7.10 Introduction

7.1.1 General Requirements

This chapter presents a description of:

- Existing hydrologic resources within the permit and adjacent areas;
- Proposed operations and the potential impacts to the hydrologic balance;
- Methods of compliance with design criteria;
- Applicable hydrologic performance standards; and
- Hydrologic reclamation plans for the Wellington Dry-Coal Cleaning Facility.

7.1.2 Certification

All appropriate maps, plans, and cross sections presented in this chapter have been certified by a qualified, registered professional engineer.

7.1.3 Inspection

Impoundments associated with the mining and reclamation operations will be inspected as described in Section 5.1.4.3 of this document.
7.20 Environmental Description

7.2.1 General Requirements

This section presents a description of the pre-operational hydrologic resources within the permit and adjacent areas that may be affected or impacted by the operation and reclamation of the facility and site.

7.2.2 Cross Sections and Maps

7.2.2.1 Location and Extent of Subsurface Water

According to Gloyn et al. (2003), groundwater in the general area occurs in shallow, discontinuous, perched Quaternary colluvial deposits above bedrock and in the Ferron Sandstone Member of the Mancos Shale, which is approximately 700 feet below the ground surface at the permit area. These two potential water-bearing units are separated by the Bluegate Shale Member of the Mancos Shale, which is highly impermeable. A generalized hydrostratigraphic cross section of the area is presented in Figure 7-1.

Shallow, perched groundwater may occur in the area in disconnected, unconsolidated materials that overly relatively impermeable bedrock. The primary sources of recharge to these layers are precipitation, infiltration from losing reaches of streams, irrigation, and groundwater discharge from bedrock. These water-bearing units generally range in thickness from a few feet to up to several tens of feet. Groundwater in these units generally contains high total dissolved solids ("TDS") concentrations (Gloyn et al., 2003).

The prior owner installed a monitoring well in the permit area in December 2008. Since shallow groundwater generally follows the surface contour, the direction of shallow groundwater flow beneath the permit area was assumed to be toward the southeast. To monitor the effects, if
any, of facility operation, the well was installed near the southeast corner of the operating facility at
the location indicated in Figure 7-2. This well was drilled using hollow-stem auger methods to a
depth of 13 feet in the Mancos Shale, at which point refusal was encountered. The well was
completed with 2-inch diameter PVC screen and casing, with a 20- to 40-mesh silica sand filter
pack and a bentonite surface seal. Lithologic and completion logs for the well are provided in
Appendix 7-1.

The monitoring well was sampled on December 24, 2008, with the data collected during
that monitoring event presented in Table 7-1. As indicated, the depth to groundwater in December
2008 was 12.0 feet. The water had a temperature of 12.1°C, with a field pH of 7.40 and a field
specific conductance of 9.900 μS. The water is a sodium-sulfate type, with a total dissolved solids
concentration of 11,000 mg/L. Total and dissolved iron concentrations were detected at 300 and
<0.050 mg/L, respectively. Total and dissolved manganese concentrations were detected at 3.9
and 0.57 mg/L, respectively. Analyses of subsequent samples collected from this monitoring well
show similar results (see Table 7-1).

The Ferron Sandstone consists of very fine-grained, silty sandstone with abundant
interbedded carbonaceous shale. It is located about 700 feet below the ground surface of the
permit area, and is approximately 80 feet thick in the region (Gloyn et al, 2003). A coal-bed
methane well constructed in Township 14S Range 10E, SLBM (one township north of the permit
area) and completed in the Ferron Sandstone contained 6,500 to 9,000 mg/L TDS (Gloyn et al,
2003). Another well drilled into the Ferron Sandstone about 0.3 mile north of the coal cleaning
facility did not encounter any groundwater (source: DOGM Oil and Gas Well Database).

7.2.2.2 Location of Surface Water Bodies

A map showing the location of surface water bodies in the area is provided in Figure 7-3.
A listing of water rights data is presented in Appendix 7-2. As indicated in that appendix, 69
point-of-use water rights exist in Section 14, T. 15 S., R. 10 E. (the section in which the permit area
is located). The vast majority of these rights are held by the Price River Water User’s Association and represent water that is diverted remote from the permit area and delivered via distribution systems throughout the region for industrial use (as well as limited stockwatering and domestic use). The only point-of-diversion water rights filed in Section 14 are for stock watering on Miller Creek (see Figure 7-3). This map also shows the locations of the facility sedimentation ponds, which are the only permitted discharge locations at the site.

