grades and locations.

9. Place Channel Rock - Rock shall be placed in the excavated channels to protect the channels from erosion. The leachate collection system will be maintained and updated as needed during the life of the landfill cell operation. The cost for the leachate collection system is not included in this cost.

10. Surveying - During all closure activities of the landfill facility, surveying shall take place to control construction of the project. This survey will also be used to complete the final documentation.

11. Materials Testing and Reporting - During all closure activities of the landfill facility, materials testing and reporting shall take place to ensure the work complies with the technical specifications of the project.

12. Oversight and Supervision - During all closure activities of the landfill facility, management of the project shall take place to oversee all phases of the work and closure. Included in this item are the costs to produce all required closure documents and associated administrative costs.

13. Total - This line item is the total cost to close the Washington County Landfill Facility.

At this time there is not a need for a gas collection system to be installed at the landfill facility. The monitoring wells will already be in place at the landfill facility, therefore there are no costs associated with installing monitoring wells in the closure costs.

Attachment 2 – 2005 Post-Closure Costs

1. Gas Collection and Monitoring - During the post-closure care period, gas collection and monitoring shall take place. The Washington County Landfill Facility has a dedicated monitor at the landfill facility, therefore the cost to rent or purchase a gas monitor in not included in this cost.

2. Repair and Maintain Surface Drainage Structures, Final Cover, On-site Permanent Improvements and Equipment - During the post-closure care period, maintenance, inspection, and repair of the final cover, run-on/run-off systems, on-site permanent improvements, and equipment shall take place. It is estimated that 5 acres a year will need to be re-worked and re-graded each year. This is only an estimate and in contingent upon closure, post-closure care, and weather.

3. Rework or Replace Defective Groundwater Monitoring Wells and Equipment, Install New Wells and Equipment - During the post-closure care period, maintenance, inspection, and repair of the monitoring wells shall take place. If any new wells are required, they shall be installed.

4. Collect Semi-annual Groundwater Samples - During the post-closure care period, collection of the groundwater samples shall take place semi-annually. This item includes the cost to contract with a 3rd party contractor to perform this work.

5. Analyze Semi-annual Groundwater Samples - During the post-closure care period, analysis of the groundwater samples shall take place semi-annually. A qualified lab will perform this activity.

6. Maintain Site Security and Access Control - During the post-closure care period, security of the site and access to the site shall be maintained and controlled. This item includes the cost to inspect and maintain site security.

7. Provide Administrative Overhead for Oversight and Record Keeping (Engineering) - During the post-closure care period, administrative oversight and record keeping of all activities of post-closure shall take place. Included in this item is the cost to review and revise the post-closure plan, cost for on-site inspections, cost to produce correctional plans if required, and monitoring of the site.

8. Prepare Post-closure Certificate (Engineering) - During the post-closure care period, preparation of post-closure certificates by qualified personnel shall take place.

9. Total - This line item is the total cost for post-closure care period for the Washington County Landfill Facility.

Attachment 3 – 2005 Post-Closure Investment

Attachment 3 demonstrates the investment that should be made for post-closure care. The starting cost is the estimated yearly cost for post-closure care at the present time. Inserting these numbers into the table demonstrates what the initial investment should be to offset the post-closure care costs for the Washington County Landfill Facility. The table shows the estimated cost, beginning amount and ending amount of the investment for each of the thirty years required for post-closure care. In creating this attachment, it was assumed that the income interest rate would equal the inflation rate. Using this assumption, the increased costs of performing associated work at the landfill facility would be offset by the interest income from the initial investment.

The cost to close the Washington County Landfill is $2,863,898. The investment for post-closure care of Washington County Landfill is $578,940.

The total investment for closure and post-closure of the Washington County Landfill Facility should be $3,442,838. If you need any additional information or you have any questions or comments, please give me a call.

Sincerely,

Gene Player

Gene Player, P.E.
Project Engineer

Attachments

ATTACHMENT 1

2005 Closure Costs

#	Description	Unit	Quantity	Cost	Total
1.	Engineering*	Job	1	11,587	11,587
2.	Technical Specifications and Drawings*	Job	1	52,139	52,139
3.	Grading of Existing Waste*	Acre	20.6	985	20,288
4.	Low Permeability Material/Seed Bedding Material**				
	2a) Excavate, Load, and Haul Material**	CY	161,334	6.23	1,004,304
	2b) Placement and Compaction of Material**	CY	161,334	7.26	1,171,688
5.	Seeding of Landfill Surface*	SF	2,187,009	0.07	152,039
6.	Excavate Drainage Channel**	CY	6,500	6.23	40,463
7.	Place Channel Rock**	CY	3,200	27.81	88,984
8.	Surveying*	Acre	50.0	889	44,434
9.	Materials Testing and Reporting*	Acre	50.0	2,317	115,865
10.	Oversight and Supervision*	Job	1	6.00%	162,107
11.	**TOTAL**				**2,863,898**

Notes:

* *Means CostWorks* was used as a reference for cost of this item.

** Known cost from a recent project or a contractor estimate was used as a reference for this item.

ATTACHMENT 2

2005 Post-Closure Costs

#	Description	Unit	Quantity	Cost	Total
1.	Gas Collection and Monitoring**	HOUR	16	65.00	1,040
2.	Repair and Maintain Surface Drainage Structures, Final				
	Cover, On-Site Permanent Improvements and Equipmen	ACRE	5	1,159	5,793
3.	Rework or Replace Defective Groundwater Monitoring				
	Wells and Equipment, Install New Wells and Equipment*	EACH	1	3,128	3,128
4.	Collect Semi-Annual Groundwater Samples**	HOUR	16	65.00	1,040
5.	Analyze Semi-Annual Groundwater Samples*	EACH	3	1,159	3,476
6.	Maintain Site Security and Access Control**	LS	1	1,300	1,300
7.	Provide Administrative Overhead for Oversight and				
	Record Keeping**	HOUR	40	80.00	3,200
8.	Prepare Post-Closure Certificate**	HOUR	4	80.00	320
9.	**TOTAL**				**19,298**

Notes:

* *Means CostWorks* was used as a reference for cost of this item.

** Known cost from a recent project or a contractor estimate was used as a reference for this item.

ATTACHMENT 3

2005 Post-Closure Investment

Starting Cost	19,298
Post-Closure Investment	***578,940***

Yearly Costs

Year	Yearly Cost	Beginning	Ending
1	19,298	578,940	559,642
2	19,298	559,642	540,344
3	19,298	540,344	521,046
4	19,298	521,046	501,748
5	19,298	501,748	482,450
6	19,298	482,450	463,152
7	19,298	463,152	443,854
8	19,298	443,854	424,556
9	19,298	424,556	405,258
10	19,298	405,258	385,960
11	19,298	385,960	366,662
12	19,298	366,662	347,364
13	19,298	347,364	328,066
14	19,298	328,066	308,768
15	19,298	308,768	289,470
16	19,298	289,470	270,172
17	19,298	270,172	250,874
18	19,298	250,874	231,576
19	19,298	231,576	212,278
20	19,298	212,278	192,980
21	19,298	192,980	173,682
22	19,298	173,682	154,384
23	19,298	154,384	135,086
24	19,298	135,086	115,788
25	19,298	115,788	96,490
26	19,298	96,490	77,192
27	19,298	77,192	57,894
28	19,298	57,894	38,596
29	19,298	38,596	19,298
30	19,298	19,298	0

August 2005

STATEMENT OF ACCOUNT

PTIF

UTAH PUBLIC TREASURERS' INVESTMENT FUND

Edward T. Alter, Utah State Treasurer, Fund Manager
215 State Capitol
Salt Lake City, Utah 84114
Local Call (801) 538-1042 Toll Free (800) 395-7665
http://www/treasurer.state.ut.us

WASHINGTON CO SP SERV DIST
CELL PREP.
ATTN: SUSIE HOLT
325 N LANDFILL RD
WASHINGTON UT 84780

03/31/04

STATEMENT OF ACCOUNT NO: 2102

REPORT PERIOD: 03/01/04 TO 03/31/04

DATE	REFERENCE	DEPOSITS	WITHDRAWALS	BALANCE
03/01/04	BEGBAL	0.00	0.00	2,192,543.39
03/31/04	NETEARN	2,738.91	0.00	2,195,282.30
03/31/04	ENDBAL	0.00	0.00	2,195,282.30

ACCOUNT SUMMARY

BEGINNING BALANCE:		2,192,543.39
DEPOSITS IN THE PERIOD:		2,738.91
WITHDRAWALS IN THE PERIOD:		0.00
ENDING BALANCE:		2,195,282.30
GROSS EARNINGS:		2,738.91
ADMINISTRATIVE FEE (0.0000%)		0.00
NET EARNINGS:		2,738.91
AVERAGE DAILY BALANCE:		2,192,543.39
GROSS EARNINGS RATE:	1.4507%	
NET EARNINGS RATE:	1.4507%	

+ EQUIVALENT 365 DAY RATE IS +
+ 1.4708% +

PLEASE RETAIN THIS STATEMENT FOR FUTURE REFERENCE

CONSTRUCTION PLANS

for

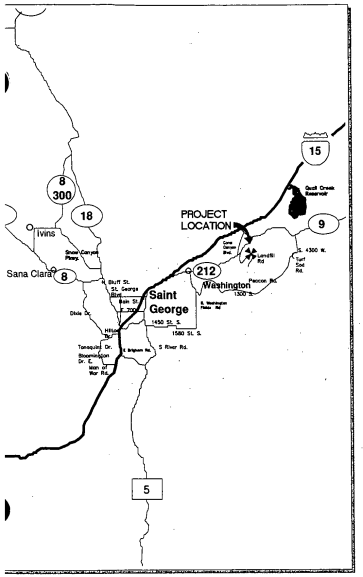
PHASE 1 EXPANSION & STORMWATER IMPROVEMENTS

