DEBEQUE STATION
POND 1 DESIGN REPORT

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INTRODUCTION

The De Beque Station will be designed for the collection of produced water from surrounding oil and gas operations along with raw water from the Colorado River. The proposed facility is located approximately 2.2 miles southwest of De Beque, Colorado in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M.

The facility will be fall under the jurisdiction of the Colorado Oil and Gas Conservation Commission (COGCC), Colorado Department of Public Health and Environment (CDPHE) and the Colorado Division of Water Resources (CDWR). The facility is located in Water Division 5 – Colorado River Basin and Water District 72 – Lower Colorado River.

PROJECT COMPONENTS

The De Beque Station facility will consist of three lined reservoirs for the storage of produced water and raw water, a pump station, a laydown yard and an office building. A layout of the facility is shown on Sheet 9 of the engineering plans. Pond 1 is designated as a produced and raw water pond while Ponds 2 and 3 are designated as produced water only. This gives the operator more flexibility for water storage.

The project will be split into several components. The first component is Pond 1, which is covered in this design report. Ponds 2 and 3 will be another component and will be submitted for review at a later date. The pump station and office building will each be their own component. Pond 1 is being submitted for review independently of Pond 2 and Pond 3 as Pond 1 is classified as a non-jurisdictional minor dam under the Colorado Division of Water Resources. The ponds were classified using the State of Colorado's *Rules and Regulations for Dam Safety and Dam Construction*. The document defines a jurisdictional size dam as "a dam creating a reservoir with a capacity of more than 100 acre-feet, or creates a reservoir with a surface area in excess of 20 acres at the high-water line, or exceeds 10 feet in height measured vertically from the elevation of the lowest point of the natural surface of the ground where that point occurs along the longitudinal centerline of the dam up to the crest of the emergency spillway of the dam."

Pond 1 has a storage volume of 40.3 acre-feet, a water surface area of 2.59 acres, and a height from the spillway crest elevation to natural ground of 9.89 feet. Under the state's guidelines Pond 1 is classified as a non-jurisdictional size dam.

Pond 2 and Pond 3 each have a height from the spillway crest elevation to natural ground that exceeds 10 feet. This will classify these ponds as minor jurisdictional size dams and require the additional review of the Colorado Division of Water Resources (CDWR).

DESIGN CRITERIA

The criteria used for the design of Pond 1 were based on the COGCC 900 Series Rules.

902 PITS – GENERAL AND SPECIAL RULES

Rule 902.a requires pits used for exploration and production of oil and gas shall be constructed and operated to protect public health, safety, and welfare and the environment, including soil, waters of the state, and wildlife, from significant adverse environmental, public health, or welfare impacts from E&P waste, except as permitted by application laws and regulations.

Pond 1 has been designed with a liner system that will prevent contamination of the existing ground water and soils. This liner system will be described in detail under Rule 904.

Black Hills Exploration and Production has been working with the Colorado Parks and Wildlife office to ensure that proper wildlife deterrents will be incorporated into the De Beque Station facilities. The proposed wildlife BMP plan is located in Attachment A. A brief overview of the best management practices that are included in this plan are:

- A 7-foot high chain-link fence capable of preventing elk, deer and other wildlife from entering the pit; concurrently with a small mesh type of fencing along the bottom of the fence (buried one-foot below grade level and extending two-feet above grade) capable of preventing small animals from entering between the gaps. This fence will have three strands of barb wire running across the top which will deter unauthorized personnel from entering the site.

- Hexprotect floating tiles cover to prevent waterfowl and other birds from coming in contact with water in the pits.

- Bear proof trash containers will be provided

- Night lighting will be full-cutoff type and/or timed or otherwise minimized to reduce disruption to wildlife.

Rule 902.b requires that pits shall be constructed, monitored, and operated to provide for a minimum of two (2) feet of freeboard at all times between the top of the pit wall at its point of lowest elevation and the fluid level of the pit. A method of monitoring and maintaining freeboard shall be employed. Any unauthorized release of fluids from a pit shall be subject to the reporting requirements of Rule 906.

Pond 1 has been designed with a freeboard of 2 feet below the crest elevation of the spillway. The water level in the pond will fluctuate as water is pumped to and from off-site locations. The water level will be monitored in the proposed pump house via a pressure transducer that will be installed in the bottom of the pond. Operation controls and warnings will be enforced to ensure this 2 feet of freeboard is maintained at all times. While not anticipated, if fluids are released from the pit all reporting requirements of Rule 906 will be followed.

Rule 902.c requires that any accumulation of oil or condensate in a pit be removed within twenty-four (24) hours of discovery. Operators shall use skimming, steam cleaning of exposed liners, or other safe and legal methods as necessary to maintain pits in clean condition and to control hydrocarbon odors. Only de minimis amounts of hydrocarbons may be present unless the pit is specifically permitted for oil or condensate recovery or disposal use. A Form 15 pit permit may be revoked by the Director and the Director may require that the pit be closed if an operator repeatedly allows more than de minimis amounts of oil or condensate to accumulate in a pit. This requirement is not applicable to properly permitted and properly fenced, lined, and netted skim pits that are designed, constructed, and operated to prevent impacts to wildlife, including migratory birds.

When produced water is returned to the facilities it will run through an oil skimming chamber located within the proposed pump station before it will return to Pond 1. If any oil or condensate is discovered within the pond, immediate action will be taken within 24 hours to ensure that it is removed safely and legally.

Rule 902.d requires that where necessary to protect public health, safety and welfare or to prevent significant adverse environmental impacts resulting from access to a pit by wildlife, migratory birds, domestic animals, or members of the general public, operators shall install appropriate netting or fencing.

As described in detail under Rule 902.a, appropriate fencing and floating hextiles will be installed at this facility to prevent adverse impacts to wildlife and the general public.

Rule 902.e requires that pits used for a period of no more than three (3) years, or more than three (3) years if the Director has issued a variance, for storage, recycling, reuse, treatment, or disposal of E&P waste or fresh water, as applicable, may be permitted in accordance with Rule 903 to service multiple wells, subject to Director approval.

A Form 15 will be submitted concurrently with this Pond 1 design report and engineering plans in accordance with Rule 903.

Rule 902.f requires that unlined pits shall not be constructed on fill material.

Pond 1 will be lined and therefore this rule does not apply.

Rule 902.g requires that except as allowed under Rule 904.a, unlined pits shall not be constructed in areas where pathways for communication with ground water or surface water are likely to exist.

Pond 1 will be lined and therefore this rule does not apply.

Rule 902.h requires that produced water shall be treated in accordance with Rule 907 before being placed in a production pit.

The produced water stored in Pond 1 will be treated in accordance with Rule 907 before being placed in the production pit.

Rule 902.i requires that operators shall utilize appropriate biocide treatments to control bacterial growth and related odors as needed.

Pond 1 will have an aeration system installed in order to prevent that water from becoming stagnant and thus reducing odors. The floating hextiles on the surface will also help reduce odors.

903 Pit Permitting/Reporting Requirements

A Form 15 permit is submitted with this Pond 1 design report and engineering plans and was completed in accordance with Rule 903.

904 Pit Lining Requirements and Specifications

Rule 904.a requires that pits that were constructed before May 1, 2009 on federal land, or before April 1, 2009 on other land shall comply with the rules in effect at the time or their construction. The following pits shall be lined if they are constructed on or after May 1, 2009 on federal land, or on or after April 1, 2009 on other land:

Pond 1 will be constructed after the April 1, 2009 date and will contain produced water from natural gas hydraulic fracturing. Pond 1 will be lined in accordance with Rules 904.b and 904.d.

Rule 904.b requires the following specifications shall apply to all pits that are required to be lined:

(1) Materials used in lining pits shall be of a synthetic material that impervious, has high puncture and tear strength, has adequate elongation, and is resistant to deterioration by ultraviolet light, weathering, hydrocarbons, aqueous acids, alkali, fungi or other substances in the produced water.

The liner used in Pond 1 will be an HDPE liner and will meet all the requirements of this rule.

(2) All pit lining systems shall be designed, constructed, installed, and maintained in accordance with the manufacturer's specifications and good engineering practices.

The HDPE pit lining system will be designed, constructed, installed and maintained in accordance to the manufacturer's specifications. A representative from the lining company will be on-site during the field installation to ensure that the liner is installed properly.

(3) Field seams must be installed and tested in accordance with the manufacturer specifications and good engineering practices. Testing results must be maintained by the operator and provided to the Director upon request.

The manufacturer will have a representative on-site during the field seeming process and during testing to ensure that they are seamed to the manufacturer's specifications. The operator will maintain all test results that are performed on the liner.

Rule 904.c requires the following specifications shall also apply to pits that are required to be lined, except those at centralized E&P waste management facilities, unless an oil and gas operator demonstrates to the satisfaction of the Director that a liner system offering equivalent protection to public health, safety, and welfare, including the environment and wildlife resources, will be used:

This rule is not applicable to the De Beque Station facility as it is a centralized E&P waste facility. It will be governed by Rule 904.d.

Rule 904.d requires the following specifications shall also apply to pits used at centralized E&P waste management facilities, unless an oil and gas operator demonstrates to the satisfaction of the Director that a liner system offering equivalent protection to public health, safety, and welfare, including the environment and wildlife resources, will be used:

(1) Liners shall have a minimum thickness of sixty (60) mils. The synthetic or fabricated liner shall cover the bottom and interior sides of the pit with the edges secured with at least twelve (12) inch deep anchor trench around the pit perimeter. The anchor trench shall be designed to secure, and prevent slippage or destruction of, the liner materials.

Pond 1 will be lined with several layers to prevent the produced water leaking into the adjacent soils. The primary liner on the surface will be a 60-mil HDPE liner. The next layer beneath the primary liner will be a 200-mil geocomposite drainage material. Shall a puncture occur in the primary liner layer this geocomposite layer will facilitate the flow of the water to the leak detection system. The next layer beneath the geocomposite layer is a secondary 40-mil HDPE liner. This layer is a backup liner that will prevent produced water from leaking into the soil shall a puncture occur in the primary liner. A geosynthetic clay liner fabric will be placed beneath the secondary liner to provide separation between the soil and liner and act as a liner foundation. The liner will be anchored with an 18” down, 18” over, and 12” up key trench configuration as recommended by the manufacture that can be seen on the engineering plans.

(2) The foundation for the liner shall be constructed with soil having a minimum thickness of twenty-four (24) inches after compaction covering the entire bottom and interior sides of the pit, and shall be constructed so that the hydraulic conductivity shall not exceed 1.0 X 10^{-7} cm/sec after testing and compaction. Compaction and permeability test results measured in the laboratory and field must be maintained by the operator and provided to the Director upon request.

A geosynthetic clay liner will installed in place of the 24-inch compacted liner foundation as allowed by the COGCC.

(3) As an alternative to the soil foundation described in Rule 904.d.(2), a secondary liner consisting of a geosynthetic clay liner, which is a manufactured hydraulic barrier typically consisting of bentonite clay or other very low permeability material, supported by geotextiles or geomembranes, which are held together by needling stitching, or chemical adhesives, may be used.

A geosynthetic clay liner (GCL) will be installed in place of the 24-inch compacted liner foundation. The GCL will have geotextile built-in to the fabric. The GCL will be placed on compacted clay soil which will reduce the probability of a puncture.

Rule 904.e requires that in Sensitive Areas, the Director may require a leak detection system for the pit or other equivalent protective measures, including but not limited to, increased record-keeping requirements, monitoring systems, and underlying gravel fill sumps and lateral systems.

The proposed facility is not located within a sensitive area. An exhibit included with the Form 15 permit shows that the facility is not in a sensitive area. However, a leak detection system will be constructed in the southeast corner of Pond 1. This is the corner of the pond that the pond bottom is sloped toward. The system will consist of a

gravel sump with a six inch diameter PVC pipe placed between the 200-mil geocomposite layer and the secondary 40-mil HDPE liner layer. If a leak occurs in the primary liner the produced water will flow to the southeast corner of the pond where it can be detected via the PVC pipe. A detail of the leak detection system is located in the Pond 1 Engineering Plans.

POND DESIGN

Pond 1 has been designed with 2H:1V interior side slopes, 3H:1V or greater exterior side slopes. A one foot deep spillway has been designed on the western berm of the pond as required by CDWR. There is a freeboard depth of 2 feet below the crest of the spillway. Pond 1 has bottom dimensions of 176 feet by 370 feet. The total pond depth from the berm to the bottom is 24.3 feet. The berms of the ponds will be 24 feet wide and will have a 3 percent cross slope that slopes away from the interior of the pond.

ACCESS ROAD

An access road will be constructed that will connect the county road V 2/10 with the proposed lay down yard. The access road will have a 20 feet wide gravel surface. The surfacing shall consist of 3 inches of aggregate surfacing and 6 inches of sub base. The aggregate surfacing will have gradation limits meeting the Colorado Department of Transportation (CDOT) Class 5 material. The sub base will have the gradation limits meeting the CDOT Class 2 material. The access road will be graded with a 3 percent cross slope away from the proposed pond and towards proposed drainage ditches.

Maintenance road will be constructed along the berm of Pond 1. Pond 1 has a 24 foot wide berm. The maintenance road will be 12 feet wide and will be located 2 feet from the exterior berm edge. The same surfacing typical section will apply to these maintenance roads as the access road to the lay down yard. The ponds berms will be graded with a 3 percent cross slope away from the interior of the pond.

POND PIPING

Water conveyance pipelines will be constructed as part of the Pond 1 construction phase. The proposed pipelines can be classified into three categories: 16-inch diameter raw water supply, 10-inch diameter produced water, and 8-inch diameter produced water. All pipelines will be constructed of steel. A pipeline flow schematic can be seen on Sheet 24 of the engineering plans.

The 16-inch diameter raw water supply pipeline will supply water from the Colorado River to Pond 1. Water will be pumped from the river via the existing Kobe pump station. An existing 16-inch diameter steel pipeline has already been installed across the Summit compressor station property as seen on Exhibit 2. The proposed pipeline

will connect into this existing pipeline. The pressure rating for this steel pipeline will be 150 psi. An electromagnetic flow meter and automated butterfly valve will be installed in a concrete vault upstream of the Pond 1 connection. Raw water stub outs have been designed for future connections to Ponds 2 and 3.

The 10-inch diameter produced water pipeline will convey water to and from the future pump station to Pond 1. The pump station will be designed as a separate submittal and will contain the flow meter and valves needed for this pipeline. The pressure rating for this steel pipeline will be 150 psi. Produced water stub outs have been designed for future connections to Ponds 2 and 3.

The 8-inch diameter produced water pipeline will convey water to and from the future pump station and off-site natural gas production sites. There are three natural gas production sites designated as Winter Flats, Homer Deep and Horseshoe Canyon (HSC). The pump station will contain the flow meter and valves for these pipelines. The pressure rating for these steel pipelines will be 1,250 psi. The Homer Deep pipeline will connect to an existing pipeline that has been installed in the northern portion of the Summit compressor station property. The Winter Flats pipeline will connect to an existing gas main on the north side of county road V 2/10 that will be converted to a produced water main. The HSC pipeline will tie into an existing pipeline that has been installed on the east side of the De Beque station property line.

GEOTECHNICAL

FIELD INVESTIGATION

A geotechnical investigation of the proposed area for the De Beque Station facilities was performed by Olsson Associates. Boreholes were drilled in February 2014 with six (6) boreholes being drilled to a depth of 30 feet and three (3) boreholes being drilled to a depth of 100 feet. The Standard Penetration Testing (SPT) method was used for each of the boreholes and spit-spoon sampling procedure was used to obtain samples throughout the bores. Bore logs and an exhibit showing the location of these boreholes are located in Attachment B. Bulk samples were obtained from the site in March 2014 with a purpose of performing a geotechnical analysis and determine soil properties. Tests performed from these bulk samples include triaxial tests and proctors. Results from these tests and the geotechnical laboratory testing schedule are located in Attachment C.

GEOTECHNICAL RESULTS

The Unified Soil Classification System (USCS) was used to determine the soil stratigraphy throughout each of the boreholes. The geotechnical results show that there is a homogenous layer of sandy lean clay (CL) throughout the project area which

penetrates to a depth greater than the proposed excavation depth of twenty-one (21) feet. Groundwater was not encountered at any of the borehole locations. Bore logs to support these findings are located in Attachment B.

The bulk samples were used to compute strength parameters of the soil by means of triaxial shear tests. To best represent the proposed constructed soils, the four bulk samples used for the triaxial tests were obtained from locations that are within the pond excavation areas and were located throughout the project area. Two types of triaxial tests were completed, an unconsolidated undrained test (UU) and a consolidated undrained test (CU). The triaxial test results are located in Attachment C.

Several proctors were run on the bulk samples to determine the maximum dry density of the soil and the associated moisture content. To best represent the soil that will be used for construction, the composite bulk samples were averaged. The average maximum dry density of the soil was found to be 116.15 pcf and 95% of the maximum dry density is 110.3 pcf. In addition, the associated optimum moisture content was found to be 16.5%. Lab results to support these findings are located in Attachment C.

SLOPE STABILITY

A slope stability analysis was performed for the interior and exterior berm slopes contained within Pond 1. The purpose of this analysis was to determine whether on-site materials would provide a sufficient factor of safety against slope failure for the slopes specified in the design. The design criterion is to achieve a minimum factor of safety on all slopes of 1.5. To remain conservative, a worst case analysis was modeled using the program Geo-Slope SLOPEW.

Due to the service road that follows the peripheral of the embankment's crest an additional live load was implemented in the SLOPEW model to represent vehicle traffic. A 10,000-lb vehicle load was applied to the model as point-loads with an axle load distribution of 70% and 30%. The resulting critical case was two separate point loads of 3,500-lb. Additionally, phreatic water conditions were neglected due to the depth of groundwater being greater than 100-feet and the pond being lined with an impermeable liner and a leak detection system being implemented. In the event that the liner was damaged the pond would be evacuated and the liner would be repaired.

To represent the embankments most critical condition, effective stress and an empty pond scenario were used. The effective stresses, obtained from the triaxial tests, were used due to effective stress resulting in a weaker structure than total stresses. Although typical soil cohesion values for sandy lean clay (CL) tend to be greater than 750 psf, a cohesion value of 50 psf was used to produce an ultra-conservative model. While total stresses represent short-term soil properties, effective stresses represent long-term soil properties. Also, as the water in the pond increases in elevation the slope's associated

factor of safety also increases. Therefore, the empty pond is the critical condition. An in situ unit weight was assumed to be 106 pcf for the sandy lean clay and a compacted fill unit weight was determined to be 110.3 pcf. Two cross sections were analyzed for the two scenarios present at Pond 1; the first scenario being predominantly at the north end of Pond 1 where the entire embankment will be in cut, the second scenario being predominantly at the south end of Pond 1 where the top half of the embankment will consist of compacted fill. The Pond 1 SlopeW results for the two described scenarios provided adequate factors of safety as shown in Attachment D.

GROUNDWATER MONITORING

Three groundwater monitoring wells have been installed around the perimeter of the De Beque Station site. Each well is 100 feet deep and was drilled during the geotechnical investigation in February 2014. The wells have been monitored periodically since they were installed, and no groundwater has been encountered down to the 100 foot depth. These wells will remain in place during the construction and use of the facilities and will continue to be monitored on a regular basis. The appropriate agencies will be notified if any significant changes to the groundwater level occur.

STORM DRAINAGE

A hydrologic and hydraulic analysis was conducted for the De Beque Station post-development conditions. Ditches will be constructed in key locations to divert upstream run-on away from the site and run-off from the site to a retention pond. While a typical retention pond is designed to store the increased volume of run-off from a development, the proposed retention pond has been designed with sufficient size to store the entire run-off volume for the design storm event. The decision to store the entire run-off volume from the facility for the design event was made with the realization that an irrigation canal crosses the ephemeral drainage downstream from the facility. The details of the analysis and design for the ditches and retention pond are presented below.

WATERSHED DESCRIPTION

The proposed site for the De Beque Station contains approximately 23.3 acres that currently has limited development. The existing site has a modular house and barn that will be removed and a gravel access road. The existing ground cover is limited to low density native grass with scrub brush with a lot of bare ground. The upstream drainage area contains an additional 265.5 acres that is estimated using the contours from a 1:24,000 quad map to delineate the watershed.

HYDROLOGIC WATERSHED ANALYSIS

The entire watershed has been split into seven sub-watersheds as shown on Exhibit 1. SWS 1 contains the majority of the upstream drainage area and is routed around the De Beque Station via a ditch along the west side of the property until intercepting the existing ephemeral drainage in the southwest corner of the property. SWS 2, 3, and 4 are the site sub-watersheds that will contribute run-off to the proposed retention pond. SWS 5, 6, and 7 are the lined surface areas of the produced water ponds that will collect direct precipitation on the ponds.

A form of the Natural Resources Conservation Service (formerly SCS) Curve Number Method was used to estimate the runoff volumes for this development. This method is appropriate for small watersheds similar to the project area. A description of the SCS Curve Number Method and the values used in the analysis are given below.

SCS CURVE NUMBER METHOD

The SCS Curve Number Method is applicable for drainage areas less than 800 hectares (approximately 2,000 acres). The calculations were performed using a computer program named “HydroCad”. HydroCAD models both the hydrology and hydraulics of storm water runoff and is based largely on hydrology techniques developed by the NRCS (formerly SCS), combined with other hydrology and hydraulics calculations. For a given rainfall event, HydroCAD generates hydrographs for the entire watershed, routes the storm water though the drainage system, and models the storage within the retention pond and releases through the outlet spillway. The HydroCAD model created for the proposed development includes the watershed, the drainage ditches and the retention pond with outflow control structures.

The major input parameters for the HydroCAD model are summarized as follows:

Drainage Area (A): The drainage areas were determined based on the existing and proposed site topography. Exhibit 1 provides a delineation of the watersheds and the soils within each watershed. The combined drainage area for the watershed modelled is approximately 288.8 acres. A summary of the drainage areas is provided in Attachment E.

Watercourse Length (L): The watercourse length is the longest drainage path contained within each watershed from the watershed divide to the point of interest. Values were determined based on existing and proposed site topography. A summary of the watercourse lengths is provided in Attachment E.

Elevation difference (H): The elevation difference is the total change in elevation along the watercourse length. Values were determined based on existing and proposed site topography. A summary of the elevation differences is provided in Attachment E.

Curve Number (CN): The curve number is a numeric, dimensionless index developed to represent the combined hydrologic effect of soil, land use, agricultural land treatment class, hydrologic condition, and antecedent soil moisture. Soils within a typical drainage are given a hydrologic classification, ranging from A (most permeable) to D (least permeable), and are further divided into land use and vegetative cover. The hydrologic soil groups within the drainage area were determined from the information provided by the NRCS web soil survey, and composite curve numbers were estimated using Table 3-6 in the HEC-22 manual. Soils in this area were determined to belong to Hydrologic Soil Groups C and D. A summary of the composite curve numbers is provided in Attachment E.

Precipitation: The precipitation amount of 2.31 inches for a 100-year, 24-hour storm was taken from an online NOAA Atlas 14, Volume 8, Version 2 for De Beque, Colorado. The precipitation distribution used for the project site is a SCS Type I. A copy of the precipitation frequency data is provided in Attachment E.

The SCS Curve Number method is considered both accurate and conservative in its estimation of watershed runoff. The method considers soil type and land use when determining the likelihood of the ground in passing precipitation as runoff instead of absorbing it. This method is useful when analyzing developed conditions as ground cover and use can dramatically change. Table 1 summarizes the post-development peak discharge and runoff volume for each sub watershed. HydroCAD results are provided in Attachment F.

Table 1. Peak Discharge and Runoff Volume

Watershed	100-Year, 1-Hour Peak Discharge (cfs)	100-Year, 1-Hour Runoff Volume (acre-feet)
SWS 1	**47.48**	**15.874**
SWS 2	**1.84**	**0.604**
SWS 3	**0.74**	**0.142**
SWS 4	**0.18**	**0.026**
SWS 5	**0.00**	**0.543**
SWS 6	**0.00**	**0.537**
SWS 7	**0.00**	**0.520**

DRAINAGE DITCH DESIGN

Storm water from run-on and run-off is conveyed in drainage ditches for the proposed development. The west drainage ditch intercepts run-on from the upstream watershed (SWS 1) and diverts the water around the facility to ensure that this water does not flow into any of the produced water ponds. At the average slope of 0.0227 ft/ft this ditch will flow at a depth of 0.89 feet during the peak discharge of 100-yr, 24-hour precipitation

event. Due to the larger upstream watershed and higher flow rate during the design storm event, this ditch will be revegetated and covered with a permanent turf reinforcement mat. This ditch will tie into the ephemeral drainage near the south-west corner of the facility and the storm water will follow the natural drainage path.

The north drainage ditch intercepts run-off from a majority of the facility site (SWS 2) including the office building, access road, and laydown yard with some run-on from the embankment surrounding the compressor station to the north. At the average slope of 0.0223 ft/ft this ditch will flow at a depth of 0.22 feet during the peak discharge from the design event. This ditch will be revegated to prevent significant erosion. The south drainage ditch intercepts a small amount of run-off from the south embankment of future Ponds 2 and 3 (SWS 3). At the average slope of 0.0167 ft/ft this ditch will flow at a depth of 0.13 feet during the peak discharge from the design event. This ditch will be revegated to prevent significant erosion. The north and south drainage ditches will convey the run-off from the facility to the proposed retention pond in the south-east corner of the facility. These calculations are included with the HydroCAD report in Attachment F.

Retention Pond Design

The proposed retention pond will be located in the south-east corner of the facility which is the low-point of the property, allowing the proposed north and south drainage ditches to convey run-off to the pond. The proposed pond will have bottom dimensions of 26-feet wide by 250-feet long with side slopes of 3H:1V. The pond will be 5-feet deep with a total capacity of 1.253 ac-ft. During the design storm event the pond will store 0.772 ac-ft of water at a depth of 3.52 feet. While not needed for the design storm event, the pond will also have a spillway that is one-foot deep and ten-feet wide. The spillway would only be used during a precipitation event that exceeds the 100-yr, 24-hour design event. These calculations are included with the HydroCAD report in Attachment F.

Produced Water Pond Spillways

Produced water ponds are regulated by the COGCC and/or the CDPHE. If the ponds are constructed to store water above the original ground surface then the CDWR considers these to be dams which also fall underneath their regulation. These three state regulatory agencies met during 2014 to discuss spillway requirements for produced water ponds to reduce duplication of efforts and minimize the regulatory conflicts for produced water ponds. These agencies released a draft policy memorandum No. 01-14 to define the requirements for spillways on produced water ponds and a copy is provided in Attachment G.

Produced water Pond 1 has been sized to meet the CDWR non-jurisdictional requirements while the future Pond 2 and 3 will be jurisdictional dams. According to the

Draft Policy Memorandum No. 01-14, non-jurisdictional dams will be permitted, regulated, and inspected by the COGCC and/or CDPHE in accordance with the rules and policies of those agencies. The COGCC and CDPHE will also communicate with the Dam Safety Branch of CDWR to evaluate the hazard classification of non-jurisdictional produced water pond dams to define the spillway design criteria. WWC Engineering has submitted a hazard classification report to the CDWR for all of the produced water ponds planned for this facility. The CDWR reviewed the hazard classification report and had minor comments on the analysis that will require a resubmittal with a final hazard classification report, but determined that these dams should be classified as Low Hazard. A copy of the CDWR letter with their review comments is included in Attachment G. Section 3.1 of the Draft Policy Memorandum No. 01-14 states that “Spillways on Low Hazard dams must be capable of passing the 50-year precipitation event with one foot of residual freeboard” and section 4.0 states that “the above spillway freeboard requirements are in addition to any limitations placed by CDPHE or COGCC on the maximum permitted pond level.” Section 902. B. of the COGCC rules requires a minimum of two feet of freeboard. To comply with requirements of all the agencies, Pond 1 has been designed with two feet of freeboard from the maximum permitted pond level to the bottom of the spillway required by CDWR. An additional one-foot of freeboard is provided to meet CDWR requirements.

Produced water pond 1 will collect direct precipitation that falls onto the water surface or the pond liner. The pond berms surrounding the ponds will be sloped away from the ponds to reduce the drainage areas contributing precipitation. Pond 1 has a liner surface area of 2.82 acres that is 100% impervious. While the spillway for Pond 1 is required to be capable of passing the 50-year precipitation event, this pond has been analyzed for the 100-year, 24-hour event. The produced water pond will be routinely changing the water surface elevation as produced water is stored in the pond and re-used for future fracing. To be conservative in this analysis it is assumed that Pond 1 has stored water at the maximum permitted pond level prior to the precipitation event. During the 100-year, 24-hour event Pond 1 will accumulate and store an estimated 0.543 ac-ft of water and increase the pond elevation by 0.21 feet, well below the two-feet of freeboard provided. The maximum estimated rate of storm water precipitation on the liner is 5.13 cfs. These calculations are included with the HydroCAD report in Attachment G.

The precipitation during the 100-year event will not raise the pond elevation to the spillway elevation and the spillway will not flow. While the spillway will not have water flowing through it during the 50-year precipitation event, a spillway is still provided to meet CDWR requirements and is proposed to be 10-feet wide. Because the spillway will likely never see flowing water, the spillway has been designed as a low-water crossing to allow traffic on the maintenance road to drive across the spillway. The spillway has been modeled in FlowMaster as a broad-crested weir and it has a maximum capacity of

28.28 cfs, exceeding the maximum flow rate into Pond 1 during the 100-year event. This spillway analysis ignores the additional flow area available that is provided by the low-water crossing cross-section. A copy of the weir calculations are provided in Attachment G. While the spillway will not flow during the design event, a small trash rack is proposed for the spillway. The trash rack will retain the floating HexProtect tiles used for bird exclusion if the spillway were to ever have water flowing through it. The downstream face of the pond berm beneath the spillway will be covered with a permanent turf reinforcement mat for erosion protection.

SITE ACCESS

V 2/10 Road does not have any public Right-of-Way through the subject property. In the Northwest corner of the property, there is an existing approach onto V 2/10 Road. In an attempt to maintain existing site and road conditions, the approach will remain in the same location and will be upgraded to meet the needs of the De Beque Station. Access from V 2/10 Road to the laydown yard was designed for a WB-67 tractor trailer combination in order to deliver support materials which will be used on well pads. For safety purposes, an access road designed for light passenger trucks was designed to encompass all mining ponds and facilities. Due to the rural location of the proposed site, there are no proposed pedestrian or bicycle facilities for neither the field office nor access roads. There are no other approaches on V 2/10 Road within 300’ of the subject point of access. The De Beque Station will have little impact on the existing roadway, and therefore, Mesa County Energy Planner, Randy Price, did not require a Traffic Impact Analysis for the project as seen in Appendix A, of the Mesa County Development Application Permit.

EXHIBITS

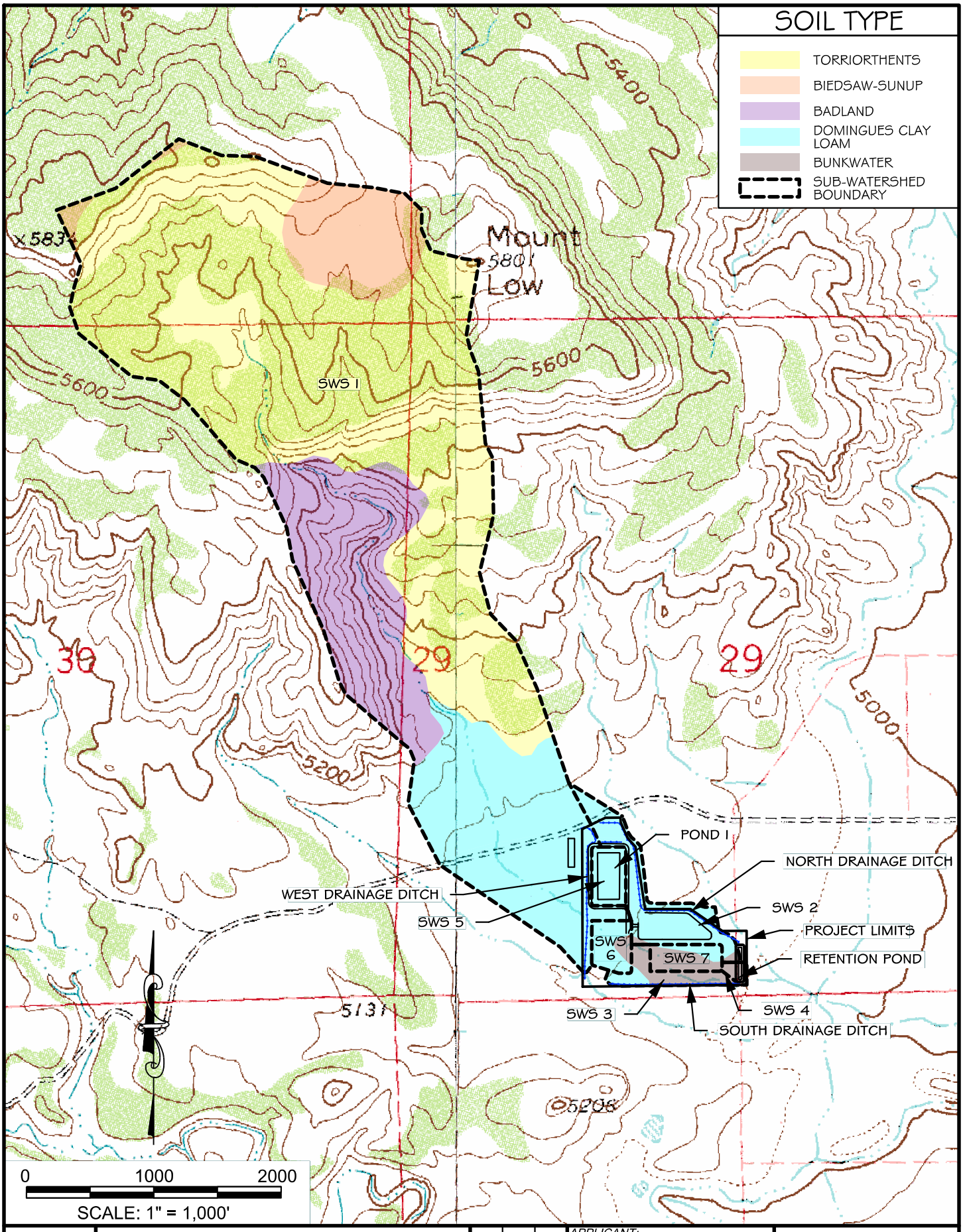

EXHIBIT 1

DE BEQUE STATION
SECTION 29, T8S, R97W 6TH P.M.

HYDROLOGY MAP

DSGN	DATE	CKD
GPV	7/2/14	STH
REV	DATE	CKD

JOB # 2013-134

APPLICANT:
Black Hills Exploration & Production
A Black Hills Corporation Enterprise
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

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ATTACHMENT A

WILDLIFE BMP PLAN

WWC ENGINEERING
1275 Maple Street, Suite F - Helena, MT 59601 - (406) 443-3962
Fax (406) 449-0056 - Email: infohln@wwcengineering.com

January 23, 2014

Jim Komatinsky
Land Use Specialist
Colorado Parks and Wildlife
711 Independent Avenue
Grand Junction, CO 81505

RE: De Beque Station Wildlife BMP Plan

Mr. Komatinksy:

On behalf of Black Hills Exploration and Production, WWC Engineering is submitting a proposed wildlife BMP plan for the De Beque Station project for review and approval. Approval of this plan will be submitted to the Colorado Oil and Gas Conservation Commission (COGCC) with permit Form 2A.

The De Beque station project is a proposed production water reuse and raw water facility to conserve water by recycling flow-back and produced water for re-use in well stimulations or drilling. The project is located in the SE ¼ of the SW ¼ of Section 29, Township 8 South, Range 97 West, 6th P.M. A site map is located in Attachment A. At this location, it was identified by Mr. Komatinsky that the project will be within mule deer critical winter range, black bear habitat, and potentially white-tailed prairie dog colonies. To mitigate impacts to these wildlife sensitive areas, the following wildlife best management practices will be incorporated into the project design and permitting:

1. A copy of the Colorado Parks and Wildlife Actions to Minimize Adverse Impacts to Wildlife Resources is located in Attachment B. This document provides general and species specific wildlife BMP guidelines that shall be followed.
2. Night lighting shall be of the full-cutoff type and/or timed or otherwise minimized to reduce disruption to wildlife.
3. The proposed location lies within year-round black bear habitat. There is potential for human/bear conflicts with gas exploration employees who are working and/or camping in these areas during development operations. The potential for human/bear conflicts within these project areas will be greatly reduced by placing and utilizing “bear proof” trash containers at work-site/camping locations during construction activities. Furthermore, workers affiliated with these projects shall be advised not to feed bears, whether intentional or not, since this activity is a violation of Colorado Parks and Wildlife Commission Regulations and is detrimental to wild bears. CPW has information on the design and purchase of “bear proof” trash containers, and will provide this information to anyone who is interested in preventing conflicts with bears during construction activities.