### 7.2.2.3 Locations of Monitoring Stations

As indicated in Section 7.4.2.2, all runoff from the permit area flows into sedimentation ponds located in the downstream portions of the site. These ponds were constructed to contain far more than the quantities of sediment and runoff required by the DOGM regulations. Hence, surface outflows from the permit boundary are not anticipated except under conditions of extreme precipitation. Since all surface runoff from the permit area will flow into the sedimentation ponds, no surface monitoring stations other than the pond outlets have been installed for this facility. The locations of these ponds are shown on Plate 5-1. BRC Wellington ("BRCW") is required to monitor the discharges from these ponds in accordance with UPDES discharge permit No. UTR000685 issued by the Utah Division of Water Quality.

The prior owner installed one monitoring well in December 2008 to monitor groundwater at the downgradient edge of the permit area. The location of this monitoring well, as shown on Figure 7-2, was selected in consultation with DOGM. Groundwater resources are not used at or near the site, and it is unlikely that they are impacted by activities within the permit area. The shallow groundwater beneath the site is not beneficially used and contains poor quality water, as indicated in Section 7.2.2.1.

The facility uses municipal water and site runoff is controlled in accordance with the R645 rules and a Storm Water Pollution Prevention Plan. No perennial water bodies occur within the permit area.
**7.2.2.4 Location and Depth of Water Wells**

No water-supply wells currently exist in the permit area. However, as noted above, a monitoring well was installed within the permit area in the fourth quarter of 2008. Stratigraphic and completion logs of this well are provided in Appendix 7-1.

**7.2.2.5 Surface Topography**

Surface topographic features in the permit and adjacent areas are shown on Plate 5-1. Note that, other than the sedimentation ponds, the topography shown on this map was surveyed prior to site grading at the facility. The size and locations of the sedimentation ponds are based on a survey performed in September 2008. The site is relatively flat and only minor site regrading was performed to facilitate the drainage of storm water runoff. Since the existing site contours approximate the original site contours and the sedimentation ponds have a great deal of extra capacity, the hydrology calculations discussed in this chapter should adequately represent site conditions.

**7.2.3 Sampling and Analysis**

A groundwater monitoring well was installed within the permit area during the fourth quarter of 2008. Water-level data and water-quality samples were collected in December 2008 and will be collected from this well on a quarterly basis for the first year following installation of the well and during the first year of reclamation after plant operations cease. Analytical parameters to be analyzed are listed in Table 7-1. These parameters were determined in consultation with DOGM.

As discussed in Section 7.2.2.3, all runoff from the permit area flows into sedimentation ponds located in the downstream (southern) portion of the site. Hence, surface water monitoring
will consist of sampling discharges (if any) from the sedimentation ponds in accordance with the UPDES permit.

7.2.4 Baseline Information

Surface water, groundwater, and climatic resource information is presented in this section to assist in determining the baseline hydrologic conditions which exist in the area of the facility. This information provides background data on the hydrologic balance of the area.

7.2.4.1 Groundwater Information

A brief discussion of groundwater information is included in section 7.2.2.1 of this document. Groundwater in the vicinity of the Wellington Dry-Coal Cleaning facility has been found in localized shallow, perched zones within unconsolidated surficial materials weathered from the Bluegate Shale and within the Ferron Sandstone. Based on the findings from a groundwater monitoring well drilled in the permit area, shallow groundwater is saline, contains high levels of dissolved solids, and is generally poorly suited for drinking or irrigation.