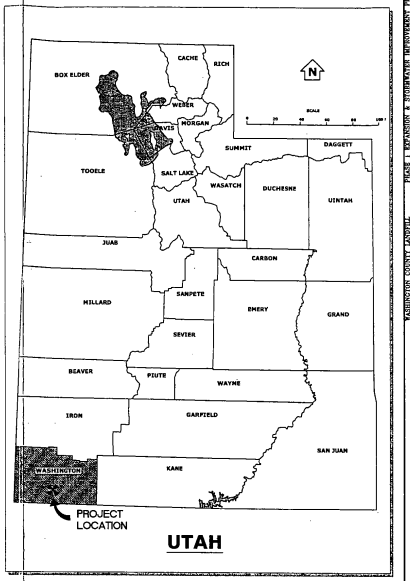
at the

WASHINGTON COUNTY LANDFILL
WASHINGTON, UTAH

prepared for

ALLIED WASTE SERVICES





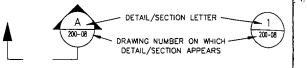
LEGEND

EXISTING	PROPOSED	PROPOSED	PROPOSED
FENCE	2820 PROPOSED 10 FT. GRADING CONTOUR	PROPOSED DRAINAGE	FOUNDATION LAYER
1700 EXISTING 10' CONTOUR (BASED ON 2005 AERIAL SURVEY)	PROPOSED 2 FT. GRADING CONTOUR	GEOSYNTHETIC CLAY LINER	OPERATIONS LAYER
EXISTING 2' CONTOUR (BASED ON 2005 AERIAL SURVEY)	HINGE LINE	GEOCOMPOSITE	ENGINEERED FILL
EXISTING CULVERT	PROPOSED ROAD	GEOMEMBRANE LINER	WASTE
PROPERTY LINE	PROPOSED FILL PLACED FOR DRAINAGE	GEOTEXTILE	CONCRETE
EXISTING LINED AREAS	MATCH LINE	1:3 SLOPE (SECTION)	RIPRAP/GRAVEL
EXISTING DRAINAGE	LEACHATE COLLECTION PIPE	3.5% GRADE OR SLOPE (PLAN) (ARROW POINTS DOWNSLOPE)	AGGREGATE BASE
EXISTING DIRT ROAD	LINER LIMITS	3:1 GRADE OR SLOPE (PLAN) (ARROW POINTS DOWNSLOPE)	SUBGRADE
EXISTING PAVED ROAD	PROPOSED CULVERT/DOWNDRAIN		INTERIM COVER
BOULDERS			
MANHOLE			
POWER POLE			
20.4 SPOT ELEVATION			
2876.99 CONTROL POINT			

ABBREVIATIONS

SDR	STANDARD DIMENSION RATIO
CMP	CORRUGATED METAL PIPE
GCL	GEOSYNTHETIC CLAY LINER
HDPE	HIGH DENSITY POLYETHYLENE
CFS	CUBIC FEET PER SECOND
FT.	FEET
TYP.	TYPICAL
MIN.	MINIMUM
MAX.	MAXIMUM
NTS	NOT TO SCALE
OC	ON CENTER
ø	DIAMETER
%	PERCENT

SYMBOLS



DRAWING INDEX

DRAWING NUMBER	TITLE AND DESCRIPTION	LATEST REVISION NUMBER	LATEST REVISION DATE
100-01	TITLE PAGE	0	09/12/05
100-02	EXISTING CONDITIONS	0	09/12/05
200-01	OVERALL GRADING PLAN & PLAN INDEX	0	09/12/05
200-02	LINER GRADING PLAN	0	09/12/05
200-03	NORTHERN STORMWATER IMPROVEMENTS	0	09/12/05
200-04	SOUTHERN STORMWATER IMPROVEMENTS	0	09/12/05
200-05	SOUTHERN STORMWATER IMPROVEMENTS (DETAILED VIEW)	0	09/12/05
200-06	WESTERN ACCESS ROAD PLAN AND PROFILE	0	09/12/05
200-07	DETAILS	0	09/12/05
200-08	DETAILS	0	09/12/05
200-09	SUMP DETAILS	0	09/12/05
200-10	DRAINAGE IMPROVEMENT DETAILS	0	09/12/05
200-11	DRAINAGE IMPROVEMENT DETAILS	0	09/12/05

NOTES:
1. GEOSYNTHETICS ON ALL SECTIONS AND DETAILS ARE N.T.S.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	WMG	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: WMG
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER — 5881634-2202 — JACOB V. RUSSELL — State of Utah

VECTOR ENGINEERING, INC.
USA • CENTRAL & SOUTH AMERICA • PHILIPPINES
1431E Spring Hill Drive, Grass Valley, CA 95945 +1-530-272-2448 +1-530-272-8533 fax

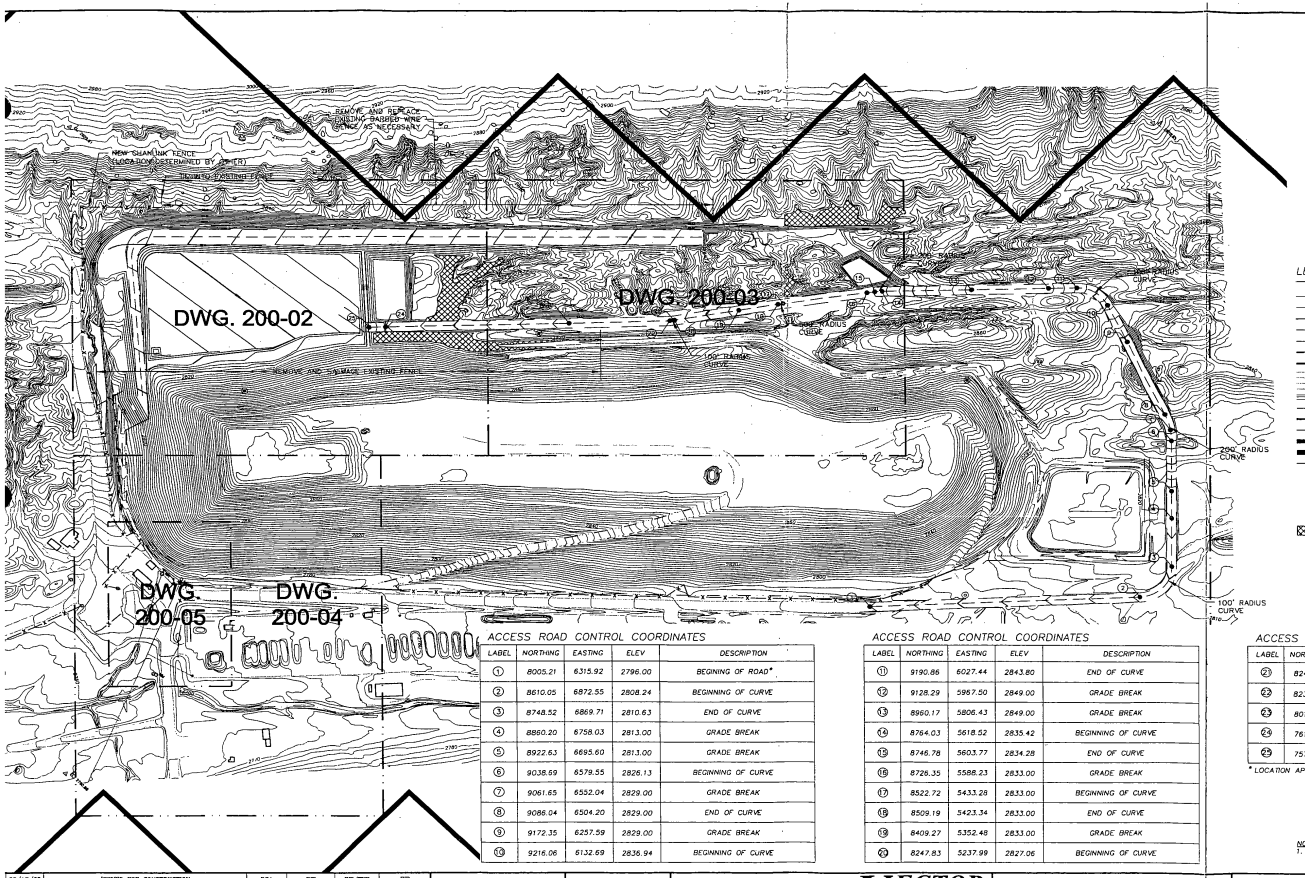
ALLIED WASTE SERVICES

WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

TITLE PAGE

DRAWING NO. 100-01
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION



GRAPHIC SCALE

150' 0 75' 150' 300' 600'

LEGEND

- EXISTING 10 FT. CONTOUR
- EXISTING 2 FT. CONTOUR
- PROPOSED 10 FT. LINER GRADING CONTOUR
- PROPOSED 2 FT. LINER GRADING CONTOUR
- PROPOSED DRAINAGE
- EXISTING CULVERT
- PROPOSED CULVERT
- EXISTING DIRT ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- DRAINAGE
- PROPOSED LINER LIMITS
- EXISTING LINED AREAS
- MATCH LINE
- PROPERTY LIMITS
- FENCE
- BOULDERS
- MANHOLE
- POWER POLE
- SPOT ELEVATION
- CONTROL POINT
- PROPOSED FILL PLACED FOR DRAINAGE

ACCESS ROAD CONTROL COORDINATES

LABEL	NORTHING	EASTING	ELEV	DESCRIPTION
①	8005.21	6315.92	2796.00	BEGINING OF ROAD*
②	8610.05	6872.55	2808.24	BEGINNING OF CURVE
③	8748.52	6869.71	2810.63	END OF CURVE
④	8860.20	6758.03	2813.00	GRADE BREAK
⑤	8922.63	6695.60	2813.00	GRADE BREAK
⑥	9038.59	6579.55	2826.13	BEGINNING OF CURVE
⑦	9061.65	6552.04	2829.00	GRADE BREAK
⑧	9086.04	6504.20	2829.00	END OF CURVE
⑨	9172.35	6257.59	2829.00	GRADE BREAK
⑩	9216.06	6132.69	2836.94	BEGINNING OF CURVE

