Arkansas River Corridor Projects
Preliminary Geotechnical Exploration

TO:	Tulsa County
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Tulsa County, as part of the Arkansas River Corridor Master Plan (Carter & Burgess, 2004; C. H. Guernsey and Company et al., 2005), is undertaking an improvement project on the Arkansas River. The primary goals of the overall project are to improve least tern habitat, improve fish habitat and fish passage, improve the function of the river system itself, enhance economic development, increase recreational opportunities, and increase connectivity between the river and surrounding communities. The conceptual project components are described in detail in the Technical Memorandum (TM) entitled Baseline Project Summary for the Arkansas River Corridor Project (CH2M HILL, 2009a). Key components include:

- Design of habitat improvements along the corridor
- Design of bank stabilization in select areas
- Design of a new Sand Springs low-head dam, pedestrian bridge, and amenities
- Design of modifications to Zink Dam and lake with whitewater features
- Design of a new South Tulsa/Jenks low-head dam, pedestrian bridge, and amenities

A preliminary geotechnical exploration is recommended at each dam site, in order to collect more information on subsurface properties and conditions. This TM summarizes the size and scope of the recommended exploration program. An estimate of exploration program costs is also provided.

Background and Site Description

As part of a master plan for the Arkansas River corridor, Tulsa County is considering a series of improvement projects on the Arkansas River, along a corridor stretching nearly 42 miles from Keystone Dam to the Tulsa County/Wagoner County border. Included in this corridor are three dam sites:

1. Sand Springs (proposed)
2. Zink Lake (upgraded)

3. South Tulsa/Jenks Dam (proposed)

Existing geologic and geotechnical information for the dam sites and project vicinity was summarized in the TM entitled Existing Geotechnical Resource Review (CH2M HILL, 2009b). That information includes geologic mapping, boring logs, and bridge foundation plans.

The general subsurface conditions at the site consist of interbedded silt, clay, and sand alluvial overburden, underlain by shale bedrock. This general subsurface profile is anticipated to be relatively consistent within the project corridor, based on the existing subsurface information reviewed.

Sand Springs Dam—Existing Geotechnical Data

In 2008, three borings were advanced in the vicinity of the Sand Springs dam location (Stantec, 2008), approximately 1,500 feet (ft) downstream of Highway 97. Two of these borings were on the river banks, near the potential abutment locations. One boring was advanced within the river bottom. These borings included coring into rock, and the depths ranged from 50.5 to 75 ft below ground surface (bgs). Six unconfined compression tests were conducted on retrieved samples of rock core.

Zink Lake Dam—Existing Geotechnical Data

In 1980, 10 borings were advanced along the alignment of the Zink Lake Dam. Two borings were advanced at each abutment location on the river bank, and six were advanced within the river channel. These borings penetrated overburden, sandstone, and shale bedrock, and were advanced to depths ranging from approximately 55 to 85 ft bgs. No quantitative information on soil strength, rock quality or hardness, or degree of weathering was available.

South Tulsa/Jenks Dam—Existing Geotechnical Data

Five borings were advanced in 2008 in the vicinity of the South Tulsa/Jenks dam location (Stantec, 2008), approximately 3,000 ft downstream of Highway 169 (Creek Turnpike). Three of these borings were on the river banks. Two borings were advanced within the river channel. These borings included coring into rock, and the depths ranged from 10.5 to 75 ft bgs. Nine unconfined compression tests were conducted on retrieved samples of rock core.

Recommended Additional Geotechnical Exploration

It is proposed that additional geotechnical borings be advanced in the vicinity of each dam location, once the alignment and concepts for each new or modified dam have been identified. The layout of the borings should cover a corridor both up- and downstream of the dam alignment, to allow flexibility in the final location. These borings would supplement the existing information by providing additional information on the depth to the rock surface and depth and frequency of weathering in the rock, as well as additional samples for strength and durability testing of the shale bedrock.

It is recommended that up to 10 borings be advanced at each new dam site. It is assumed that the alignment of both the Sand Springs dam and the South Tulsa/Jenks dam will not

coincide with the location of the borings advanced by Stantec (2008). Information obtained from those explorations will supplement the new information obtained. Ultimately, it is recommended that approximately three borings be advanced at each river bank plus three or four borings within the river channel at the final alignment location for both the Sand Springs dam and the South Tulsa/Jenks dam.

