Zipper Zeman Associates, Inc.
Geotechnical and Environmental Consulting

J-1578
April 4, 2003

Murphy and Associates, Inc.
c/o Olympia Welding and Machine
3225 Sleater-Kinney N.E.
Olympia, Washington 98506

Attention: Mr. Dean Burton

Subject: Subsurface Exploration and Geotechnical Engineering Study
Proposed Water Tank Reservoirs
Driftwood Valley Camping Club
Yelm, Washington

Dear Mr. Burton:

Zipper Zeman Associates, Inc. has completed a geotechnical engineering study relative to foundation design and construction considerations for the proposed water tanks at the Driftwood Valley Camping Club in Thurston County, Washington. Our services have been completed in general conformance with our proposal P-1918. Authorization to proceed with this study was provided via e-mail by Mr. Bob Norton on March 12, 2003.

The purpose of the study was to establish general surface and subsurface conditions at the site from which conclusions and recommendations regarding foundation design and construction considerations could be formulated. The scope of our services included visual reconnaissance, field explorations, laboratory testing, geotechnical engineering analysis, and preparation of this report. Our scope of services did not include sampling or testing of soil or water for regulated environmental contaminants.

This report is an instrument of service and has been prepared in accordance with generally accepted geotechnical engineering practices for the exclusive use of Driftwood Valley Camping Club and its agents, for specific application to this project and site location.

SITE AND PROJECT DESCRIPTION

The project site is an undeveloped tract located between Driftwood Valley Road and Fennel Road in Thurston County, Washington. The site is a located on a vacated street alignment that slopes from the east downward to the west.

We understand that the Driftwood Valley Camping Club is planning to construct two new water tanks approximately 250 feet to the west of the existing well. The reservoirs will be on the order of approximately 13 feet in diameter and 20 feet high. The preliminary design information conveyed to us indicates that two 20,000-gallon cylindrical steel tanks will be supported on

5113 Pacific Highway East, #1-P Fife, Washington 98424 (253) 896-5082

reinforced concrete slabs. The sloped nature of the site is such that some grading and a 2 to 4 feet high retaining wall will be required to develop the tank slab and pump house subgrade. Figure 1, Site and Exploration Plan, illustrates the approximate tanks and pump house locations.

SITE CONDITIONS

The site conditions for the project were evaluated by excavating two test pits on March 21, 2003. The approximate test pit locations are shown on the Site and Exploration Plan, Figure 1. The surface and subsurface conditions are described below, while the exploration procedures and interpretive logs of the test pits are presented in Appendix A. Appendix B describes the soil laboratory tests and presents the test results.

Surface Conditions

The project site is located on a gently sloped hillside with an inclination of approximately 10H:1V (Horizontal:Vertical). The site is situated in a vacated street alignment, with some previous grading activities apparent in the alignment. The planned tanks and pump house location is sparsely vegetated with weeds and grasses, with sand and gravel observed on the surface. The area to the north of the site is heavily forested and to the south are trees and grass. Surface water was observed approximately 20 feet west of the site seeping from the slope during the field exploration.

Subsurface Conditions

Soil and groundwater descriptions presented in this report are based on the subsurface conditions encountered at specific exploration locations across the site. Variations in subsurface conditions may exist between the exploration locations and the nature and extent of variations between the explorations may not become evident until construction. If variations then appear, it may be necessary to reevaluate the recommendations of this report.

The publication *Geologic Map of Washington - Southwest Quadrant* (Washington State Department of Natural Resources Map GM-34, 1987) describes the site as underlain by Vashon outwash gravel. Recessional outwash was deposited by flowing water beyond the lobe of the retreating ice mass during the most recent glaciation. The deposits in the site vicinity are described as stratified sand and gravel with horizons of silt and clay. Recessional outwash deposits are normally consolidated and generally capable of supporting light to moderate foundation loads. The recessional outwash deposits are mapped as underlain by Vashon lodgement glacial till, a glacially consolidated deposit. Tertiary bedrock has been mapped in the site vicinity as well.

The published mapping designation is consistent with conditions observed at the locations of test pits TP-1 and TP-2, excavated at the approximate locations shown on the Site and Exploration Plan, Figure 1. Test pit TP-1 disclosed approximately 1.5 feet of fill material consisting of loose, sandy gravel with some silt. The fill was underlain by approximately 1.0

45050100000 - Page 33 of 73

foot of loose, silty gravelly sand with tree roots (relic topsoil). Below this sand, medium dense, silty sandy gravel was observed, and extended to the bottom of the test pit.