ACCESS ROAD CONTROL COORDINATES

LABEL	NORTHING	EASTING	ELEV	DESCRIPTION
⑪	9190.86	6027.44	2843.80	END OF CURVE
⑫	9128.29	5967.50	2849.00	GRADE BREAK
⑬	8960.17	5806.43	2849.00	GRADE BREAK
⑭	8764.03	5618.52	2835.42	BEGINNING OF CURVE
⑮	8746.78	5603.77	2834.28	END OF CURVE
⑯	8726.35	5588.23	2833.00	GRADE BREAK
⑰	8522.72	5433.28	2833.00	BEGINNING OF CURVE
⑱	8509.19	5423.34	2833.00	END OF CURVE
⑲	8409.27	5352.48	2833.00	GRADE BREAK
⑳	8247.83	5237.99	2827.06	BEGINNING OF CURVE

ACCESS ROAD CONTROL COORDINATES

LABEL	NORTHING	EASTING	ELEV	DESCRIPTION
㉑	8246.14	5236.77	2827.00	GRADE BREAK
㉒	8234.64	5288.77	2827.00	END OF CURVE
㉓	8015.67	5017.94	2827.00	GRADE BREAK
㉔	7613.90	4634.60	2815.89	GRADE BREAK
㉕	7576.76	4599.17	2820.00	END OF ROAD

* LOCATION APPROXIMATE, TIE INTO EXISTING ROAD

NOTES:
1. TOPOGRAPHY IS BASED ON JUNE 8, 2005 AERIAL SURVEY BY OLYMPUS AERIAL SURVEYS, INC., WITH FIELD SURVEY BY TALON RESOURCES, INC. ON MAY 23, 2005.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER
5881834-2202
JASON V. RUSSELL
State of Utah

VECTOR ENGINEERING, INC.
USA • CENTRAL & SOUTH AMERICA • PHILIPPINES
143E Spring Hill Drive, Grass Valley, CA 95945 +1-530-272-2448 +1-530-272-8533 fax

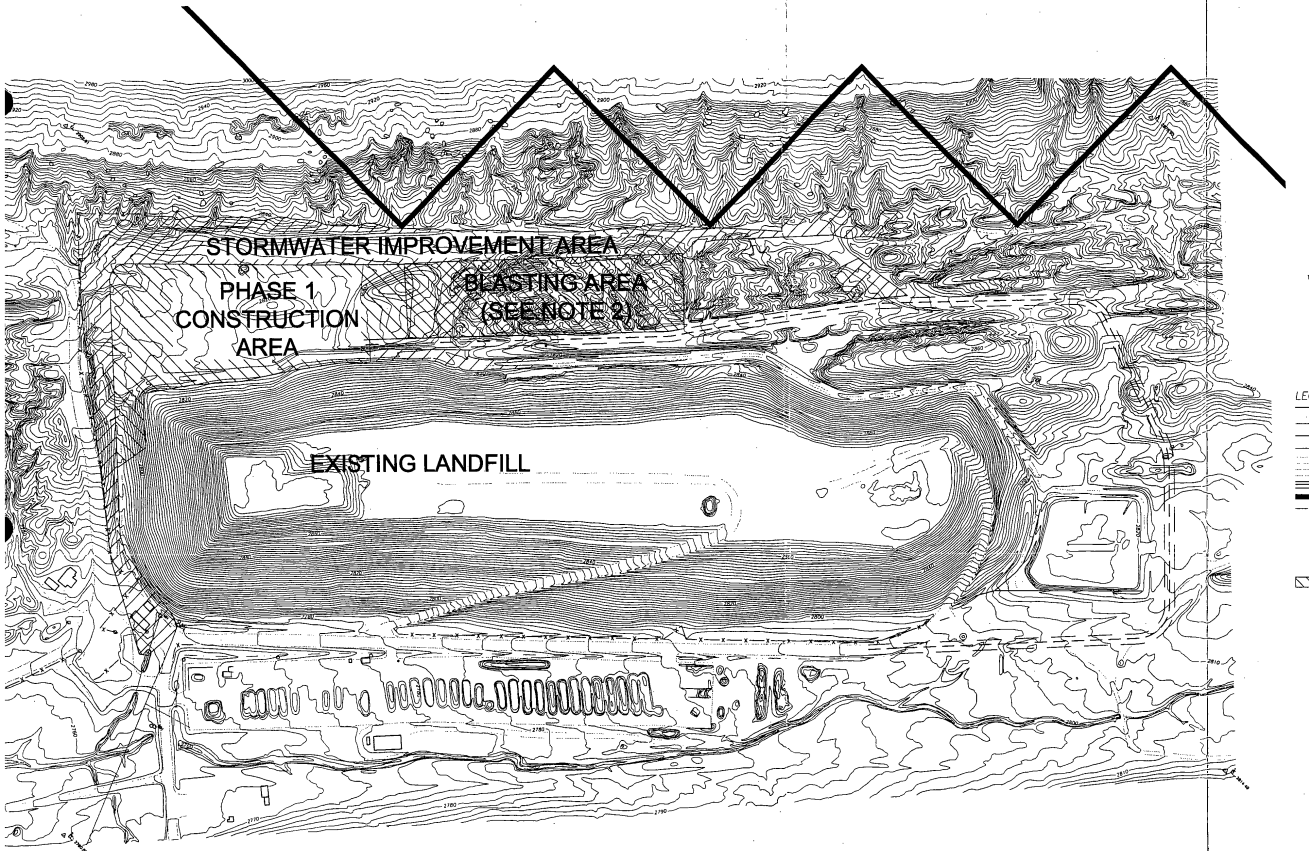
ALLIED WASTE SERVICES

WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

OVERALL GRADING PLAN & PLAN INDEX

DRAWING NO. 200-01
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION



NORTH

GRAPHIC SCALE

150' 0 75' 150' 300' 600'

LEGEND

- EXISTING 10 FT. CONTOUR
- EXISTING 2 FT. CONTOUR
- EXISTING DRAINAGE
- EXISTING DIRT ROAD
- EXISTING PAVED ROAD
- PROPOSED ACCESS ROAD
- PROPERTY LIMITS
- FENCE
- BOULDERS
- MANHOLE
- POWER POLE
- SPOT ELEVATION
- CONTROL POINT
- PROPOSED BLASTING AREA (~4.4 ACRES) (SEE NOTE 2)

NOTES:

1. TOPOGRAPHY IS BASED ON JUNE 8, 2005 AERIAL SURVEY BY OLYMPUS AERIAL SURVEYS, INC., WITH FIELD SURVEY BY TALON RESOURCES, INC. ON MAY 23, 2005.
2. BLASTING AREA TO BE APPROVED BY OWNER PRIOR TO BLASTING. PURPOSE OF BLASTING IS TO FREE 50,000 C.Y. MATERIAL FOR REMOVAL BY OWNER.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	RGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: RGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER
5889634-2202
JACOB V. RUSSELL
State of Utah

VECTOR ENGINEERING, INC.
USA • CENTRAL & SOUTH AMERICA • PHILIPPINES
1438 Spring Hill Drive, Grass Valley, CA 95945 +1-530-272-2448 +1-530-272-8533 fax

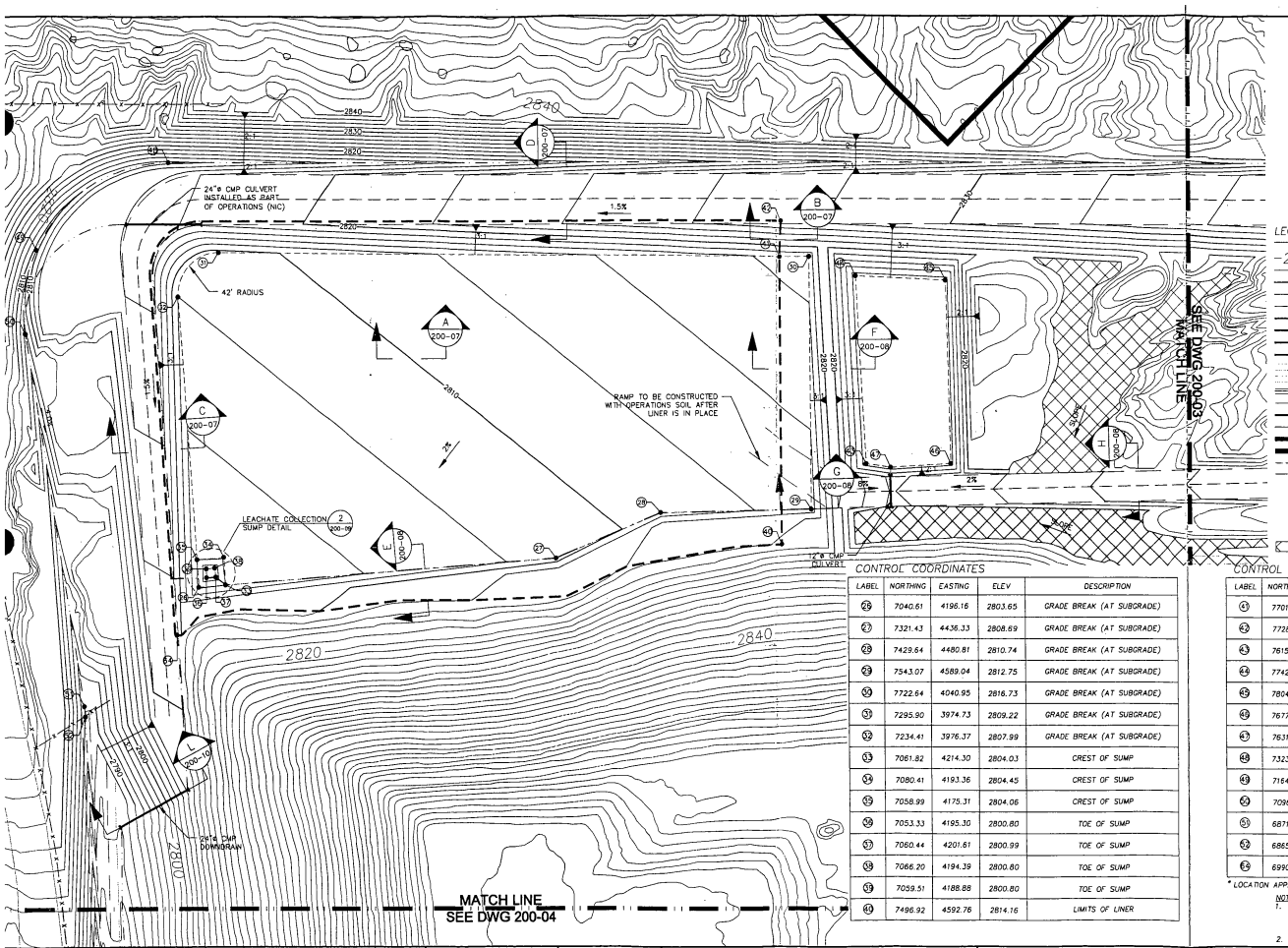
ALLIED WASTE SERVICES

WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

EXISTING CONDITIONS

DRAWING NO. 100-02
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION



GRAPHIC SCALE

50' 0 25' 50' 100' 200'