4. Following the completion of construction activities, newly exposed soils shall be revegetated as soon as possible to prevent erosion and to reduce the likelihood of non-native plants becoming established in the area. Seed mix used for revegetation shall be certified as weed-free and consist of native seeds from plants that are common to the area.
5. To reduce the likelihood of truck – wildlife collisions, proper speed limits (< 25 mph) shall be posted and enforced on all service roads.
6. Fencing around the pit shall consist of a minimum of a 7-foot chain-link fence capable of preventing elk, deer and other wildlife from entering the pit; concurrently it shall have a small mesh type of fencing along the bottom of the fence (buried one-foot below grade level and extending a minimum of two-feet above grade) capable of preventing small animals from entering between the gaps (gaps should be no larger than three-inches).
7. The pits shall be constructed with a 4:1 slope escape ramp and/or with chain-link fencing in one corner of the pit to allow entrapped wildlife to escape.
8. The pits shall be adequately protected to ensure that waterfowl and other birds are prevented – excluded – from entering or coming in contact with water in the pits. Blacks Hill would like to use an innovative product called Hexprotect Cover. This HDPE cover has an AQUA version that self ballasts and is wind resistant up to 130 mph. Documentation for this product is included in Attachment C.
9. CPW shall be notified immediately if any birds and/or wildlife are found dead or trapped within or around the pits, netting, or fences.

It is our sincere hope that this plan adequately addresses the requirements of CPW and that the **De Beque Station Wildlife BMP Plan** be approved as soon as possible. Please do not hesitate to contact us should you have any further questions or require additional clarification.

Sincerely,

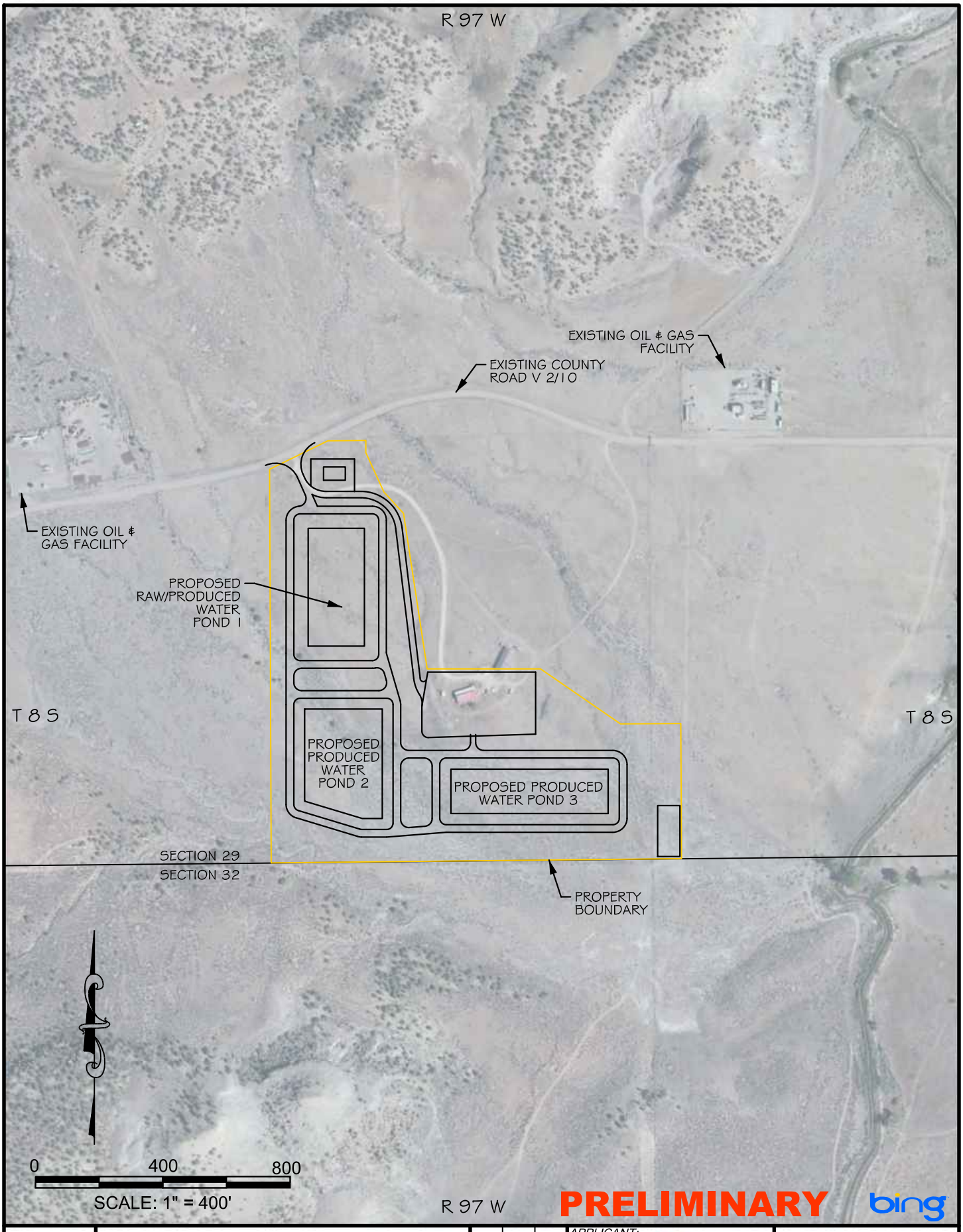
Drew Pearson, P.E.
Project Engineer

cc: File

Encl.: As Noted
DP

ATTACHMENT A

SITE MAP



ATTACHMENT A

DE BEQUE STATION
SECTION 29, T8S, R97W 6TH P.M.

SITE MAP

DSGN	DATE	CKD
DDP	01/14	STH
REV	DATE	CKD
DDP	2/7/14	STH

JOB # 2013-134

APPLICANT:
Black Hills Exploration & Production
1515 WYNKOOP ST., SUITE 500
DENVER, CO 80202
(303) 566-3356

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
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ATTACHMENT B

COLORADO PARKS AND WILDLIFE ACTIONS TO MINIMIZE ADVERSE IMPACTS TO WILDLIFE RESOURCES

ACTIONS TO MINIMIZE ADVERSE IMPACTS TO WILDLIFE RESOURCES

The purpose of this document is to enumerate potential actions that may avoid, minimize, and/or mitigate adverse impacts of oil and gas operations on Colorado's wildlife resources.

I. PLANNING INFRASTRUCTURE PLACEMENT AND DEVELOPMENT ACTIVITIES

Planning infrastructure placement and the timing of development activities to avoid and minimize impacts to wildlife resources is a critical component to any development strategy that balances the needs of wildlife with the rights of the oil and gas operator to produce oil and gas. To accomplish this objective, a Wildlife Impact Avoidance and Minimization Plan should be prepared prior to development that incorporates the following strategies:

A. Bring operators, CDOW personnel and surface owners together early in the planning process to assess wildlife needs and operational constraints, and to collaborate on a planning document that provides guidelines to avoid or minimize impacts to wildlife resources.

B. Plan development activities at the largest scale possible (i.e. landscape level) in order to allow for phased or clustered development to avoid or minimize impacts to wildlife resources. Use unitization, operator agreements, and other agreements to improve communication, to consolidate and minimize infrastructure, and to allow for effective landscape level planning.

C. Develop and implement an adaptive management program that provides for monitoring and evaluation, that documents environmental changes, and that implements mid-course corrections to development and operational practices. Correlate oil and gas operations with environmental changes through ongoing monitoring and evaluation and adaptively adjust future oil and gas development activities as necessary to protect wildlife resources.

II. ELEMENTS OF AN IMPACT AVOIDANCE AND MINIMIZATION PLAN

The following elements may be used collectively for the development of a landscape Wildlife Impact Avoidance and Minimization Plan, or individually as Avoidance Measures on a well-by-well basis.

A. GENERAL WILDLIFE AND ENVIRONMENTAL PROTECTION MEASURES: *These measures are meant to educate field personnel regarding specific wildlife concerns.*

1. Provide annual educational training for staff and contractors on specific wildlife issues of concern, (e.g., how to recognize lek sites, the location and importance of seasonal wildlife habitats and migratory patterns, how to locate mountain plover nests, the effects of winter range disturbance on wildlife, etc.,) and on the overall aspects of the landscape planning documents and any agreements with CDOW.
2. Establish policies to protect wildlife (e.g., no poaching, no firearms, no dogs on location, no feeding of wildlife, etc.).
3. Promptly report spills that affect wildlife to the Water Quality Control Division of CDPHE and CDOW.
4. Store and stage emergency spill response equipment at strategic locations along perennial water courses so that it is available to expedite effective spill response.
5. Avoid locating staging, refueling, and storage areas within 300 feet of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.

6. Install automated emergency response systems (e.g., high tank alarms, emergency shut- down systems, etc.).

B. INFRASTRUCTURE LAYOUT WILDLIFE PROTECTION MEASURES (including production facilities, ancillary facilities, and roads): *The purpose of these measures is to consolidate development activities and production facilities in order to minimize direct habitat loss and fragmentation, and to minimize displacement of wildlife due to audible, olfactory and visual disturbances.*

1. Avoid new surface disturbance and placing new facilities in key wildlife habitats in consultation with CDOW.
2. Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain. Maintain undeveloped areas within development boundaries sufficient to allow wildlife to persist within development boundaries during all phases of construction, drilling, and production. Minimize the duration of development and avoid repeated or chronic disturbance of developed areas. Complete all anticipated drilling within a phased, concentrated, development area during a single, uninterrupted time period.
3. Develop a transportation plan to incorporate the following strategies:
    - **a.** Minimize the number, length, and footprint of oil and gas development roads;
    - **b.** Use existing routes where possible;
    - **c.** Combine utility infrastructure (gas, electric, and water) planning with roadway planning to avoid separate utility corridors;
    - **d.** Combine and share roads to minimize habitat fragmentation
    - **e.** Place roads to avoid obstructions to migratory routes for wildlife, and to avoid displacement of wildlife from public to private lands.
    - **f.** Design roads with visual and auditory buffers or screens (e.g., topographic barriers, vegetation, and distance).
    - **g.** Surface roads to ensure that the anticipated volume of traffic and the weight and speed of vehicles using the road do not cause environmental damage, including generation of fugitive dust and contribution of sediment to downstream areas.
    - **h.** Locate roads as far from riparian areas and bottoms of drainages as possible and outside of riparian habitat.
    - **i.** Avoid constructing any road segment in the channel of an intermittent or perennial stream.
    - **j.** Avoid low water crossings. Structures for perennial or intermittent stream channel crossings should be engineered using bridges or appropriately sized culverts.
    - **k.** Design road crossings of streams to allow fish passage at all flows and to minimize the generation of sediment.
    - **l.** Design road crossings of streams at right angles to all riparian corridors and streams to minimize the area of disturbance.
    - **m.** Construct stream crossings “in the dry” to minimize sedimentation.
    - **n.** Protect culvert inlets from erosion and sedimentation and install energy dissipation structures at outfalls.
    - **o.** Implement fugitive dust control measures.
    - **p.** Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
    - **q.** Coordinate employee transport, encourage carpooling or provide bus transport to work sites.

r. Prohibit or substantially limit the amount of traffic on lease roads in important wildlife habitats within 3 hours of sunrise and sunset.

s. Install and use locked gates or other means to prevent unauthorized vehicular travel on roads and facility rights-of-way.

t. Limit parking to already disturbed areas.

u. Use man camps to reduce travel related disturbance when the benefits outweigh the disadvantages of developing human concentrations in wildlife habitats.

4. Develop and implement appropriate density caps or thresholds on wells sites, facilities and infrastructure (see the species-specific well site density recommendations in this document).

5. Maximize the utility of surface facilities by developing multiple wells from a single pad (directional drilling), and by co-locating multipurpose facilities (for example, well pads and compressors) to avoid unnecessary habitat fragmentation and disturbance of additional geographic areas.

6. Minimize the number, size and distribution of well pads and locate pads along existing roads where possible.

7. Cluster well pads in the least environmentally sensitive areas.

8. Consolidate and centralize fluid collection and distribution facilities.

9. Share/consolidate corridors for pipeline ROW's to the maximum extent possible.

10. Engineer pipelines to avoid field fitting and reduce excessive ROW widths and reclamation.

11. Adequately size infrastructure and facilities to accommodate both current and future gas production. Economize gas transportation.

C. AQUATIC and WETLAND ENVIRONMENT PROTECTION MEASURES: *The purpose of these measures is to avoid, minimize or mitigate disturbances to aquatic and wetland habitats and the unique wildlife communities associated with these habitats.*

1. Minimize activities and operations within 300 feet of the ordinary high water mark of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.

2. Schedule necessary construction in stream courses to avoid critical spawning times. General spawning avoidance guidelines are found under Species Specific chapters in this document.

3. Bore pipelines that cross perennial streams.

4. Use the minimum right-of-way width where pipelines cross riparian areas and streams.

5. Construct all crossings at right angles to the stream.

6. Do not remove native riparian canopy or stream bank vegetation where possible.

7. Avoid direct discharge of pipeline hydrostatic test water to any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.

8. Avoid dust suppression activities within 300 feet of the ordinary high water mark of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.

9. Screen water suction hoses to exclude fish.

10. Disinfect heavy equipment, hand tools, boots and any other equipment that was previously used in a river, stream, lake, pond, or wetland prior to moving the equipment to another water body. The disinfection practice should follow this outline:

a. Remove all mud and debris from equipment and spray/soak equipment with a 1:15 solution of disinfection solution containing the following ingredients:

1. Dialkyl dimethyl ammonium chloride, 5-10% by weight;
2. Alkyl dimethyl benzyl ammonium chloride, 5-10% by weight;
3. Nonyl phenol ethoxylate, 5-10% by weight;
4. Sodium sesquicarbonate, 1-5%;

5. Ethyl alcohol, 1-5%; and
6. Tetrasodium ethylene diaminetetraacetate, 1-5%;
7. and water, keeping the equipment moist for at least 10 minutes and managing rinsate as a solid waste in accordance with local, county, state, or federal regulations; or

b. Spray/soak equipment with water greater than 140 degrees Fahrenheit for at least 10 minutes.

c. Sanitize water suction hoses and water transportation tanks (using methods described above) and discard rinse water at an appropriately permitted disposal facility.

D. DRILLING AND PRODUCTION OPERATIONS WILDLIFE PROTECTION MEASURES: *The purpose of these measures is to reduce disturbance on the actual drill site and the surrounding area, to reduce direct conflict with wildlife and hunters, and to prevent wildlife access to equipment.*

1. Schedule construction, drilling, and completion activities to avoid particularly sensitive seasonal wildlife habitats in consultation with CDOW.

2. Schedule construction, drilling, and completion activities to avoid seasons and locations when public use of lands is at its highest (e.g., big game hunting seasons).

3. Reduce visits to well-sites through remote monitoring (i.e. SCADA) and the use of multi-function contractors.

4. Use centralized hydraulic fracturing operations.

5. Transport water through centralized pipeline systems rather than by trucking.

6. Where possible, locate pipeline systems under existing roadways, or roadways that are planned for development.

7. Maximize use of state-of-the-art drilling technology (e.g., high efficiency rigs, coiled-tubing unit rigs, closed-loop or pitless drilling, etc.) to minimize disturbance.

8. Conduct well completions with drilling operations to limit the number of rig moves and traffic.

9. Employ state-of-the-art technology to protect existing vegetation (e.g., use mats if possible to preserve topsoil/vegetative root stock).

10. Install exclusionary devices to prevent bird and other wildlife access to equipment stacks, vents and openings.

11. Ensure that surface discharged produced water meets minimum standards for Total Dissolved Solids (TDS) and Sodium Adsorption Ratio (SAR) to benefit wildlife.

12. Reduce noise by using effective sound dampening devices or techniques (e.g., hospital-grade mufflers, equipment housing, insulation, installation of sound barriers, earthen berms, vegetative buffers, etc.). Appropriate noise limits are included in the species-specific recommendations in included in this document.

13. Locate above-ground facilities to minimize the visual effect (e.g., low profile equipment, appropriate paint color, vegetation screening in wooded areas, etc.).

14. During pipeline installations install trench plugs, earthen ramps, or other means as necessary to ensure that open pipeline trenches do not trap wildlife, and that pipe strings to not impair wildlife movements.

E. FLUID PIT WILDLIFE PROTECTION MEASURES: *The purpose of these measures is to prevent wildlife access to fluid pits and to reduce potential for contamination of water and soil by pit contents.*

1. Avoid locating fluid pits within 300 feet of the ordinary high water mark of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river.
2. Install and maintain adequate measures to exclude all types of wildlife (e.g., big game, birds, and small rodents) from all fluid pits (e.g., fencing, netting, and other appropriate exclusion measures).
3. Construct fluid pit fences and nets that are capable of withstanding animal pressure and environmental conditions and that are appropriately sized for the wildlife encountered.
4. Install impermeable barriers beneath fluid pits to protect groundwater, riparian areas and wetlands.
5. Skim and eliminate oil from produced water ponds and fluid pits at a rate sufficient to prevent oiling of birds or other wildlife that could gain access to the pit.
6. Construct fluid pits with a 4:1 escape ramp to allow entrapped wildlife to escape.
7. Treat waste water pits and/or any associated pit containing water with Bti (*B. thuringiensis v. israelensis*)**,** commonly known as Mosquito Dunks, to control mosquito larvae that may spread West Nile Virus to wildlife or take other effective approaches to controlling mosquito larvae in ponds and pits.
    a. The appropriate application rate of Bti is 1 dunk/100 sq. ft. of standing water, applied each 30 day period during 1 June – 30 September.

F. INVASIVE/NON-NATIVE VEGETATION CONTROL: *The purpose of these measures is to ensure proper planning, assessment and control of weed infestations on all locations.*

1. Develop an aggressive, integrated, noxious and invasive weed management plan. Utilize an adaptive management strategy that permits effective responses to monitored findings and reflects local site and geologic conditions. Use of dedicated personnel with single responsibility for weed control is often the most effective approach.
2. Map the occurrence of existing weed infestations prior to development to effectively monitor and target areas that will likely become issues after development.
3. Establish a systematic and thorough noxious and invasive monitoring program for all disturbed areas and maintain monitoring records.
4. Continue control programs for the life of the well field.
5. Use reclamation as a weed management tool. Plant competition provided by established reclamation is the most effective weed management tool.
6. Thoroughly clean vehicles and other equipment to remove weed seeds before moving equipment to new sites.
7. Educate employees and contractors about noxious and invasive weed issues.

G. RESTORATION, RECLAMATION AND ABANDONMENT: *The purpose of these measures is to restore disturbed sites to their pre-development conditions, using native vegetation that can be used by the indigenous wildlife. Develop a reclamation plan in consultation with CDOW, NRCS, and the land owner or land management agency that incorporates wildlife species-specific goals and that defines reclamation performance standards, including the following components:*

1. Soil
    a. Store topsoil in windrows no higher than 5 feet.
    b. Strip and segregate topsoil prior to construction. Appropriately configure topsoil piles and immediately seed to control erosion, prevent weed establishment and maintain soil microbial activity.

c. Maintain separation between pit contents and soils.
d. Salvage topsoil from all road construction and other rights-of-way and re-apply during interim and final reclamation.
e. Evaluate the utility of soil amendment application or consider importing topsoil to achieve effective reclamation.

2. Seed
a. Use only certified weed-free native seed in seed mixes, unless use of non-native plant materials is recommended by CDOW.
b. Test seed rigorously and frequently for purity, germination/viability, and the presence of weeds.
c. Use locally adapted seed whenever available, especially for species which have wide geographic ranges and much genetic variation (e.g., big sagebrush (*Artemesia tridentata*), antelope bitterbrush (*Purshia tridentata*), etc.).
d. Where more than one ecotype of a given species is available and potentially adapted to the site, include more than one ecotype per species in the seed mix.
e. Use appropriately diverse reclamation seed mixes that mirror an appropriate reference area for the site being reclaimed (see also species-specific recommendations).
f. Conduct seeding in a manner that ensures that seedbed preparation and planting techniques are targeted toward the varied needs of grasses, forbs and shrubs (e.g., seed forbs and shrubs separately from grasses, broadcast big sagebrush but drill grasses, etc.).
g. Emphasize bunchgrass over sod-forming grasses in seed mixes in order to provide more effective wildlife cover and to facilitate forb and shrub establishment.
h. Seed immediately after recontouring and spreading topsoil. Spread topsoil and conduct seeding during optimal periods for seed germination and establishment. Use of the same contractor for re-contouring land as used for seeding is often the most effective approach.
i. Do not include aggressive, non-native grasses (e.g., intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, smooth brome, etc.) in reclamation seed mixes. Site specific exceptions may be considered.
j. Distribute quick germinating site adapted native seed or sterile non-native seed for interim reclamation on cut and fill slopes and topsoil piles.
k. Plan for reclamation failure and be prepared to repeat seeding as necessary to meet vegetation cover, composition, and diversity standards.
l. Consider reclaiming with tubelings/plantings where seed failure is likely or has occurred.

3. Vegetative Cover Standard
a. Choose reference areas as goals for reclamation that have high wildlife value, with attribute such a diverse and productive understory of vegetation, productive and palatable shrubs, and a high prevalence of native species.
b. Establish vegetation with total perennial non-invasive plant cover of at least eighty (80) percent of pre-disturbance or reference area levels.
c. Establish vegetation with plant diversity of non-invasive species which is at least half that of pre-disturbance or reference area levels. Quantify diversity of vegetation that considers only species with at least 3 percent relative plant cover.
d. Establish permanent and monumented photo points and vegetation measurement plots or transects; monitor at least annually until plant cover, composition, and diversity standards have been met.

e. Observe and maintain a performance standard for reclamation success characterized by the establishment of a self-sustaining, vigorous, diverse, locally appropriate plant community on the site, with a density sufficient to control erosion and non-native plant invasion and diversity sufficient to allow for normal plant community development.

4. Timing
- **a.** Use early and effective reclamation techniques, including interim reclamation to accelerate return of disturbed areas for use by wildlife.
- **b.** Remove all unnecessary infrastructure.
- **c.** Close and reclaim roads not necessary for development immediately, including removing all bridges and culverts and recontouring/reclaiming all stream crossings.
- **d.** Reclaim reserve pits as quickly as possible after drilling and ensure that pit contents do not contaminate soil.
- **e.** Remediate hydrocarbon spills on disturbed areas prior to reclamation.
- **f.** Reclaim sites during optimum seasons (e.g. late fall/early winter or early spring).
- **g.** Complete final reclamation activities so that seeding occurs during the first optimal season following plugging and abandonment of oil and gas wells.

5. Interim reclamation
- **a.** Use a variety of native grasses and forbs to establish effective, interim reclamation on all disturbed areas (e.g., road shoulders and borrow areas), including disturbed areas where additional future ground disturbance is expected to occur.
- **b.** Perform interim reclamation to final reclamation species composition and establishment standards.
- **c.** Perform "interim" reclamation on all disturbed areas not needed for active support of production operations.

6. Riparian areas
- **a.** Replace all riparian vegetation removed during development at a rate of at least 3:1.
- **b.** Restore both form and function of impacted wetlands and riparian areas and mitigate erosion.

7. Disposal
- **a.** Remove well pad and road surface materials that are incompatible with post-production land use and re-vegetation requirements.
- **b.** Remove and properly dispose of degraded silt fencing and erosion control materials after their utility has expired.
- **c.** Remove and properly dispose of pit contents where contamination of surface water, groundwater, or soil by pit contents cannot be effectively prevented.

8. Establishing reclaimed areas
- **a.** Apply certified weed free mulch and crimp or tacify to remain in place to reclaim areas for seed preservation and moisture retention.
- **b.** Utilize staked soil retention blankets for erosion control and reclamation of large surface areas with 3:1 or steeper slopes. Avoid use of plastic blanket materials, known to cause mortality of snakes.
- **c.** Install cattle guards to regulate livestock pasture utilization;
- **d.** Control weeds in areas surrounding reclamation areas in order to reduce weed competition.

9. Educate employees and contractors about weed issues. Fencing

a. Support development and implementation of portable wildlife-proof fencing that could be used to protect vegetation during early stages of development then moved to another area. These should be implemented in areas where establishment of browse species is a priority. Monitor production of browse in areas receiving protection and compare to browse production in an adjacent area.

b. Fence livestock and/or wildlife out of newly reclaimed areas until reclamation standards have been met and plants are capable of sustaining herbivory.

c. Inventory, monitor and remove obsolete, degraded, or hazardous fencing.

H. MONITORING: *These measures assess the ecological condition of a disturbed area and measure the success or failure of the reclamation effort as well as measuring effects of development activities on other resources.*

1. Conduct necessary reclamation and invasive plant monitoring.
2. Census and assess the utilization of the reclaimed areas by the target species.
3. Maintain pre and post development site inspection records and monitor operations for compliance.
4. For those surface waters supporting fisheries, establish baseline water chemistry prior to development and establish a regular and repeated water chemistry monitoring and reporting program for groundwater, surface waters, and produced water discharged on the surface to detect and allow effective response to water quality issues that may impact aquatic wildlife. Quantify levels of pH, alkalinity, specific conductance, major cations/anions (including Cl, Fl, Sulphate, Sodium), total dissolved solids, BTEX/GRO/DRO, TPH, PAH (including benzo (a) pyrene), and metals (including As, Ba, Ca, Cd, Cr, Fe, Mg, Pb, Se), nitrate, nitrite, ammonia-N, turbidity, dissolved oxygen, hydrogen sulfide, and water temperature.
5. Monitor soil chemistry and structure where CBM or other produced water is put to a beneficial use (i.e., irrigation, water sources for wildlife, etc.).
6. Utilize GIS technologies to assess the extent of disturbance and document the reclamation progression and the footprint of disturbances.

III. RESEARCH

These measures are suggested where questions or uncertainties exist about the degree of impact to specific resources or other aspects of oil and gas development or reclamation is unknown.

A. Collaborate and/or fund research investigation into the impacts of oil and gas development activities on wildlife resources.

B. Support research to test the effectiveness of specific Best Management Practices.

C. Identify native species for which commercial seed sources are not available. Provide support to contractors for developing cultivation and seed production techniques for needed species.

D. Conduct reclamation field trials to match seed mixes, soil preparation techniques, and planting methods to local conditions.

IV. SPECIES SPECIFIC RECOMMENDATIONS

These reasonable recommendations are derived from the best available science and represent preferred management actions to protect wildlife and wildlife habitats where oil and gas development is occurring.

BAT ROOST SITES

- Consult with CDOW regarding locations of known bat roost sites.
- Avoid surface disturbance activities within 0.25 mile of all Townsend's Big-Eared Bat, Fringed Myotis, and Brazilian Free-Tailed Bat roost sites.

BIGHORN SHEEP

- Consult with CDOW regarding big game seasonal restrictions on wintering or production areas.
- Avoid surface disturbance and construction activities on or within any bighorn sheep production or wintering areas.
- Where oil and gas activities must occur in bighorn sheep production areas, avoid conducting these activities from April 15 to June 30 for Rocky Mountain Bighorn Sheep and from February 28 to May 1 for Desert Bighorn Sheep.
- Where oil and gas activities must occur in bighorn sheep winter range, avoid conducting these activities from November 1 through April 15.
- Avoid low elevation (below 500 feet altitude) helicopter overflights within 1 mile radius of bighorn sheep winter range between November 1 and April 15.
- Avoid low elevation (below 500 feet altitude) helicopter overflights within 1 mile radius of bighorn sheep production areas from April 15 to June 30 for Rocky Mountain Bighorn Sheep and from February 28 to May 1 for Desert Bighorn Sheep.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in bighorn sheep winter range and production areas.
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Gate single-purpose roads to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Identify critical habitat types and adjust development sites to avoid these areas.
- Restrict post-development well site visitations to the hours of 10:00 a.m. to 3:00 p.m. and reduce well site visitations during winter months.

BLACK BEAR

- Identify, avoid and protect climax mast producing vegetation that annually provides a significant source of fall forage for black bear, especially those areas that can be identified as being consistently frost-free and that provide mast when unfavorable conditions exist elsewhere.
- Initiate a food and waste/refuse management program that uses bear-proof food storage containers and trash receptacles.
- Initiate an education program that reduces bear conflicts.
- Establish policy to prohibit keeping food and trash in sleeping quarters.
- Establish policy to support enforcement of state prohibition on feeding of black bear.
- Report bear conflicts immediately to CDOW.

BLACK-FOOTED FERRET

- Place surface facilities outside of prairie dog colonies in the Wolf Creek Management Area, the Coyote Basin Management Area, and the valley bisected by Highway 40 running from the Utah/Colorado border to the town of Dinosaur.

- Avoid oil and gas activities in prairie dog colonies where documented sightings of black-footed ferrets have occurred since 2005.
- Avoid surface disturbances between March 1 and July 15, with special attention to the period between May 1 and July 15, in prairie dog colonies where black-footed ferrets have been released or documented since 2001.
- Conduct seismic activity outside the period from March 1 to July 15 in prairie dog colonies where black-footed ferrets have been released or where black-footed ferret occurrence has been documented since 2001.
- Limit seismic activity to daylight hours in these colonies.
- Limit development of new roads within Wolf Creek Management Area and Coyote Basin Management Area.
- Gate single-purpose roads and restrict general public access to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Promptly reclaim disturbed areas within prairie dog colonies within the Wolf Creek Management Area, the Coyote Basin Management Area, and the valley bisected by Highway 40 running from the Utah/Colorado border to the town of Dinosaur, CO with native grasses and forbs appropriate to the ecological site.
- Aggressively control non-native and invasive weeds, particularly cheatgrass, in reclamation areas within the Wolf Creek Management Area, the Coyote Basin Management Area, and the valley bisected by Highway 40 running from the Utah/Colorado border to the town of Dinosaur, CO.
- Survey for black-footed ferret when impacting prairie dog colonies unless the site is less than 80 acres in size for black-tailed prairie dogs, less than 200 acres in size for white-tailed prairie dogs or Gunnison's prairie dogs, or within a designated block-cleared area.

COLUMBIAN SHARP-TAILED GROUSE

- Consult with CDOW at the earliest stage of development to review detailed maps of Columbian sharp-tailed grouse seasonal habitats and to help select development sites.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.4 mile of any known Columbian sharp-tailed grouse lek.
- Avoid oil and gas operations within 1.25 miles of any known Columbian sharp-tailed grouse lek, and within mapped Columbian sharp-tailed grouse breeding, summer, and winter habitat outside the 1.25 mile buffer. Select sites for development that will not disturb suitable nest cover or brood-rearing habitats within 1.25 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 1.25 mile perimeter.
- Where oil and gas activities must occur within 1.25 miles of Columbian sharp-tailed grouse leks or within other mapped Columbian sharp-tailed grouse breeding or summer habitat, conduct these activities outside the period between March 15 and July 30.
- Where oil and gas activities must occur within mapped Columbian sharp-tailed grouse winter habitat, conduct these activities outside the period between December 1 and March 15.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 1 to June 1).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.

- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in Columbian sharp-tailed grouse breeding and summer habitat (within 1.25 miles of active leks).
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Retain core habitat areas and limit disturbance to ensure Columbian sharp-tailed grouse survival.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Minimize surface disturbance and fragmentation of Columbian sharp-tailed grouse habitat through use of the smallest facility footprints possible, use of multiple well pads, clustering of roads and pipelines, and the widest possible spacing of surface facilities.
- When compressor stations must be sited within 1.25 miles of Columbian sharp-tailed grouse active and inactive (within last 10 years) lek sites, locate compressor stations no closer than 2500 feet from the lek.
- Use noise reduction equipment on compressors and other development and production equipment.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in Columbian sharp-tailed grouse habitat.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Where feasible, bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered Columbian sharp-tailed grouse seasonal habitats by enhancing marginal sagebrush steppe communities (sagebrush and mountain shrub) and grassland within or immediately adjacent to mapped seasonal Columbian sharp-tailed grouse habitat.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program to return habitat to use by Columbian sharp-tailed grouse as quickly as possible.

- Reclaim/restore Columbian sharp-tailed grouse habitats with native grasses and forbs conducive to optimal Columbian sharp-tailed grouse habitat and other wildlife appropriate to the ecological site.
- Use high diversity (10 species or more) reclamation seed mixes in Columbian sharp-tailed grouse habitat.
- Use approved CP-4D (Columbian sharp-tailed grouse) seed mixes, based on soil type, available from Farm Service Agency or Natural Resources Conservation Service, or other seed mixes approved by CDOW.
- Avoid aggressive non-native grasses in Columbian Sharp-tailed Grouse habitat reclamation.
- A small percentage of the appropriate species of big sagebrush should be re-seeded on disturbed sites.
- Reclamation of breeding habitat should include a substantially higher percentage of forbs than other areas.
- Native and select non-native forbs and legumes should be considered a vital component of reclamation seed mixes.

CUTTHROAT TROUT

- No surface disturbance within 300 feet of any water within a Designated Cutthroat Trout Habitat watershed.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in Designated Cutthroat Trout Habitat watersheds.
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Bridge stream crossings or use culverts to prevent stream bed damages and the transfer of disease organisms.
- Minimize stream disturbances during June and July to avoid impacts to spawning cutthroat trout.
- When working in designated cutthroat trout habitat, disinfect heavy equipment, hand tools, boots and any other equipment that was previously used in a river, stream, lake, pond, or wetland prior to moving the equipment to another water body. The disinfection practice should follow this outline:
    - Remove all mud and debris from equipment and spray/soak equipment with a 1:15 solution of disinfection solution containing the following ingredients:
        - Dialkyl dimethyl ammonium chloride, 5-10% by weight;
        - Alkyl dimethyl benzyl ammonium chloride, 5-10% by weight;
        - Nonyl phenol ethoxylate, 5-10% by weight;
        - Sodium sesquicarbonate, 1-5%;
        - Ethyl alcohol, 1-5%; and
        - Tetrasodium ethylene diaminetetraacetate, 1-5%
        - and water, keeping the equipment moist for at least 10 minutes and managing rinsate as a solid waste in accordance with local, county, state, or federal regulations; or
    - Spray/soak equipment with water greater than 140 degrees Fahrenheit for at least 10 minutes.
    - Sanitize water suction hoses and water transportation tanks (using methods described above) and discard rinse water at an appropriately permitted disposal facility.

DEER AND ELK

- Consult with CDOW at the earliest stage of development to identify the locations of mule deer and elk important wintering habitats and production areas. Adjust development sites to avoid critical habitat patches.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- Avoid oil and gas activities within mule deer critical winter range, elk winter concentration areas, elk production areas, and migration corridors.
- Where oil and gas activities must occur in mule deer critical winter range or elk winter concentration areas, conduct these activities outside the time period from December 1 through April 15.
- Where oil and gas activities must occur in elk production areas, conduct these activities outside the time period from May 15 through June 30.
- Restrict post-development well site visitations to between the hours of 10:00 a.m. and 3:00 p.m. and reduce well site visitations between December 1 and April 15 in mule deer and elk winter range.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in mule deer and elk winter range and in elk production areas.
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Identify critical habitat types and patches and adjust development sites to avoid these areas.
- Prior to development, establish baseline vegetation condition and inventory and to provide a basis for post-development habitat restoration.
- Gate single-purpose roads and restrict general public access to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Avoid aggressive non-native grasses and shrubs in mule deer and elk habitat restoration.
- Reclaim mule deer and elk habitats with native shrubs, grasses, and forbs appropriate to the ecological site disturbed.
- Restore appropriate sagebrush species or subspecies on disturbed sagebrush sites. Use locally collected seed for reseeding where possible.

GREATER PRAIRIE CHICKEN

- Consult with CDOW at the earliest stage of development to review detailed maps of greater prairie chicken seasonal habitats and to help select development sites.

- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.6 mile of any active or inactive (within past 10 years) greater prairie chicken leks.
- Avoid oil and gas operations within 2.2 miles of active leks and within greater prairie chicken nesting and early brood-rearing habitat outside the 2.2 mile buffer. Select sites for development that will not disturb suitable nest cover or brood-rearing habitats within 2.2 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 2.2 mile perimeter.
- Where oil and gas activities must occur within 2.2 miles of active leks, conduct these activities outside the period between March 1 and June 30.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 1 to May 15).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in greater prairie chicken nesting and early brood-rearing habitat (within 2.2 miles of active leks).
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Locate compressor stations at least 2.2 miles away from greater prairie chicken active and historic (within last 10 years) lek sites. When compressor stations must be sited within 2.2 miles of greater prairie chicken active and historic (within last 10 years) lek sites, locate compressor stations farther than 0.6 mile (3200 feet) from greater prairie chicken lek sites.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in greater prairie-chicken habitat.
- Bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered sand sagebrush habitat within identified nesting and brood rearing range through enhancement of

existing or marginal sand sagebrush habitat or reclamation of altered or converted habitat within or immediately adjacent to mapped nesting or brood rearing habitat.

- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program, to return habitat to use by greater prairie-chicken as quickly as possible.
- Restore greater prairie chicken habitat with native grasses and forbs conducive to optimal greater prairie chicken habitat and other wildlife appropriate to the ecological site.
- Use one of several approved CP-4D (greater prairie chicken) seed mixes, based on soil type, available from Farm Service Agency or Natural Resources Conservation Service, or other seed mixes approved by CDOW.
- Do not plant buffalo grass, blue grama and sideoats grama in greater prairie chicken habitat as they will eventually dominate the resulting stand and will not provide greater prairie chicken habitat.
- Restore appropriate native shrub species to disturbed sites.
- Do not use non-native grasses or shrubs in greater prairie chicken habitat reclamation.
- Reclamation of breeding habitat should include a substantially higher percentage of forbs than other areas.
- Utilize native and select non-native forbs and legumes in seed mixes as they are a vital component of brood-rearing habitat. Dryland adapted varieties of alfalfa and yellow sweet clover should be the primary non-native forbs used.

GUNNISON AND GREATER SAGE-GROUSE

- Consult with CDOW at the earliest stage of development to review detailed maps of Gunnison or greater sage-grouse seasonal habitats and to help select development sites.
- Identify seasonal habitats and migratory patterns of sage-grouse. Map all seasonal habitats using CDOW habitat selection models as they become available.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.6 mile of any known Gunnison or greater sage-grouse lek.
- Avoid oil and gas operations within 4 miles of any known Gunnison or greater sage-grouse lek, and within mapped Gunnison or greater sage-grouse breeding, summer, and winter habitat outside the 4 mile buffer. Select sites for development that will not disturb suitable nest cover or brood-rearing habitats within 4 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 4-mile perimeter.
- Where oil and gas activities must occur within 4 miles of Gunnison or greater sage-grouse leks or within other mapped Gunnison or greater sage-grouse breeding or summer habitat, conduct these activities outside the period between March 1 and June 30.
- Where oil and gas activities must occur within mapped Gunnison or greater sage-grouse winter habitat, conduct these activities outside the period between December 1 and March 15.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 1 to May 15).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in Gunnison or greater sage-grouse breeding and summer habitat (within 4 miles of active leks).

- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Avoid core areas as outlined in the Greater Sage-Grouse Statewide Plan, available from CDOW to ensure sage-grouse persistence and retain Gunnison sage-grouse core areas to ensure Gunnison sage-grouse persistence
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Minimize surface disturbance and fragmentation of Gunnison or greater sage-grouse habitat through use of the smallest facility footprints possible, use of multiple well pads, clustering of roads and pipelines, and the widest possible spacing of surface facilities.
- Locate facilities in vegetation types other than sagebrush to avoid impacts to sage-grouse breeding and wintering habitat.
- Use drill mats to prevent habitat loss or disturbance and reduce reclamation costs.
- When compressor stations must be sited within 4 miles of Gunnison or greater sage-grouse active and inactive (within last 10 years) lek sites, locate compressor stations farther than 0.6 mile (3,200 feet) from sage-grouse lek sites. Use noise reduction equipment on compressors and other development and production equipment.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in Gunnison or greater sage-grouse habitat.
- Remove all unnecessary infrastructure.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Where feasible, bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered Gunnison or greater sage-grouse seasonal habitats by enhancing marginal sagebrush steppe communities (big sagebrush and related communities) and grasslands within or immediately adjacent to mapped seasonal Gunnison or greater sage-grouse habitat.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program, to return habitat to use by Gunnison or greater sage-grouse as quickly as possible.

- Reclaim/restore Gunnison or greater sage-grouse habitats with native grasses, forbs, and shrubs conducive to optimal Gunnison or greater sage-grouse habitat and other wildlife appropriate to the ecological site.
- Use high diversity (10 species or more) reclamation seed mixes in Gunnison or greater sage-grouse habitat.
- Use approved CP-4D (Gunnison or greater sage-grouse) seed mixes, based on soil type, precipitation, and elevation, available from Farm Service Agency or Natural Resources Conservation Service, or other seed mixes approved by CDOW.
- Avoid aggressive non-native grasses in Gunnison or greater sage-grouse habitat reclamation.
- Restore disturbed sagebrush sites with the appropriate sagebrush species or subspecies on disturbed sagebrush sites. Use locally collected seed for reseeding where possible.
- Reclaim mapped summer habitat with a substantially higher percentage of forbs (> 15 percent cover post establishment) than used in other areas.
- Utilize native and select non-native forbs and legumes in seed mixes as they are a vital component of brood-rearing habitat.

KIT FOX

- Survey for kit fox den sites in appropriate habitats before development and avoid surface disturbance within 0.25 mile of den sites while young are den dependent (Feb 1 to May 1).
- Gate single-purpose roads and restrict general public access to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Utilize native vegetation for reclamation within kit fox overall range.
- Restrict use of pesticides for rodent control in kit fox overall range to prevent reduction of kit fox food supplies and secondary toxicity.
- Limit or restrict artificial water sources within kit fox overall range to prevent the spread of competitive predators into kit fox habitat.

LEAST TERN

- No surface occupancy within 300 feet of the high water mark of mapped least tern nesting habitat usually occurring on bare sandy shorelines of reservoirs, islands in reservoirs, or sand bars along major rivers in eastern Colorado.
- No surface disturbance to least tern foraging areas during the nesting season (April 1 to July 31) to include shallow water areas in lakes, ponds, and river backwater areas within 0.5 mile of known least tern production areas.

LESSER PRAIRIE CHICKEN

- Consult with CDOW at the earliest stage of development to review detailed maps of lesser prairie chicken seasonal habitats and to help select development sites.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.6 mile of any active or inactive (within past 10 years) lesser prairie chicken leks.
- Avoid oil and gas operations within 2.2 miles of active leks and within lesser prairie chicken nesting and early brood-rearing habitat outside the 2.2 mile buffer. Select sites for

development that will not disturb suitable nest cover or brood-rearing habitats within 2.2 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 2.2 mile perimeter.

- Where oil and gas activities must occur within 2.2 miles of active leks, conduct these activities outside the period between March 15 and June 15.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 15 to June 15).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in lesser prairie chicken nesting and early brood-rearing habitat (within 2.2 miles of active leks).
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Locate compressor stations at least 2.2 miles away from lesser prairie chicken active and historic (within last 10 years) lek sites. When compressor stations must be sited within 2.2 miles of lesser prairie chicken active and historic (within last 10 years) lek sites, locate compressor stations farther than 0.6 mile (3,200 feet) from lesser prairie chicken lek sites.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in lesser prairie-chicken habitat.
- Bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program to return habitat to use by lesser prairie-chicken as quickly as possible.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered sand sagebrush habitat within identified nesting and brood rearing range through enhancement of existing or marginal sand sagebrush habitat or reclamation of altered or converted habitat within or immediately adjacent to mapped nesting or brood rearing habitat.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.

- When reclaiming breeding habitat, include a substantially higher percentage of forbs than used in other areas.
- Reclaim lesser prairie chicken habitats with native grasses including switchgrass, big bluestem, little bluestem, sand bluestem, yellow Indian grass, and prairie sandreed.
- Do not plant buffalo grass, blue grama and sideoats grama in lesser prairie chicken habitat as they will eventually dominate the resulting stand and will not provide lesser prairie chicken habitat.
- Restore appropriate native shrub species to disturbed sites.
- Do not use aggressive non-native grasses or shrubs in lesser prairie chicken habitat reclamation.
- Utilize native and select non-native forbs and legumes in seed mixes as they are a vital component of brood-rearing habitat. Dry land adapted varieties of alfalfa and yellow sweet clover should be the primary non-native forb species used.

LYNX

- Consult with DOW regarding lynx use of the development area.
- Avoid locating facilities within lynx breeding habitat (spruce-fir forest south of Interstate 70 above 9,000 feet in elevation and with slopes greater than 25%).
- Prior to development, establish baseline vegetation condition and inventory and to provide a basis for post-development habitat restoration.
- Identify, avoid, and protect vegetation used by snowshoe hare.
- Apply stipulations during programmatic planning stage for oil and gas that limit occupancy, control surface use or control timing of activities in lynx habitats.
- On projects where over-the-snow access is required, restrict use to designated routes.
- Minimize snow compaction when authorizing and monitoring developments.
- Utilize remote monitoring of sites that are located in lynx habitat, to reduce disturbance from well visitation.
- Restrict public access on single purpose roads during project activities.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Report all lynx sightings to DOW.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Minimize traffic in occupied lynx habitat between 3:00 p.m. and 7:00 a.m.
- Reclaim newly constructed pipelines immediately following construction and do not allow any motorized vehicles access to pipeline (i.e.,. install barriers, boulders etc).
- Encourage developers to pipe produced water to a central site for transport, in order to reduce truck traffic to each well pad site.
- Minimize upgrading of roads used to access oil/gas developments or transmission pipelines in lynx habitat or linkage areas.
- Develop a reclamation plan (e.g. road reclamation and vegetation rehabilitation) for abandoned well sites to restore suitable habitat for lynx.

MOUNTAIN PLOVER

- Survey suitable nesting habitat within the known range of mountain plover that is proposed for development during the appropriate season. Flag active nests and apply the seasonal restriction described below.
- No surface occupancy within 300 feet of active mountain plover nest sites until young are hatched and independent of nest.

PIPING PLOVER

- No surface occupancy within 300 feet of the high water mark of mapped piping plover nesting habitat usually occurring on sandy open shorelines of reservoirs and lakes, or islands in reservoirs or lakes in eastern Colorado.
- No surface disturbance to piping plover foraging areas during the nesting season (April 1 to July 31) to include shallow water areas along exposed beach substrates associated with lakes, ponds, and beaches, and dry, barren sandbars along backwater river areas with abundant macro-invertebrate and insect populations within 0.5 mile of known piping plover production areas.

PLAINS SHARP-TAILED GROUSE

- Consult with CDOW at the earliest stage of development to review detailed maps of plains sharp-tailed grouse seasonal habitats and to help select development sites.
- Conduct comprehensive development planning that provides a clear point of reference in evaluating, avoiding, and mitigating large scale and cumulative impacts.
- No surface occupancy within 0.4 mile of any known plains sharp-tailed grouse lek.
- Avoid oil and gas operations within 1.25 miles of any known plains sharp-tailed grouse lek, and within mapped plains sharp-tailed grouse breeding or summer habitat outside the 1.25 mile buffer. Select sites for development that will not disturb suitable nest cover or brood-rearing habitats within 1.25 miles of an active lek, or within identified nesting and brood-rearing habitats outside the 1.25 mile perimeter.
- Where oil and gas activities must occur within 1.25 miles of plains sharp-tailed grouse leks or within other mapped plains sharp-tailed grouse breeding or summer habitat, conduct these activities outside the period between March 1 and June 30.
- Restrict well site visitations to portions of the day between 9:00 a.m. and 4:00 p.m. during the lekking season (March 1 to June 1).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in plains sharp-tailed grouse breeding and summer habitat (within 1.25 miles of active leks).
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Phase and concentrate all development activities, so that large areas of undisturbed habitat for wildlife remain and thorough reclamation occurs immediately after development and before moving to new sites. Development should progress at a pace commensurate with reclamation success.
- Retain core habitat areas and limit disturbance to ensure plains sharp-tailed grouse survival.
- Implement the species appropriate Infrastructure Layout and Drilling and Production Operations Wildlife Protection Measures found in Section II B. and Section II D. of this document.
- Minimize surface disturbance and fragmentation of plains sharp-tailed grouse habitat through use of the smallest facility footprints possible, use of multiple well pads, clustering of roads and pipelines, and the widest possible spacing of surface facilities.
- When compressor stations must be sited within 1.25 miles of plains sharp-tailed grouse active and inactive (within last 10 years) lek sites, locate compressor stations no closer than 2500 feet from the lek.

- Use noise reduction equipment on compressors and other development and production equipment.
- Use topographical features to provide visual concealment of facilities from known lek locations and as a noise suppressant.
- Muffle or otherwise control exhaust noise from pump jacks and compressors so that operational noise will not exceed 49 dB measured at 30 feet from the source.
- Design tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in plains sharp-tailed grouse habitat.
- Utilize a central generator to feed the entire field via underground electrical lines.
- Bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.
- Design wastewater pits to minimize retention of stagnant surface water.
- Treat waste water pits and any associated pit containing water that provides a medium for breeding mosquitos with Bti (*Bacillus thuringiensis v. israelensis*) or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife, especially grouse.
- In consultation with CDOW, replace any permanently impacted, disturbed, or altered plains sharp-tailed grouse habitat within identified nesting and brood rearing range through enhancement of existing or marginal plains sharp-tailed grouse habitat or reclamation of altered or converted habitat within or immediately adjacent to mapped nesting or brood rearing habitat.
- Implement the species appropriate reclamation guidelines found in Section II G. of this document.
- Use early and effective reclamation techniques, including an aggressive interim reclamation program to return habitat to use by plains sharp-tailed grouse as quickly as possible.
- Reclaim/restore plains sharp-tailed grouse habitats with native grasses and forbs conducive to optimal plains sharp-tailed grouse habitat and other wildlife appropriate to the ecological site.
- Use approved CP-4D (plains sharp-tailed grouse) seed mixes, based on soil type, available from Farm Service Agency or Natural Resources Conservation Service, or other seed mixes approved by CDOW.
- Do not use aggressive non-native grasses in plains sharp-tailed grouse habitat reclamation.
- Establish a small percentage (i.e., less than 5% cover) of adapted native shrubs listed in the Farm Service Agency and Natural Resources Conservation Service's CP-4D plains sharp-tailed grouse seed mixes on disturbed sites.
- Reclaim brood rearing areas with a substantially higher percentage of forbs than other areas.
- Utilize native and select non-native forbs and legumes in seed mixes as they are a vital component of brood-rearing habitat. Suitable species include those forbs approved by the Farm Service Agency and the Natural Resources Conservation Service's CP-4D seed mixes for CRP. Dryland adapted varieties of alfalfa and yellow sweet clover should be the primary non-native forb species used.

PRAIRIE DOGS (White-Tailed & Gunnison's)

- Survey for active and inactive prairie dog colonies within development areas prior to development.
- Avoid construction on or in prairie dog colonies wherever possible.

- Where oil and gas activities must occur on or in white-tailed or Gunnison's prairie dog colonies, conduct these activities outside the period between March 1 and June 15.
- Avoid surface facility density in excess of 10 well pads per 10-square mile area (one well pad per section) in White-tailed and Gunnison's Prairie Dog Management Emphasis Areas that will be described in the Colorado Statewide Implementation Plan for the species.
- When surface density of oil and gas facilities exceeds 1 well pad/section, initiate a Comprehensive Development Plan (CDP) that includes recommendations for off-site and compensatory mitigation actions.
- Manage oil and gas activities within prairie dog colonies to minimize impacts to attributes that maintain the functional integrity of the prairie dog colony (e.g., vegetation, soils, burrow systems, etc.).
- Minimize road development and close roads to recreational use.
- Promptly reclaim disturbed areas within prairie dog colonies with native grasses and forbs appropriate to the ecological site.
- Aggressively control non-native and invasive weeds, particularly cheatgrass, in reclamation areas within prairie dog habitat.
- Install raptor perch deterrents on equipment, fences, cross arms and pole tops in prairie dog habitat.

PREBLE'S MEADOW JUMPING MOUSE

- No surface occupancy within 300 feet either side of centerline along streams of known or potentially occupied habitat along the northern Front Range from the Colorado Wyoming state line through northern El Paso County.
- Consult with the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers when permitting any permanent or temporary activity within known or potentially occupied habitat Preble's meadow jumping mouse habitat.

PRONGHORN ANTELOPE

- Avoid surface disturbance to and construction activities within pronghorn winter concentration areas west of I-25 from January 1 through March 31.
- Identify critical habitat types and adjust development sites to avoid these areas.
- Gate single-purpose roads to reduce traffic disruptions to wildlife.
- Close and immediately reclaim all roads that are redundant, not used regularly, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- Limit fence construction in pronghorn habitat. Use CDOW recommended pronghorn fence designs.
- Prior to development, establish baseline vegetation condition and inventory to provide a basis for post-development habitat restoration.
- Avoid aggressive non-native grasses and shrubs in pronghorn habitat restoration.
- Reclaim pronghorn habitats with native shrubs, grasses, and forbs appropriate to the ecological site disturbed.
- Restore appropriate sagebrush species or subspecies on disturbed sagebrush sites. Use locally collected seed for reseeding where possible. Sagebrush is less important in pronghorn reclamation on the eastern plains than it is in western Colorado (west of I-25).

RAPTORS

General Raptor Mitigation Measures

- Prior to ground disturbing activities, determine either through consultation with CDOW or surveys the locations of raptor nesting and roosting sites.
- Provide raptor survey data for incorporation into the CDOW raptor database.
- Consult with and implement CDOW recommendations regarding raptor protection measures including seasonal timing restrictions and recommended buffer zones.
- Avoid disturbance of raptor nesting habitat during the breeding season (variable by species--January 1 to July 15).
- Avoid impacts to raptor roost sites during the wintering period (variable by species--November 15 to April 1).
- Survey any suitable habitat (cliffs, large trees, snags) within 1 mile of a proposed project site for raptor nests. Where raptor nests are found, site the project to provide a suitable buffer zone, and/or place sufficient seasonal limitations on construction activity to protect the nest site.
- Bury utility lines in defined areas with high collision risk for birds.
- Implement recommendations from both *"Suggested Practices for Avian Protection on Power Lines, the State of the Art in 2006"* and the *"Avian Protection Plan (APP) Guidelines"* (2005) for proper design and retrofit considerations for powerlines and poles to minimize raptor electrocution. These documents can be ordered at the Edison Electric Institute web site (www.eei.org) or can be downloaded at the Avian Power Line Interaction Committee web site (www.aplic.org).

Bald Eagle

- No surface occupancy (beyond that which historically occurred in the area) within 0.25 mile of any active or historic bald eagle nest site.
- No human disturbance or construction activity within 0.5 mile of any active bald eagle nest from November 15 to July 31. Activity within 0.5 mile of bald eagle nest sites would be best conducted between August 15 and October 15.
- No surface occupancy or construction within 0.25 mile of any active bald eagle winter night roost site, where there is no direct line of sight to the roost, between December 1 and February 28 and within 0.5 mile of any active bald eagle winter night roost site, where there is a direct line of sight to the roost, between December 1 and February 28.
- No human disturbance within 0.5 mile of any active bald eagle winter roost site from November 15 to March 15 except for periodic visits such as oil maintenance and monitoring Maintenance and monitoring work within the buffer zone after development should be restricted to the period between 10:00 a.m. and 2:00 p.m.
- No human disturbance within any mapped winter concentration areas between November 15 and March 15.

Ferruginous Hawk

- No surface occupancy (beyond that which historically occurred in the area) within 0.5 mile of active nest sites and associated alternate nests.
- No human encroachment or construction activity within 0.5 mile of any active ferruginous hawk nest or alternate nest site from February 1 to July 15.

Golden Eagle

- No surface occupancy (beyond that which historically occurred in the area) within 0.25 mile of any active golden eagle nest site.

- No human encroachment or construction activity within 0.5 mile of any active golden eagle nest from December 15 to July 15.

Mexican Spotted Owl

- No surface occupancy (beyond that which historically occurred in the area) within designated Mexican spotted owl protected activity centers (PAC's) without USFWS consultation.
- No surface disturbance between March 1 to August 31 within and adjacent to Mexican spotted owl protected activity centers (PAC's) without USFWS consultation.

Osprey

- No surface occupancy (beyond that which historically occurred in the area) within 0.25 mile of any active osprey nest site.
- No human encroachment or construction activity within 0.25 mile of any active osprey nest from April 1 to August 31.

Peregrine Falcon

- No surface occupancy (beyond that which historically occurred in the area) within 0.5 mile of any active or historic peregrine falcon nest site.
- No human encroachment or construction activity within 0.5 mile of any active peregrine falcon nest site from March 15 to July 31.

Burrowing Owl

- Adhere to recommended survey protocol and actions to protect nesting Burrowing Owls (e.g. survey active and inactive prairie dog colonies for presence of Burrowing Owls when construction will occur between March 1 and October 31).
- Conduct surface disturbance within 300 feet of any active burrowing owl nest site outside the period between March 1 and August 15.

RIVER OTTER

- Avoid or limit the use of pesticides, herbicides, and fertilizers within the flood plain in occupied river otter habitat.
- Minimize disturbance of riparian vegetation adjacent to waterways (i.e., within 300 feet) of occupied river otter habitat.
- Minimize road development within 300 feet of occupied river otter habitat, especially the creation of new stream or river crossings (bridges) in occupied river otter habitat.
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Provide information on sightings of live or dead river otters for incorporation into the CDOW river otter sightings database. Sighting forms are located at: http://wildlife.state.co.us/WildlifeSpecies/SpeciesOfConcern/Mammals/RiverOtterObservation.htm

SOUTHWEST WILLOW FLYCATCHER

- Survey for active nest sites during the breeding season within southwest willow flycatcher overall range.
- No Surface Occupancy within 300 feet of southwest willow flycatcher nest sites.
- No surface disturbance or removal of riparian habitat within 300 feet from stream edge within potential southwest willow flycatcher habitat

- Restrict activities May 15 to August 1 in potential southwest willow flycatcher habitat.

SWIFT FOX

- Survey for swift fox den sites and avoid surface disturbance within 0.25 mile while young are den dependent (March 15 to June 15).
- Establish company guidelines to minimize wildlife mortality from vehicle collisions on roads.
- Utilize native vegetation for reclamation within swift fox overall range
- Restrict use of pesticides for rodent control in swift fox overall range.

WESTERN BOREAL TOAD

- No Surface Occupancy within 0.5 mile of known breeding sites.
- Consult with CDOW prior to any surface disturbance or construction activities within 600 feet of any documented western boreal toad field sighting or production area.

AQUATIC SPECIES/AMPHIBIANS

- Consult with CDOW or collect baseline aquatic species and macro-invertebrate inventory data both pre and post development.
- Conduct two pass population estimations for streams potentially affected. Report species composition, length-frequency and individual weights.
- Collect water samples to monitor water quality before, during and after occupation and document data and changes.
- No surface disturbance within 300 feet of any designated Gold Medal water.
- Design stream crossings to minimize the total number of crossings and so that crossings are at or as near to 90 degrees to the direction of stream flow.
- Construct stream crossings “in the dry” and avoid impacts to trout during spawning and hatching periods.
- Restrict trucks from crossing streams and utilize appropriate and effective culverts that don’t preclude upstream movement of fish.
- Avoid using low water crossings.
- Control erosion and sedimentation, and manage storm water runoff; reclaim sites as quickly as possible to restore vegetation.
- Control weeds along riparian corridors and manage livestock grazing to maintain riparian corridor health.
- Consider fencing riparian areas.
- Avoid changes to water quality and quantity.
- Repair incised channels where excessive erosion and sedimentation is occurring.
- Consider directional boring of pipeline crossings of perennial streams.
- Replace non-native riparian vegetation such as tamarisk and Russian olive with appropriate native plantings such as cottonwood or willow.
- Protect groundwater, riparian areas and wetlands by installing impermeable barriers beneath fluid pits.
- When working in designated Gold Medal waters, disinfect heavy equipment, hand tools, boots and any other equipment that was previously used in a river, stream, lake, pond, or wetland prior to moving the equipment to another water body. The disinfection practice should follow this outline:
    - Remove all mud and debris from equipment and spray/soak equipment with a 1:15 solution of disinfection solution containing the following ingredients:

        - Dialkyl dimethyl ammonium chloride, 5-10% by weight;
        - Alkyl dimethyl benzyl ammonium chloride, 5-10% by weight;
        - Nonyl phenol ethoxylate, 5-10% by weight;
        - Sodium sesquicarbonate, 1-5%;
        - Ethyl alcohol, 1-5%; and
        - Tetrasodium ethylene diaminetetraacetate, 1-5%
        - and water, keeping the equipment moist for at least 10 minutes and managing rinsate as a solid waste in accordance with local, county, state, or federal regulations; or
    - Spray/soak equipment with water greater than 140 degrees Fahrenheit for at least 10 minutes.
    - Sanitize water suction hoses and water transportation tanks (using methods described above) and discard rinse water at an appropriately permitted disposal facility.
- Avoid stream channel disturbances during fish spawning seasons. Fish spawn at specific times of the year. The eggs incubate in the gravel until the yolk sac is absorbed and the larval fish can swim up through the gravel and into the main body of water. Eggs incubating in the redds can be smothered by the excessive deposition of sediment, and further affected by fungal spores carried in the sediment. Adults can be affected by the same fungal species with high mortality rates. Fish spawning dates and incubation times vary by elevation and temperatures, but in general the following intervals will apply in Colorado:
    - Rainbow trout: March 1 - June 15
    - Brown trout: October 1 – May 1
    - Brook trout: August 15 – May 1
    - Cutthroat trout: June 1 – September 1
    - Bluehead sucker: May 1 – July 15
    - Flannelmouth sucker: April 1 – July 1
    - Roundtail chub: May 15 – July 15

ATTACHMENT C

HEXPROTECT COVER

Hexprotect Cover

Advanced Water Treatment Technologies
Engineered for a lifetime

Wind resistant hexagonal tile cover.

AWTT INC. **Hexprotect** cover system is the result of intense and extensive research leading to a product which fulfills demands of an affordable and wind resistant floating cover for liquids.

This innovative hexagonal floating cover offers highly effective solutions to problematic liquid storage systems such as municipal and industrial wastewater, treatment processing plants, metal and petrochemical plants, leachate ponds, airports, raw water reservoirs and other applications for heat retention, photosynthesis prevention and or a wildlife deterrent.

The Hexprotect system ensures coverage of up to 99%. The resulting thermal insulation barrier combines the insulation factor of the air held in each tile with the poor heat conductivity of plastic. While the small air pockets between the tiles are not sealed, they also contribute to this insulation system, which dramatically reduces heat loss and light transfer. The cover also reduces liquid loss through evaporation and prevents odor problems.

The Hexprotect tile barrier, contrary to standard covers, does not represent an obstacle to static, moving or dipping equipment. The tiles can be easily pushed aside and the cover reforms itself as the basin and obstacles change configuration, as in a clarifier.

In fact, the tiles will keep up with liquid level, rising, lowering and restacking themselves as needed.

Hexprotect is also an effective wildlife deterrent. When entirely covered, the body of water becomes un-attractive to waterfowl and other wildlife such as deer. They simply don't recognize it as water. Compared to netting, Hexprotect is not sensitive to ice or snow damage and do not require any kind of support.

Hexprotect is produced with high quality high density polyethylene. The expected life time is 25 years.

Hexprotect features:

- Quick and simple to install
- Up to 99% surface coverage
- Decrease liquid loss by evaporation by up to 95%
- Decrease emission by up to 95%
- Heating cost reduced by up to 85%
- Wind resistant up to 75 mph

Hexprotect added benefits :

- Deters waterfowl from landing on covered waters
- Each tile is made of long lasting, UV resistant, high quality HDPE
- Allow movement of equipment through liquid. Unlimited and easy access to the liquid.
- Adjust to the variation of the liquid level by spreading & stacking
- Naturally Self arrange and interlock on the liquid surface
- Fast and Effective solution to odor problems
- Virtually maintenance free
- Cannot tear like conventional membrane cover
- Reduces penetration of UV rays: prohibit growth of algae and clogging weeds.
- Aeration can be installed underneath the Hexprotect
- Reduce chemical consumption.
- Unaffected by rain water
- Life expectancy of 25 years

Technical Data:

Diagonal measure:	220 mm
Weight dry:	172 g
Weight installed:	455g
Height:	60 mm
No. per m2:	32
No. per square foot:	3

AWTT INC.
ADVANCED WATER TREATMENT TECHNOLOGIES
Engineered for a lifetime...
Corporate headquarters
515W 3rd Pl, The Dalles, OR 97058
Visit us on the web:
http://www.awtti.com

Hexprotect™ AQUA: technical data

Wind resistant

Product Info

Hexprotect™ technical data

Hexprotect™ tiles are made of virgin or recycled, high density polyethylene HDPE (FDA (3) and NSF approved HDPE resins available for special applications). The cover self ballasts, increasing its weight more than 260%, making it suitable for high wind applications. The proprietary features and manufacturing process ensures the cover floats with slightly more than 50% of its shell above water. Compared to other hexagonal tile covers, the Hexprotect cover is often cheaper to ship and offers improved wind resistance. Installation remains extremely simple, and simply consists of unloading the product directly onto the liquid.

Description	Water ballasted hexagonal tile
Construction	100% HDPE shell
Diameter	220 mm
Average total weight (dry)	400g
Average total weight (installed)	400g
Number per sq. ft	3
Number per square meter	32
Wind resistant (up to) (1)	209 km/h (130 MPH)
Operating temperature range (1)	-50°C / + 80 °C
Projected Life Expectancy	25+ years

Resin & Ballast Properties (1)(2)

Shell Material	High Density Blow Molding polyethylene
Melt Flow Index (190°C/2.16 kg)	0.35
Density	0.955
Melting Point, °F	264
Tensile Strength (PSI)	4000
Elongation at Break, %	600
Flexure Modulus (PSI)	200,000
Ballast Filler	Drinking water

(1) Data developed under laboratory conditions.
(2) Some of the data listed was determined on compression molded specimens and may, therefore, vary from specimen taken from molded articles.
(3) Complies with FDA 21 CFR § 177.1520, Para. (c) 2.1 and 2.

Contact AWTT Inc.

Email AWTT
Request a Quote
Tel: 1-541-716-5255
Tel: 1-541-399-0636
Monday - Friday
9:30 a.m. - 5:00 p.m. (PST)

Products & Brochures

- Armor Ball™
- Armor Ball™ Aqua
- Hexprotect™
- Hexprotect™ *MAX R*
- Hexprotect™ Aqua

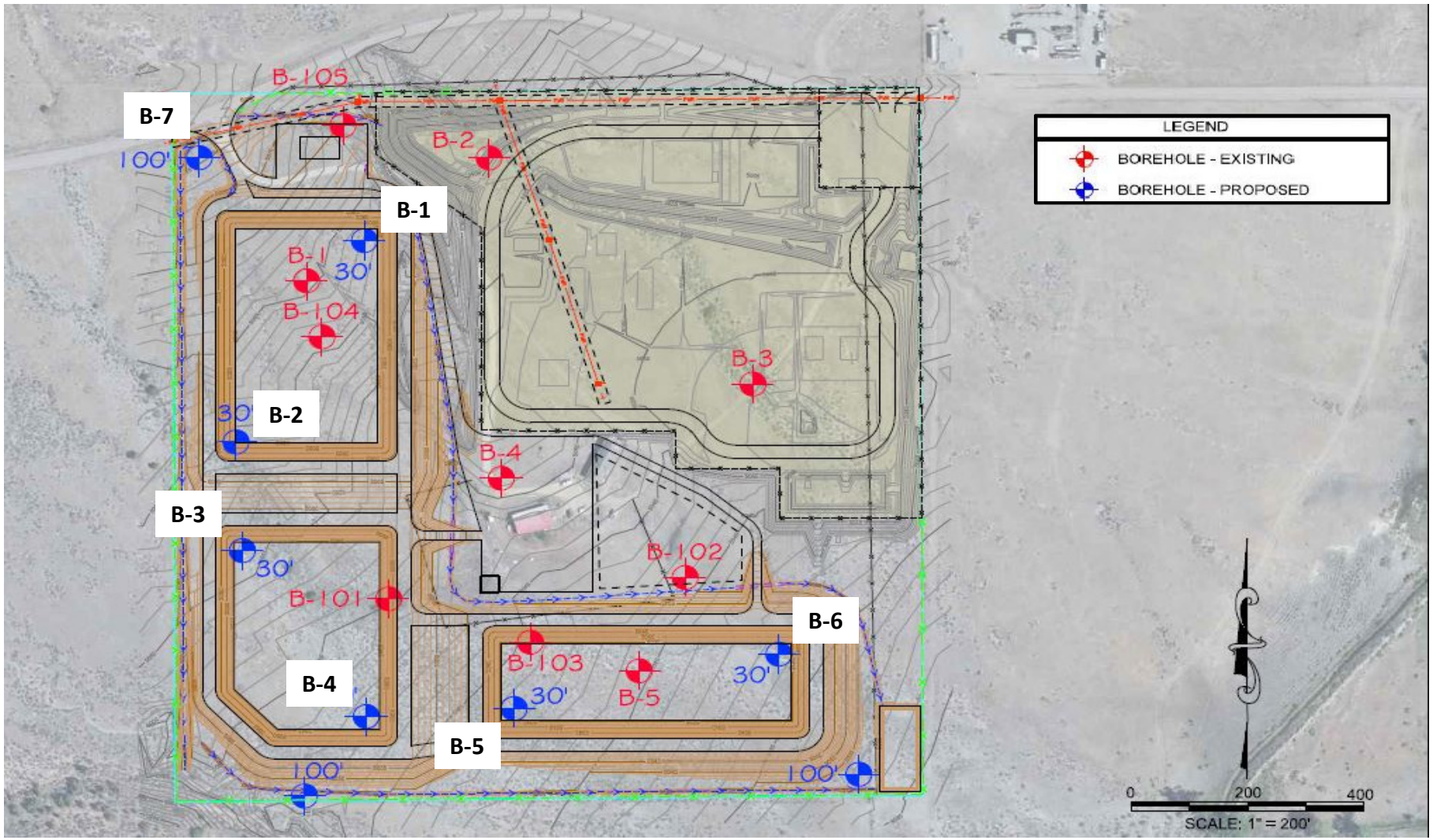
Testimonials

'*Thanks for the communication and for keeping everything on schedule. [...] Your scheduling, production, shipping and communication have been a welcome change from how everything else has gone*'. Mike

Find Us on

ATTACHMENT B

SOIL BORE LOGS



OLSSON ASSOCIATES

North

Scale: n.t.s.	**Boring Location Plan**
Project No. 014-0292	
Approved by: CLW	**De Beque, Colorado**
Date: 3/5/14	

LOG OF BOREHOLE NO. B-1

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
SANDY CLAY										
Stiff, light brown with gray			SS 1		8-6-6 N=12					
		2.5								
3.0'										
Trace cemented sand, light brown with gray			SS 2	CL	4-5-9 N=14				37/16	P-200 = 64.5%
		5.0								
			SS 3		4-7-7 N=14					
7.5'		7.5								
CLAYEY SAND										
Silty, very dense, light gray			SS 4		7-11-15 N=26					
		10.0								
		12.5								
13.0'										
SANDY CLAY										
Trace sandstone fragments, hard, light gray			SS 5		13-33-50 N=83					
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-1

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
SANDY CLAY		15.0								
Trace sandstone fragments, hard, light gray (continued)		17.5								
		20.0	SS 6		25-33-50 N=83					P-200 = 83.0%
		22.5								
			SS 7		38-50 N=88					
		25.0								
		27.5								
28.0'										
Trace sand, hard, light gray			SS 8		50/5" N=50					
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-2

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
LEAN CLAY										
Sandy, very stiff, dark brown			SS 1		10-12-13 N=25					
		2.5								
			SS 2		5-11-11 N=22					
4.5'										
Sandy, with sandstone fragments, very stiff to hard, dark brown		5.0	SS 3	CL	6-9-19 N=28				40/19	P-200 = 60.8%
7.0'										
SANDY CLAY		7.5	SS 4		11-17-22 N=39					
Trace gravel, hard, dark brown										
		10.0	SS 5		14-20-24 N=44					
		12.5								
13.0'										
With sandstone fragments, brown			SS 6	CL	17-24-23 N=47				34/18	P-200 = 69.4%
		15.0								

CONTINUED NEXT PAGE

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-2

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		15.0								
With sandstone fragments, brown (continued)										
		17.5								
18.0'										
LEAN CLAY			SS 7		50/6" N=50					
Hard, light brown with gray										
		20.0								
		22.5								
23.0'										
SANDY CLAY			SS 8		25-20 N=45					
Hard, light brown with gray										
		25.0								
		27.5								
28.0'										
WEATHERED SHALE			SS 9		38-50 N=88					
Hard, gray										
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-3