7.2.4.2 Surface Water Information

The Wellington Dry-Coal Cleaning Facility is located on land that drains to the south toward Miller Creek, located approximately 2000 feet south of the permit area. Drainage occurs as overland flow or in ephemeral washes that flow in direct response to precipitation events. Based on field observations of vegetation, geomorphic conditions, and the presence of some surface water in the late summer/early autumn of 2007 and 2008 as well as the late winter/early spring of 2009, it appears that Miller Creek is a perennial stream at its location south of the permit area. These observations are supported by the fact that Miller Creek appears on the USGS topographic map of the area as a solid line (the symbol used for perennial streams). Miller Creek feeds into the Price River in Wellington, Utah. The Price River is a tributary of the Green River. Stream gage data
collected from 1972 to 1986 shows that the average annual flow volume of the Price River just below its confluence with Miller Creek is 105,565 acre-feet (Utah Division of Water Resources, 2000). No historical stream gage data exist for Miller Creek.

Figure 7-3 shows a tributary to Miller Creek approximately 400 feet southwest of the southwest corner of the permit area. Based on field observations of vegetation, geomorphic conditions, the lack of surface water, and the lack of a well-defined surface flow path within the greater channel, this tributary appears to be an ephemeral channel that receives surface runoff in response to rainfall and snowmelt events. These observations are supported by the limited drainage area and the fact that this stream is represented on the USGS topographic map with a symbol other than a solid line. Irrigation return flow may also discharge into this channel 900 to 1000 feet south-southeast of the permit area.

As part of the UPDES permit, water samples will be collected from the sedimentation ponds before any impounded water is released. A copy of the UPDES Permit is included in Appendix 7-3. Published water quality data for the Price River show a decrease in water quality as it flows from the Wasatch Plateau toward the Green River. This decrease is attributed to the presence of soluble minerals in the surrounding rocks (principally the Mancos Shale), saline soils, and irrigation return flows. Typical TDS values are 400 mg/L in the upper reaches of the Price River, 600 to 2,400 mg/L near Wellington, and 2,000 to 4,000 mg/L at Woodside, which is several miles downstream (Mundorff, 1972).

7.2.4.3 Geologic Information

Geologic information related to the permit and adjacent areas is presented in Chapter 6 of this document.
7.2.4.4 Climatological Information

Based on regional data collected from June 1980 to January 2005, normal annual precipitation at the permit area is about 9.2 inches per year. Most of this precipitation occurs during July through September as a result of summer thunderstorms (Western Regional Climate Center - http://www.wrec.dri.edu/index.html).

The station closest to the facility that reports wind data is located at the airport at Price, Utah (approximately 5 miles west of the facility). The average annual wind speed at this location between 1996 and 2006 was 6.8 mph (Western Regional Climate Center web site).

The normal annual temperature at the Price Warehouses, Utah station (located 5 miles west of the facility) is 49.9°F. Seasonally, this temperature varies from a normal monthly low of 13.4°F in January to a normal monthly high of 90.0°F in July (Western Regional Climate Center web site).

7.2.4.5 Supplemental Information

No supplemental information is required at this time.

7.2.4.6 Survey of Renewable Resource Lands

The existence and recharge of aquifers in the permit and adjacent areas is discussed in Sections 7.2.2.1 and 7.2.4.1 of this document.

7.2.4.7 Alluvial Valley Floor Requirements

Information regarding the presence or absence of alluvial valley floors in the permit and adjacent areas is presented in Chapter 9 of this document.
7.2.5 Baseline Cumulative Impact Area Information

Information concerning the hydrology of the region is available in various publications, including Mundorff (1972), Waddell et al. (1981), Waddell et al. (1982), Waddell et al. (1986), and Gloyn et al. (2003). Since the hydrologic impact of the operations will be insignificant, it is not anticipated that revisions will be needed to the Cumulative Hydrologic Impact Assessment of the area.

7.2.6 Modeling

No numerical groundwater or surface water modeling was conducted in support of this document.

7.2.7 Alternative Water Source Information

No surface mining has been or will be conducted in the permit and adjacent areas. Therefore, this section does not apply to the Wellington Dry-Coal Cleaning Facility.

7.2.8 Probable Hydrologic Consequences

This section addresses the probable hydrologic consequences of coal cleaning and reclamation operations in the permit and adjacent areas. Mitigating measures are discussed generally in this section and as well as in Section 7.3 of this document.
7.2.8.1 Potential Impacts to Surface and Groundwater

Potential impacts of coal cleaning on the quality and quantity of surface and groundwater flow are discussed in the facility’s Storm Water Pollution and Prevention Plan and may include the following:

- Coal, equipment fuels and fluids from the truck dump and coal storage area;
- Equipment fuels and fluids from the front end loader;
- Coal and lubricant from the conveyor belt; and
- Coal and lubricant from the silo.