LEGEND

- 2840 — EXISTING 10 FT. CONTOUR
- EXISTING 2 FT. CONTOUR
- 2820 — PROPOSED 10 FT. LINER GRADING CONTOUR
- PROPOSED 2 FT. LINER GRADING CONTOUR
- PROPOSED DRAINAGE
- EXISTING CULVERT
- PROPOSED CULVERT
- PROPOSED LINER LIMITS
- PROPOSED LEACHATE COLLECTION PIPE
- EXISTING DIRT ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- DRAINAGE
- PROPOSED LINER LIMITS
- EXISTING LINED AREAS
- MATCH LINE
- PROPERTY LIMITS
- HINGE LINE
- X — X — FENCE
- BOULDERS
- MANHOLE
- POWER POLE
- SPOT ELEVATION
- CONTROL POINT
- PROPOSED FILL PLACED FOR DRAINAGE (2)

CONTROL COORDINATES

LABEL	NORTHING	EASTING	ELEV	DESCRIPTION
29	7040.61	4196.16	2803.65	GRADE BREAK (AT SUBGRADE)
27	7321.43	4436.33	2808.69	GRADE BREAK (AT SUBGRADE)
28	7429.64	4480.81	2810.74	GRADE BREAK (AT SUBGRADE)
29	7543.07	4589.04	2812.75	GRADE BREAK (AT SUBGRADE)
30	7722.64	4040.95	2816.73	GRADE BREAK (AT SUBGRADE)
31	7295.90	3974.73	2809.22	GRADE BREAK (AT SUBGRADE)
32	7234.41	3976.37	2807.99	GRADE BREAK (AT SUBGRADE)
33	7061.82	4214.30	2804.03	CREST OF SUMP
34	7080.41	4193.36	2804.45	CREST OF SUMP
35	7058.99	4175.31	2804.06	CREST OF SUMP
36	7053.33	4195.30	2800.80	TOE OF SUMP
37	7060.44	4201.61	2800.99	TOE OF SUMP
38	7066.20	4194.39	2800.80	TOE OF SUMP
39	7059.51	4188.88	2800.80	TOE OF SUMP
40	7496.92	4592.76	2814.16	LIMITS OF LINER

CONTROL COORDINATES

LABEL	NORTHING	EASTING	ELEV	DESCRIPTION
41	7701.67	4388.11	2816.36	LIMITS OF LINER
42	7728.31	4363.73	2827.37	LIMITS OF LINER
43	7615.40	4596.84	2811.00	TOE OF POND
44	7742.70	4456.99	2811.00	TOE OF POND
45	7804.70	4525.01	2811.00	TOE OF POND
46	7677.47	4658.37	2811.00	TOE OF POND
47	7631.02	4617.46	2811.00	TOE OF POND
48	7323.83	3874.70	2811.42	DRAINAGE CHANNEL CORNER
49	7164.77	3840.25	2808.84	DRAINAGE CHANNEL GRADE BREAK
50	7095.91	3891.60	2805.39	DRAINAGE CHANNEL CORNER
51	6871.65	4197.06	2790.21	DRAINAGE CHANNEL CORNER
52	6865.00	4205.16	2789.79	DRAINAGE CHANNEL CORNER
53	6990.60	4214.23	2809.64	TOP OF RIPRAP*

* LOCATION APPROXIMATE, TIE INTO INTERIM CHANNEL

NOTES:
1. TOPOGRAPHY IS BASED ON JUNE 8, 2005 AERIAL SURVEY BY OLYMPUS AERIAL SURVEYS, INC., WITH FIELD SURVEY BY TALON RESOURCES, INC. ON MAY 23, 2005.
2. PLACE FILL TO PROMOTE DRAINAGE INTO POND AND CHANNEL.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER 5881634-2202 JACOB V. RUSSELL State of Utah

VECTOR ENGINEERING, INC.

USA • CENTRAL & SOUTH AMERICA • PHILIPPINES
143E Spring Hill Drive, Grass Valley, CA 95945 +1-530-272-2448 +1-530-272-8533 fax

ALLIED WASTE SERVICES

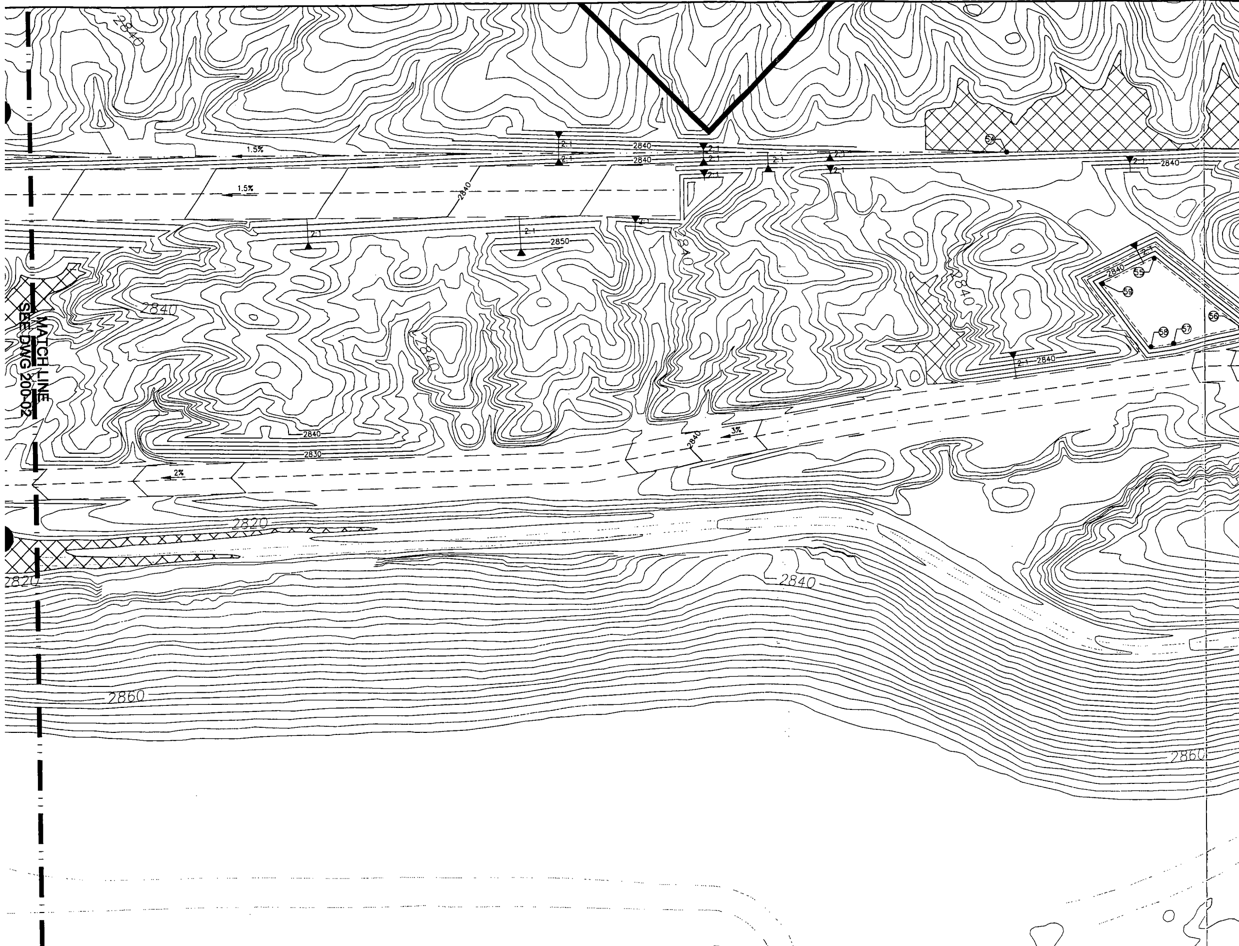
WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

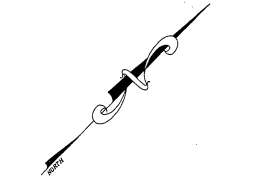
LINER GRADING PLAN

DRAWING NO. 200-02

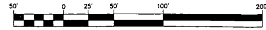
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION





GRAPHIC SCALE



LEGEND

- EXISTING 10 FT. CONTOUR
- EXISTING 2 FT. CONTOUR
- PROPOSED 10 FT. LINER GRADING CONTOUR
- PROPOSED 2 FT. LINER GRADING CONTOUR
- PROPOSED DRAINAGE
- EXISTING CULVERT
- PROPOSED CULVERT
- EXISTING DIRT ROAD
- EXISTING PAVED ROAD
- PROPOSED ROAD
- DRAINAGE
- PROPOSED LINER LIMITS
- EXISTING LINED AREAS
- MATCH LINE
- PROPERTY LIMITS
- FENCE
- BOULDERS
- MANHOLE
- POWER POLE
- SPOT ELEVATION
- CONTROL POINT
- PROPOSED FILL PLACED FOR DRAINAGE (2)

CONTROL COORDINATES

LABEL	NORTHING	EASTING	ELEV	DESCRIPTION
53	8951.62	5501.06	2844.00	DRAINAGE CHANNEL
54	8763.45	5317.91	2842.00	DRAINAGE CHANNEL GRADE BREAK
55	8792.46	5496.26	2827.00	TOE OF POND
56	8806.75	5606.85	2827.00	TOE OF POND
57	8746.51	5569.64	2827.00	TOE OF POND
58	8727.66	5555.30	2827.00	TOE OF POND
59	8738.24	5477.37	2827.00	TOE OF POND

NOTES:

1. TOPOGRAPHY IS BASED ON JUNE 8, 2005 AERIAL SURVEY BY OLYMPUS AERIAL SURVEYS, INC., WITH FIELD SURVEY BY TALON RESOURCES, INC. ON MAY 23, 2005.
2. PLACE FILL TO PROMOTE DRAINAGE INTO POND AND CHANNEL.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER 5881834-2202 JACOB V. RUSSELL State of Utah

VECTOR ENGINEERING, INC.