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		0.0								
DEVELOPED ZONE										
1.0'										
LEAN CLAY										
With sand, very stiff, brown			SS 1		5-12-17 N=29					
3.0'		2.5								
SANDY CLAY			SS 2		16-22-33 N=55				41/19	
Hard, brown		5.0	SS 3		18-31-38 N=69					P-200 = 75.5%
		7.5	SS 4		25-20-16 N=36					
8.5'										
With silt, very stiff, dark brown		10.0								
		12.5	SS 5	CL	10-6-12 N=18				41/19	P-200 = 59.1%
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-3

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		15.0								
With silt, very stiff, dark brown (continued)										
		17.5								
18.0'										
LEAN CLAY										
With weathered shale, hard, brown with grayish green			SS 6		20-22-32 N=54					
		20.0								
		22.5								
23.0'										
With sand, hard, light gray			SS 7		28-36-50 N=86					
		25.0								
		27.5								
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/18/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-4

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
SANDY CLAY										
Hard, brown			SS 1		13-16-26 N=42					
		2.5								
			SS 2	CL	7-18-24 N=42				39/18	P-200 = 63.8%
		5.0								
			SS 3		17-24-26 N=50					
		7.5								
			SS 4		15-18-23 N=41					
9.5'										
With gravel, hard, light brown with yellowish brown		10.0								
		12.5								
			SS 5		23-30-50 N=80					
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-4

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		15.0								
With gravel, hard, light brown with yellowish brown (continued)		17.5								
18.0'										
Hard, light brown with olive brown			SS 6		16-27-33 N=60					
		20.0								
		22.5	SS 7		24-34-50 N=84					
		25.0								
		27.5	SS 8		32-50 N=82					
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-5

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		0.0								
DEVELOPED ZONE *1.0'*										
SANDY CLAY *With silt, hard, light brown*		2.5	SS 1		12-21-23 N=44					
			SS 2		12-18-20 N=38					P-200 = 76.7%
		5.0	SS 3	CL	9-14-23 N=37				47/26	P-200 = 63.4%
		7.5	SS 4		12-18-20 N=38					
		10.0								
		12.5								
13.0'										
LEAN CLAY *Hard, olive brown*			SS 5		15-16-16 N=32					
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-5

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		15.0								
LEAN CLAY										
Hard, olive brown (continued)		17.5								
			SS 6		14-20-29 N=49					
		20.0								
		22.5								
			SS 7		29-50 N=79					
		25.0								
		27.5								
			SS 8		50/4" N=50					
30.0'		30.0								
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-6

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		0.0								
DEVELOPED ZONE										
1.0'										
SANDY CLAY										
Hard, light brown			SS 1		3-14-21 N=35					
		2.5								
3.0'										
Stiff, dark brown			SS 2		12-5-5 N=10					
		5.0								
			SS 3	CL	4-5-10 N=15				42/21	P-200 = 67.7%
6.5'										
Hard, brown										
		7.5	SS 4		17-21-38 N=59					
		10.0								
		12.5								
13.0'										
SANDSTONE										
Very dense, brown			SS 5		27-35-50 N=85					
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-6

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		15.0								
SANDSTONE *Very dense, brown (continued)*		17.5	SS 6		30-50 N=80					
20.0'		20.0								
		22.5	SS 7		50/4" N=50					
		25.0								
		27.5								
30.0'		30.0								

CONTINUED NEXT PAGE

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-6

CLIENT	PROJECT NO.
Western Water Consultants, Inc	**014-0292**
LOCATION	PROJECT NAME
DeBeque, CO	**WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
SANDY CLAY										
Hard, light brown										
BASE OF BORING AT 30.0 FEET										

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/19/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

LOG OF BOREHOLE NO. B-8

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
DEVELOPED ZONE		0.0								
1.0'										
LEAN CLAY										
With sand and silt, brown		2.5								
5.0'		5.0								
Brown		7.5								
10.0'		10.0								
SANDSTONE										
With clay, brown with gray		12.5								
		15.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
SANDSTONE		15.0								
With clay, brown with gray (continued)		17.5								
		20.0								
		22.5								
		25.0								
		27.5								
		30.0								

CONTINUED NEXT PAGE

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
SANDSTONE		30.0								
With clay, brown with gray (continued)		32.5								
35.0'		35.0								
Silty, clayey, grayish green		37.5								
		40.0								
		42.5								
		45.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		45.0								
Silty, clayey, grayish green (continued)		47.5								
		50.0								
		52.5								
		55.0								
		57.5								
		60.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS

WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
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STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		60.0								
Silty, clayey, grayish green (continued)		62.5								
		65.0								
		67.5								
		70.0								
		72.5								
		75.0								
CONTINUED NEXT PAGE										

WATER LEVEL OBSERVATIONS	
WD	Not Encountered
AB	Not Encountered
AD	Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		75.0								
Silty, clayey, grayish green (continued)		77.5								
		80.0								
		82.5								
		85.0								
		87.5								
		90.0								

CONTINUED NEXT PAGE

WATER LEVEL OBSERVATIONS

WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

OLSSON ASSOCIATES

LOG OF BOREHOLE NO. B-8

CLIENT: **Western Water Consultants, Inc**

PROJECT NO.: **014-0292**

LOCATION: **DeBeque, CO**

PROJECT NAME: **WWC DeBeque Station CO Monitoring Wells**

MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (PP) (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
		90.0								
Silty, clayey, grayish green (continued)		92.5								
		95.0								
		97.5								
100.0'		100.0								

BASE OF BORING AT 100.0 FEET

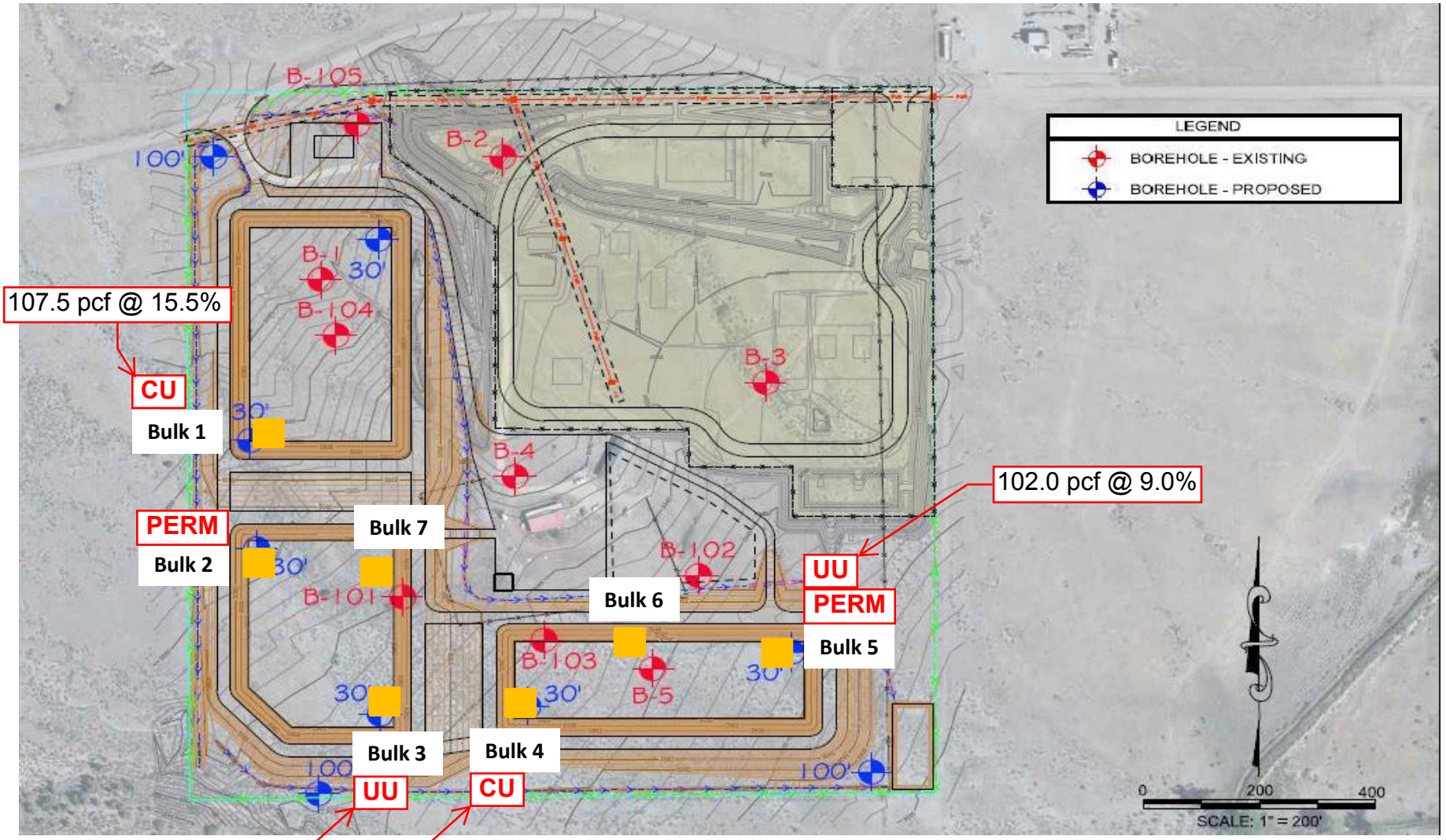
WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
AB	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, Kansas 66061
Telephone: 913-829-0078
Fax: 913-829-0258

STARTED	2/18/14	FINISHED	2/19/14
DRILL CO.	Olsson	DRILL RIG	
DRILLER	Shelton	LOGGED BY	WM
METHOD	Hollow Stem Auger 4"		

ATTACHMENT C

SOIL TEST RESULTS



Bulk Sample Locations

Scale: n.t.s.	**De Beque, Colorado**
Project No. 014-0292	
Approved by: CLW	
Date: 3/17/14	

OLSSON ASSOCIATES

North

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, KS 66061
TEL 913.829.0078
FAX 913.829.0258
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Moisture - Density Relationship

Project Information	
Project Name:	WWC DeBeque Station
Project Number:	014-0292
Client Name:	Western Water Consultants, Inc.
Project Location:	DeBeque, CO

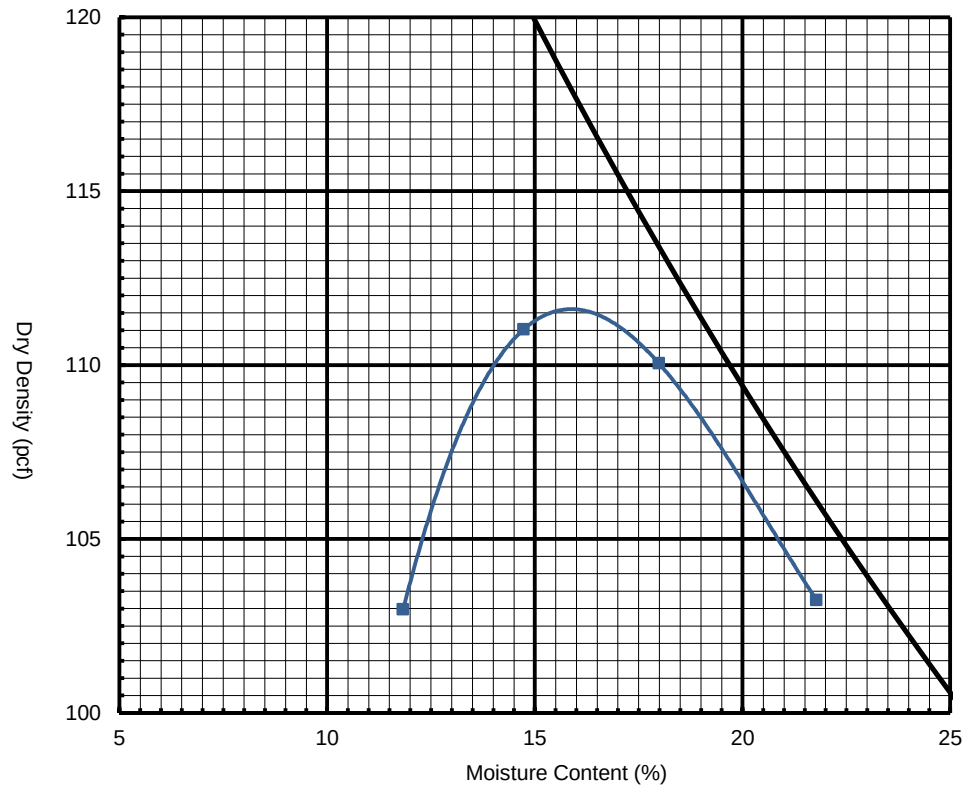
Sample Information	
Sample ID/Proctor #:	Bulk Sample 6
Sample Location:	See Boring Location Map
Date Sampled:	
Date Tested:	27-Mar-14
Sample Description:	CL, with silt, dark brown

Test Method	
Type of Test:	ASTM D-698
Method of Test:	A
Preparation Method:	Moist
Rammer Type:	Mechanical
Specific Gravity:	2.7
Gs Determination:	Estimated

Remarks

N/A

Test Results	
Maximum Dry Density:	111.5 pcf
Optimum Moisture Content:	15.8 %
Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Classification:	N/A
Retained on 3/4" (%)	N/A
Retained on 3/8" (%)	N/A
Retained on No.4 (%)	< 5



LEGEND

100% Saturation Curve:

Proctor Curve:

Corrected Proctor Curve:

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, KS 66061
TEL 913.829.0078
FAX 913.829.0258
www.olssonassociates.com

Moisture - Density Relationship

Project Information	
Project Name:	WWC DeBeque Station
Project Number:	014-0292
Client Name:	Western Water Consultants, Inc.
Project Location:	DeBeque, CO

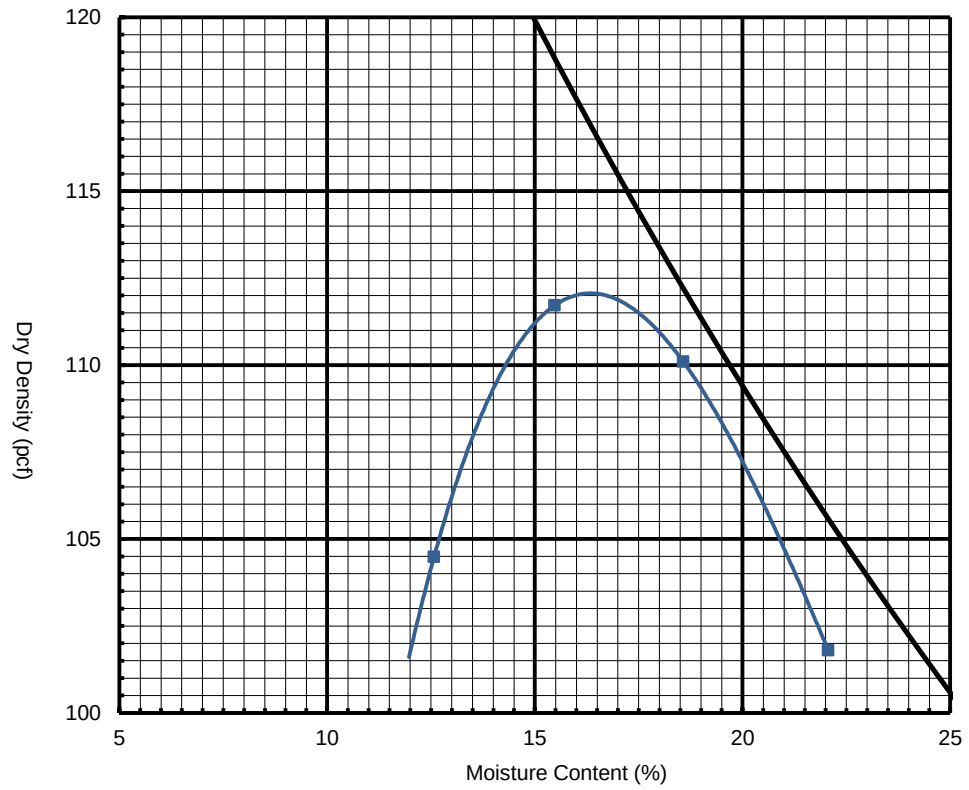
Sample Information	
Sample ID/Proctor #:	Bulk Sample 7
Sample Location:	See Boring Location Map
Date Sampled:	
Date Tested:	27-Mar-14
Sample Description:	CL, with silt, dark brown

Test Method	
Type of Test:	ASTM D-698
Method of Test:	A
Preparation Method:	Moist
Rammer Type:	Mechanical
Specific Gravity:	2.7
Gs Determination:	Estimated

Remarks

N/A

Test Results	
Maximum Dry Density:	112.0 pcf
Optimum Moisture Content:	16.2 %
Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Classification:	N/A
Retained on 3/4" (%)	N/A
Retained on 3/8" (%)	N/A
Retained on No.4 (%)	< 5



LEGEND

100% Saturation Curve:

Proctor Curve:

Corrected Proctor Curve:

OLSSON ASSOCIATES
1802 East 123rd Street
Olathe, KS 66061
TEL 913.829.0078
FAX 913.829.0258
www.olssonassociates.com

Moisture - Density Relationship

Project Information	
Project Name:	WWC DeBeque Station
Project Number:	014-0292
Client Name:	Western Water Consultants, Inc.
Project Location:	DeBeque, CO

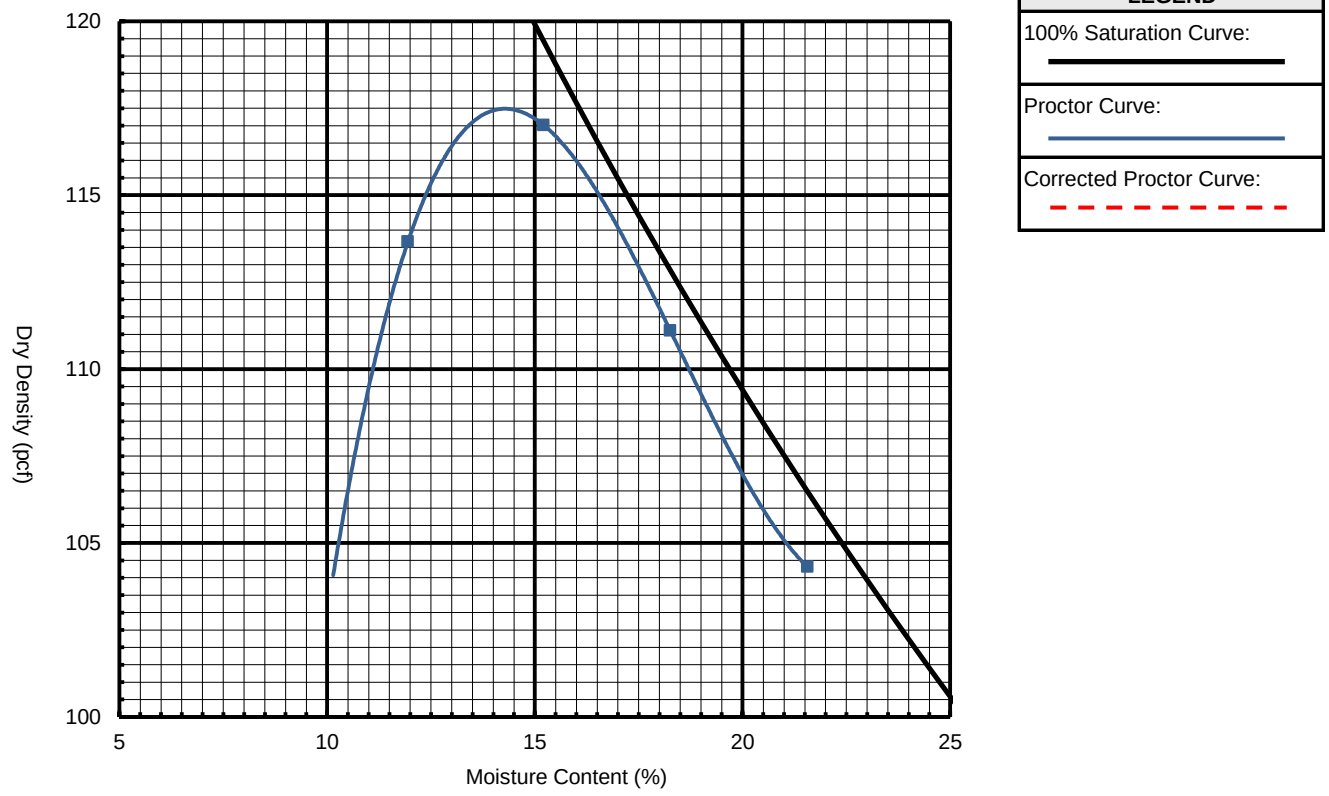
Sample Information	
Sample ID/Proctor #:	Composite Sample No.1
Sample Location:	Composite
Date Sampled:	18-Feb-14
Date Tested:	19-Mar-14
Sample Description:	B3 (SS-5), B3 (SS-9), B4 (SS-7), B5 (SS-4), B5 (SS-7), B5 (SS-8), B7 (SS-6), B7 (SS-7), B8 (SS-6)

Test Method	
Type of Test:	ASTM D-698
Method of Test:	A
Preparation Method:	Moist
Rammer Type:	Mechanical
Specific Gravity:	2.7
Gs Determination:	Estimated

Remarks

N/A

Test Results	
Maximum Dry Density:	117.5 pcf
Optimum Moisture Content:	14.3 %
Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Classification:	N/A
Retained on 3/4" (%)	N/A
Retained on 3/8" (%)	N/A
Retained on No.4 (%)	< 5



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1802 East 123rd Street
Olathe, KS 66061
TEL 913.829.0078
FAX 913.829.0258
www.olssonassociates.com

Moisture - Density Relationship

Project Information	
Project Name:	WWC DeBeque Station
Project Number:	014-0292
Client Name:	Western Water Consultants, Inc.
Project Location:	DeBeque, CO

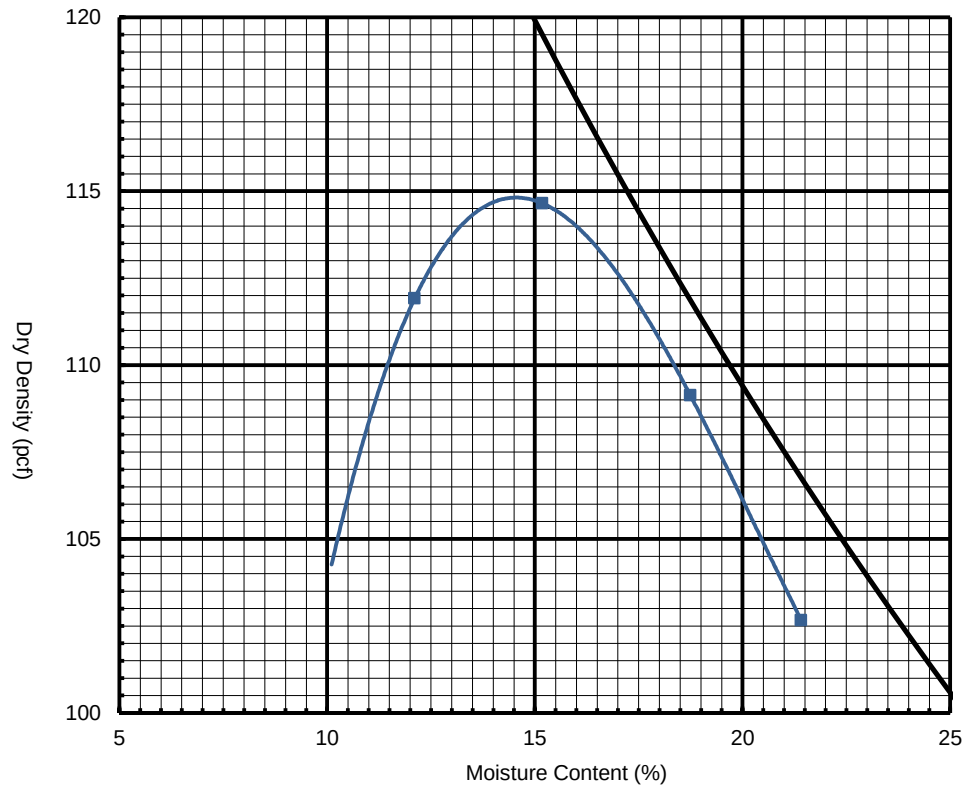
Sample Information	
Sample ID/Proctor #:	Composite Sample No.2
Sample Location:	Composite
Date Sampled:	
Date Tested:	19-Mar-14
Sample Description:	B2 (SS-1), B2 (SS-2), B2 (SS-3), B2 (SS-4), B3 (SS-1), B3 (SS-2), B4 (SS-1), B4 (SS-2), B4 (SS-3), B4 (SS-4), B5 (SS-1), B5 (SS-3), B7 (SS-1), B7 (SS-3), B7 (SS-4), B8 (SS-1), B8 (SS-2), B8 (SS-3)

Test Method	
Type of Test:	ASTM D-698
Method of Test:	A
Preparation Method:	Moist
Rammer Type:	Mechanical
Specific Gravity:	2.7
Gs Determination:	Estimated

Remarks

N/A

Test Results	
Maximum Dry Density:	114.8 pcf
Optimum Moisture Content:	14.6 %
Liquid Limit:	N/A
Plastic Limit:	N/A
Plasticity Index:	N/A
Classification:	N/A
Retained on 3/4" (%)	N/A
Retained on 3/8" (%)	N/A
Retained on No.4 (%)	< 5



LEGEND

100% Saturation Curve:

Proctor Curve:

Corrected Proctor Curve:

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/15/14
Sample Identification:	**Sample Description:**	
Bulk 1	Bulk #1	

INDEX TEST DATA

USCS _____ ; LL _____; PI _____ ;
%FINER (mm): 0.002 _____; 0.005_____;
0.074 (#200) _____
G_s (-#4) _____ G_s (+#4) _____
Standard: γ_d MAX. _____ w_{opt} _____
Modified: γ_d MAX. _____ w_{opt} _____

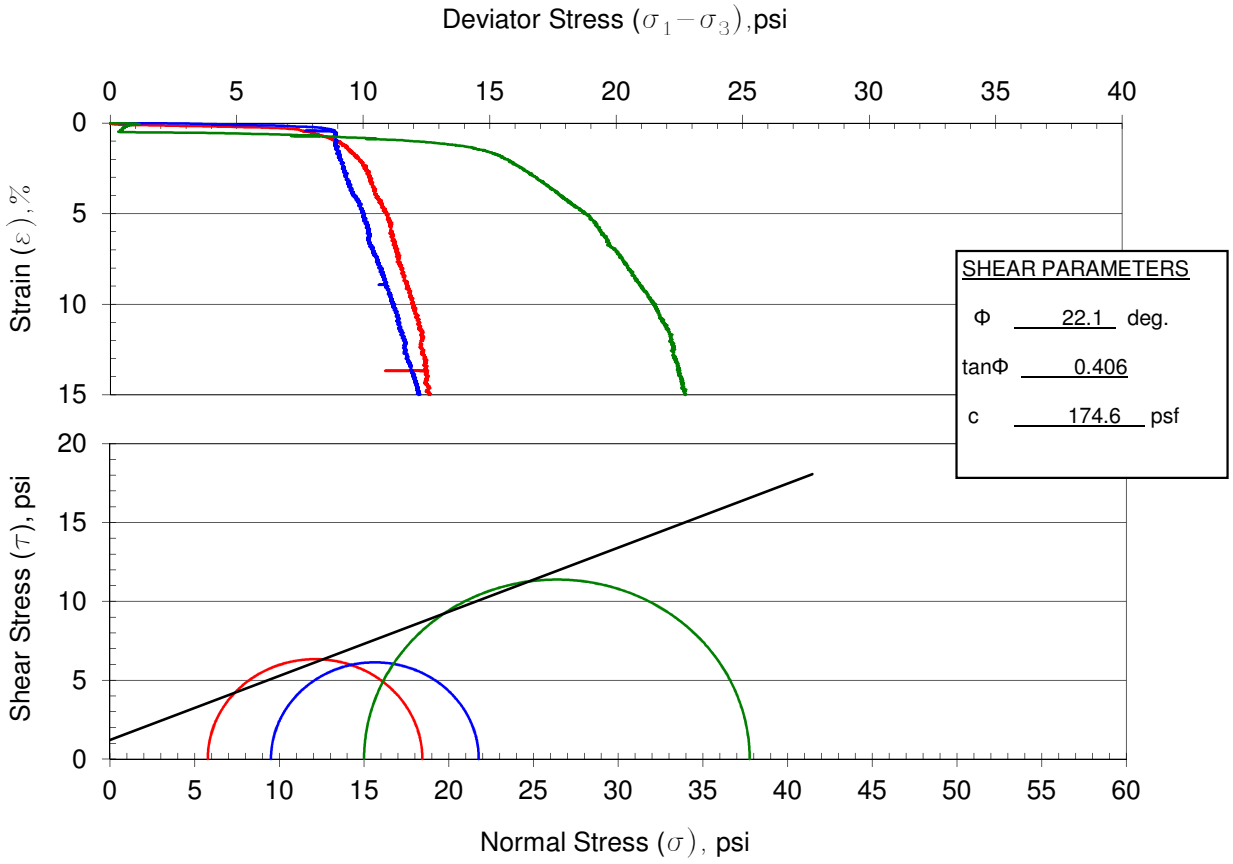
SPECIMEN DATA

HEIGHT 3.2 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED____ SIEVE
METHOD OF PREPARATION:
Remolded from a bulk sample
MOLDING MOISTURE 15.50%
MOLDED AT 100% OF 107.5

TYPE OF TEST

UU	
CU	
CU'	
CD	

DRY DENSITY			MOISTURE CONTENT, %						
INITIAL pcf ☒ g/cc	CONSOL-IDATED pcf ☒ g/cc	B PARAM-ETER	START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST	TIME OF CONSOL-IDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1-\sigma_3$ (psi)	AXIAL STRAIN AT FAILURE ε (%)
108.8	107.1	0.95	15.8	75.7	24.2	72.5	5.8	12.7	14.9
107.5	107.8	0.96	15.5	73.7	22.1	26.4	9.5	12.3	15.0
107.7	104.8	0.99	14.8	70.7	20.2	20.1	15.0	22.8	14.7



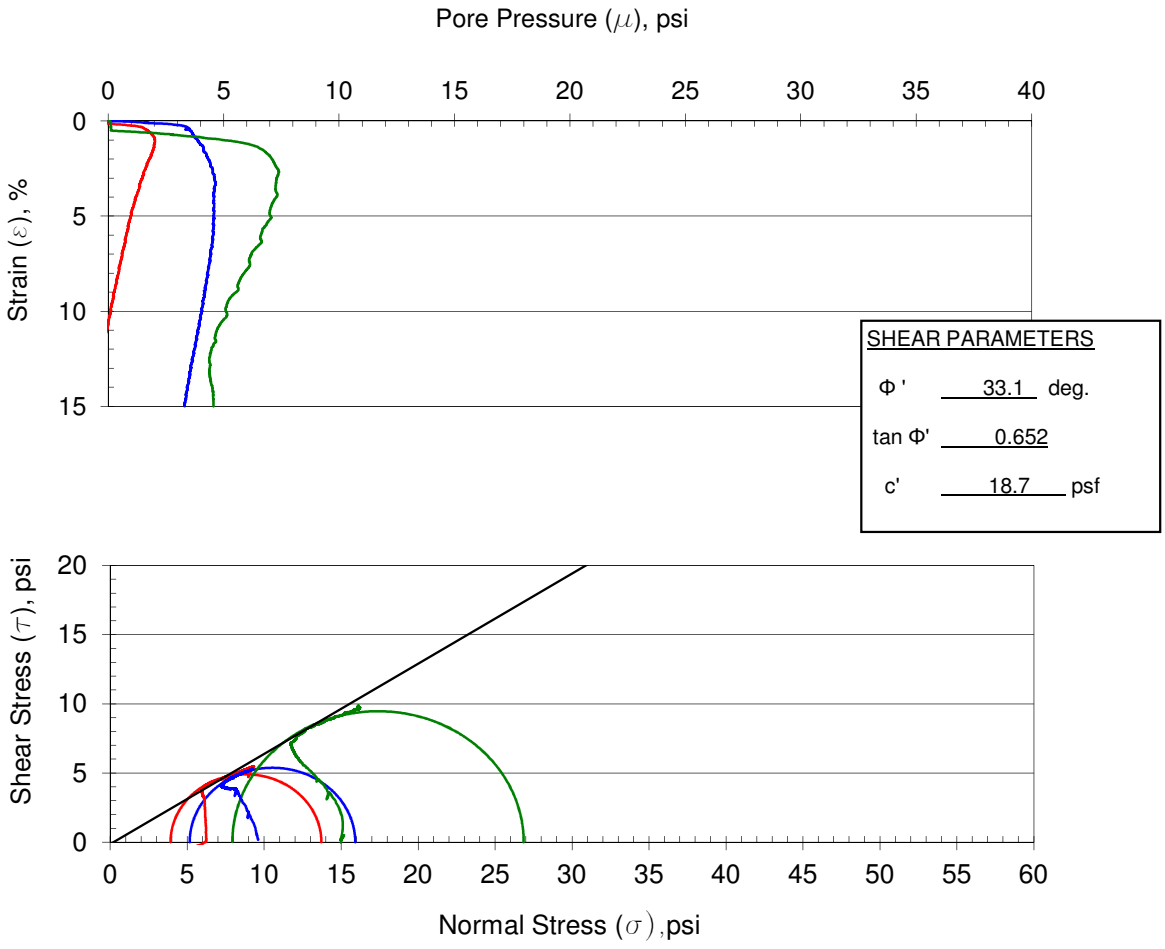
REMARKS

OLSSON ASSOCIATES

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/15/14
Sample Identification:	**Sample Description:**	
Bulk 1	Bulk #1	

MINOR PRINCIPAL STRESS σ_3 (psi)	PORE PRESSURE μ, (psi)	EFFECTIVE MINOR PRINCIPAL STRESS σ_3' (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA MAXIMUM PRINCIPAL EFFECTIVE STRESS RATIO	AXIAL STRAIN AT FAILURE ε (%)
5.8	1.9	3.9	9.8	$\left(\frac{\sigma_1'}{\sigma_3'}\right)_{max}$	1.9
9.5	4.3	5.2	10.8		8.1
15.0	7.1	7.9	18.9		5.1



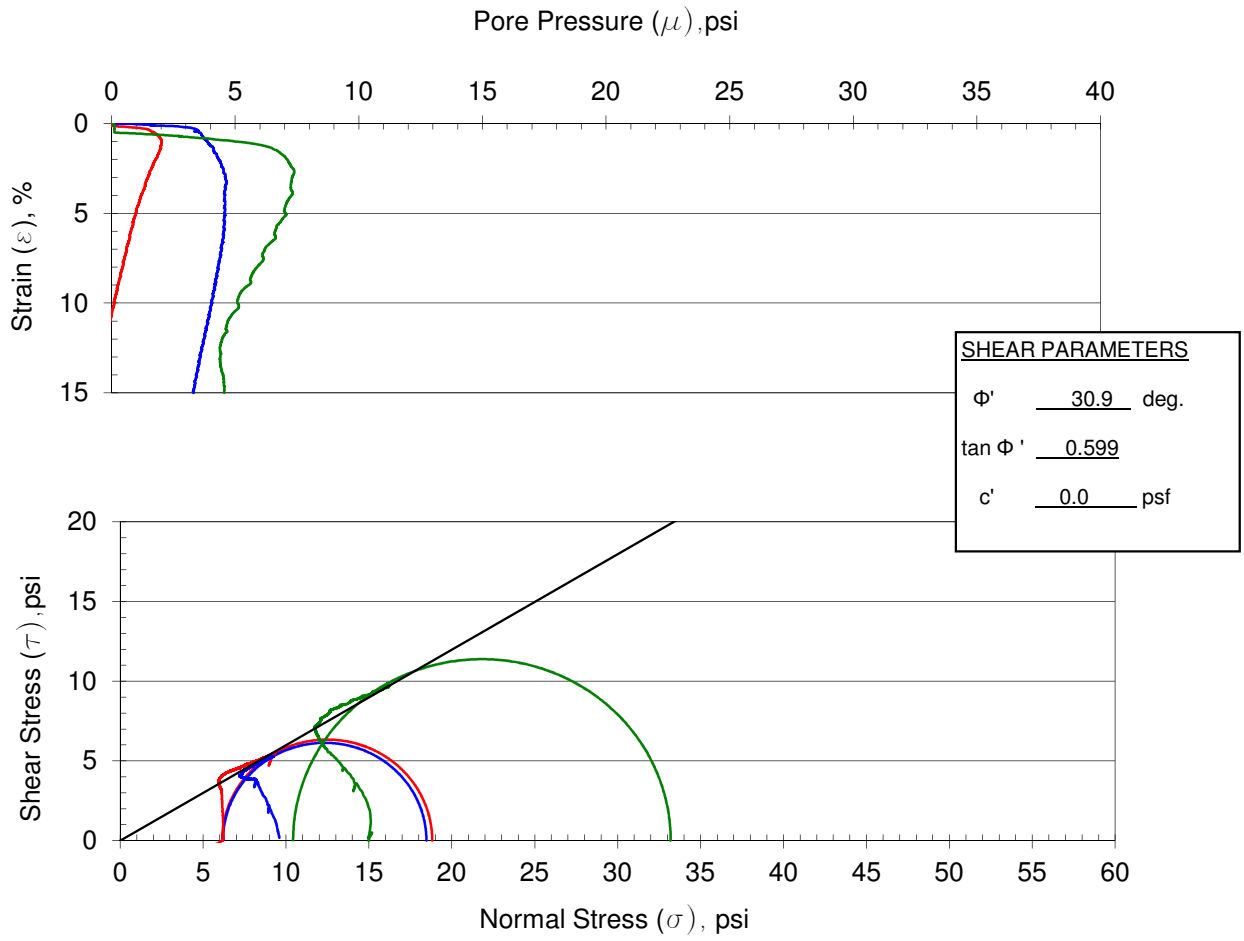
REMARKS

OLSSON ASSOCIATES

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/15/14
Sample Identification:	**Sample Description:**	
Bulk 1	Bulk #1	