Test pit TP-2 disclosed approximately 1.2 feet of loose, sandy gravel with some silt over stiff, sandy silt with trace gravel that extended to a depth of approximately 2.5 feet below grade. Test pit TP-2 was terminated at a depth of 8 feet below grade in medium dense, silty sandy gravel.

The soils were generally moist to wet at the time the test pits were excavated. Moisture contents of the soil samples that were tested in our laboratory ranged from 15 to 24 percent. It should be noted that the test pits were excavated during a period of substantial rainfall. Soil moisture content should be expected to vary seasonally.

Groundwater

Perched groundwater, in the form of minor seepage, was encountered in test pit TP-1 at a depth of approximately 5 feet below grade. No groundwater seepage was observed in test pit TP-2. The permanent groundwater table is anticipated to be at depths of over 10 feet below the ground surface. Groundwater conditions will vary due to seasonal precipitation patterns, site utilization, and other on- and off-site factors.

CONCLUSIONS AND RECOMMENDATIONS

Based on the subsurface conditions observed in the test pits, the site is considered suitable for construction of the planned water tanks. The following recommendations are based upon the subsurface conditions encountered at the test pit locations and our understanding of project plans. However, it should be noted that the subsurface conditions across the site may vary, and can change with time. Therefore, the specific site preparation operations will depend upon the weather and soil conditions encountered at the time of construction.

Site Preparation

The following site preparation recommendations are based on our understanding that cuts on the order of 2 to 3 feet will be required to level the site to planned finish grades. If final grading plans are changed, we should be notified so appropriate modifications to our recommendations can be made.

We recommend that the fill, remnant topsoil, or other deleterious debris be removed in the tank and pump house areas. Based on subsurface conditions observed in the exploratory borings, exposed soils at the tank pad subgrade elevation should consist of the native medium dense silty sandy gravel.

Following removal of the fill, topsoil, and any deleterious material, we recommend that the exposed subgrade surface be proofrolled using a heavy truck or vibratory compactor.

Zipper Zeman Associates, Inc.
5113 Pacific Highway East, #1-P
Fife, Washington 98424
(253) 896-5082
Resource Stewardship & Land Use

Proofrolling efforts should result in the upper one foot of subgrade achieving a compaction level of at least 95 percent of the maximum dry density per the ASTM D-1557 test method. We recommend that the exposed subgrade and compaction be monitored by Zipper Zeman Associates, Inc. The purpose of proofrolling/compacting is to detect the presence of unsuitable or disturbed soils, and to provide a suitable base for additional structural fill (if required) and/or support of foundation slabs. If unsuitable or disturbed soils are encountered, they should be removed and replaced with compacted structural fill in accordance with the recommendations in this report for structural fill.

The contractor should protect the exposed subgrade soils in the tank and pump house areas from disturbance during wet site conditions. Towards this end, it may be prudent to spread a working surface of clean, well-graded sand and gravel or crushed rock over the exposed subgrades.

We recommend that provisions be used to direct storm runoff away from excavations. Based on the observed conditions in the test explorations, we do not anticipate that groundwater will be encountered within the depth of the slab excavations.

Structural Fill Materials

The existing sandy gravel is considered suitable for structural fill provided the moisture content of the soil can be maintained within +/- 2 percent of optimum soil moisture as determined by the ASTM D-1557 test method. We recommend that imported structural fill consist of "clean", free-draining pit-run sand and gravel. Such material should generally contain less than 5 percent fines based on that soil fraction passing the U.S. No. 4 sieve, and not contain discrete particles greater than 3 inches in maximum dimension. It should be noted that the placement of structural fill is, in many cases, weather-dependent. Delays due to inclement weather are common, even when using select granular fill. We recommend that site grading and earthwork be scheduled for the drier months, if at all possible.

Structural Fill Placement

We recommend that all structural fill be placed in lifts not exceeding 8 inches in loose measure. Structural fill material should be compacted to a minimum of 95 percent of the ASTM D-1557 test method in building areas. Fill should be compacted to at least 90 percent of the maximum dry density per the ASTM D-1557 test method in utility trenches. Non-structural fill, such as in landscaping areas, need only be compacted to the extent required for trafficability of construction equipment. Final structural fill slopes should be no steeper than 2:1 (H:V).