USA • CENTRAL & SOUTH AMERICA • PHILIPPINES
143E Spring Hill Drive, Grass Valley, CA 95945 +1-530-272-2448 +1-530-272-8533 fax

ALLIED WASTE SERVICES

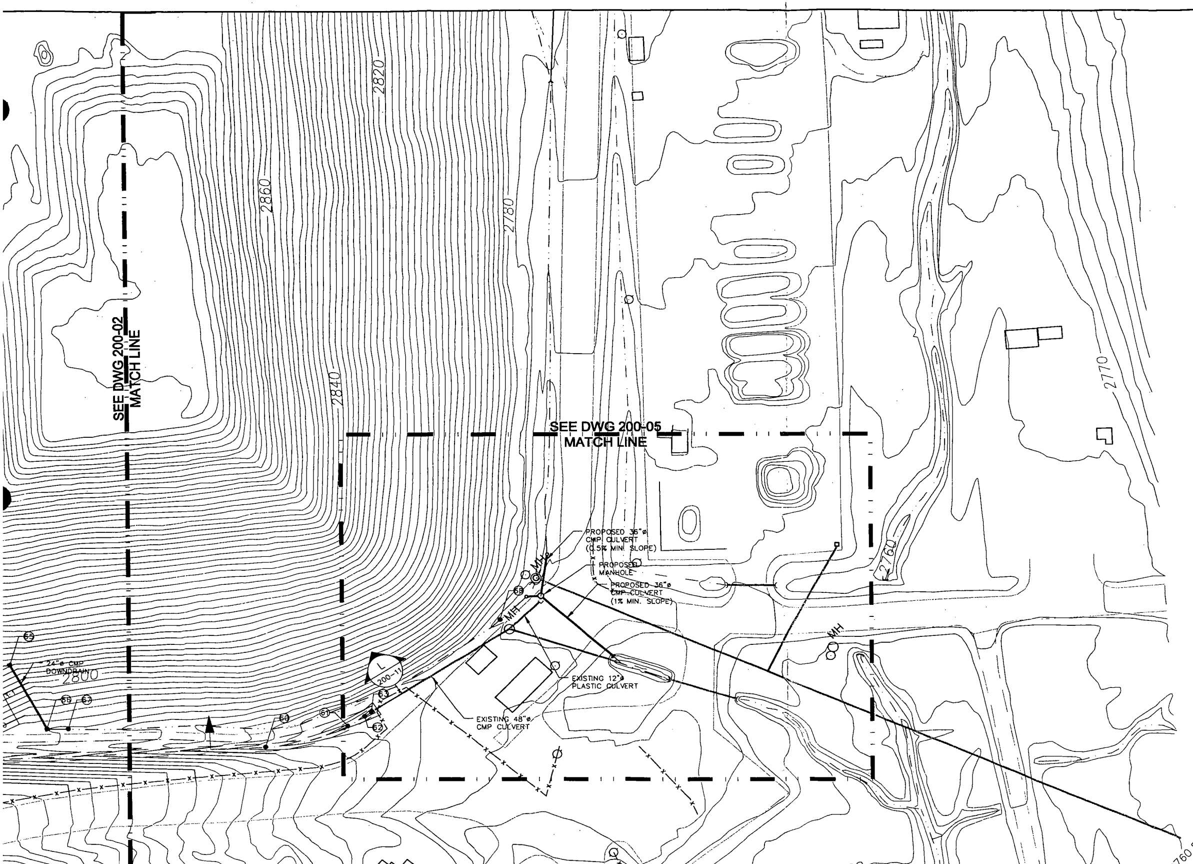
WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

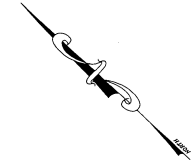
NORTHERN STORMWATER IMPROVEMENTS

DRAWING NO. 200-03

PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION





GRAPHIC SCALE

50' 0 25' 50' 100' 200'

LEGEND

- EXISTING 10 FT. CONTOUR
- EXISTING 2 FT. CONTOUR
- PROPOSED 10 FT. LINER GRADING CONTOUR
- PROPOSED 2 FT. LINER GRADING CONTOUR
- PROPOSED DRAINAGE
- EXISTING CULVERT
- PROPOSED CULVERT
- EXISTING DIRT ROAD
- EXISTING PAVED ROAD
- DRAINAGE
- PROPOSED LINER LIMITS
- EXISTING LINED AREAS
- MATCH LINE
- PROPERTY LIMITS
- FENCE
- BOULDERS
- MANHOLE
- POWER POLE
- SPOT ELEVATION
- CONTROL POINT

CONTROL COORDINATES

LABEL	NORTHING	EASTING	ELEV	DESCRIPTION
60	6641.57	4449.74	2776.54	DRAINAGE CHANNEL CORNER
61	6598.38	4524.85	2773.05	DRAINAGE CHANNEL GRADE BREAK
62	6593.19	4545.03	2771.38	DRAINAGE CHANNEL CORNER
63	6591.54	4553.22	2770.71	EXISTING PIPE INVERT
65	6886.48	4330.94	2808.00	TOP OF RIPRAP
66	6811.98	4608.46	2786.00	TOP OF RIPRAP
67	6797.13	4323.20	2785.40	TOP OF RIPRAP
68	6570.63	4715.88	2771.05	TOP OF RIPRAP

NOTES:
1. TOPOGRAPHY IS BASED ON JUNE 8, 2005 AERIAL SURVEY BY OLYMPUS AERIAL SURVEYS, INC., WITH FIELD SURVEY BY TALON RESOURCES, INC. ON MAY 23, 2005.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER
5881834-2202
JACOB V. RUSSELL
State of Utah

VECTOR ENGINEERING, INC.
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ALLIED WASTE SERVICES

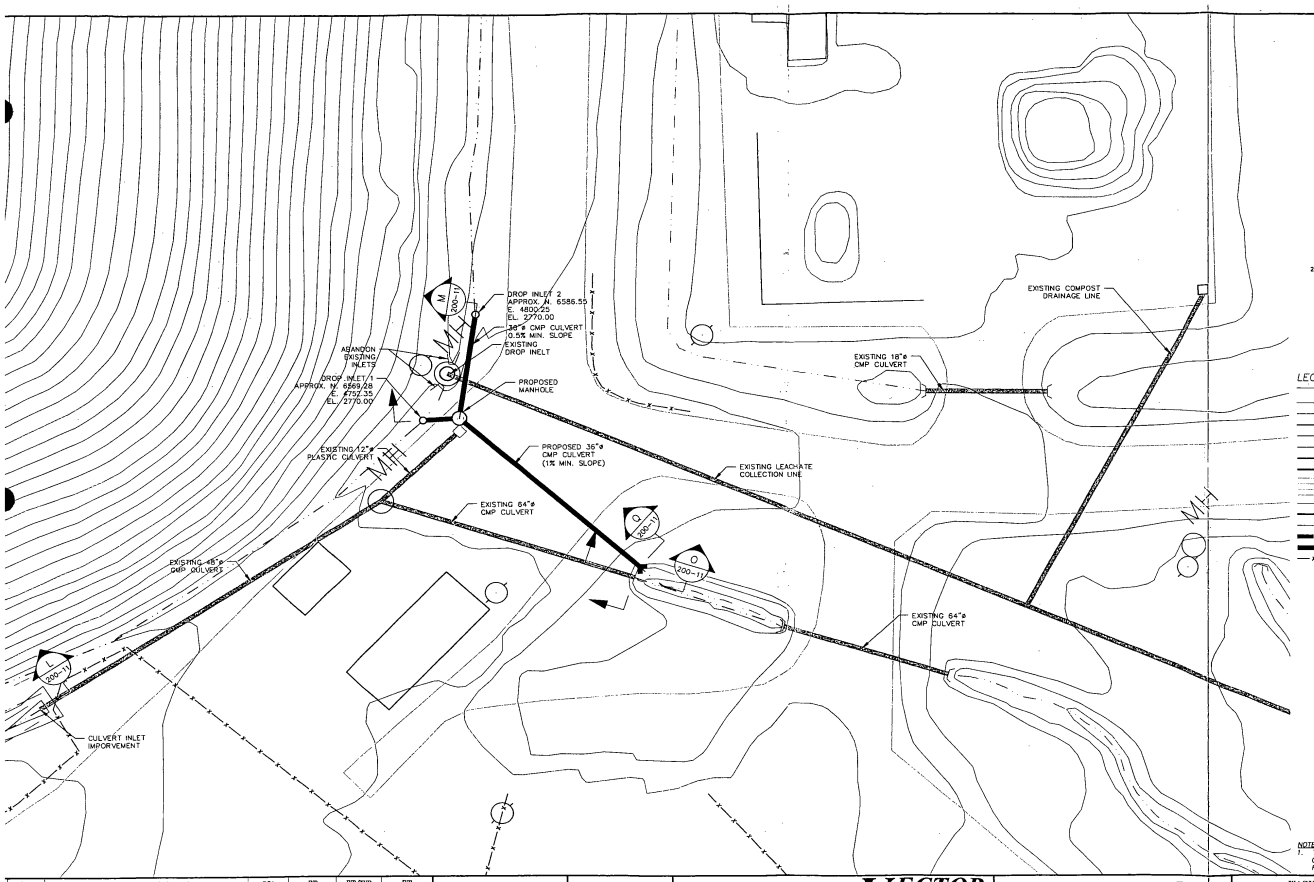
WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