MINOR PRINCIPAL STRESS σ_3 (psi)	PORE PRESSURE μ, (psi)	EFFECTIVE MINOR PRINCIPAL STRESS σ_3' (psi)	DEVIATOR STRESS $\sigma_1-\sigma_3$ (psi)	FAILURE CRITERIA MAXIMUM DEVIATOR STRESS	AXIAL STRAIN AT FAILURE ε (%)
5.8	-0.4	6.1	12.7	$(\sigma_1-\sigma_3)_{max}$	14.9
9.5	3.3	6.2	12.3		15.0
15.0	4.6	10.4	22.8		14.7



REMARKS

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/04/14
Sample Identification:	**Sample Description:**	
Bulk 4	Bulk #4	

INDEX TEST DATA

USCS _____ ; LL _____; PI _____ ;
%FINER (mm): 0.002 _____; 0.005_____;
0.074 (#200) _____
G_s (-#4) _____ G_s (+#4) _____
Standard: γ_d MAX. _____ pcf w_{opt} _____ %
Modified: γ_d MAX. _____ pcf w_{opt} _____ %

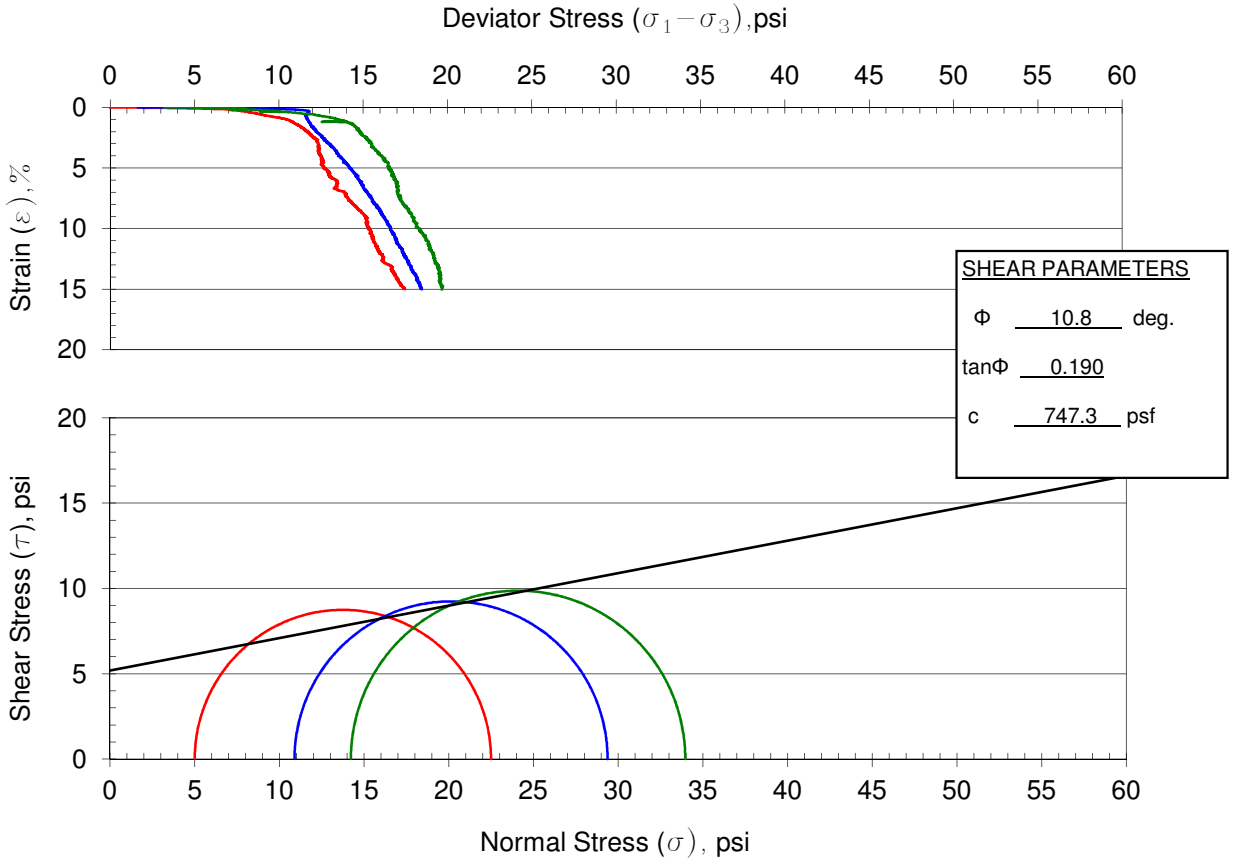
SPECIMEN DATA

HEIGHT 3.2 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED____ SIEVE
METHOD OF PREPARATION:
Remolded from a bulk sample
MOLDING MOISTURE 15.50%
MOLDED AT 100% OF 107.5

TYPE OF TEST

UU	
CU	X
CU'	
CD	

DRY DENSITY		B PARAM-ETER	MOISTURE CONTENT, %			TIME OF CONSOL-IDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1-\sigma_3$ (psi)	AXIAL STRAIN AT FAILURE ε (%)
INITIAL pcf ☒ g/cc	CONSOL-IDATED pcf ☒ g/cc		START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
109.2	105.2	1.00	15.7	78.2	20.9	29.5	5.0	17.5	15.0
108.0	110.5	0.96	16.3	78.5	21.3	47.9	10.9	18.5	15.0
107.4	112.6	0.97	15.9	75.3	22.5	47.7	14.2	19.7	14.8



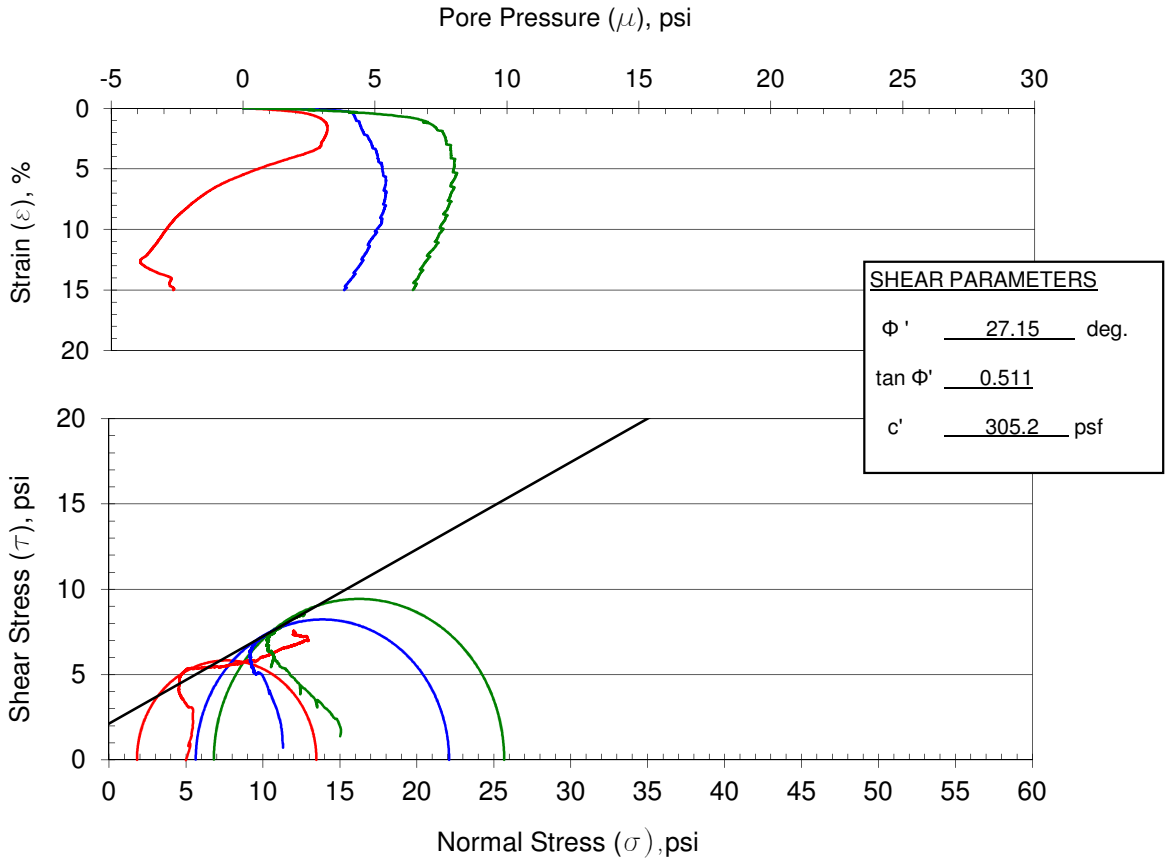
REMARKS

OLSSON ASSOCIATES

TRIAXIAL SHEAR TEST

Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/04/14
Sample Identification:	**Sample Description:**	
Bulk 4	Bulk #4	

MINOR PRINCIPAL STRESS σ_3 (psi)	PORE PRESSURE μ, (psi)	EFFECTIVE MINOR PRINCIPAL STRESS σ_3' (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA MAXIMUM PRINCIPAL EFFECTIVE STRESS RATIO	AXIAL STRAIN AT FAILURE ε (%)
5.0	3.2	1.8	11.7	$\left(\frac{\sigma_1'}{\sigma_3'}\right)_{max}$	1.9
10.9	5.3	5.6	16.5		9.4
14.2	7.4	6.8	18.9		11.1



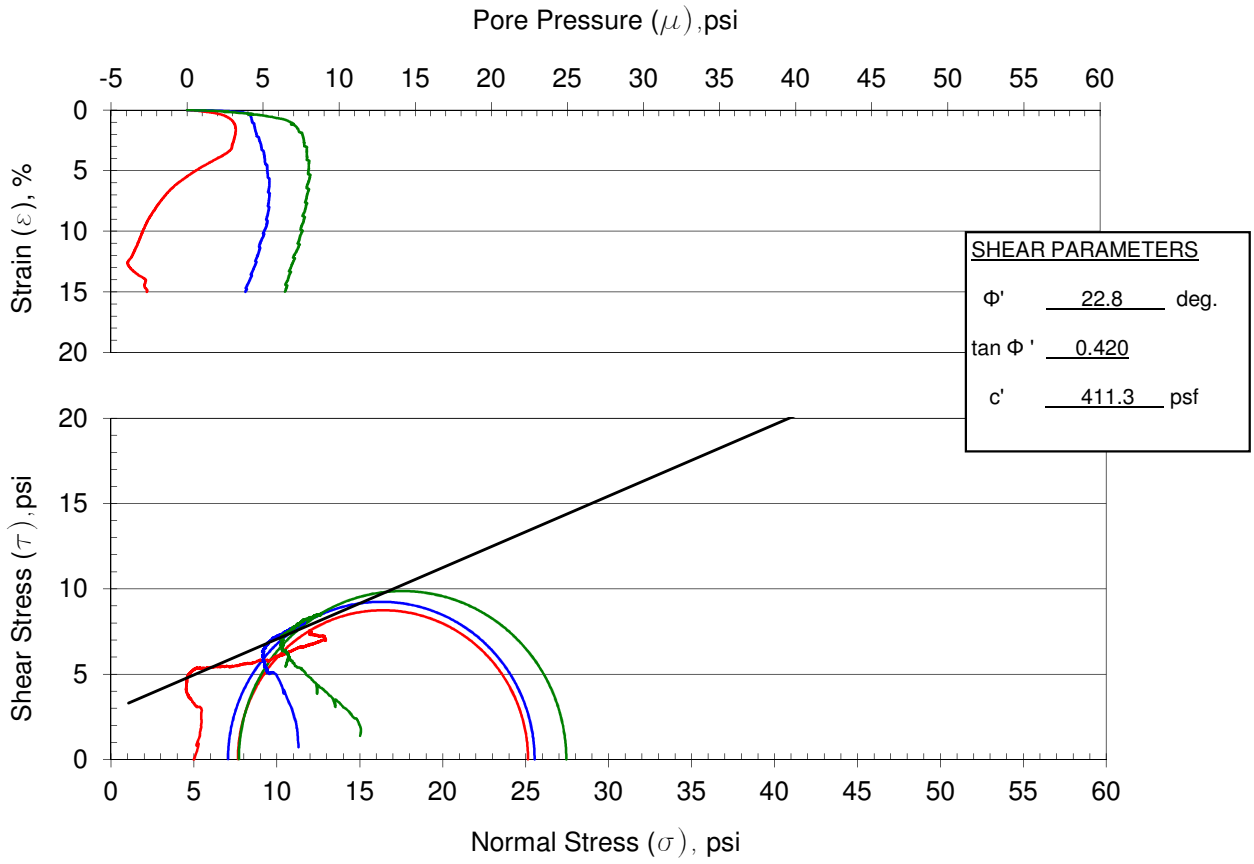
REMARKS

OLSSON ASSOCIATES

TRIAXIAL SHEAR TEST

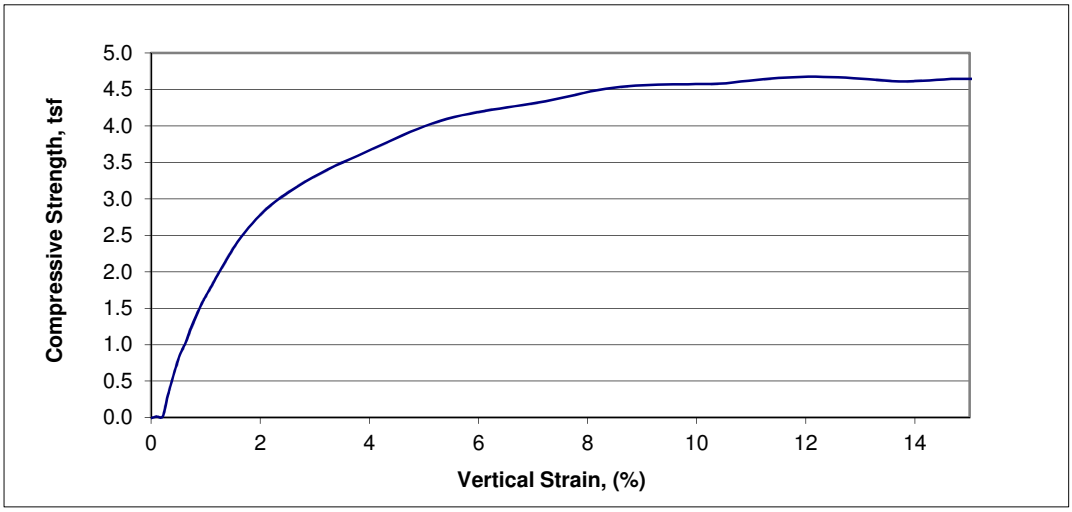
Project:	Job Number:	Date:
DeBeque Station CO Monitoring Wells	014-0292	04/04/14
Sample Identification:	**Sample Description:**	
Bulk 4	Bulk #4	

MINOR PRINCIPAL STRESS σ_3 (psi)	PORE PRESSURE μ, (psi)	EFFECTIVE MINOR PRINCIPAL STRESS σ_3' (psi)	DEVIATOR STRESS $\sigma_1-\sigma_3$ (psi)	FAILURE CRITERIA MAXIMUM DEVIATOR STRESS	AXIAL STRAIN AT FAILURE ε (%)
5.0	-2.7	7.7	17.5	$(\sigma_1-\sigma_3)_{max}$	15.0
10.9	3.8	7.1	18.5		15.0
14.2	6.5	7.7	19.7		14.8



REMARKS

Unconsolidated Undrained Triaxial Test

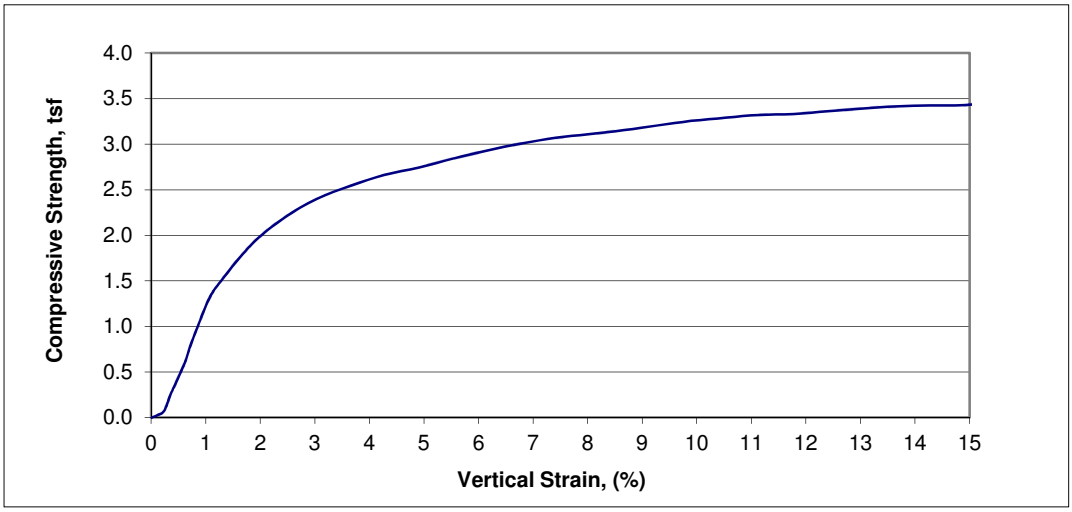


Boring		Bulk 3			
Sample		NA			
Initial	**Diameter (in)**	2.805			
	Height, (in)	5.887			
	Water Content, (%)	17.2			
	Dry Density, (pcf)	101.6			
	Saturation, (%)	70.5			
	Void Ratio	0.659			
Compressive Strength, (tsf)		4.6			
Undrained Shear Strength, (tsf)		2.3			
Time to Failure, (min)		10.9			
Strain Rate, (%/min)		1.1			
Assumed Specific Gravity		2.7			
Liquid Limit		N/A			
Plastic Limit		N/A			
Plasticity Index		N/A			
Failure Sketch		N/A			

OLSSON ASSOCIATES

Project:	KC - DeBeque, CO
Location:	DeBeque, CO
Project Number:	014-0292
Boring No:	Bulk 3
Sample Type:	Remold
Description:	NA
Remarks:	Consolidated to 12.5 psi (0.9 tsf)

Unconsolidated Undrained Triaxial Test



Boring		Bulk 5			
Sample		NA			
Initial	**Diameter (in)**	2.809			
	Height, (in)	5.885			
	Water Content, (%)	15.5			
	Dry Density, (pcf)	102.5			
	Saturation, (%)	65			
	Void Ratio	0.645			
Compressive Strength, (tsf)		3.4			
Undrained Shear Strength, (tsf)		1.7			
Time to Failure, (min)		12.4			
Strain Rate, (%/min)		1.25			
Assumed Specific Gravity		2.7			
Liquid Limit		N/A			
Plastic Limit		N/A			
Plasticity Index		N/A			
Failure Sketch		N/A			

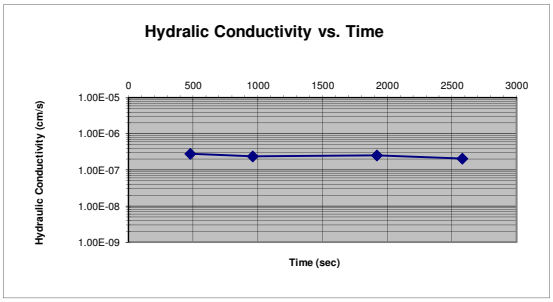
OLSSON ASSOCIATES

Project:	KC - DeBeque, CO
Location:	DeBeque, CO
Project Number:	014-0292
Boring No:	Bulk 5
Sample Type:	Remold
Description:	NA
Remarks:	Consolidated to 12.5 psi (0.9 tsf)

Revision No.	2
Revision Date	4/23/2006

Flexible Wall Permeability (ASTM D 5084-03)

Project Name	KC- DeBeque, CO			**Date**	4/24/2014
Project No.	014-0292	**Boring No.**	Bulk 2	**Sample No.**	Remold
Scale No.				**Laboratory #**	



Sample Parameters	Initial	Final
Height of Sample (cm)	7.445	7.347
Diameter of Sample (cm)	7.176	7.088
Wet density, lb/cu ft	125.749	136.246
Dry density, lb/cu ft	109.400	113.950
Water content	14.94%	19.57%
SG of solids	2.70	2.70
Saturation	74.72%	100.00%

	Test 1	Test 2	Test 3	Test 4
Cell Pressure (psi)	56.68	56.68	56.68	56.68
Lower Cap Pressure (psi)	54.10	54.10	54.10	54.10
Upper Cap Pressure (psi)	52.50	52.50	52.50	52.50
Differential Pressure (psi)	1.60	1.60	1.60	1.60
Hydraulic Gradient	15	15	15	15
Test time (sec)	480.0	480.0	960	660.0
Elapsed Time (sec)	480	960	1920	2580
Lower Cap Burette Initial Reading (mL)	27.2	28.2	29	30.7
Lower Cap Burette Final Reading (mL)	28.2	29	30.7	31.6
Upper Cap Burette Initial Reading (mL)	21.1	20.2	19.4	17.8
Upper Cap Burette Final Reading (mL)	20.2	19.4	17.8	16.9
Inflow/Outflow Ratio (0.75-1.25)	1.11	1.00	1.06	1.00
Permeability (cm/sec)	2.84E-07	2.44E-07	2.58E-07	2.11E-07
Temperature ©	20.8	21.0	21.0	21.2
Temperature Correction	0.98	0.98	0.98	0.97
Permeability, K @ 20 C (cm/sec)	2.79E-07	2.38E-07	2.52E-07	2.05E-07
Average +/- 25%	Pass	Pass	Pass	Pass

AVERAGE PERMEABILITY (cm/s) **2.44E-07**

Remarks:

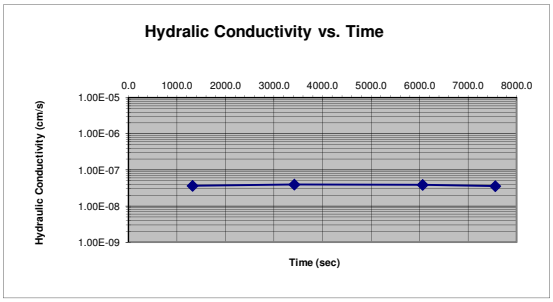
Technician:	DK
Computed By:	SJ
Checked By:	AP

OLSSON ASSOCIATES

Revision No.	2
Revision Date	4/23/2006

Flexible Wall Permeability (ASTM D 5084-03)

Project Name	KC- DeBeque, CO			**Date**	4/16/2014
Project No.	014-0292	**Boring No.**	Bulk 5	**Sample No.**	Remold
Scale No.				**Laboratory #**	



Sample Parameters	Initial	Final
Height of Sample (cm)	9.386	9.411
Diameter of Sample (cm)	7.225	7.296
Wet density, lb/cu ft	123.354	127.681
Dry density, lb/cu ft	105.725	103.545
Water content	16.67%	23.31%
SG of solids	2.70	2.70
Saturation	75.85%	100.00%

	Test 1	Test 2	Test 3	Test 4
Cell Pressure (psi)	67.03	67.03	67.03	67.03
Lower Cap Pressure (psi)	65.80	65.80	65.80	65.80
Upper Cap Pressure (psi)	62.50	62.50	62.50	62.50
Differential Pressure (psi)	3.30	3.30	3.30	3.30
Hydraulic Gradient	25	25	25	25
Test time (sec)	1320.0	2100	2640	1500
Elapsed Time (sec)	1320.0	3420	6060	7560
Lower Cap Burette Initial Reading (mL)	42.6	43.2	44.2	45.4
Lower Cap Burette Final Reading (mL)	43.2	44.2	45.4	46
Upper Cap Burette Initial Reading (mL)	18.1	17.6	16.7	15.6
Upper Cap Burette Final Reading (mL)	17.6	16.7	15.6	15
Inflow/Outflow Ratio (0.75-1.25)	1.20	1.11	1.09	1.00
Permeability (cm/sec)	3.82E-08	4.18E-08	4.07E-08	3.78E-08
Temperature ©	22.1	22.2	22.4	22.6
Temperature Correction	0.95	0.95	0.94	0.94
Permeability, K @ 20 C (cm/sec)	3.63E-08	3.97E-08	3.85E-08	3.55E-08
Average +/- 25%	Pass	Pass	Pass	Pass

AVERAGE PERMEABILITY (cm/s) **3.75E-08**

Remarks:

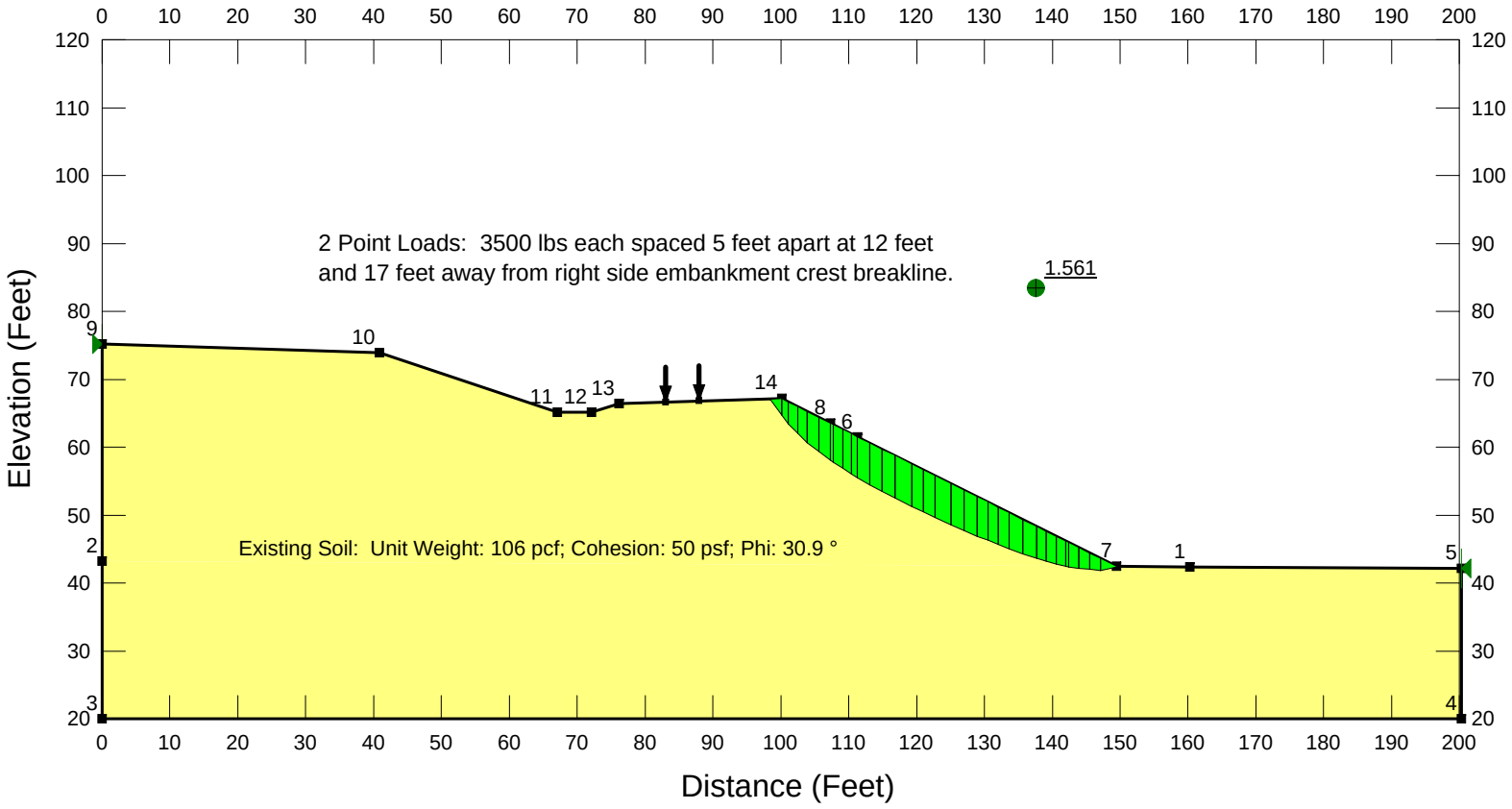
Technician:	DK
Computed By:	SJ
Checked By:	AP

OLSSON ASSOCIATES

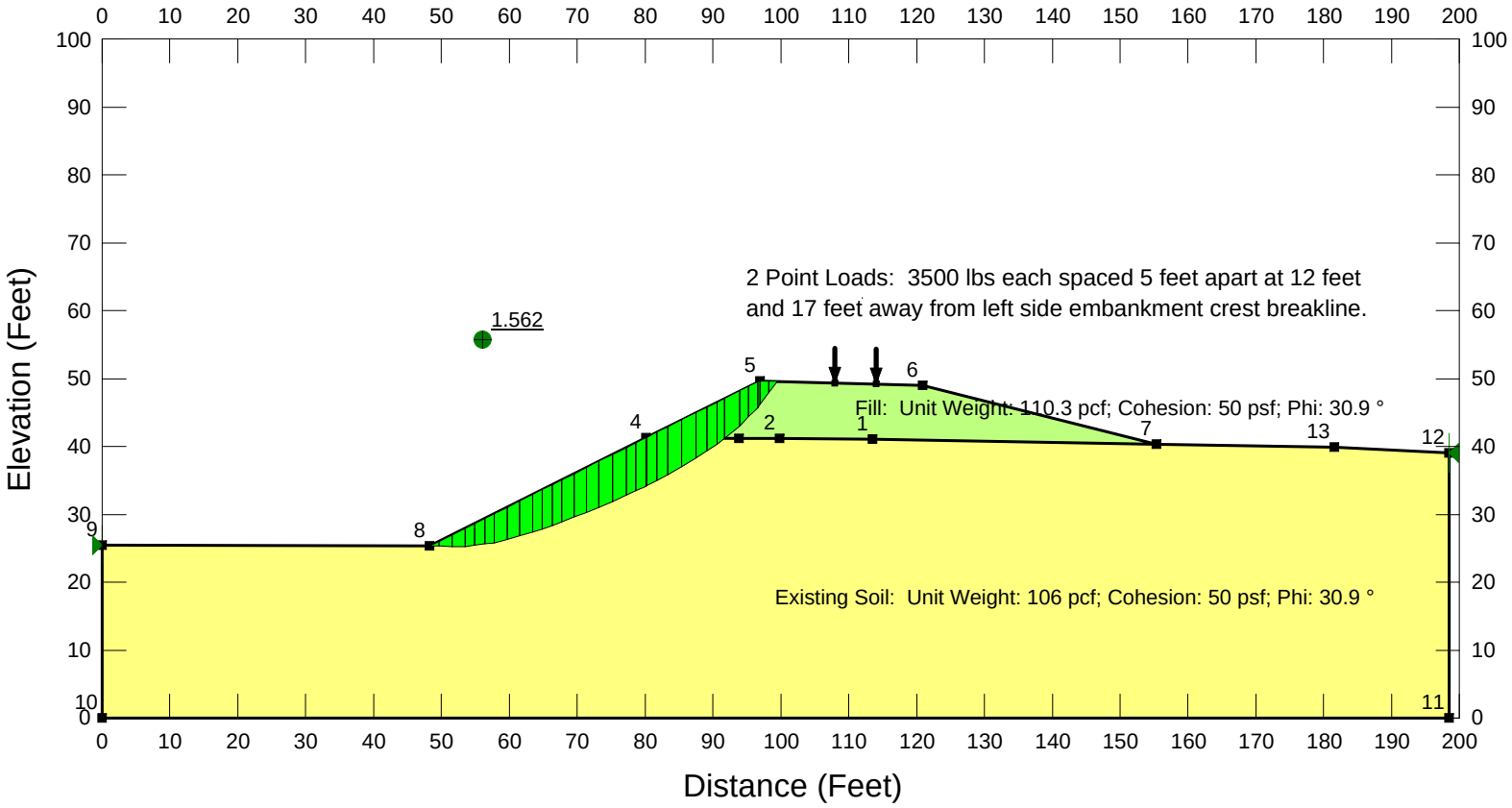
ATTACHMENT D

GEOSLOPE ANAYLSIS

DeBeque Station - Pond 1 Analysis
Existing Soil: Unit Weight=106 pcf; c=50 psf; phi=30.9 °
Model: Mohr-Coulomb



DeBeque Station - Pond 1 Analysis
Fill: Unit Weight=110.3 pcf; c=50 psf; phi=30.9 °
Existing Soil: Unit Weight=106 pcf; c=50 psf; phi=30.9 °
Model: Mohr-Coulomb



ATTACHMENT E

SCS CURVE NUMBER METHOD INPUTS

SWS Name	SWS Soils Name	SWS Hydro. Group	Land Cover Description	Drainage Area (acres)	Curve Number
SWS 1	Torriorthents	D	Range	158.03	80
	Biedsaw-Sunup	C	Range	28.68	74
	Domingues clay loam	C	Range	39.74	74
	Domingues clay loam	C	Roadway	1.74	92
	Badland	D	Range	39.04	80
				Weighted CN	**78.5**
SWS 2	Domingues clay loam	C	Range	6.09	74
	Domingues clay loam	C	Roadway	3.11	92
	Bunkwater	C	Range	0.22	74
	Bunkwater	C	Roadway	0.12	92
				Weighted CN	**80.1**
SWS 3	Domingues clay loam	C	Range	0.60	74
	Domingues clay loam	C	Roadway	0.18	92
	Bunkwater	C	Range	1.78	74
	Bunkwater	C	Roadway	0.57	92
				Weighted CN	**75.3**
SWS 4	Bunkwater	C	Range	0.58	74
	Bunkwater	C	Roadway	0.04	92
				Weighted CN	**74.0**
SWS 5	Domingues clay loam	C	Range	2.82	74
				Weighted CN	**74.0**
SWS 6	Domingues clay loam	C	Range	2.31	74
	Bunkwater	C	Range	0.48	74
				Weighted CN	**74.0**
SWS 7	Domingues clay loam	C	Range	0.81	74
	Bunkwater	C	Range	1.89	74
				Weighted CN	**74.0**

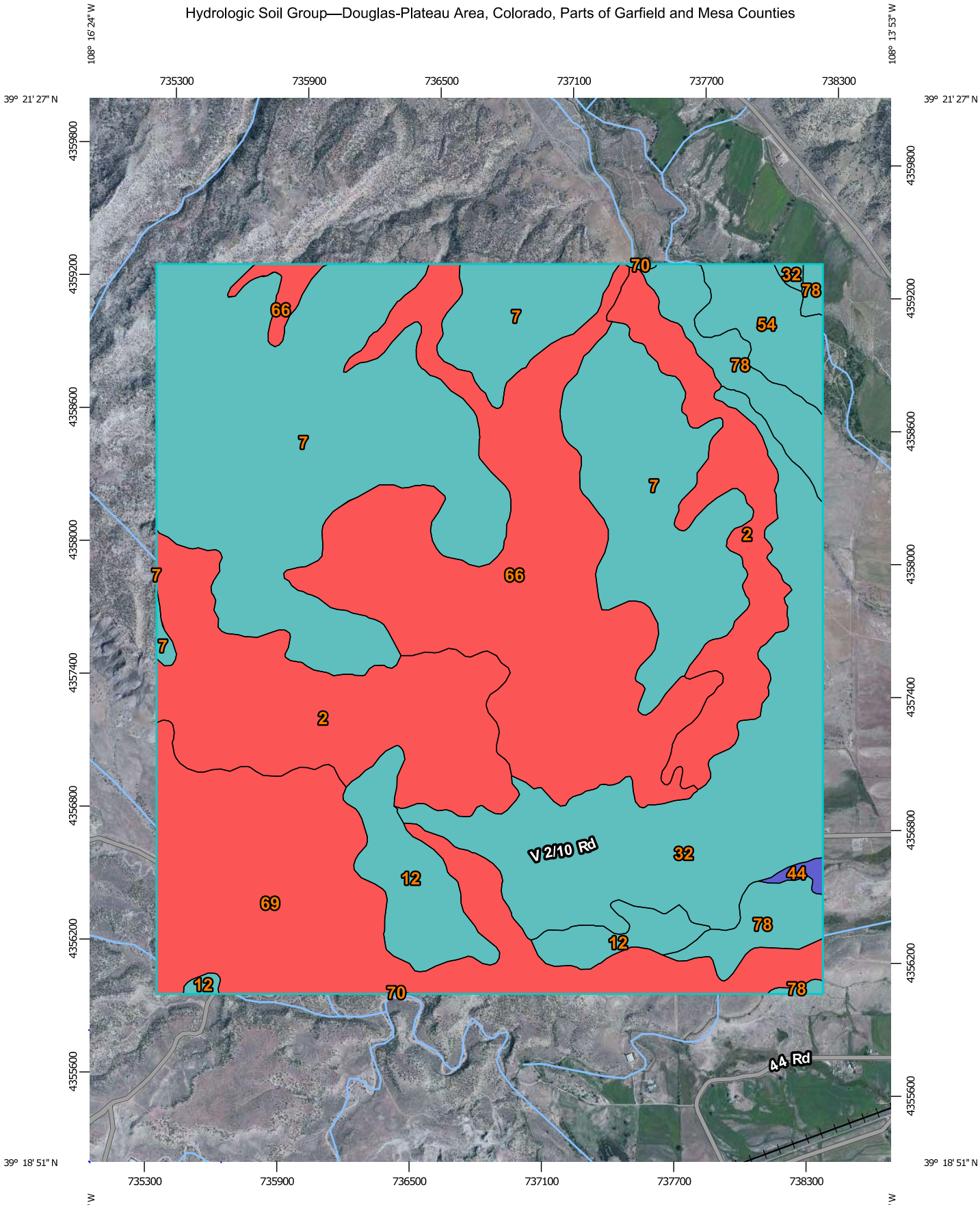
Blue Text or Values are manually entered into the cell.
Green Text or Values are referenced or interpolated from another ta
Red Values are calculated within the cell.