We recommend that all fill procedures include maintaining grades that promote drainage and do not allow for ponding within the fill area. The contractor should protect compacted fill subgrades from disturbance during wet weather. In the event of rain during structural fill placement, the exposed fill surface should be allowed to dry prior to placement of additional fill. Alternatively, the wet soil can be removed and wasted. We recommend that consideration be

4505010000 - Page 35 of 73

given to protecting haul routes and other high traffic areas with free-draining granular fill material (i.e. sand and gravel containing less than 5 percent fines) or quarry spalls to reduce the potential for disturbance to the structural fill during inclement weather.

We recommend that structural fill placement be observed and tested by a representative from our firm to determine that suitable compaction is being achieved.

Temporary Slopes

Cut slopes are anticipated on the east side of the tank slabs due to the sloping conditions of the site. Temporary slope stability is a function of many factors, including the following:

1. The presence and abundance of groundwater;
2. The type and density of the various soil strata;
3. The depth of cut;
4. Surcharge loadings adjacent to the excavation; and
5. The length of time the excavation remains open.

It is exceedingly difficult under the variable circumstances to pre-establish a safe and "maintenance-free" temporary cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since the contractor is continuously at the job site, able to observe the nature and condition of the cut slopes, and able to monitor the subsurface materials and groundwater conditions encountered. It may be necessary to drape temporary slopes with plastic or to otherwise protect the slopes from the elements and minimize sloughing and erosion. We do not recommend vertical slopes or cuts deeper than 4 feet if worker access is necessary. The cuts should be adequately sloped or supported to prevent injury to personnel from local sloughing and spalling. The excavation should conform to applicable Federal, State, and local regulations. We recommend that all temporary cut slopes be no steeper than 1H:1V and that permanent fill and cut slopes be no steeper than 2H:1V.

Tank Slabs

We recommend supporting the reinforced concrete foundation slab above compacted subgrade, as described in the Site Preparation and Structural Fill sections of this report. We recommend embedding the foundation slab at least 12 inches below the lowest adjacent grade.

For subgrade prepared as described above in the Site Preparation and Structural Fill sections of this report, we recommend an allowable bearing capacity of 2000 pounds per square foot (psf). This value may be increased by one-third when considering wind or seismic loads.

Lateral loads applied to the foundation slab could be resisted by a combination of passive earth pressure and frictional sliding resistance. We recommend that an allowable equivalent fluid weight of 250 pounds per cubic foot (pcf) be used for passive resistance. An allowable

45050100000 - Page 36 of 73

coefficient of friction equal to 0.40 could also be used along the base of the foundation. A factor of safety equal to at least 1.5 has been incorporated into these allowable values.

Under no circumstances should the foundation slab be cast atop loose or soft soil, slough, debris, or surfaces bearing water. We recommend that a representative from our firm observe the condition of the slab subgrade prior to placing concrete in order to verify that the bearing soils are undisturbed and that conditions are consistent with the recommendations contained within this report.

Drainage Considerations

Permanent site grades should be set so that water does not collect adjacent to the tank slab and pump house slabs. We recommend that the ground surface adjacent to the tanks and pump house be sloped to drain surface water away from the structure.

Seismic Design Criteria

The seismic design criteria presented in this section are based on the American Water Works Association (AWWA) standards for welded steel tanks (ANSI/AWWA D-100-96). Figure 7 presented in the AWWA standard classifies the subject site as being within Seismic Zone 3. Based on the subsurface conditions encountered at the site and published geologic literature, it is our opinion that a Soil Profile Type B should be used to describe the average soil properties beneath the site.

Erosion Mitigation

Soil erosion is a natural process that is often aggravated by construction activities. Removal of vegetation, modification of topography, and poorly managed stormwater runoff are major contributors to erosion. In addition, some soils are particularly susceptible to erosion because of particle size gradation or density. Efforts should be made to reduce the potential for disturbance of the graded site and surrounding slopes. This may be accomplished by establishing well marked clearing limits to the north and south of the slope.