SOUTHERN STORMWATER IMPROVEMENTS

DRAWING NO. 200-04
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION

WASHINGTON COUNTY LANDFILL PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLAN



DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER
5601834-2202
JACOB V. RUSSELL
State of Utah

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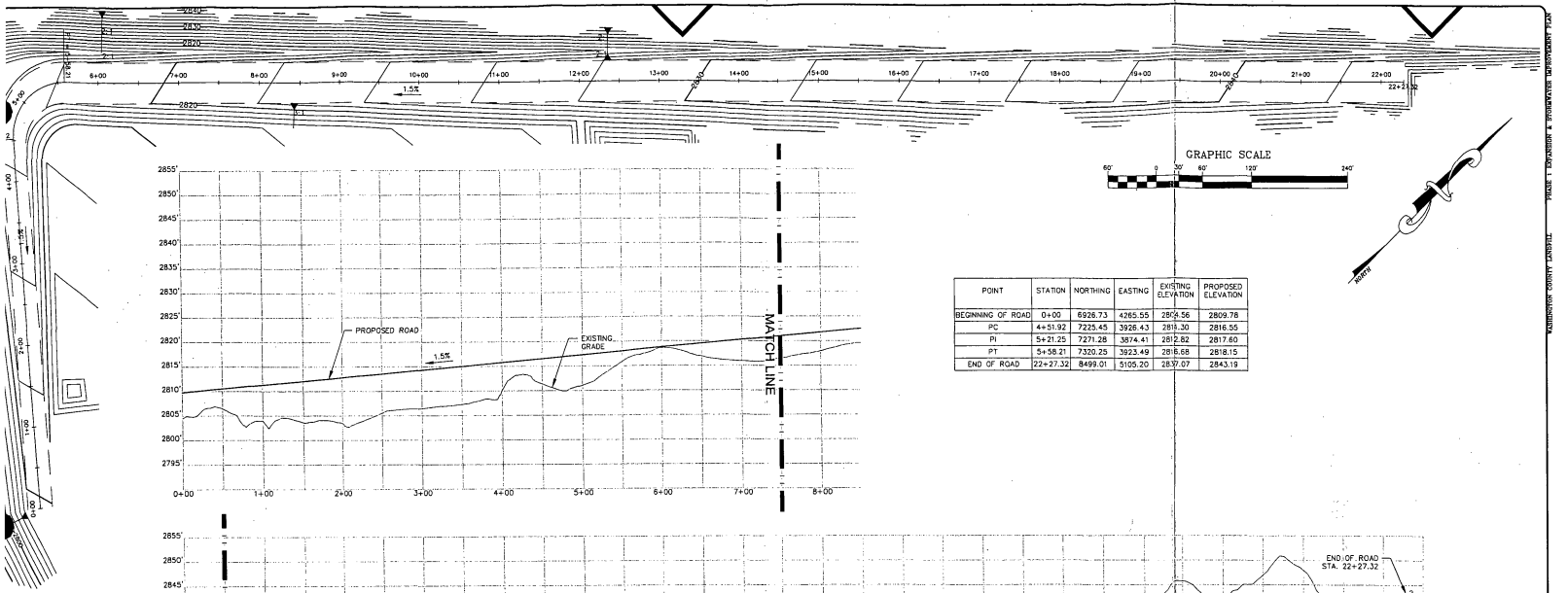
ALLIED WASTE SERVICES

WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION &
STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

SOUTHERN STORMWATER IMPROVEMENTS (DETAILED VIEW)

DRAWING NO. 200-05
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION



GRAPHIC SCALE

60' 0 30' 60' 120' 240'

NORTH

POINT	STATION	NORTHING	EASTING	EXISTING ELEVATION	PROPOSED ELEVATION
BEGINNING OF ROAD	0+00	6926.73	4265.55	2804.56	2809.78
PC	4+51.92	7225.45	3926.43	2811.30	2816.55
PI	5+21.25	7271.28	3874.41	2812.82	2817.60
PT	5+58.21	7320.25	3923.49	2816.68	2818.15
END OF ROAD	22+27.32	8499.01	5105.20	2837.07	2843.19

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DATE OF ISSUE: 09/12/2005
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DRAWN BY: BGA
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REGISTERED PROFESSIONAL ENGINEER
368634-2202
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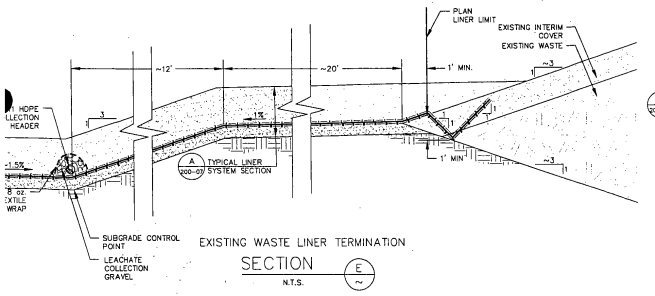
ALLIED WASTE SERVICES

WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION &
STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

WESTERN ACCESS ROAD PLAN AND PROFILE

DRAWING NO. 200-06
PROJECT NO. 041206.02

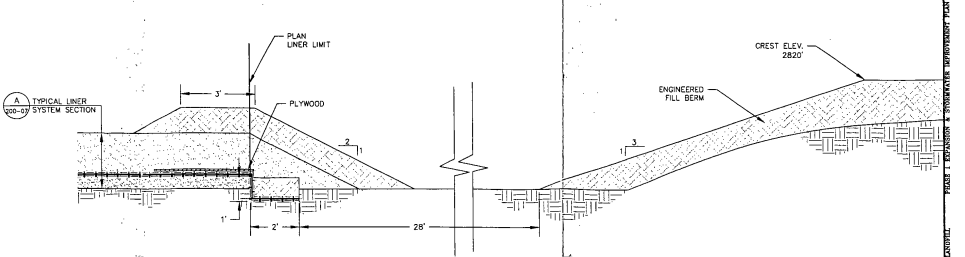
ISSUED FOR CONSTRUCTION



EXISTING WASTE LINER TERMINATION

SECTION E

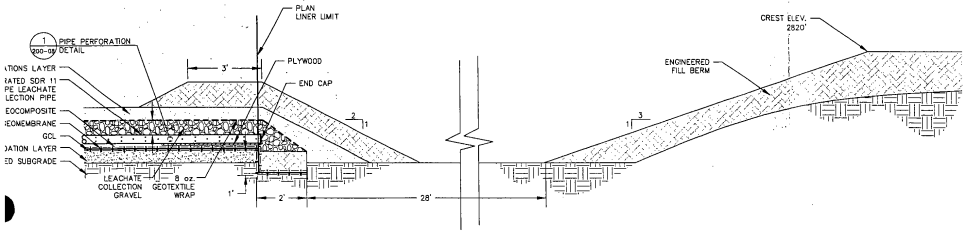
N.T.S.



TEMPORARY LINER TERMINATION

SECTION F

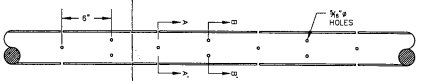
N.T.S.

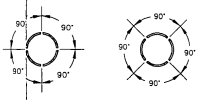


LEACHATE COLLECTION PIPE

SECTION G

N.T.S.

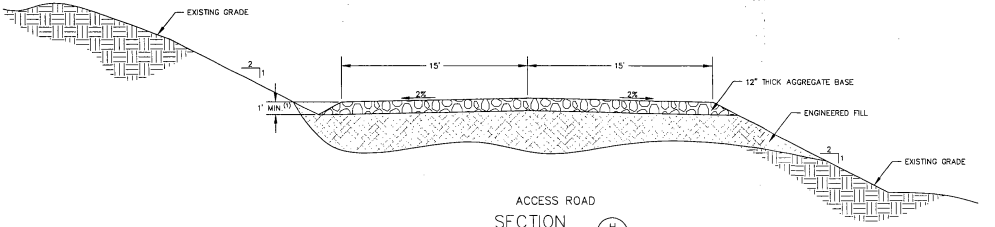




PIPE PERFORATION

DETAIL 1

N.T.S.



ACCESS ROAD

SECTION H

N.T.S.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
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DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER
5881834-2202
JACOB V. RUSSELL
State of Utah

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ALLIED WASTE SERVICES

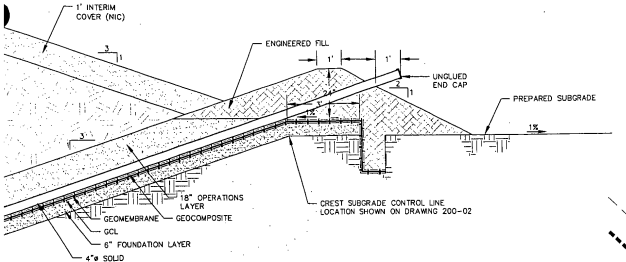
WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION &
STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