Runoff Curve Numbers				
	SWS Hydrologic Group			
Land Cover Description	**A**	**B**	**C**	**D**
Commercial	89	92	94	95

***Note:** All curve numbers were taken out of table 3-18 in *Hydrologic Analysis and Design, Second Edition,* by Richard H McCuen (1989)
[1]Curve numbers for commercial were based on commercial and business areas with 80% impervious
[2]Curve numbers for impervious apply to paved parking lots, roofs, and driveways.
[3]Curve numbers for open space with hydrologic soils group B or C were based on a good hydrologic condition.
[4]Curve numbers for railroad were based on impervious areas; streets and roads; gravel.

SWS 1	Drainage Area:	0.418	sq mi	267.23	acres					
	Overland Flow --	Length:	300	Elevation 1:	5803	Elevation 2:	5686	Difference:		117
	Stream 1 --	Length:	7806	Elevation 1:	5686	Elevation 2:	5051	Difference:		635
	Stream 2 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Watercourse --	Length:	8106							752
SWS 2	Drainage Area:	0.015	sq mi	9.54	acres					
	Overland Flow --	Length:	300	Elevation 1:	5084	Elevation 2:	5077	Difference:		7
	Stream 1 --	Length:	2105	Elevation 1:	5077	Elevation 2:	5033	Difference:		44
	Stream 2 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Watercourse --	Length:	2405							51
SWS 3	Drainage Area:	0.005	sq mi	3.13	acres					
	Overland Flow --	Length:	114	Elevation 1:	5049	Elevation 2:	5047	Difference:		2.5
	Stream 1 --	Length:	934	Elevation 1:	5047	Elevation 2:	5031	Difference:		15.5
	Stream 2 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Watercourse --	Length:	1048							18
SWS 4	Drainage Area:	0.001	sq mi	0.62	acres					
	Overland Flow --	Length:	174	Elevation 1:	5051	Elevation 2:	5031	Difference:		20
	Stream 1 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Stream 2 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Watercourse --	Length:	174							20
SWS 5	Drainage Area:	0.004	sq mi	2.82	acres					
	Overland Flow --	Length:	15	Elevation 1:	5065	Elevation 2:	5062	Difference:		3
	Stream 1 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Stream 2 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Watercourse --	Length:	15							3
SWS 6	Drainage Area:	0.004	sq mi	2.79	acres					
	Overland Flow --	Length:	15	Elevation 1:	5060	Elevation 2:	5057	Difference:		3
	Stream 1 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Stream 2 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Watercourse --	Length:	15							3
SWS 7	Drainage Area:	0.004	sq mi	2.70	acres					
	Overland Flow --	Length:	15	Elevation 1:	5051	Elevation 2:	5048	Difference:		3
	Stream 1 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Stream 2 --	Length:	-----	Elevation 1:	-----	Elevation 2:	-----	Difference:		-----
	Watercourse --	Length:	15							3

Hydrologic Soil Group—Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties



Map Scale: 1:23,400 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 300 600 1200 1800

Feet: 0 1000 2000 4000 6000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties
Survey Area Data: Version 6, Dec 23, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 22, 2010—Sep 2, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Douglas-Plateau Area, Colorado, Parts of Garfield and Mesa Counties (CO682)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
2	Badland	D	377.6	15.3%
7	Biedsaw-Sunup gravelly loams, 10 to 40 percent slopes	C	727.4	29.5%
12	Bunkwater very fine sandy loam, 1 to 8 percent slopes	C	106.7	4.3%
32	Dominguez clay loam, 3 to 8 percent slopes	C	313.9	12.7%
44	Happle very channery sandy loam, 3 to 12 percent slopes	B	4.8	0.2%
54	Panitchen loam, 1 to 6 percent slopes	C	55.1	2.2%
66	Torriorthents, warm-Rock outcrop complex, 35 to 90 percent slopes	D	438.0	17.7%
69	Travessilla-Rock outcrop complex, 10 to 35 percent slopes	D	347.2	14.1%
70	Uffens loam, 1 to 8 percent slopes	C	0.8	0.0%
78	Youngston loam, 1 to 6 percent slopes	C	96.0	3.9%
Totals for Area of Interest			**2,467.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

NOAA Atlas 14, Volume 8, Version 2
Location name: De Beque, Colorado, US*
Coordinates: 39.3271, -108.2450
Elevation: 5054 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.132** (0.104-0.171)	**0.151** (0.119-0.196)	**0.199** (0.156-0.258)	**0.252** (0.197-0.329)	**0.348** (0.273-0.496)	**0.439** (0.331-0.623)	**0.545** (0.395-0.787)	**0.667** (0.463-0.984)	**0.853** (0.567-1.28)	**1.01** (0.645-1.51)
10-min	**0.193** (0.152-0.250)	**0.222** (0.175-0.287)	**0.291** (0.228-0.377)	**0.370** (0.289-0.482)	**0.510** (0.400-0.727)	**0.643** (0.485-0.912)	**0.798** (0.579-1.15)	**0.977** (0.678-1.44)	**1.25** (0.830-1.88)	**1.48** (0.945-2.21)
15-min	**0.236** (0.186-0.305)	**0.270** (0.213-0.350)	**0.355** (0.279-0.460)	**0.451** (0.352-0.587)	**0.621** (0.488-0.886)	**0.784** (0.591-1.11)	**0.973** (0.706-1.41)	**1.19** (0.827-1.76)	**1.52** (1.01-2.29)	**1.80** (1.15-2.69)
30-min	**0.285** (0.225-0.369)	**0.371** (0.292-0.480)	**0.526** (0.414-0.683)	**0.671** (0.524-0.874)	**0.893** (0.683-1.23)	**1.08** (0.804-1.50)	**1.29** (0.922-1.82)	**1.51** (1.04-2.19)	**1.83** (1.21-2.72)	**2.09** (1.34-3.12)
60-min	**0.357** (0.282-0.462)	**0.464** (0.365-0.600)	**0.649** (0.510-0.843)	**0.815** (0.636-1.06)	**1.06** (0.805-1.45)	**1.26** (0.932-1.74)	**1.47** (1.05-2.07)	**1.70** (1.16-2.45)	**2.02** (1.33-2.99)	**2.27** (1.45-3.39)
2-hr	**0.429** (0.343-0.546)	**0.556** (0.444-0.710)	**0.772** (0.614-0.988)	**0.958** (0.758-1.23)	**1.23** (0.939-1.64)	**1.44** (1.07-1.94)	**1.66** (1.20-2.29)	**1.89** (1.31-2.67)	**2.21** (1.47-3.20)	**2.45** (1.59-3.60)
3-hr	**0.492** (0.396-0.622)	**0.613** (0.493-0.774)	**0.819** (0.656-1.04)	**0.999** (0.796-1.27)	**1.26** (0.975-1.67)	**1.47** (1.11-1.97)	**1.69** (1.23-2.32)	**1.93** (1.35-2.70)	**2.25** (1.51-3.24)	**2.50** (1.64-3.64)
6-hr	**0.617** (0.503-0.767)	**0.733** (0.597-0.913)	**0.933** (0.757-1.16)	**1.11** (0.894-1.39)	**1.36** (1.07-1.77)	**1.57** (1.20-2.07)	**1.78** (1.32-2.40)	**2.01** (1.43-2.78)	**2.33** (1.59-3.30)	**2.58** (1.71-3.70)
12-hr	**0.768** (0.634-0.940)	**0.893** (0.737-1.09)	**1.11** (0.911-1.36)	**1.29** (1.06-1.60)	**1.56** (1.24-2.00)	**1.78** (1.38-2.30)	**2.00** (1.50-2.65)	**2.24** (1.61-3.04)	**2.57** (1.78-3.58)	**2.83** (1.90-3.99)
24-hr	**0.928** (0.777-1.12)	**1.07** (0.896-1.29)	**1.31** (1.09-1.59)	**1.52** (1.26-1.85)	**1.82** (1.47-2.29)	**2.06** (1.62-2.62)	**2.31** (1.75-3.00)	**2.57** (1.87-3.42)	**2.92** (2.05-4.00)	**3.20** (2.19-4.43)
2-day	**1.08** (0.919-1.28)	**1.25** (1.06-1.48)	**1.53** (1.29-1.82)	**1.77** (1.49-2.11)	**2.11** (1.72-2.60)	**2.38** (1.89-2.97)	**2.65** (2.05-3.40)	**2.94** (2.18-3.86)	**3.34** (2.38-4.49)	**3.65** (2.53-4.97)
3-day	**1.18** (1.01-1.39)	**1.36** (1.17-1.60)	**1.67** (1.42-1.97)	**1.93** (1.64-2.29)	**2.30** (1.89-2.82)	**2.60** (2.09-3.22)	**2.90** (2.26-3.68)	**3.22** (2.40-4.18)	**3.65** (2.63-4.86)	**3.99** (2.79-5.38)
4-day	**1.26** (1.08-1.47)	**1.46** (1.25-1.70)	**1.78** (1.52-2.09)	**2.06** (1.75-2.42)	**2.45** (2.03-2.98)	**2.77** (2.23-3.40)	**3.09** (2.42-3.88)	**3.42** (2.57-4.41)	**3.88** (2.81-5.13)	**4.24** (2.98-5.67)
7-day	**1.46** (1.27-1.69)	**1.68** (1.46-1.94)	**2.04** (1.76-2.36)	**2.34** (2.02-2.72)	**2.77** (2.32-3.32)	**3.11** (2.54-3.77)	**3.46** (2.73-4.28)	**3.81** (2.90-4.84)	**4.30** (3.15-5.60)	**4.67** (3.33-6.17)
10-day	**1.64** (1.44-1.88)	**1.87** (1.64-2.14)	**2.25** (1.97-2.58)	**2.58** (2.23-2.96)	**3.03** (2.55-3.58)	**3.38** (2.78-4.05)	**3.74** (2.98-4.58)	**4.11** (3.14-5.16)	**4.60** (3.40-5.93)	**4.98** (3.58-6.52)
20-day	**2.16** (1.92-2.43)	**2.43** (2.16-2.73)	**2.88** (2.55-3.24)	**3.25** (2.86-3.67)	**3.76** (3.20-4.36)	**4.15** (3.46-4.88)	**4.54** (3.67-5.46)	**4.94** (3.84-6.09)	**5.47** (4.10-6.92)	**5.87** (4.29-7.54)
30-day	**2.59** (2.32-2.88)	**2.91** (2.60-3.24)	**3.43** (3.06-3.83)	**3.85** (3.42-4.32)	**4.42** (3.80-5.08)	**4.86** (4.09-5.65)	**5.29** (4.31-6.29)	**5.71** (4.48-6.96)	**6.27** (4.74-7.84)	**6.68** (4.94-8.50)
45-day	**3.13** (2.83-3.45)	**3.53** (3.19-3.89)	**4.17** (3.75-4.60)	**4.67** (4.18-5.19)	**5.35** (4.62-6.05)	**5.85** (4.95-6.71)	**6.33** (5.20-7.43)	**6.79** (5.37-8.17)	**7.38** (5.63-9.11)	**7.81** (5.83-9.82)
60-day	**3.59** (3.27-3.93)	**4.07** (3.70-4.46)	**4.83** (4.37-5.29)	**5.42** (4.88-5.97)	**6.19** (5.38-6.94)	**6.75** (5.75-7.68)	**7.28** (6.01-8.47)	**7.79** (6.19-9.28)	**8.40** (6.44-10.3)	**8.84** (6.64-11.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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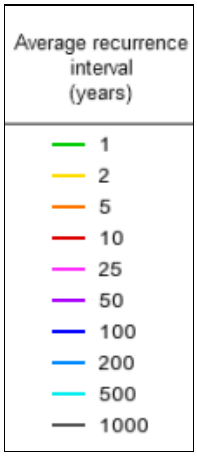
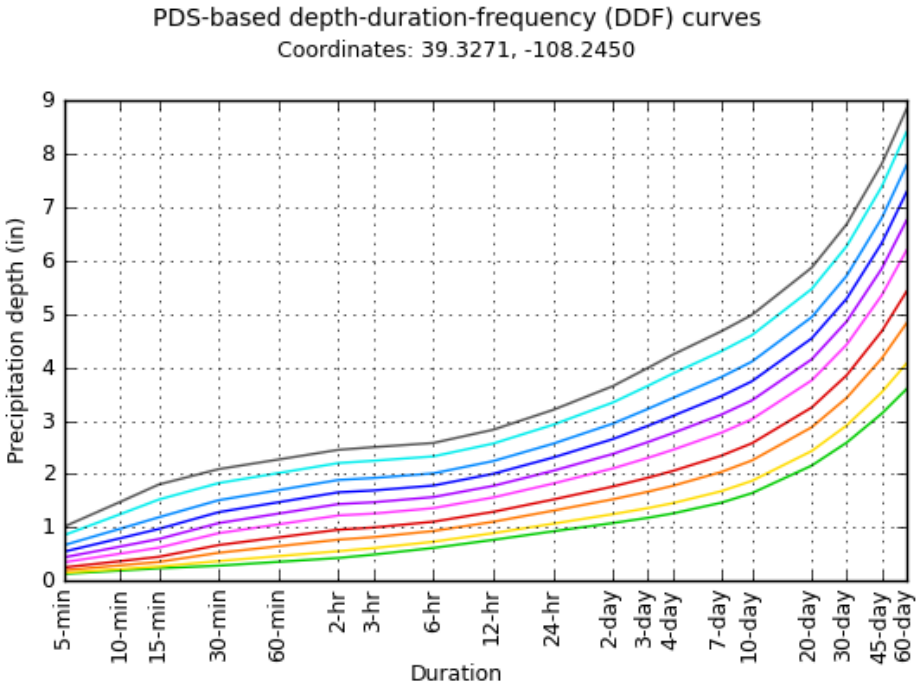
PF graphical


Average recurrence interval (years)
1
2
5
10
25
50
100
200
500
1000


PDS-based depth-duration-frequency (DDF) curves
Coordinates: 39.3271, -108.2450
Precipitation depth (in)
0
1
2
3
4
5
6
7
8
9
5-min
10-min
15-min
30-min
60-min
2-hr
3-hr
6-hr
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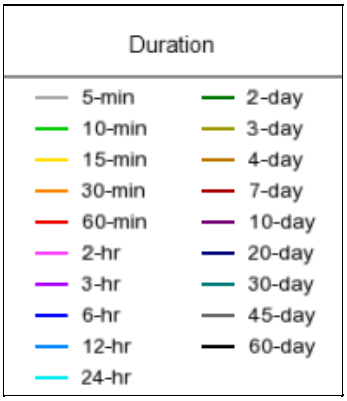
30-day
45-day
60-day
Duration


Duration
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10-min
15-min
30-min
60-min
2-hr
3-hr
6-hr
12-hr
24-hr
2-day
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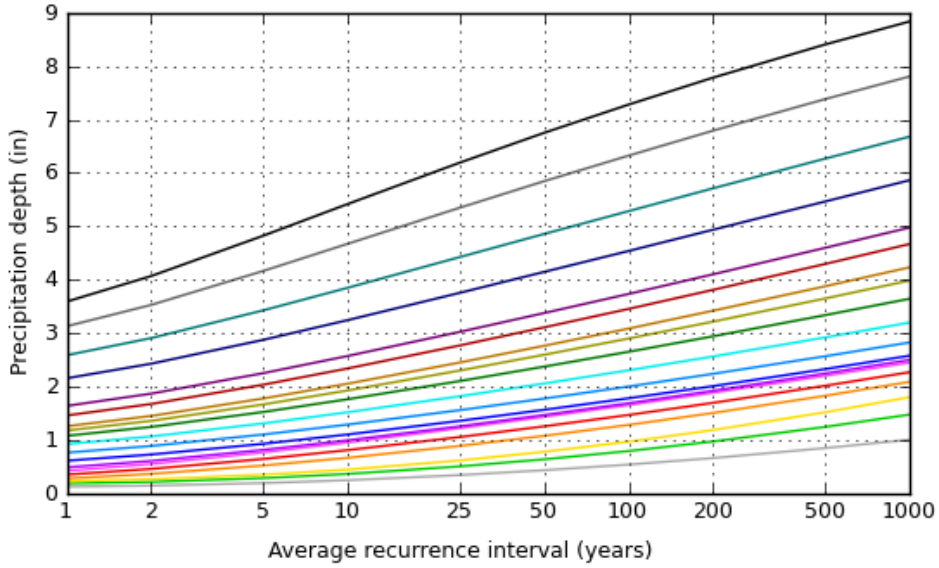
30-day
45-day
60-day



NOAA/NWS/OHD/HDSC

Created (GMT): Wed Jun 12 17:40:52 2013

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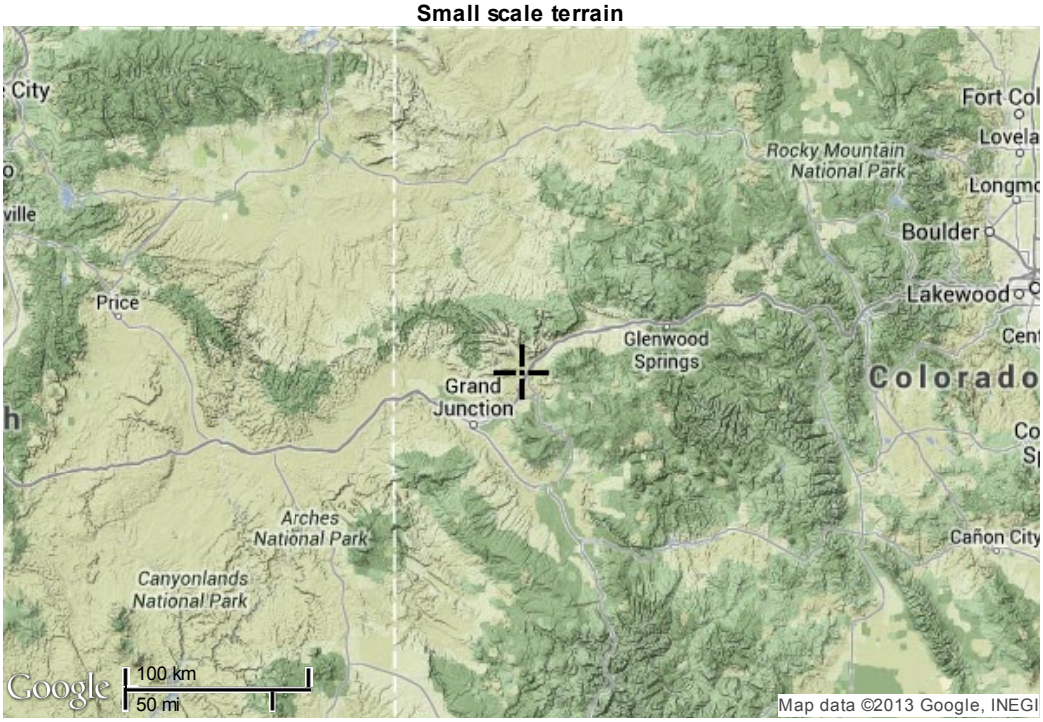
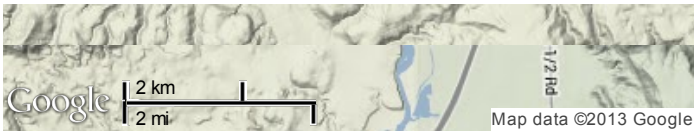
Maps & aerials

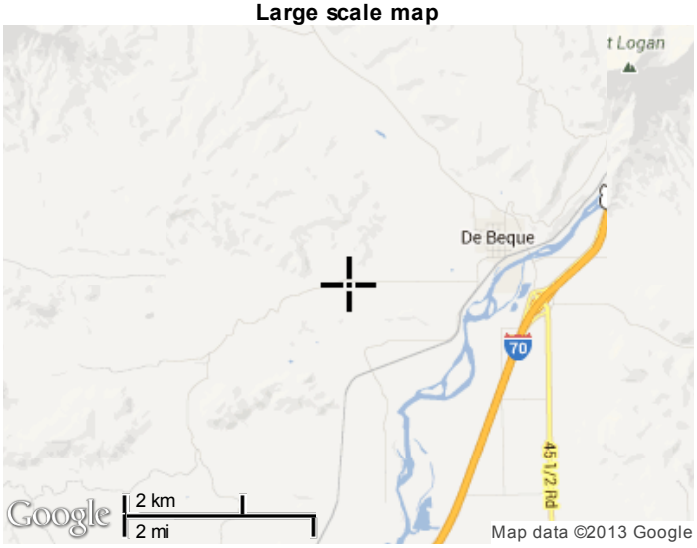
Small scale terrain



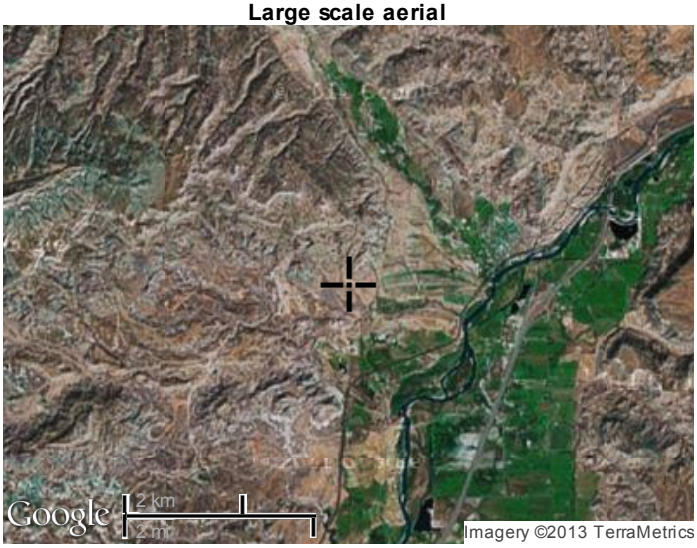
Large scale terrain



Large scale map



Large scale aerial



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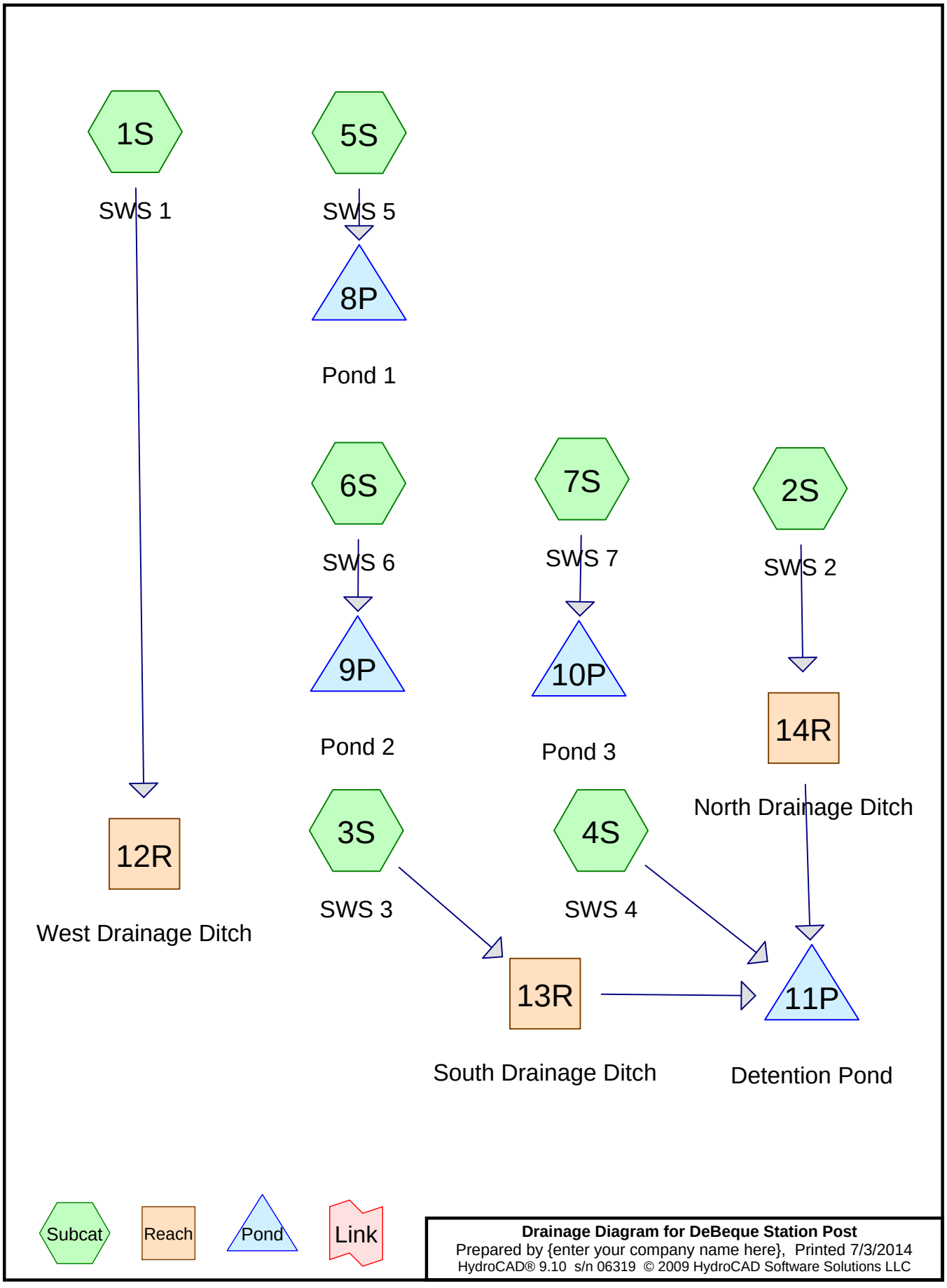
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

ATTACHMENT F

HYDROCAD HYDROLOGY & HYDRAULICS REPORT



Drainage Diagram for DeBeque Station Post
Prepared by {enter your company name here}, Printed 7/3/2014

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.620	74	Weighted Curve Number (4S)
3.130	75	Weighted Curve Number (3S)
267.230	79	Weighted Curve Number (1S)
9.540	80	Weighted Curve Number (2S)
8.310	100	Liner (5S, 6S, 7S)
288.830		**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: SWS 1 Runoff Area=267.230 ac 0.00% Impervious Runoff Depth=0.71"
Flow Length=8,106' Tc=56.7 min CN=79 Runoff=47.48 cfs 15.874 af

Subcatchment 2S: SWS 2 Runoff Area=9.540 ac 0.00% Impervious Runoff Depth=0.76"
Flow Length=2,405' Tc=58.5 min CN=80 Runoff=1.84 cfs 0.604 af

Subcatchment 3S: SWS 3 Runoff Area=3.130 ac 0.00% Impervious Runoff Depth=0.54"
Flow Length=934' Tc=14.6 min CN=75 Runoff=0.74 cfs 0.142 af

Subcatchment 4S: SWS 4 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=0.50"
Flow Length=174' Tc=3.8 min CN=74 Runoff=0.18 cfs 0.026 af

Subcatchment 5S: SWS 5 Runoff Area=2.820 ac 100.00% Impervious Runoff Depth=2.31"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=5.13 cfs 0.543 af

Subcatchment 6S: SWS 6 Runoff Area=2.790 ac 100.00% Impervious Runoff Depth=2.31"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=5.07 cfs 0.537 af

Subcatchment 7S: SWS 7 Runoff Area=2.700 ac 100.00% Impervious Runoff Depth=2.31"
Flow Length=15' Slope=0.5000 '/' Tc=0.1 min CN=100 Runoff=4.91 cfs 0.520 af

Reach 12R: West Drainage Ditch Avg. Flow Depth=0.89' Max Vel=7.87 fps Inflow=47.48 cfs 15.874 af
n=0.022 L=1,297.4' S=0.0231 '/' Capacity=219.29 cfs Outflow=47.29 cfs 15.874 af

Reach 13R: South Drainage Ditch Avg. Flow Depth=0.13' Max Vel=2.01 fps Inflow=0.74 cfs 0.142 af
n=0.022 L=1,015.0' S=0.0156 '/' Capacity=107.67 cfs Outflow=0.60 cfs 0.142 af

Reach 14R: North Drainage Ditch Avg. Flow Depth=0.22' Max Vel=3.35 fps Inflow=1.84 cfs 0.604 af
n=0.022 L=1,723.1' S=0.0242 '/' Capacity=134.16 cfs Outflow=1.79 cfs 0.604 af

Pond 8P: Pond 1 Peak Elev=5,061.78' Storage=40.600 af Inflow=5.13 cfs 0.543 af
Outflow=0.00 cfs 0.000 af

Pond 9P: Pond 2 Peak Elev=5,057.50' Storage=31.306 af Inflow=5.07 cfs 0.537 af
Outflow=0.00 cfs 0.000 af

Pond 10P: Pond 3 Peak Elev=5,048.21' Storage=29.803 af Inflow=4.91 cfs 0.520 af
Outflow=0.00 cfs 0.000 af

Pond 11P: Detention Pond Peak Elev=5,029.52' Storage=0.772 af Inflow=2.06 cfs 0.772 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 288.830 ac Runoff Volume = 18.246 af Average Runoff Depth = 0.76"
97.12% Pervious = 280.520 ac 2.88% Impervious = 8.310 ac

Summary for Subcatchment 1S: SWS 1

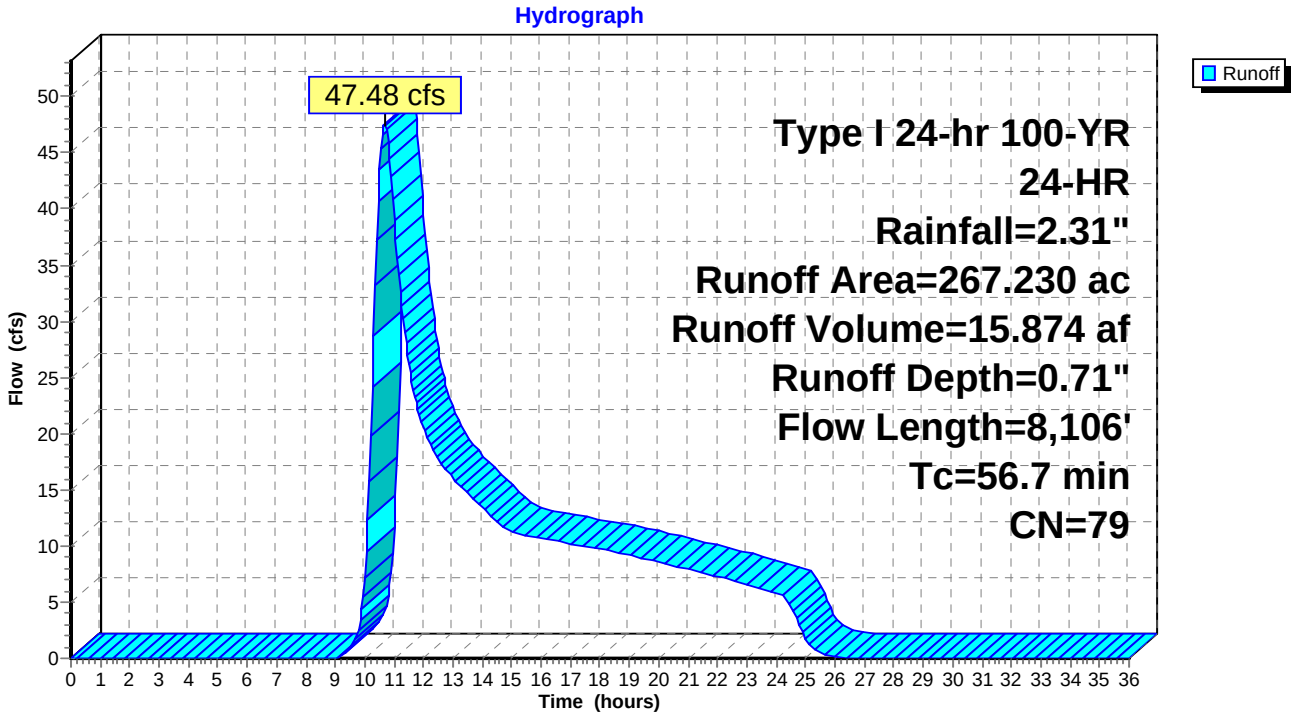
Runoff = 47.48 cfs @ 10.67 hrs, Volume= 15.874 af, Depth= 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR, 24-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	267.230	79	Weighted Curve Number
	267.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	300	0.3900	0.45		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
45.6	7,806	0.0813	2.85		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
56.7	8,106	Total			