If construction is accomplished during the inclement weather, we recommend covering soil stockpiles with anchored plastic sheeting to reduce the potential for off-site sediment transport. We recommend that all bare soil areas be planted or mulched as soon as possible after construction. It may be necessary to provide temporary erosion protection, such as a 3-inch thick layer of straw, until vegetation has been reestablished.

45050100000 - Page 37 of 73

CLOSURE

The conclusions and recommendations presented in this report are based on the explorations accomplished for this study. The number, location and depth of the explorations for this study were completed within the site and scope constraints of the project so as to yield the information necessary to formulate our recommendations.

We appreciate this opportunity to be of service to you, and would be pleased to discuss the contents of this report or other aspects of the project with you at your convenience.

Respectfully submitted,

Zipper Zeman Associates, Inc.

Timothy H. Roberts, P.E., P.G.
Senior Engineer

John E. Zipper, P.E.
President

JOHN E. ZIPPER
STATE OF WASHINGTON
22811
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 1/24/05

Enclosures: Figure 1 – Site and Exploration Plan
Appendix A – Field Exploration Procedures and Logs
Appendix B - Laboratory Testing Procedures and Results

Zipper Zeman Associates, Inc.
5113 Pacific Highway East, #1-P Fife, Washington 98424 (253) 896-5082

APPENDIX A
FIELD EXPLORATION PROCEDURES AND LOGS

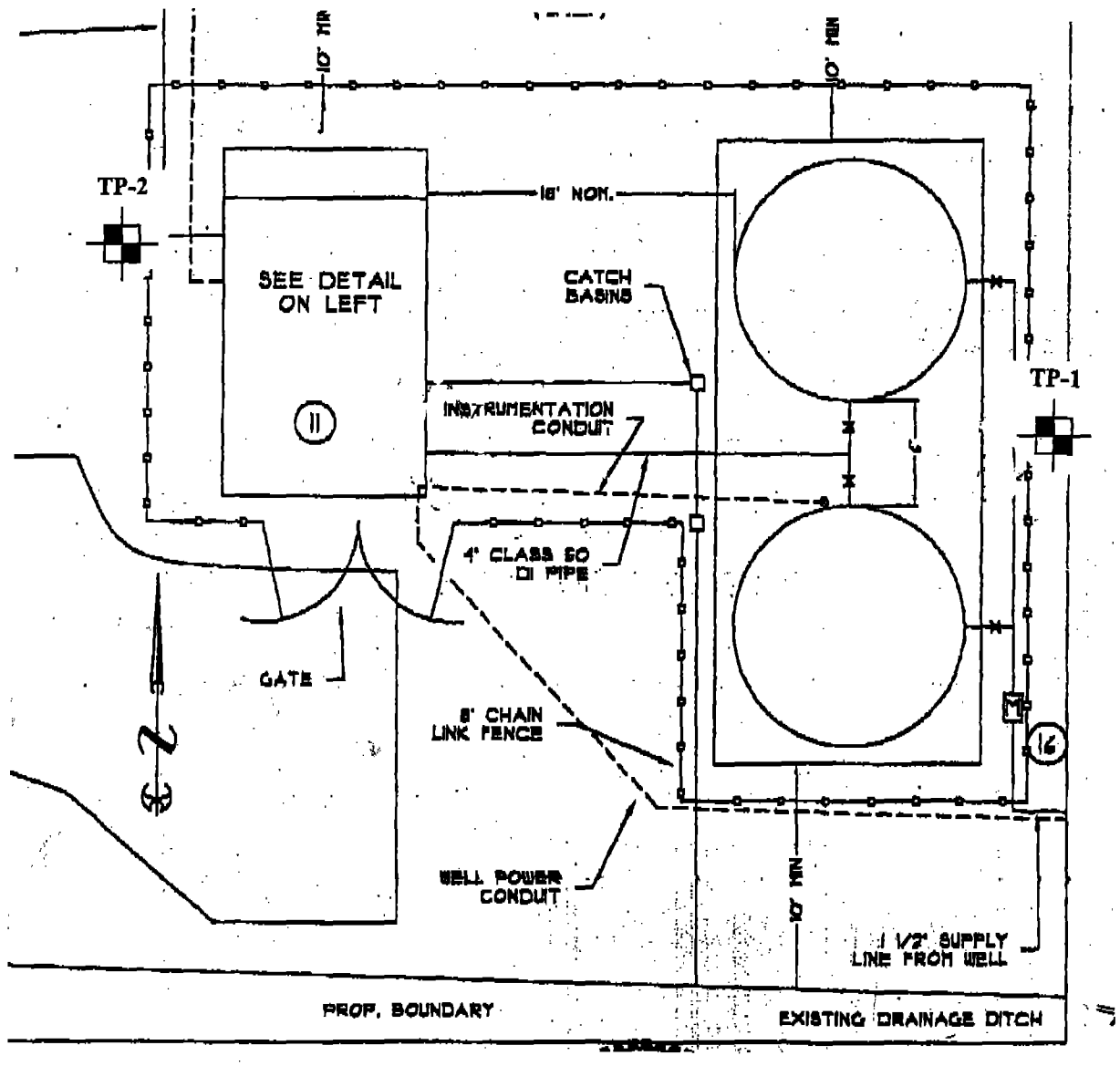
Our field exploration for this project included two test pits advanced on March 21, 2003. Approximate exploration locations are shown on the Site and Exploration Plan, Figure 1. Exploration locations were determined by measuring distances from existing site features. As such, the exploration locations should be considered accurate to the degree implied by the measurement method. The following sections describe our procedures associated with the exploration. Descriptive logs of the explorations are enclosed in this appendix.