DETAILS

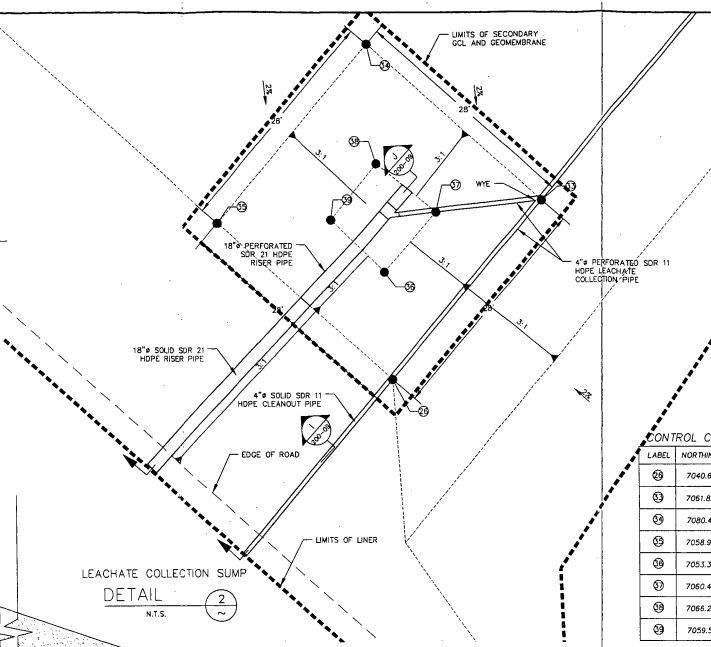
DRAWING NO. 200-08

PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION

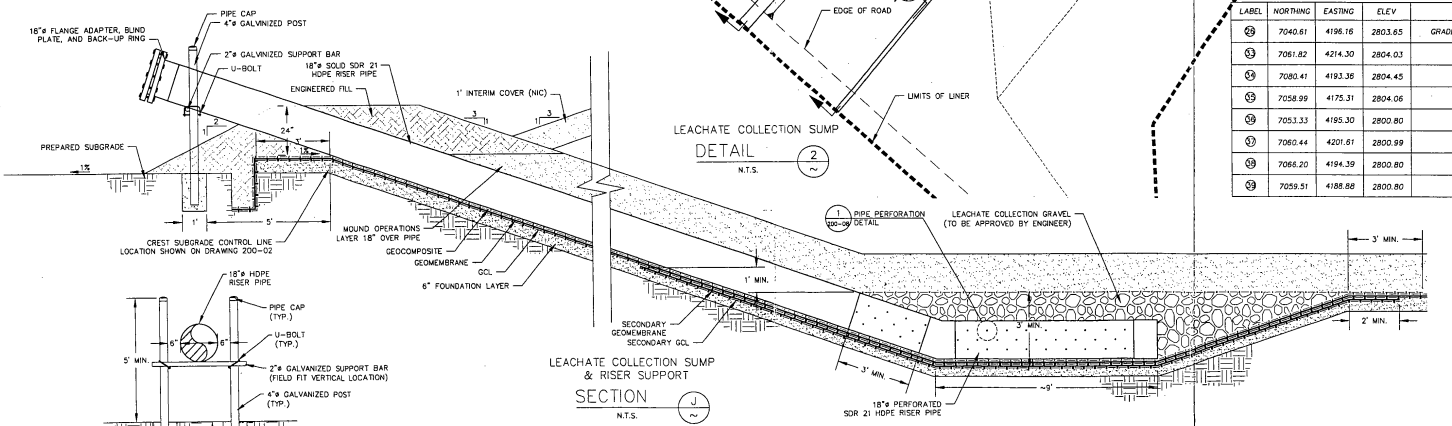


LEACHATE COLLECTION PIPE CLEANOUT SECTION I N.T.S.



CONTROL COORDINATES

LABEL	NORTHING	EASTING	ELEV	DESCRIPTION
29	7040.61	4196.16	2803.65	GRADE BREAK (AT SUBGRADE)
53	7061.82	4214.30	2804.03	CREST OF SUMP
54	7080.41	4193.38	2804.45	CREST OF SUMP
55	7058.99	4175.31	2804.06	CREST OF SUMP
56	7053.33	4195.30	2800.80	TOE OF SUMP
57	7060.44	4201.61	2800.99	TOE OF SUMP
58	7066.20	4194.39	2800.80	TOE OF SUMP
59	7059.51	4188.88	2800.80	TOE OF SUMP



LEACHATE COLLECTION SUMP DETAIL 2 N.T.S.

LEACHATE COLLECTION SUMP & RISER SUPPORT SECTION J N.T.S.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER — 588634-2202 — JACOB V. RUSSELL — State of Utah

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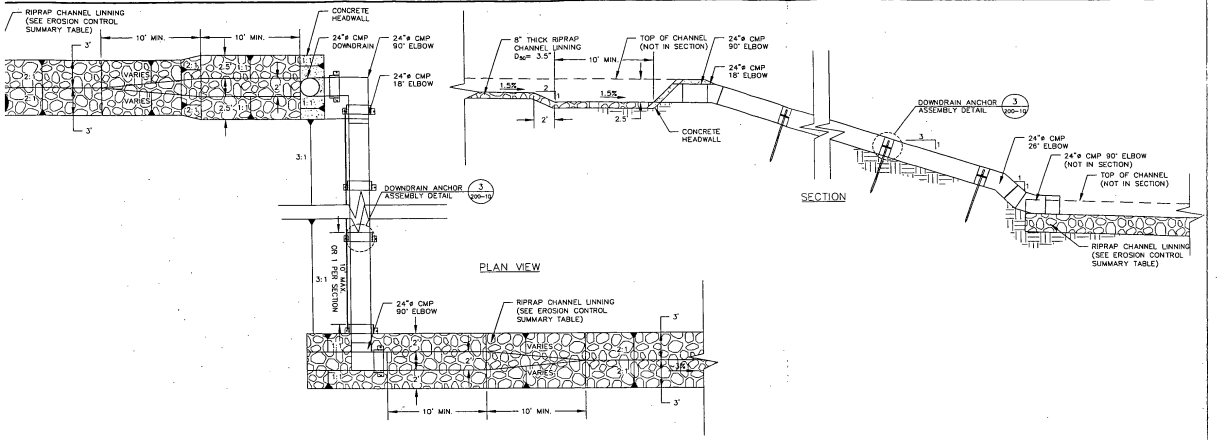
ALLIED WASTE SERVICES

WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

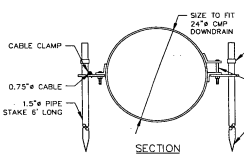
SUMP DETAILS

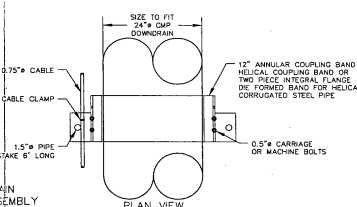
DRAWING NO. 200-09
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION

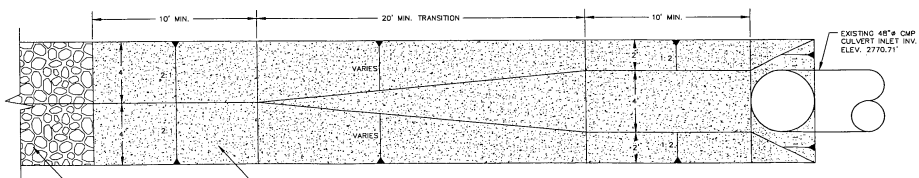


DOWNDRAIN
SECTION K
N.T.S.





DOWNDRAIN ANCHOR ASSEMBLY
SECTION 3
N.T.S.



STORMWATER CHANNEL TRANSITION INTO EXISTING CULVERT INLET
SECTION L
N.T.S.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER 5881834-2202 JACOB V. RUSSELL State of Utah

VECTOR ENGINEERING, INC.
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ALLIED WASTE SERVICES

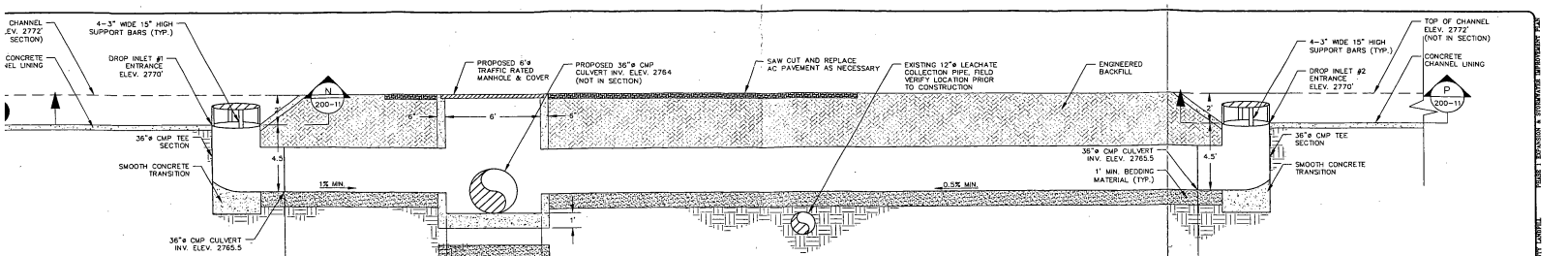
WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

DRAINAGE IMPROVEMENT DETAILS

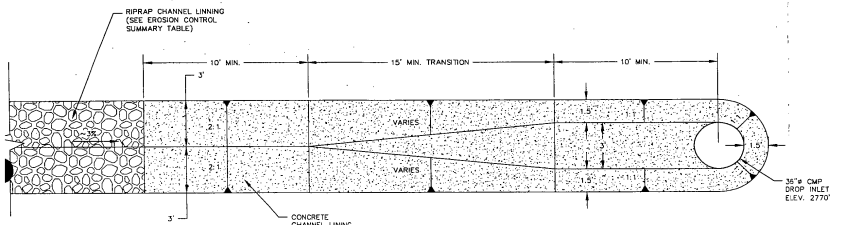
DRAWING NO. 200-10
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION

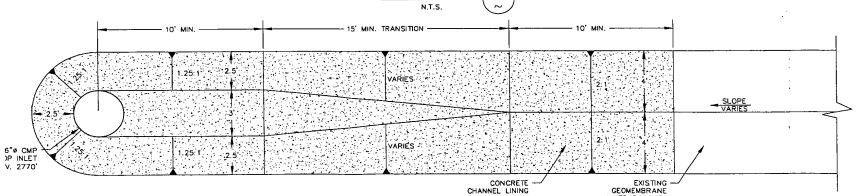
WASHINGTON COUNTY LANDFILL PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLAN



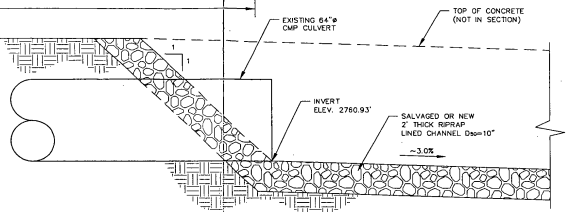
STORMWATER RUNOFF
CULVERTS
SECTION M
N.T.S.