Subcatchment 1S: SWS 1



Summary for Subcatchment 2S: SWS 2

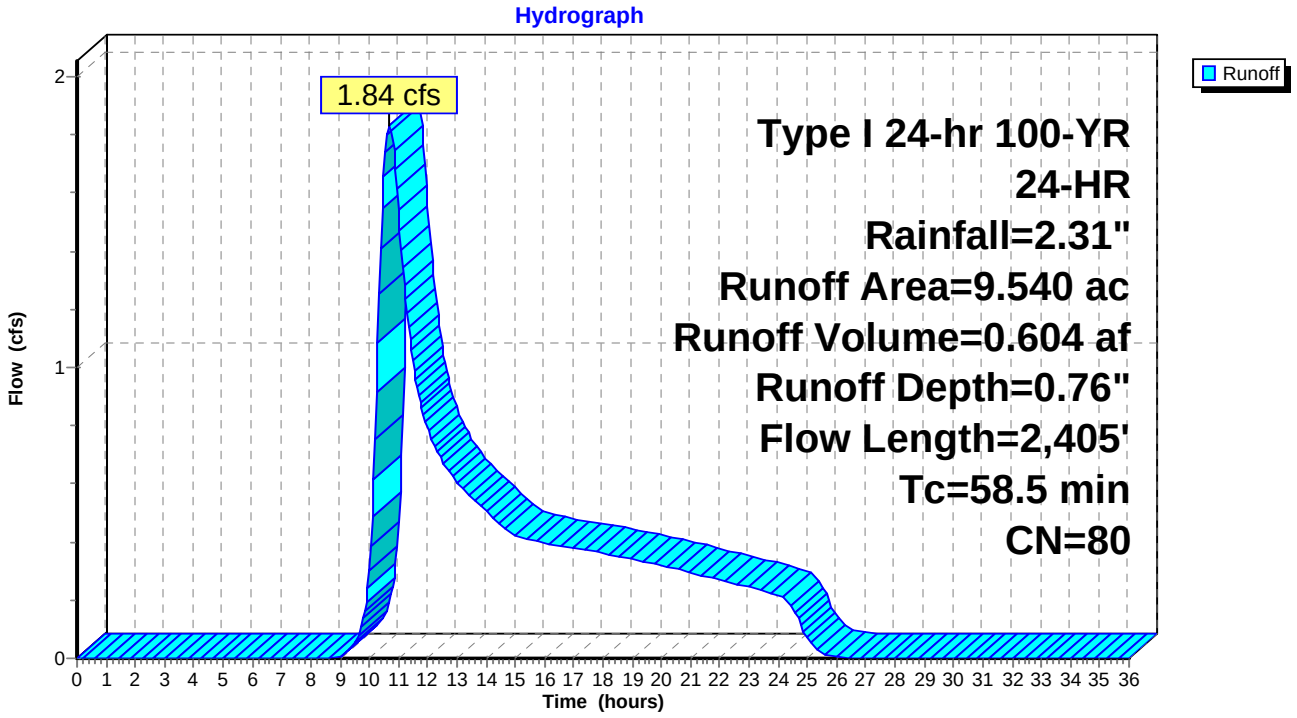
Runoff = 1.84 cfs @ 10.70 hrs, Volume= 0.604 af, Depth= 0.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR, 24-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	9.540	80	Weighted Curve Number
	9.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.2	300	0.0233	0.15		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
24.3	2,105	0.0209	1.45		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
58.5	2,405	Total			

Subcatchment 2S: SWS 2



Summary for Subcatchment 3S: SWS 3

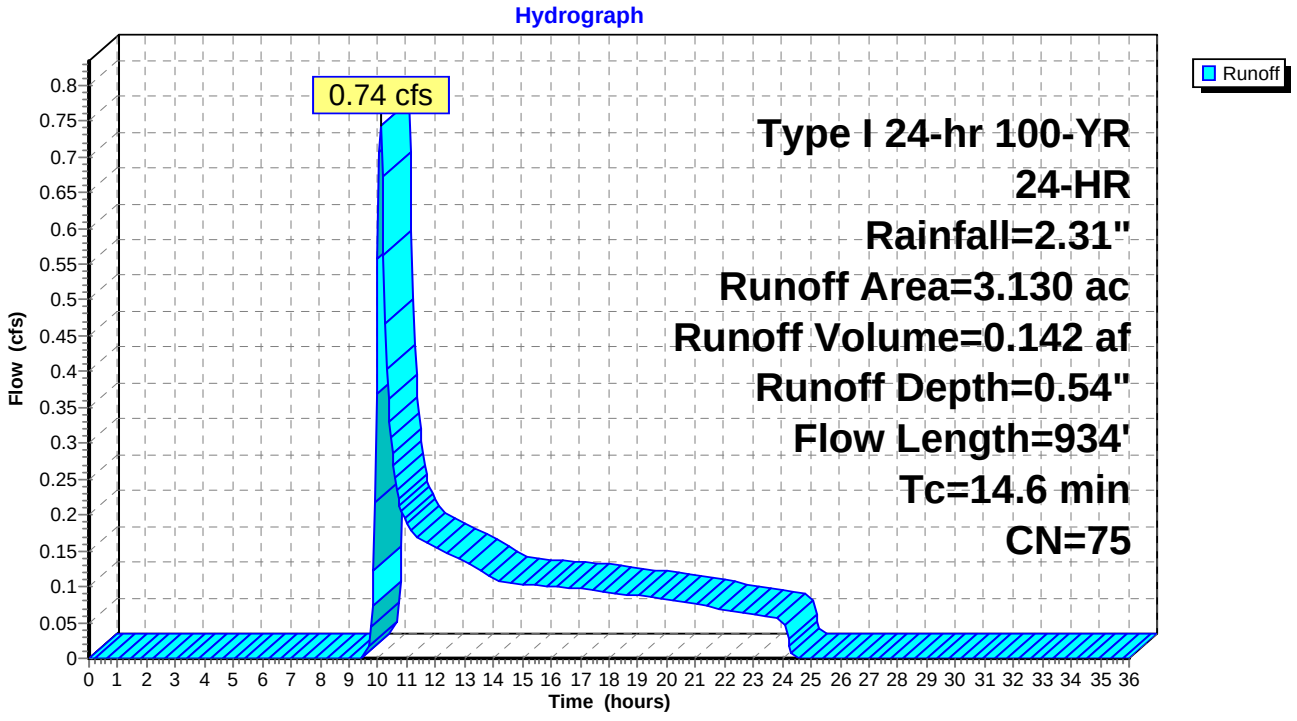
Runoff = 0.74 cfs @ 10.09 hrs, Volume= 0.142 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR, 24-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	3.130	75	Weighted Curve Number
	3.130		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
11.4	884	0.0166	1.29		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
14.6	934	Total			

Subcatchment 3S: SWS 3



Summary for Subcatchment 4S: SWS 4

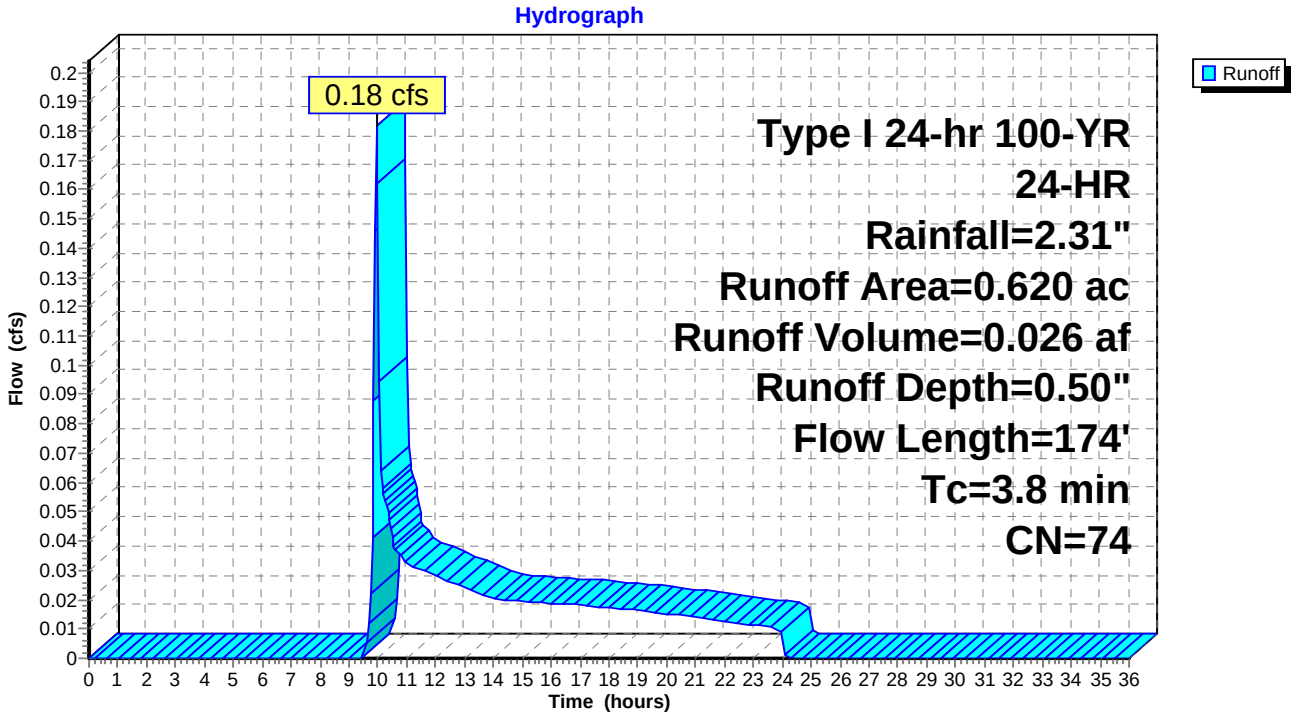
Runoff = 0.18 cfs @ 9.96 hrs, Volume= 0.026 af, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR, 24-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	0.620	74	Weighted Curve Number
	0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.2500	0.26		**Sheet Flow, Overland Flow** Range n= 0.130 P2= 1.07"
0.6	124	0.1149	3.39		**Shallow Concentrated Flow, Shallow Concentred Flow** Nearly Bare & Untilled Kv= 10.0 fps
3.8	174	Total			

Subcatchment 4S: SWS 4



Summary for Subcatchment 5S: SWS 5

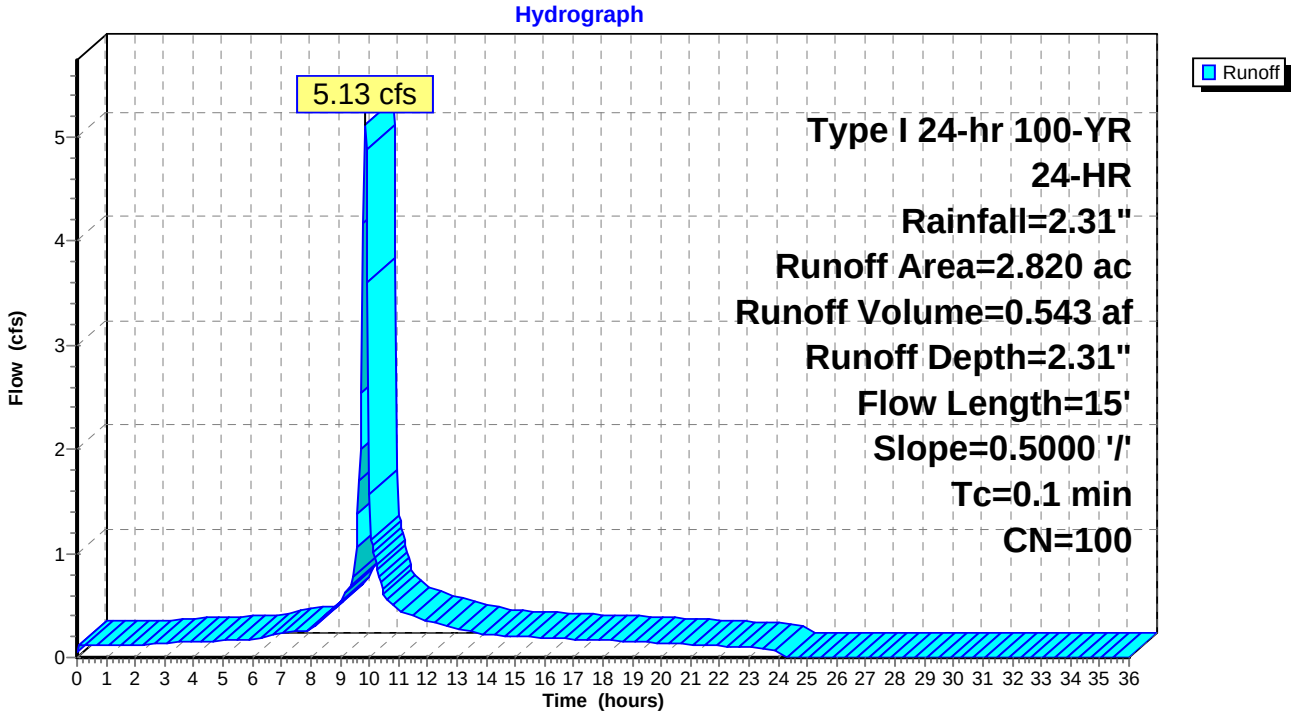
Runoff = 5.13 cfs @ 9.87 hrs, Volume= 0.543 af, Depth= 2.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR, 24-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	2.820	100	Liner
	2.820		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 5S: SWS 5



Summary for Subcatchment 6S: SWS 6

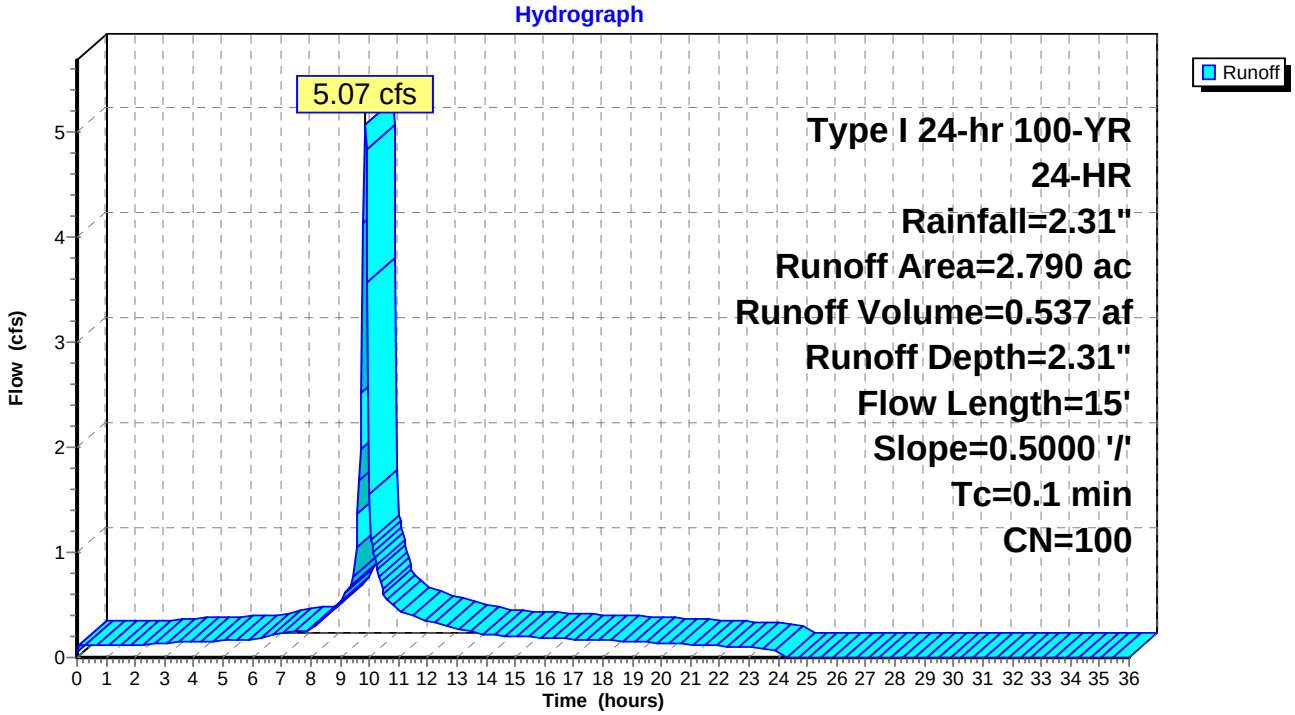
Runoff = 5.07 cfs @ 9.87 hrs, Volume= 0.537 af, Depth= 2.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR, 24-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	2.790	100	Liner
	2.790		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 6S: SWS 6



Summary for Subcatchment 7S: SWS 7

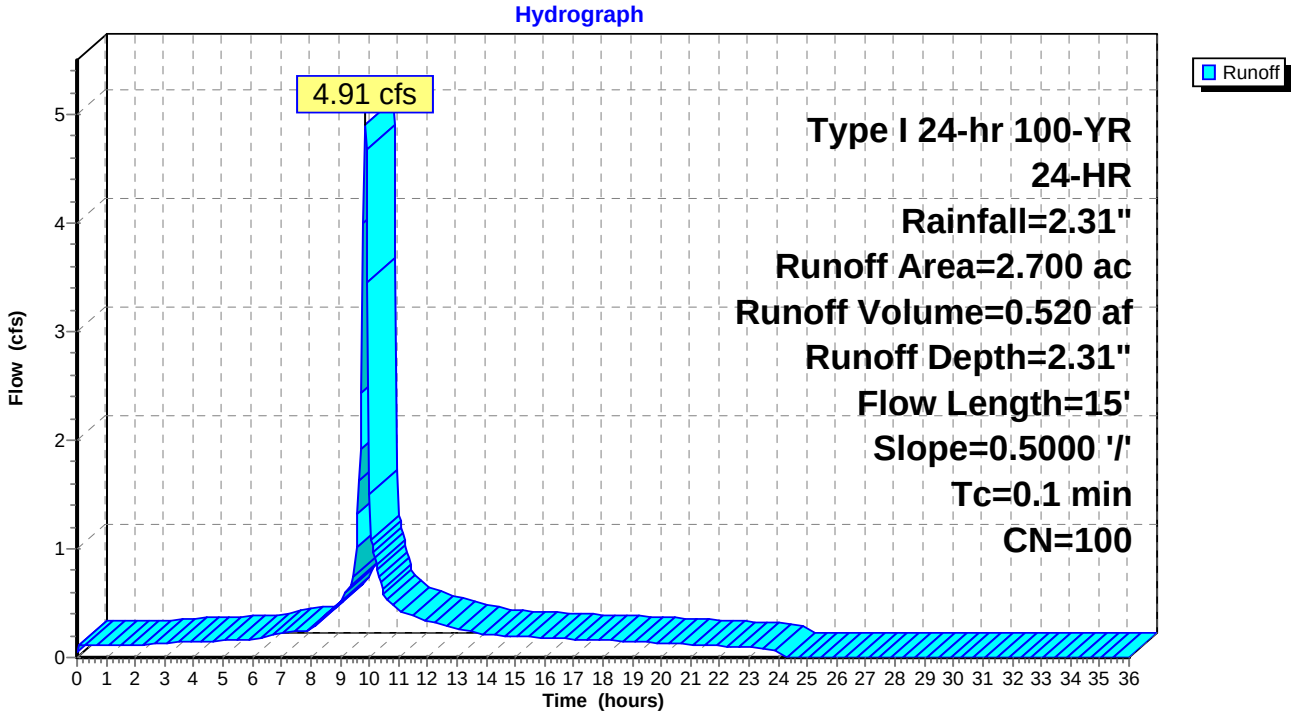
Runoff = 4.91 cfs @ 9.87 hrs, Volume= 0.520 af, Depth= 2.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR, 24-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	2.700	100	Liner
	2.700		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	15	0.5000	1.97		**Sheet Flow, Overland Flow** Smooth surfaces n= 0.011 P2= 1.07"

Subcatchment 7S: SWS 7



Summary for Reach 12R: West Drainage Ditch

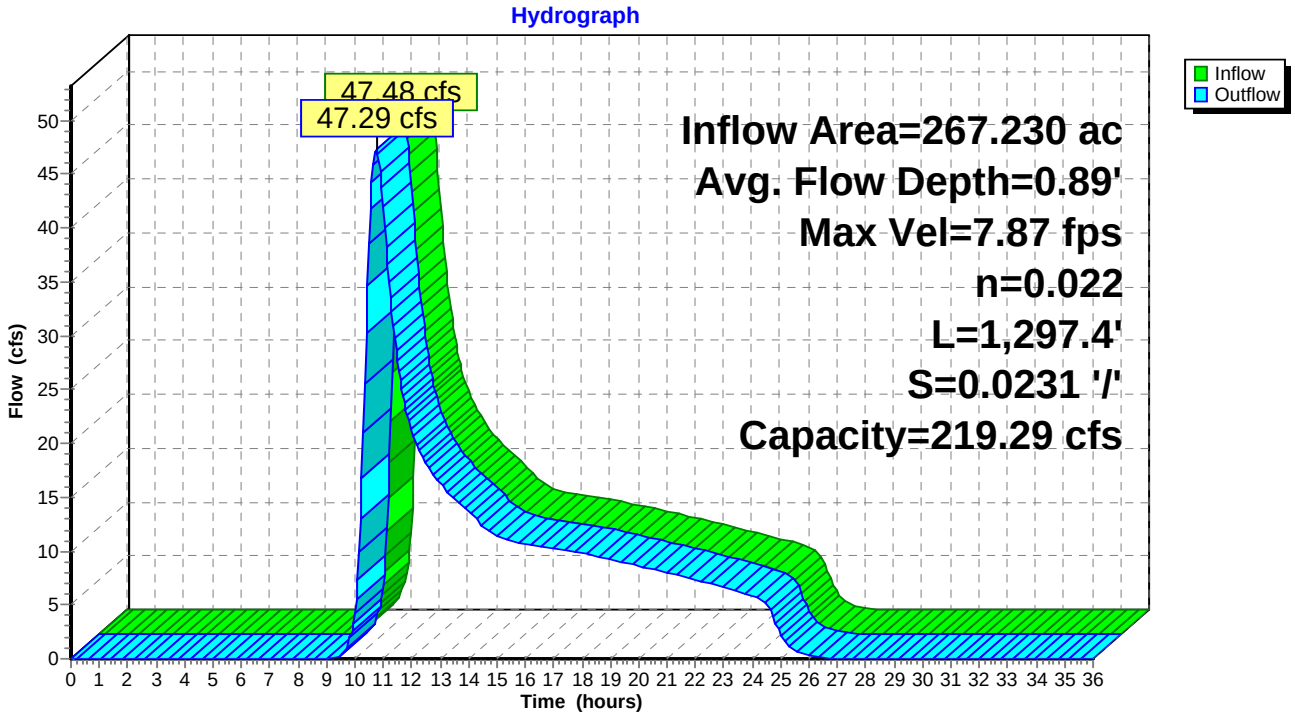
Inflow Area = 267.230 ac, 0.00% Impervious, Inflow Depth = 0.71" for 100-YR, 24-HR event
Inflow = 47.48 cfs @ 10.67 hrs, Volume= 15.874 af
Outflow = 47.29 cfs @ 10.75 hrs, Volume= 15.874 af, Atten= 0%, Lag= 5.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.87 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 3.85 fps, Avg. Travel Time= 5.6 min

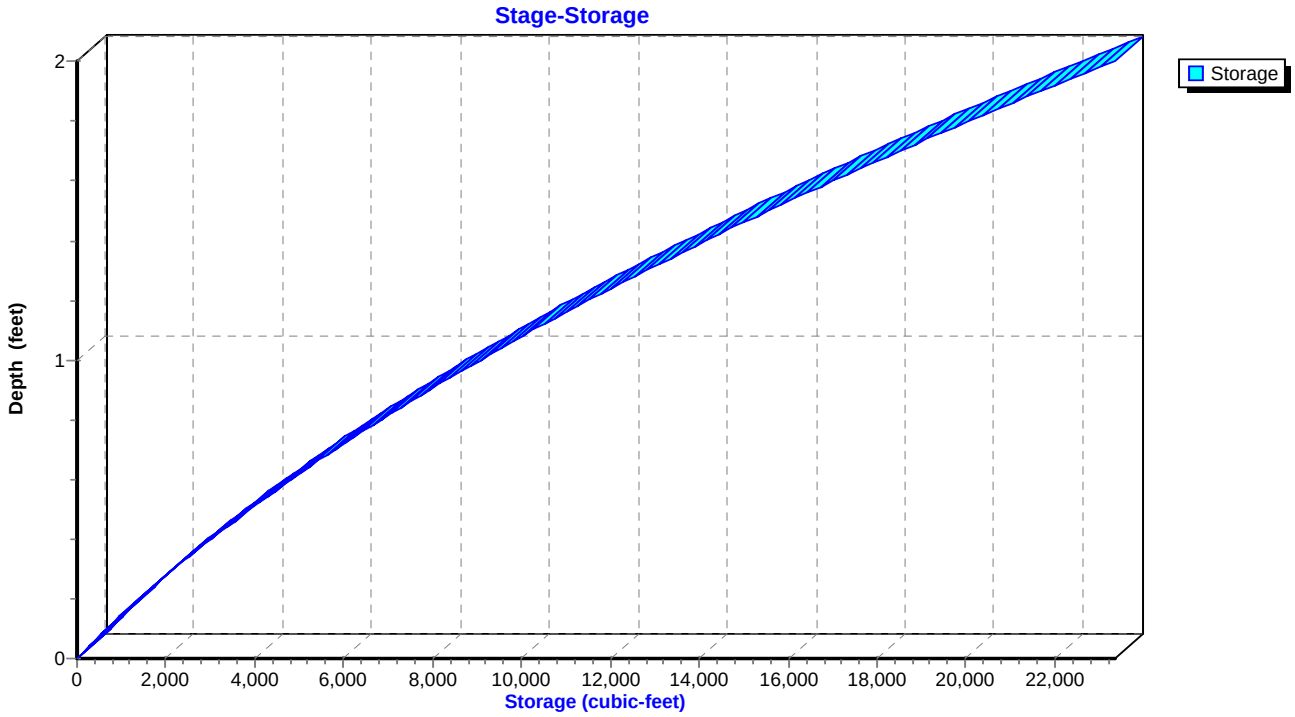
Peak Storage= 7,799 cf @ 10.71 hrs
Average Depth at Peak Storage= 0.89'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 219.29 cfs

5.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 13.00'
Length= 1,297.4' Slope= 0.0231 '/'
Inlet Invert= 5,077.00', Outlet Invert= 5,046.97'

Reach 12R: West Drainage Ditch



Reach 12R: West Drainage Ditch



Summary for Reach 13R: South Drainage Ditch

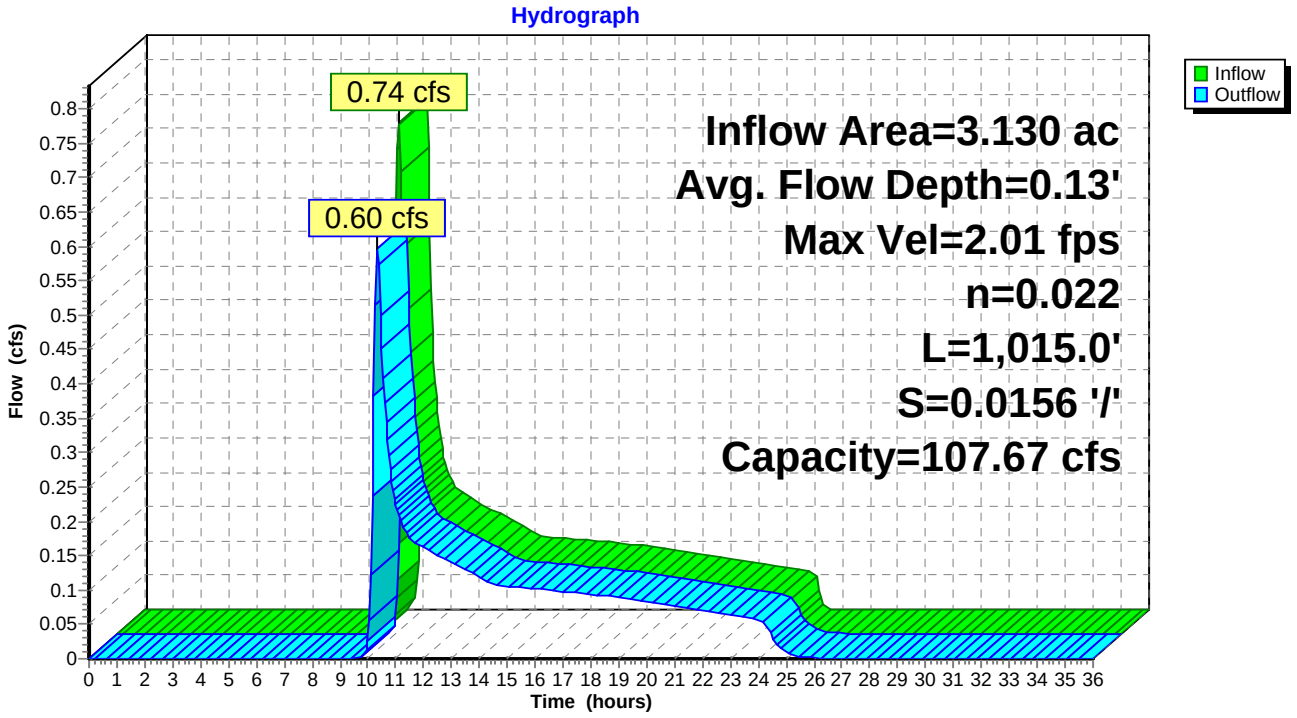
Inflow Area = 3.130 ac, 0.00% Impervious, Inflow Depth = 0.54" for 100-YR, 24-HR event
Inflow = 0.74 cfs @ 10.09 hrs, Volume= 0.142 af
Outflow = 0.60 cfs @ 10.33 hrs, Volume= 0.142 af, Atten= 20%, Lag= 14.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.01 fps, Min. Travel Time= 8.4 min
Avg. Velocity = 1.00 fps, Avg. Travel Time= 17.0 min

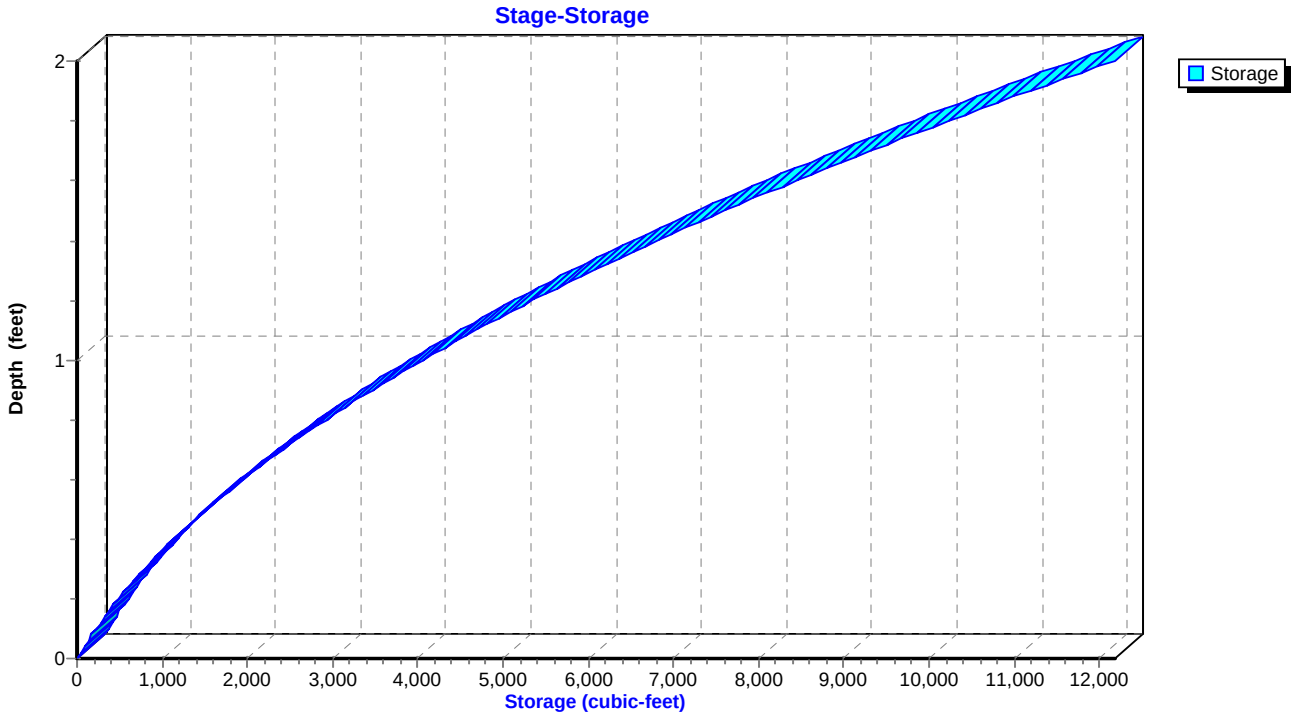
Peak Storage= 304 cf @ 10.19 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 107.67 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,015.0' Slope= 0.0156 '/'
Inlet Invert= 5,045.22', Outlet Invert= 5,029.38'

Reach 13R: South Drainage Ditch



Reach 13R: South Drainage Ditch



Summary for Reach 14R: North Drainage Ditch

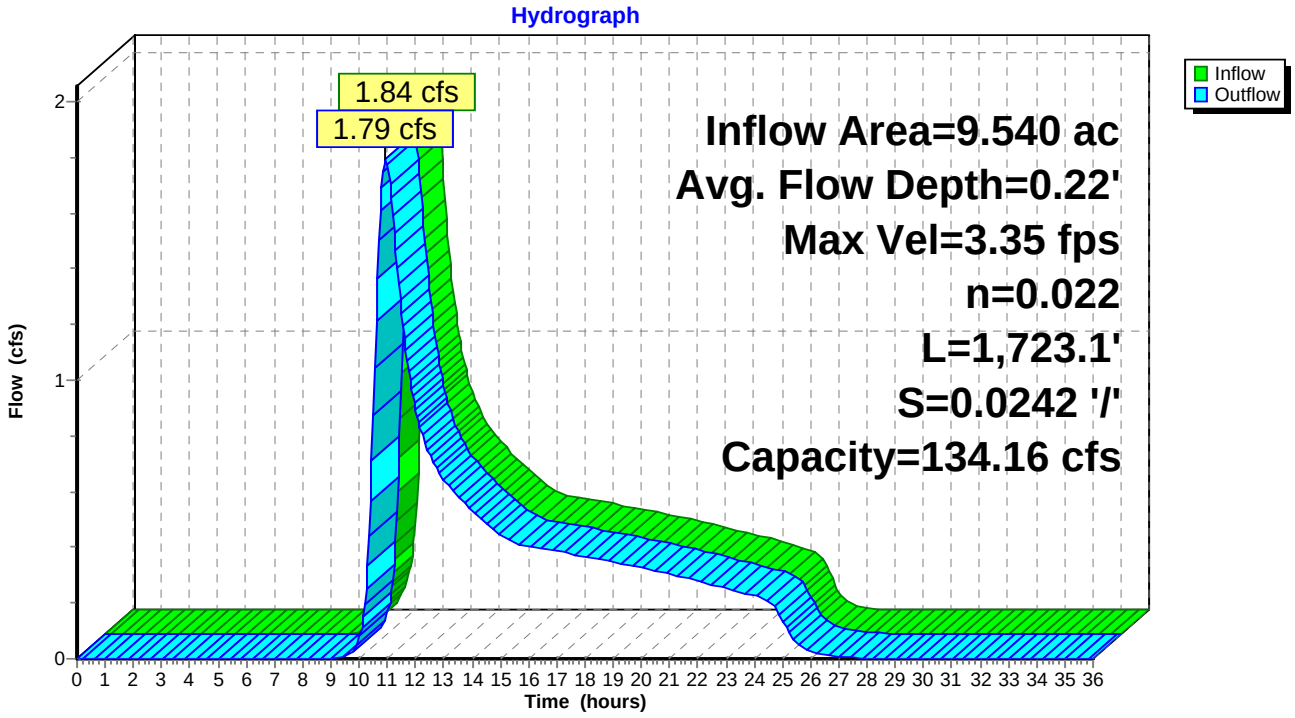
Inflow Area = 9.540 ac, 0.00% Impervious, Inflow Depth = 0.76" for 100-YR, 24-HR event
Inflow = 1.84 cfs @ 10.70 hrs, Volume= 0.604 af
Outflow = 1.79 cfs @ 10.95 hrs, Volume= 0.604 af, Atten= 3%, Lag= 15.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.35 fps, Min. Travel Time= 8.6 min
Avg. Velocity = 1.70 fps, Avg. Travel Time= 16.9 min