Test Pit Procedures

Exploratory test pits were advanced with a backhoe provided by Driftwood Valley. An engineer from our firm continuously observed the test pits, logged the subsurface conditions encountered, and obtained representative soil samples. All samples were stored in moisture-tight containers and transported to our laboratory for further visual classification and testing. After each test pit was completed, the test pit was backfilled with soil cuttings.

The enclosed logs describe the vertical sequence of soils and materials encountered in each test pit, based primarily upon our field classifications and supported by our subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. If any groundwater was encountered in a test pit, the approximate groundwater depth is depicted on the log.

45050100000 - Page 39 of 73



EXPLANATION
TP-1 TEST PIT NUMBER AND APPROXIMATE LOCATION

10 5 0 10 20

SCALE IN FEET

REFERENCE: SITE PLAN FAX DATED 3/6/03, AND ZZA FIELD MEASUREMENTS

ZIPPER ZEMAN ASSOCIATES, INC. Geotechnical and Environmental Consulting 5113 Pacific Highway East, #1-P Fife, Washington 98424 (253) 896-5082	SITE AND EXPLORATION PLAN Driftwood Valley Yelm, Washington	
	J-1413-10	FIGURE 1

Test Pit TP-1

Depth (feet)	Material Description	Sample No.
0.0-1.5	Loose, moist to wet, brown, sandy GRAVEL with some silt (Fill)	S-1 @ 1'
1.5-2.5	Loose, wet, gray, silty gravelly SAND with tree roots (Relic Topsoil)	S-2 @ 1.5'
2.5-8.5	Medium dense, moist to wet, brown, silty gravelly SAND	S-3 @ 3.5'
	Test pit completed at 8.5 feet No seepage observed	

Test Pit TP-2

Depth (feet)	Material Description	Sample No.
0.0-1.2	Loose, wet, brown, sandy GRAVEL with some silt (Fill)	
1.2-2.5	Stiff, moist to wet, mottled brown, SILT with some sand and gravel	S-1 @ 1.5'
2.5-8.0	Medium dense, moist becoming saturated at 5 feet, brown, silty gravelly SAND	
	Test pit completed at 8.0 feet Severe seepage observed at ~5 feet	

APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS

A series of laboratory tests were performed during the course of this study to evaluate the index and geotechnical engineering properties of the subsurface soils. Descriptions of the types of tests performed are given below.

Visual Classification

Samples recovered from the exploration locations were visually classified in the field during the exploration program. Representative portions of the samples were carefully packaged in moisture tight containers and transported to our laboratory where the field classifications were verified or modified as required. Visual classification was generally done in accordance with the Unified Soil Classification system. Visual soil classification includes evaluation of color, relative moisture content, soil type based upon grain size, and accessory soil types included in the sample. Soil classifications are presented on the exploration logs in Appendix A.

Moisture Content Determinations

Moisture content determinations were performed on representative samples obtained from the exploration in order to aid in identification and correlation of soil types. The determinations were made in general accordance with the test procedures described in ASTM: D-2216.

Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses were performed on representative samples in general accordance with ASTM: D-422. The results of the grain size determinations for the samples were used in classification of the soils, and are presented in this appendix.

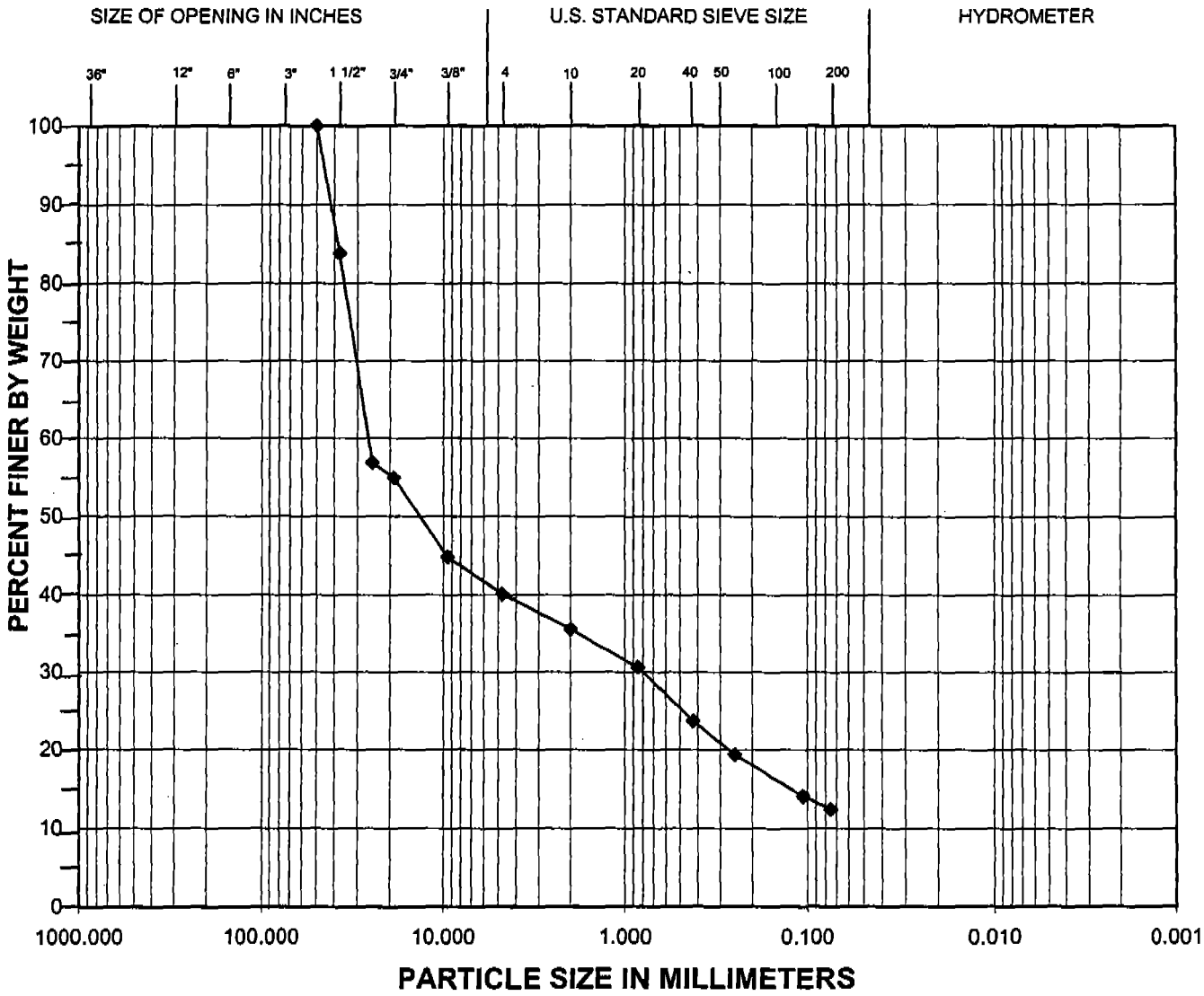
4505010000 - Page 42 of 73

Resource Stewardship & Land Use

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 1140,422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-1	S-3	3.5	15	12.4	silty sandy GRAVEL