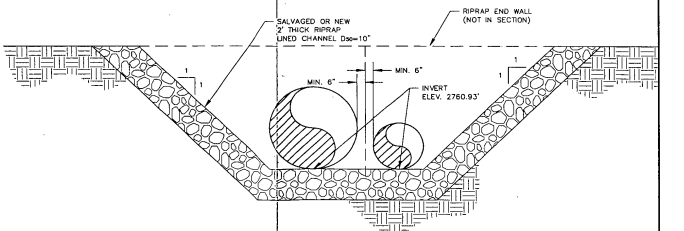
DROP INLET #1
SECTION N
N.T.S.



DROP INLET #2
SECTION P
N.T.S.



STORMWATER RUNOFF
CULVERT ENDWALL PENETRATION
SECTION O
N.T.S.



STORMWATER RUNOFF
CULVERT ENDWALL
SECTION Q
N.T.S.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

DATE OF ISSUE: 09/12/2005
DESIGNED BY: JVR
DRAWN BY: BGA
CHECKED BY: JVR/TVR
APPROVED BY: JVR

REGISTERED PROFESSIONAL ENGINEER
5881634-2202
JACOB V. RUSSELL
State of Utah

VECTOR
ENGINEERING, INC.

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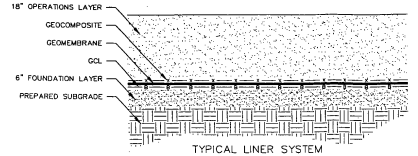
ALLIED WASTE SERVICES

WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION &
STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

DRAINAGE IMPROVEMENT DETAILS

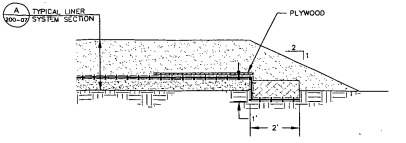
DRAWING NO. 200-11
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION



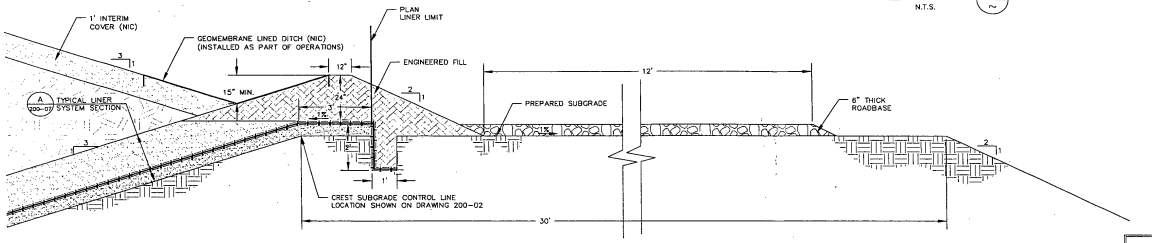
TYPICAL LINER SYSTEM

SECTION A N.T.S.



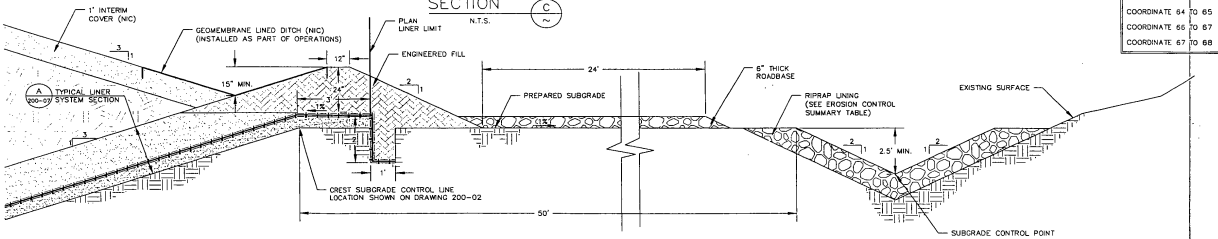
SIDESLOPE LINER TERMINATION

SECTION B N.T.S.



SOUTHWEST PERMANENT LINER TERMINATION AND PERIMETER ROAD

SECTION C N.T.S.



NORTHWEST PERMANENT LINER TERMINATION AND PERIMETER ROAD

SECTION D N.T.S.

EROSION CONTROL SUMMARY

CHANNEL SECTION	EROSION CONTROL MATERIAL	MEDIAN STONE SIZE, D_{50} (INCHES)	MAX STONE SIZE (INCHES)	LAYER THICKNESS (INCHES)
COORDINATE 53 TO 48	RIPRAP	6	9	12
COORDINATE 48 TO 63	GROUTED RIPRAP	6	9	12
COORDINATE 64 TO 65	RIPRAP	7	10	15
COORDINATE 66 TO 67	RIPRAP	9	13.5	24
COORDINATE 67 TO 68	RIPRAP	7	10	15

NOTES:
1. PLACE DRAINAGE CHANNELS WHERE APPLICABLE AS DETERMINED IN FIELD.

DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY
09/12/05	ISSUED FOR CONSTRUCTION	BGA	JVR	JVR/TVR	JVR

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REGISTERED PROFESSIONAL ENGINEER 5681634-2202 JACOB V. RUSSELL State of Utah

VECTOR ENGINEERING, INC.

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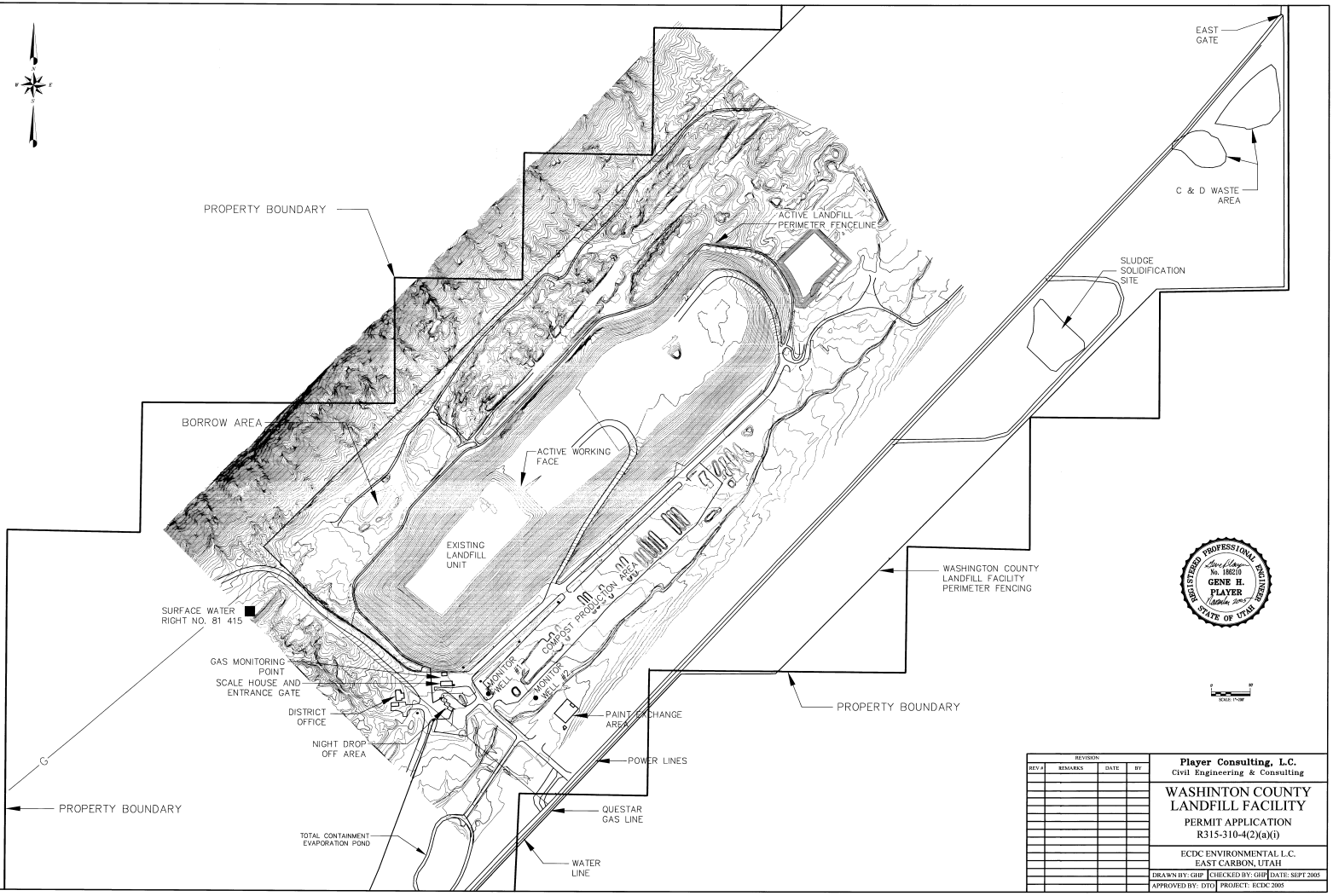
ALLIED WASTE SERVICES

WASHINGTON COUNTY LANDFILL
PHASE 1 EXPANSION & STORMWATER IMPROVEMENT PLANS
WASHINGTON, UTAH

DETAILS

DRAWING NO. 200-07
PROJECT NO. 041206.02

ISSUED FOR CONSTRUCTION



REVISION			
REV #	REMARKS	DATE	BY

Player Consulting, L.C.
Civil Engineering & Consulting

WASHINTON COUNTY LANDFILL FACILITY

PERMIT APPLICATION
R315-310-4(2)(a)(i)

ECDC ENVIRONMENTAL L.C.
EAST CARBON, UTAH

DRAWN BY: GHP	CHECKED BY: GHP	DATE: SEPT 2005
APPROVED BY: DTO	PROJECT: ECDC 2005	