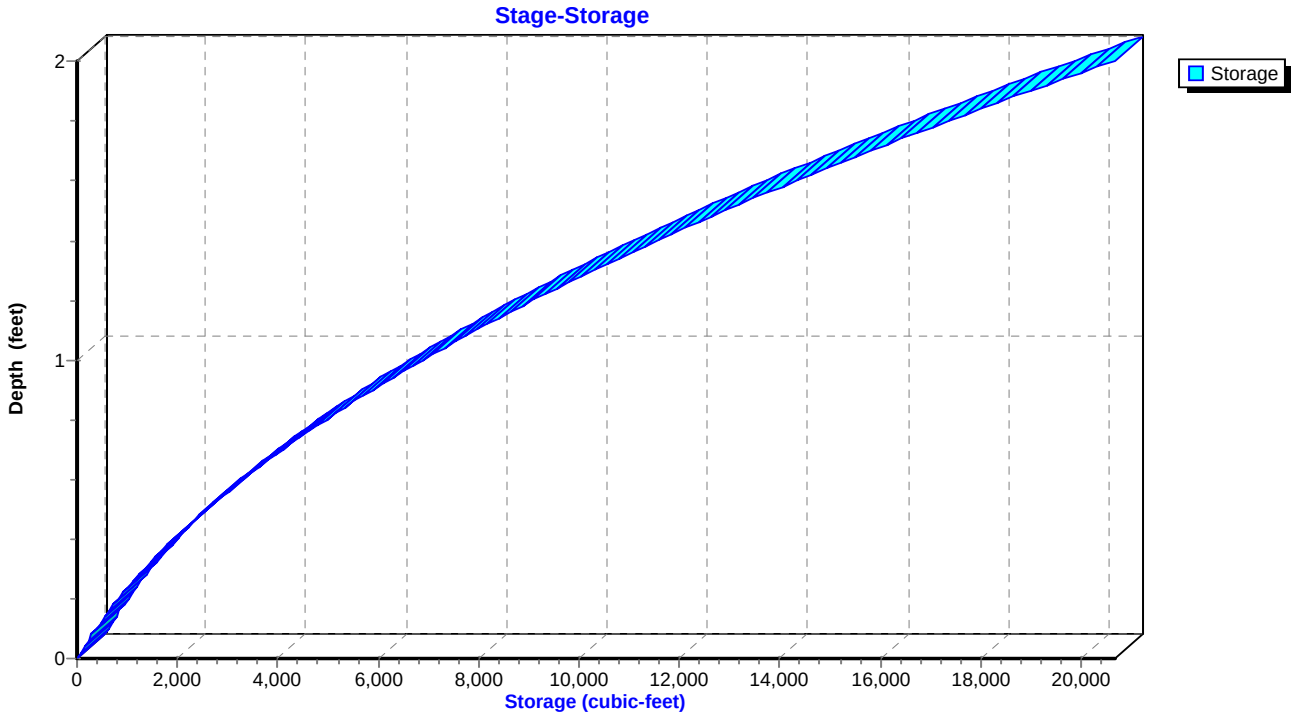
Peak Storage= 922 cf @ 10.80 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 134.16 cfs

2.00' x 2.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 1,723.1' Slope= 0.0242 '/'
Inlet Invert= 5,071.25', Outlet Invert= 5,029.50'

Reach 14R: North Drainage Ditch



Reach 14R: North Drainage Ditch



Summary for Pond 8P: Pond 1

Inflow Area = 2.820 ac,100.00% Impervious, Inflow Depth = 2.31" for 100-YR, 24-HR event
Inflow = 5.13 cfs @ 9.87 hrs, Volume= 0.543 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,061.57' Surf.Area= 0.000 ac Storage= 40.057 af
Peak Elev= 5,061.78' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 40.600 af (0.543 af above start)
Flood Elev= 5,063.57' Surf.Area= 0.000 ac Storage= 45.421 af (5.364 af above start)

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

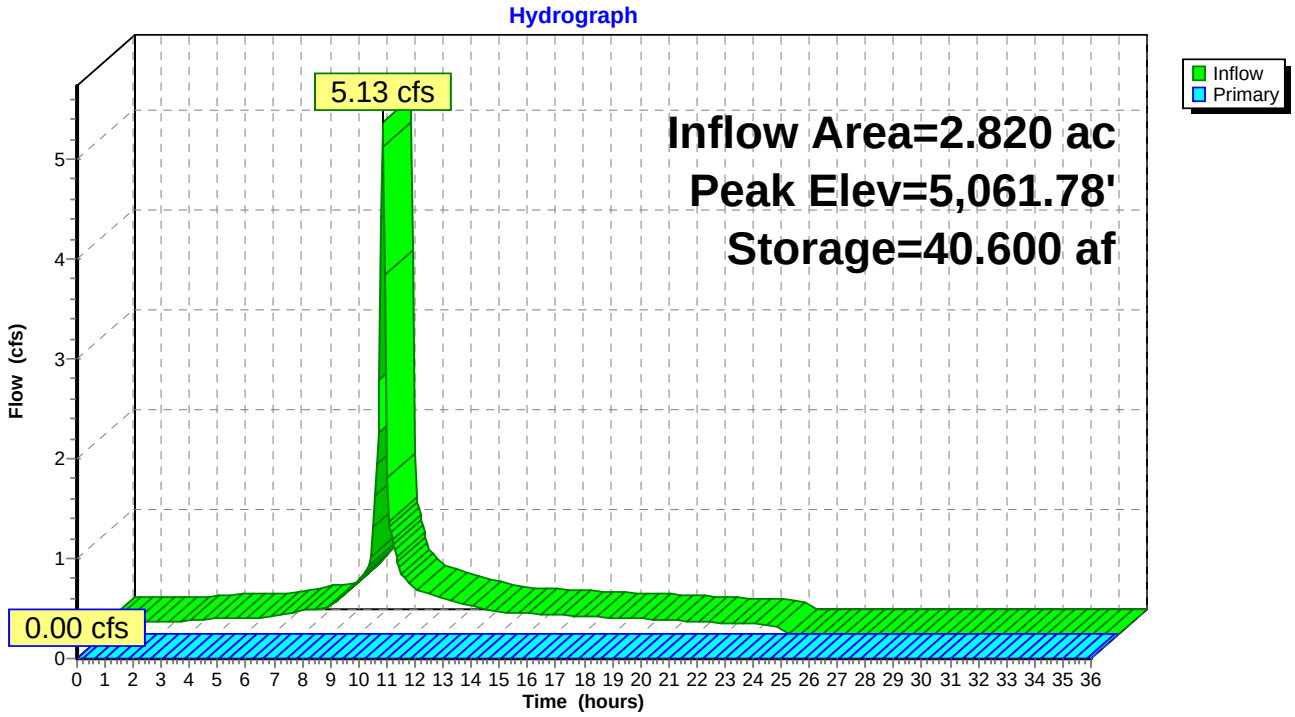
Volume	Invert	Avail.Storage	Storage Description
#1	5,041.87'	48.198 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,041.87	0.000
5,042.87	1.523
5,043.87	3.096
5,044.87	4.721
5,045.87	6.398
5,046.87	8.127
5,047.87	9.910
5,048.87	11.747
5,049.87	13.638
5,050.87	15.584
5,051.87	17.587
5,052.87	19.645
5,053.87	21.761
5,054.87	23.935
5,055.87	26.167
5,056.87	28.459
5,057.87	30.810
5,058.87	33.222
5,059.87	35.697
5,060.87	38.235
5,061.87	40.838
5,062.87	43.506
5,063.87	46.242
5,064.57	48.198

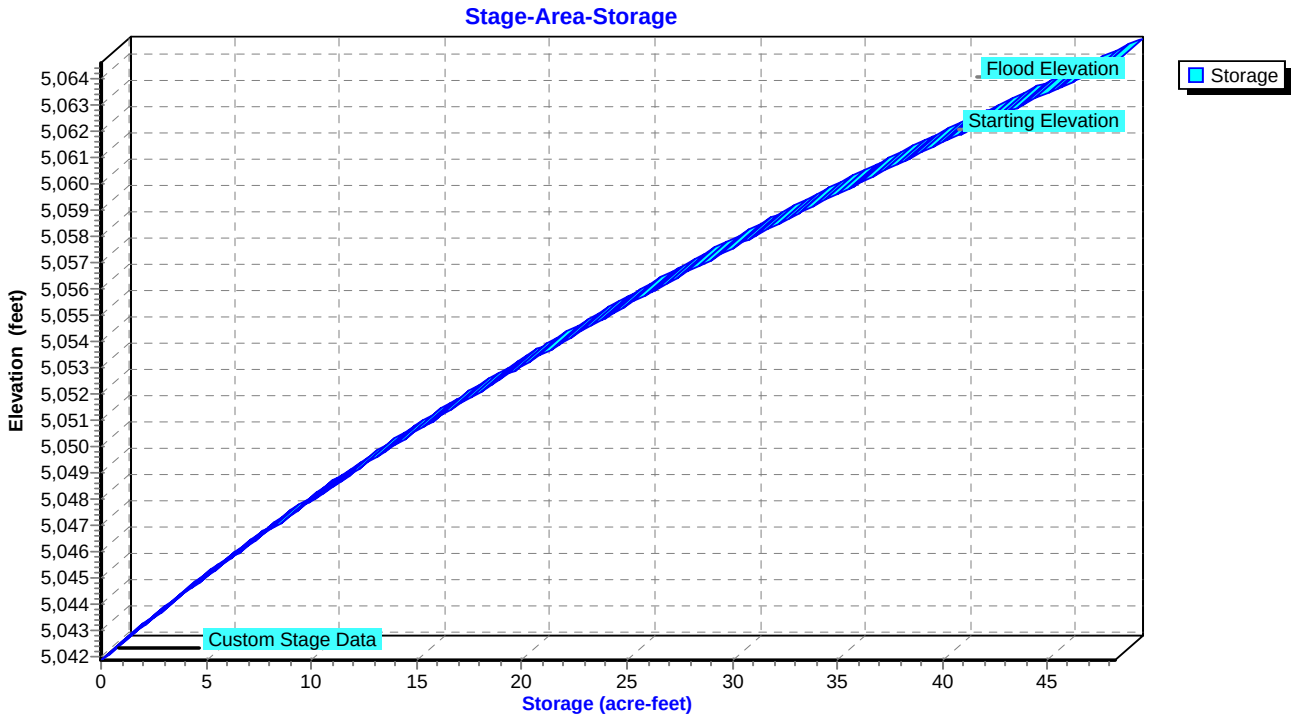
Device	Routing	Invert	Outlet Devices
#1	Primary	5,063.57'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,061.57' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 8P: Pond 1



Pond 8P: Pond 1



Summary for Pond 9P: Pond 2

Inflow Area = 2.790 ac,100.00% Impervious, Inflow Depth = 2.31" for 100-YR, 24-HR event
Inflow = 5.07 cfs @ 9.87 hrs, Volume= 0.537 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,057.30' Surf.Area= 0.000 ac Storage= 30.769 af
Peak Elev= 5,057.50' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 31.306 af (0.537 af above start)
Flood Elev= 5,059.30' Surf.Area= 0.000 ac Storage= 36.101 af (5.332 af above start)

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

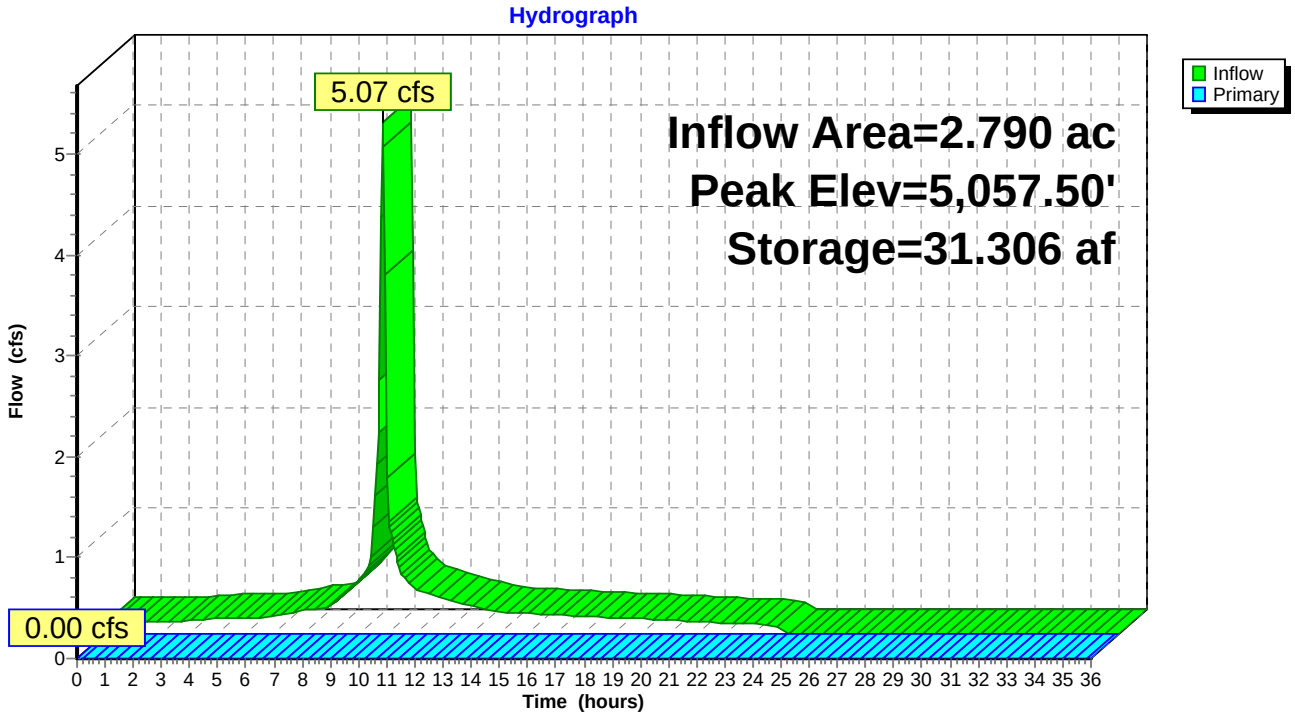
Volume	Invert	Avail.Storage	Storage Description
#1	5,043.30'	38.860 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,043.30	0.000
5,044.30	1.839
5,045.30	3.731
5,046.30	5.675
5,047.30	7.674
5,048.30	9.727
5,049.30	11.835
5,050.30	14.000
5,051.30	16.220
5,052.30	18.498
5,053.30	20.834
5,054.30	23.228
5,055.30	25.682
5,056.30	28.195
5,057.30	30.769
5,058.30	33.404
5,059.30	36.101
5,060.30	38.860

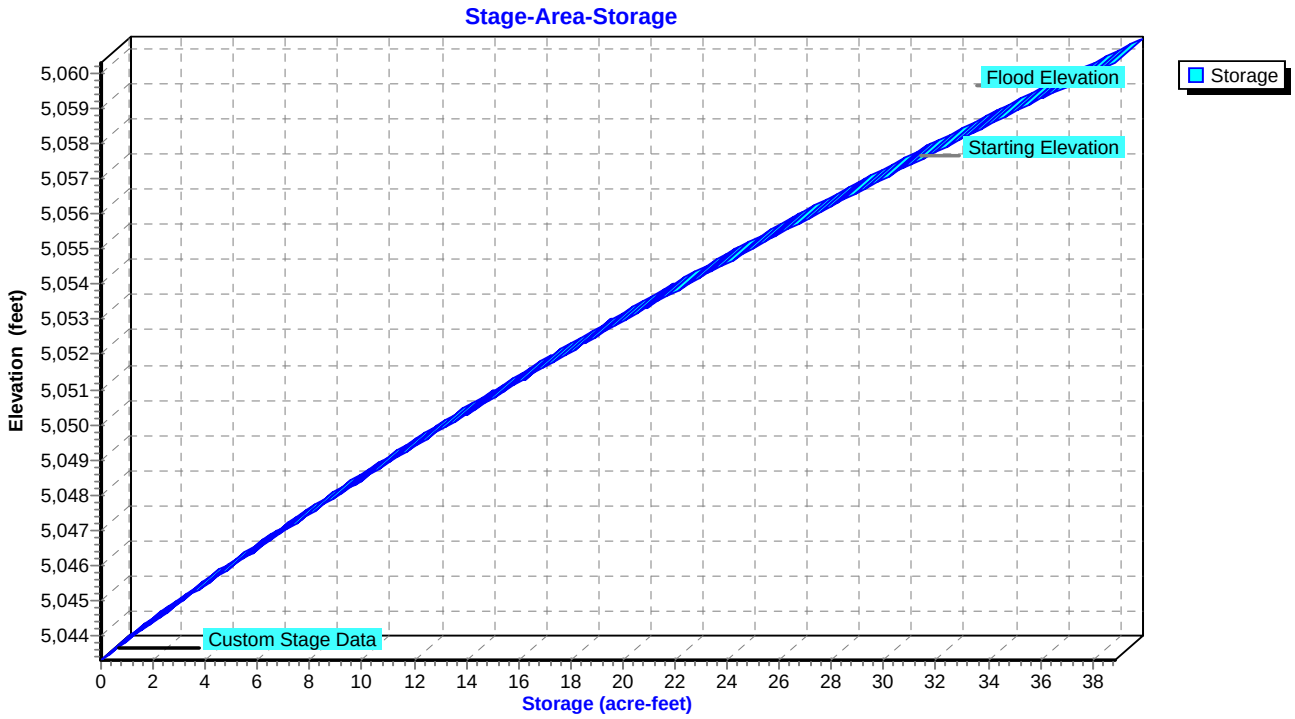
Device	Routing	Invert	Outlet Devices
#1	Primary	5,059.30'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,057.30' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 9P: Pond 2



Pond 9P: Pond 2



Summary for Pond 10P: Pond 3

Inflow Area = 2.700 ac,100.00% Impervious, Inflow Depth = 2.31" for 100-YR, 24-HR event
Inflow = 4.91 cfs @ 9.87 hrs, Volume= 0.520 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Starting Elev= 5,048.00' Surf.Area= 0.000 ac Storage= 29.283 af
Peak Elev= 5,048.21' @ 24.05 hrs Surf.Area= 0.000 ac Storage= 29.803 af (0.520 af above start)
Flood Elev= 5,050.00' Surf.Area= 0.000 ac Storage= 34.396 af (5.113 af above start)

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

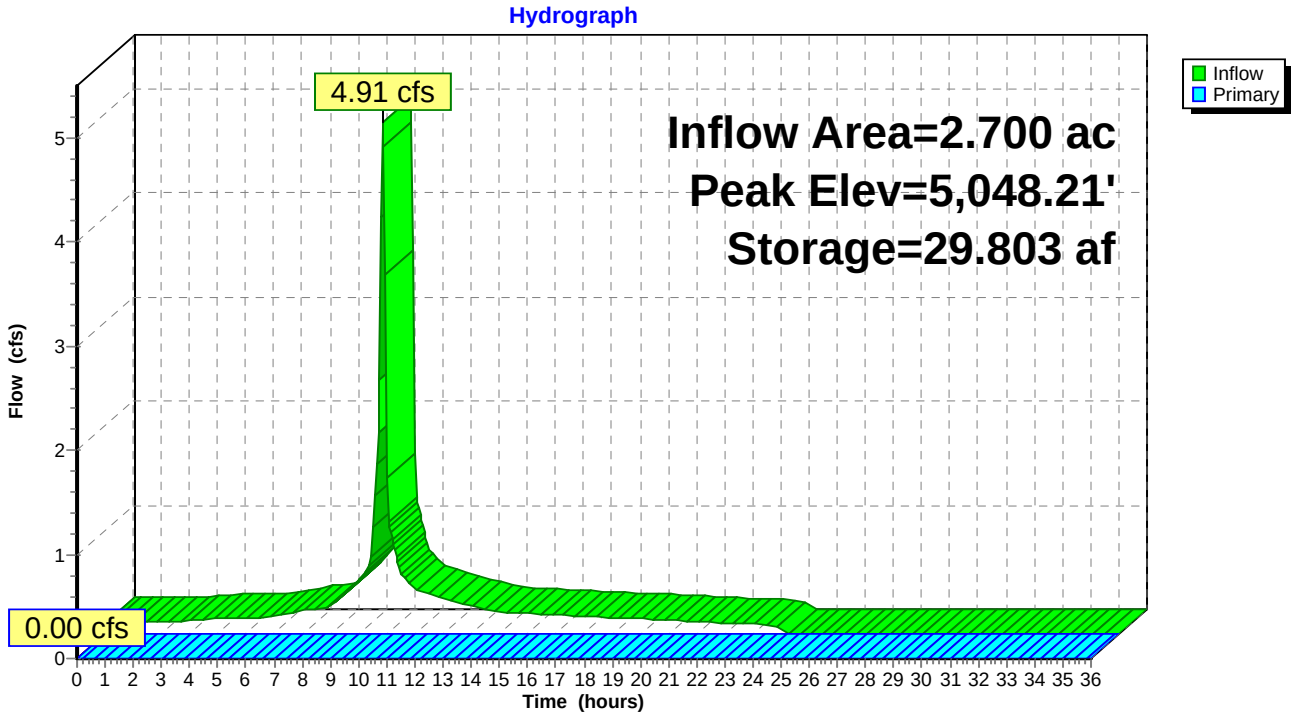
Volume	Invert	Avail.Storage	Storage Description
#1	5,033.50'	37.050 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
5,033.50	0.000
5,034.50	1.606
5,034.80	2.099
5,035.50	3.270
5,036.50	4.993
5,037.50	6.777
5,038.50	8.620
5,039.50	10.525
5,040.50	12.492
5,041.50	14.520
5,042.50	16.612
5,043.50	18.766
5,044.50	20.986
5,045.50	23.270
5,046.50	25.621
5,047.50	28.040
5,048.50	30.527
5,049.50	33.083
5,050.50	35.710
5,051.00	37.050

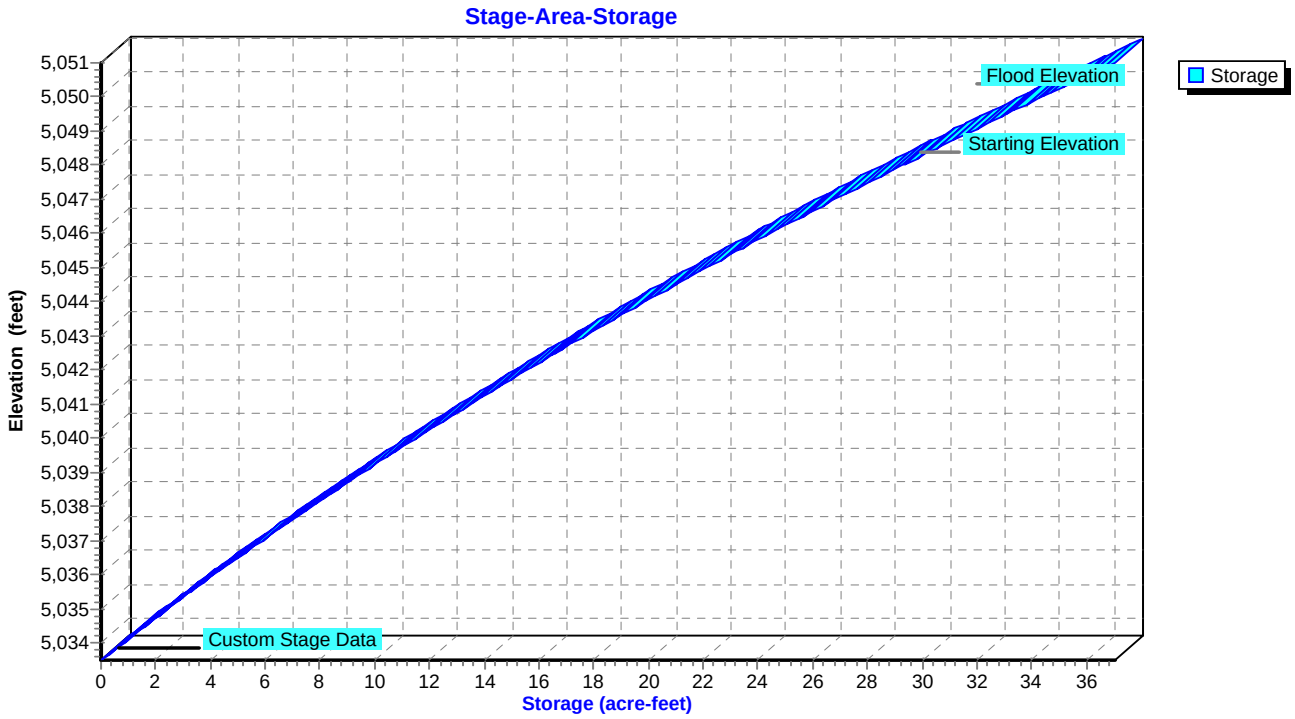
Device	Routing	Invert	Outlet Devices
#1	Primary	5,050.00'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,048.00' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 10P: Pond 3



Pond 10P: Pond 3



Summary for Pond 11P: Detention Pond

Inflow Area = 13.290 ac, 0.00% Impervious, Inflow Depth = 0.70" for 100-YR, 24-HR event
Inflow = 2.06 cfs @ 10.92 hrs, Volume= 0.772 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 5,029.52' @ 36.00 hrs Surf.Area= 0.293 ac Storage= 0.772 af

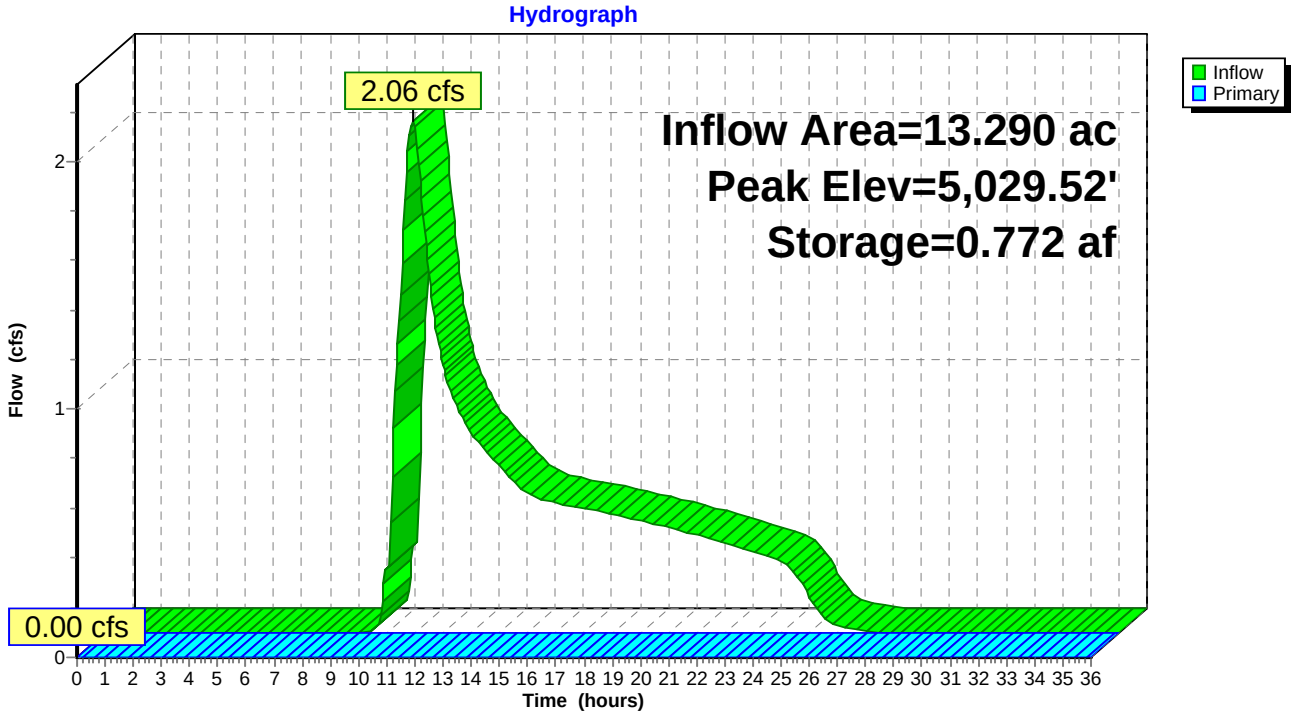
Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	5,026.00'	1.256 af	**26.00'W x 250.00'L x 5.00'H Prismatoid Z=3.0**

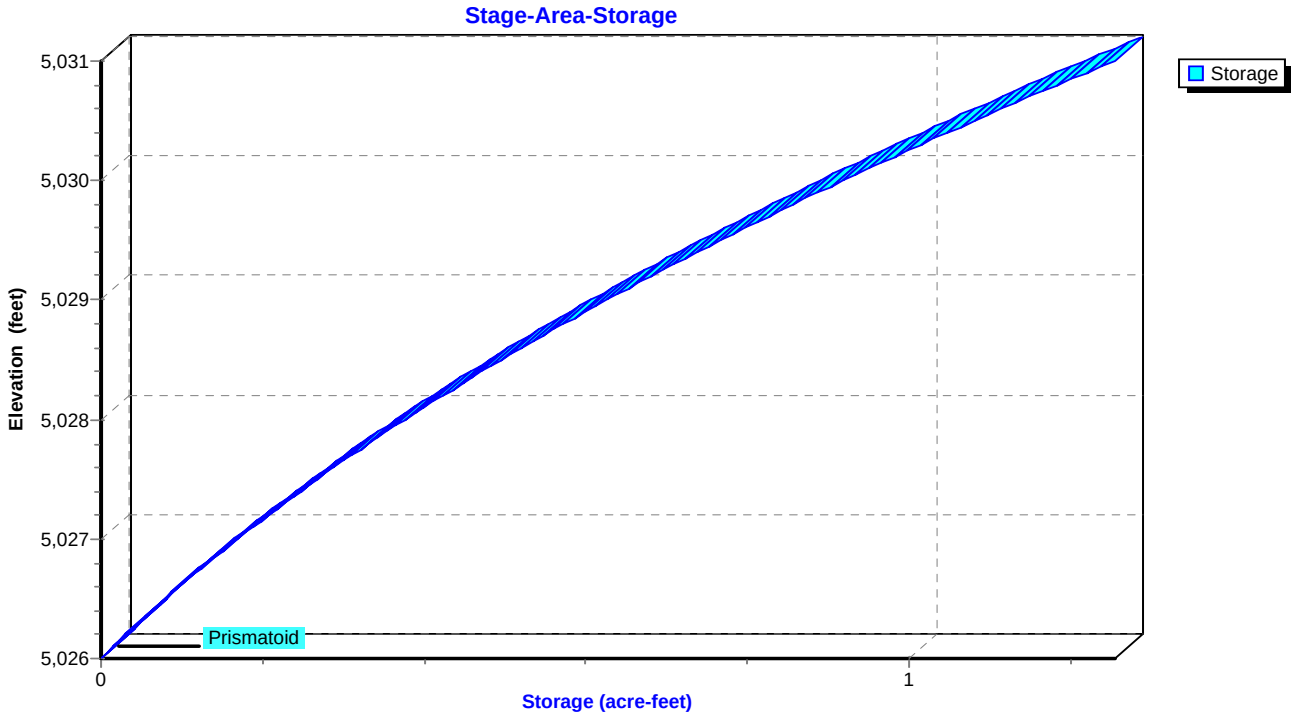
Device	Routing	Invert	Outlet Devices
#1	Primary	5,030.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5,026.00' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 11P: Detention Pond



Pond 11P: Detention Pond



ATTACHMENT G

SPILLWAY REQUIREMENTS AND DESIGN

Colorado Division of Water Resources
Dam Safety Branch

DRAFT Policy Memorandum No. 01-14
Subject: Produced Water Pond Dams

1.0 Background

Ponds constructed for storage or treatment of water produced from oil and gas exploration and extraction operations are regulated by the Colorado Department of Public Health and Environment (CDPHE) and/or the Colorado Oil and Gas Conservation Commission (COGCC). However, produced water ponds are sometimes constructed to store water above the original ground surface and should be considered dams, which are generally regulated by the Colorado Division of Water Resources (CDWR). Although most dams associated with mining and similar extractive development are exempt from the CDWR dam safety requirements, it is generally accepted that produced water should be prevented from entering the surface waters of the state. Policies are currently being developed between the three state regulatory agencies to reduce duplication of efforts and minimize regulatory conflicts in permitting and regulating produced water pond dams. In the interim, this draft policy memorandum defines the spillway design criteria for produced water pond dams.

2.0 Produced water pond dams that meet the size criteria for jurisdictional dams (Rule 4.2.5.1) will be designed and constructed in accordance with the Rules and Regulations for Dam Safety and Dam Construction as follows:

2.1. The minimum spillway capacity must be as required by Table 5.2 plus one foot of residual freeboard, or

2.2. The dam can be designed with no spillway, but the dam must have 5 feet of total freeboard or adequate freeboard to retain the direct Probable Maximum Precipitation, whichever freeboard is greater.

2.3. No surface runoff will be permitted to flow into the pond.

3.0 Produced water pond dams that meet the size criteria for non-jurisdictional dams (Rule 4.2.5.2) will be permitted, regulated, and inspected by CDPHE and/or COGCC in accordance with the rules and policies of those agencies. CDPHE and COGCC will communicate with the Dam Safety Branch of CDWR to evaluate the hazard classification of non-jurisdictional produced water pond dams and define the spillway design criteria.

3.1. Spillways on Low Hazard dams must be capable of passing the 50-year precipitation event with on foot of residual freeboard.

3.2. Spillways on Significant Hazard or High Hazard non-jurisdictional dams must be designed according to the requirements for jurisdictional dams listed in paragraphs 2.1-2.3 above.

4.0 The above spillway freeboard requirements are in addition to any limitations placed by CDPHE or COGCC on the maximum permitted pond level.

5.0 The CDWR Dam Safety Branch reserves the right to alter the procedures and requirements of this policy memo as necessary to meet the goals of the Dam Safety Branch.

COLORADO
Division of Water Resources
Department of Natural Resources

DAM SAFET Y BRANCH

June 26, 2014

Mr. Drew Pearson
WWC Engineering
1275 Maple Street, Ste F
Helena, MT 59601
dpearson@wwcengineering.com

VIA EMAIL

When replying, please refer to:
DEBEQUE STATION POND 1 (DAMID 700108), POND 2 (DAMID 700109), AND POND 3 (DAMID 700110)
Water Division 5, Water District 70

SUBJECT: Review of Hazard Classification Report

Dear Mr.Pearson:

This letter is being sent to tramsmit the results of our review of Hazard Classification Report and Attachments (Report) for the Debeque Station Ponds, 1, 2 and 3, received by this office on Month, 15, Year. We found the documents to be well prepared and thorough and in accordance with the Rules and Regulations for Dam Safety and Dam Construction. We have completed our review of the report and offer the following comments.

1. We agree with the general analyses that were performed, and agree that the dams, if constructed as shown in the Report will not be classified as either High or Significant hazard dam. The following hazard classificaitons are defined in Rule 4.2.14 in the State of Colorado Rules and Regulations for Dam Safety and Dam Construction (Rules):
    a. “Low Hazard Dam” is a dam for which loss of human life is not expected, and significant damage to structures and public facilities as defined for a "Significant Hazard" dam is not expected to result from failure of the dam.
    b. “No Public Hazard NPH) Dam” is a dam for which no loss of human life is expected and which damage only to the dam owner’s property will result in failure of the dam.

Since a failure of the dam(s) would result in damage outside of the owner's property, these dams should be classified as Low Hazard.

2. It is acceptable that a multiple dam breach analysis of was not performed since the embankments between the ponds are sufficiently wide. It is however suggested that precautions are incorporated into the final design of the ponds to prevent this scenario such as providing diversion berms between the ponds.

3. The orifice coefficient used for the culverts in HEC-HMS appears to be high, and no blockage of the culverts during a breach event was assumed. This appears to potentially overestimate the outflow from the Road Storage Area, and may underestimate the water surface at the road. The model should be revised to reflect a more realistic orifice coefficient and incorporate a potentail culvert blockage to reflect the possible additional damage downstream of the dams. I am available to discuss the modeling assumptions with you at any time.

The next steps are: 1) resubmit the final hazard classification report after you have had an opportunity to consider incorporating the comments listed above, and 2) follow the design process outlined in the Rules and the Project Review Guide which is attached to this memorandum. When you submit the plans and specifications for review, we require that each dam be submitted as a separate package. Prior to proceeding with final design, we would like to have a pre-design meeting with you as outlined in our Project Review Guide.

If you have any questions on the comments in this letter or the design process, please contact me at 970.945.5665, ext. 5016.

Sincerely,

Erin K Gleason

Erin Gleason, P.E.
Division 5 Dam Safety Engineer

Enc: Colorado Dam Safety Project Review Guide

ec: Alan Martellero, Division Engineer, Water Division 5
Garrett Jackson, Division 5 Dam Safety Engineer
Bill McCormick, Chief, Dam Safety Branch
Jeremy Franz, Design Review Engineer
Shawn Higley, WWC Engineering, shigley@wwcengineering.com

Worksheet for Pond 1 Spillway

Project Description

Solve For	Discharge

Input Data

Headwater Elevation		5064.57	ft
Crest Elevation		5063.57	ft
Tailwater Elevation		5059.00	ft
Crest Surface Type	Gravel		
Crest Breadth		28.60	ft
Crest Length		10.00	ft

Results

Discharge	28.28	ft^3/s
Headwater Height Above Crest	1.00	ft
Tailwater Height Above Crest	-4.57	ft
Weir Coefficient	2.83	US
Submergence Factor	1.00	
Adjusted Weir Coefficient	2.83	US
Flow Area	10.00	ft^2
Velocity	2.83	ft/s
Wetted Perimeter	12.00	ft
Top Width	10.00	ft