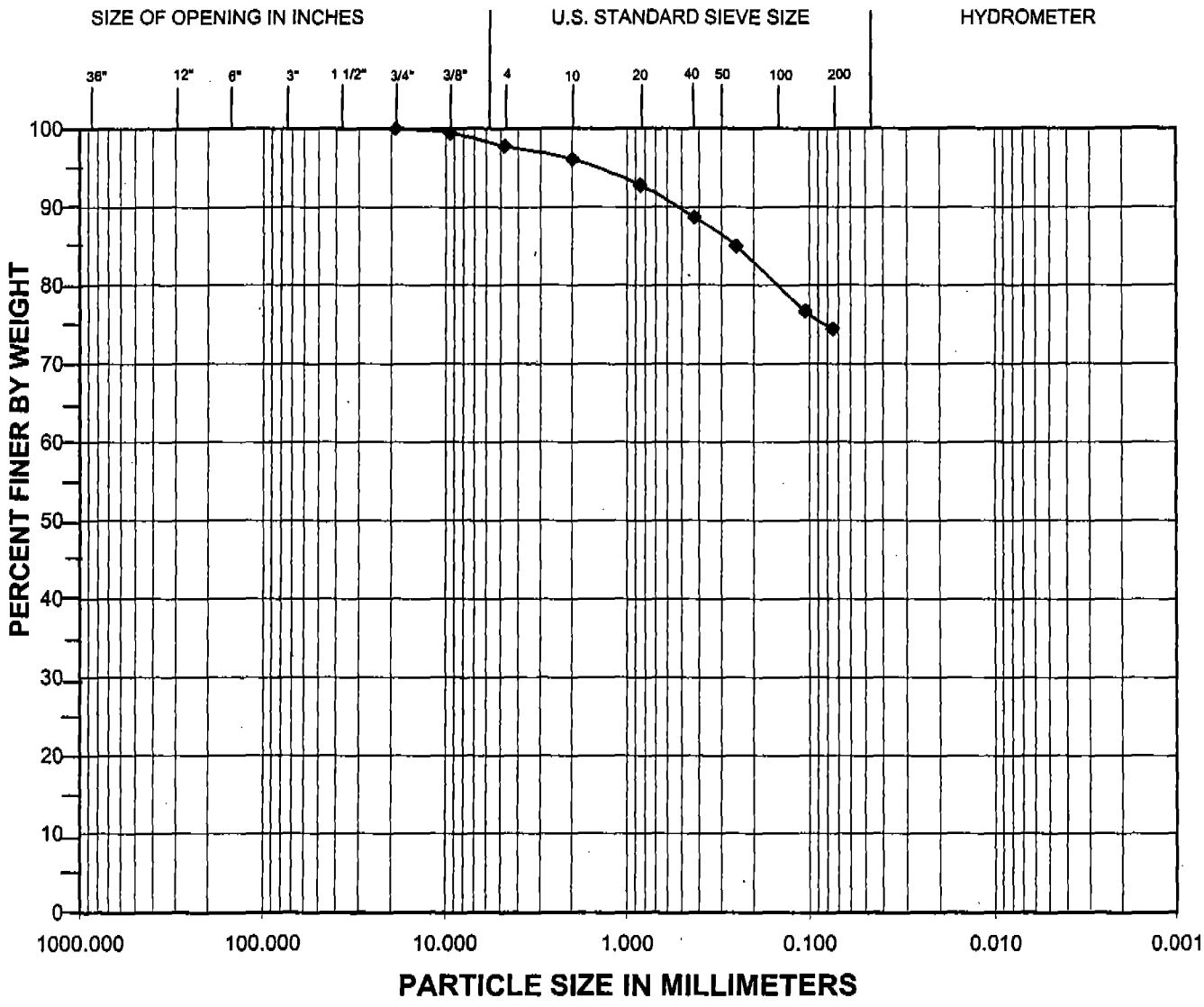
Zipper Zeman Associates, Inc. Geotechnical and Environmental Consulting	PROJECT NO: J-1578 DATE OF TESTING: 3/24/03	PROJECT NAME: Driftwood Valley

Resource Stewardship & Land Use

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 1140,422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-2	S-1	1.5	24	74.5	sandy SILT with trace gravel

Zipper Zeman Associates, Inc. Geotechnical and Environmental Consulting	PROJECT NO: J-1578 DATE OF TESTING: 3/24/03	PROJECT NAME: Driftwood Valley