At Zink Lake, it is recommended that two borings be advanced at each river bank, plus two borings within the river channel (six borings total), in order to confirm existing geotechnical information and to obtain geotechnical information on strength, rock quality, hardness, and weathering.

Mud rotary methods are recommended for drilling in the overburden, in order to obtain accurate Standard Penetration Test (SPT) data below the groundwater level. Rock coring methods should be used in the borings to obtain relatively undisturbed samples of the bedrock. Borings should be observed by a geotechnical engineer, and boring logs and a rock core photo log should be produced in order to identify weak or weathered zones of rock. In situ deformation testing may also be utilized within the rock core holes.

Recovered samples of soil and rock should be retained for laboratory testing. The scope of testing is anticipated to consist of index, strength (shear and compressive), and durability testing.

Depending on the variability of the subsurface profile observed in the borings, geophysical testing may also be warranted at the Sand Springs and South Tulsa/Jenks dam sites. Geophysics could be used to define a clearer and continuous rock profile, and to obtain shear wave velocity information within the rock material, which would provide empirical correlation with strength and excavatability.

Preliminary Geotechnical Exploration Cost Estimate

In order to develop a cost estimate, a preliminary geotechnical exploration scope is outlined below. Although costs are based on current drilling and testing rates in the Tulsa area, they should be regarded as tentative only, since final bids and contracts have not been executed with subcontractors. The specific number of borings, depth of borings, and scope of laboratory and field testing should be reviewed and finalized once the dam alignment and concept are determined, and final quotes obtained from subcontractors. In lieu of this, a contingency amount has been included to account for this uncertainty in price. The scope of the exploration and associated costs are outlined in Table 1.

The scope and costs in Table 1 are provided as a guideline in procuring specific bids for performing the work. A 10 percent contingency is included in subcontractor costs. Actual costs may vary from those shown in Table 1 depending on when the work is actually completed, seasonal and weather factors, and the subcontractors selected for the work.

TABLE 1
Estimated Cost Summary

Item	Cost	Description
Geotechnical Engineering[a]		Project Management and Field Oversight (logging of all borings and field characterization of all samples) Subcontractor Procurement (driller, laboratory, geophysics, pressuremeter testing) Data Reduction Survey and Map Production (2 mobilizations: layout and as-built locations) Geotechnical Data Report (boring logs and testing/data summary) Expenses (travel, per diem, sampling supplies, and shipping)
- Labor	$47,000	
- Direct Expenses	$6,000	Travel, Equipment, Shipping, Misc Expenses, etc.,
Drilling Costs[b]	$68,000	26 Total Boreholes (10) 40-ft Borings (within river channel) (16) 60-ft Borings (at/on river bank) Includes: 500-ft of drilling using mud rotary advancement methods 860-ft of drilling using rock coring methods
Geophysical Testing	$15,000	Assumes 3 days of spectral-analysis-of-surface-waves (SASW) and downhole testing
Pressuremeter Testing[c]	$14,000	Assumes 10 locations: conducting 2 pairs of tests per borehole, and 2 boreholes tested per day (5 days/20 tests)
Analytical Costs (laboratory)	$17,000	20 – Direct Shear Tests 6 – Triaxial UC Tests (3 points per test) 20 – Unconfined Compression Tests 6 – Composite Durability Suite Tests Index Testing Shipping Costs
Estimated Total Costs	**$167,000**	

Notes:

[a] It is assumed that access will be authorized by Tulsa County and that minimal site clearing activities will be required for testing and other geotechnical activities.

[b] Drilling sites are accessible by either truck- or track-mounted drill rigs. No costs are included for barge-supported drilling in the Arkansas River channel.

[c] Driller standby time is included in Drilling cost.

References

Carter & Burgess. 2004. *Final Arkansas River Corridor Master Plan, Phase I Vision Plan.* Prepared for Indian Nations Council of Governments (INCOG).

CH2M HILL. 2009a. *Baseline Project Summary for the Arkansas River Corridor Project.* Technical Memorandum prepared for Tulsa County – AR River Projects.

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Stantec Consulting Services. 2008. *Geotechnical Investigation and Testing; Arkansas River Corridor Project, Arkansas River*. Prepared for the USACE Tulsa District, Tulsa, Oklahoma. Contract No. DACW912BV-07-D-1000. Sand Springs/Jenks, Oklahoma. May 2008.