A copy of the SWP3 is included in Appendix 7-4. These potential impacts are addressed in the following sections of this document.

7.2.8.2 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of this document. Baseline hydrologic information is presented in Sections 7.2.4.1 and 7.2.4.2 of this document.

7.2.8.3 PHC Determination

Potential Impacts to the Hydrologic Balance. Potential impacts to the hydrologic balance are addressed in the following subsections of this document.

Acid- or Toxic- Forming Materials. As noted in Section 5.2.8.3, the coal processed in the permit area comes from coal fields that historically have not produced significant acid or toxic materials. This greatly minimizes the potential for acid- or toxic-forming materials to be present at the site. Furthermore, coal is only temporarily stored in the permit area, the native soils at the site are alkaline, and sediment and runoff are retained on site through the use of sedimentation ponds.
This further minimizes the potential for drainage from the site to adversely affect water quality, vegetation, public health, and safety of workers and the public.

**Sediment Yield.** The potential impact of mining and reclamation on sediment yield is an increase in sediment in the surface waters downstream from disturbed areas. Sediment-control measures (such as sedimentation ponds, drainage ditches, etc.) have been designed and constructed to minimize this impact. All runoff from the facility is directed toward one of two on-site sedimentation ponds that allow for sediment to settle. The ponds contain spillways to control discharge in the unlikely event that the ponds overflow. All runoff controls are regularly inspected (see Section 5.1.4) and maintained. The facility operates under UPDES Permit UTR000685, and also has a Storm Water Pollution Prevention Plan and a Spill Prevention Control and Countermeasure Plan. Copies of these permits are attached in Appendices 7-2, 7-3, and 7-4 respectively.

**Acidity, Total Suspended Solids, and Total Dissolved Solids.** Probable impacts of operations on the acidity and total suspended solids concentrations of surface and groundwater in the permit and adjacent areas were addressed previously in this section.

**Flooding or Streamflow Alteration.** The disturbed area is isolated from surrounding areas by runoff control structures such as earthen berms, diversion ditches, and sedimentation ponds. Runoff from all disturbed areas flows to sedimentation ponds prior to discharge to adjacent undisturbed drainages. Since no mining or exploration will occur at this site, there will be no impact on flooding or stream flows due to subsidence.

**Groundwater and Surface Water Availability.** Runoff controls at the site will minimize impacts to adjacent surface resources. As noted in Section 7.2.4.2, impacts to groundwater are also considered to be insignificant due to a combination of limited groundwater resources, poor groundwater quality, and relatively impermeable geologic materials at the site. Furthermore, the
coal cleaning facility uses limited amounts of water, thereby further minimizing potential adverse impacts to surface and groundwater.

**Potential Hydrocarbon Contamination.** Diesel fuel, oils, greases, and other hydrocarbon products are stored and used at the site for a variety of purposes. Diesel is stored in an above-ground tank that is provided with secondary containment. Spills onto the ground have the potential to occur during filling of the storage tank or filling of mobile equipment. Similarly, spills from drums containing greases and other oils may potentially occur during use at the site.

The probable future extent of the contamination caused by diesel and oil spillage is expected to be small for four reasons. First, all tanks and drums are stored in secondary containment structures that prevent leaks from reaching the ground. Second, spills caused by filling operations outside of the secondary containment structures will be minimized due to the economic value of the product. Third, because the tanks and drums are located above ground, leakage from the tanks can be readily detected and repaired. Finally, the Spill Prevention Control and Countermeasure Plan included in Appendix 7-5 mandates inspection, training, and operational measures to minimize the extent of contamination resulting from the use of hydrocarbons at the site.

**Road Salting.** No salting of the haul road occurs within the permit area. Hence, no impact will result from this action in the permit or adjacent areas.

**Coal Haulage.** Coal is hauled on the haul road within the permit area. Coal spillage will be promptly picked up. In addition to spills, wind may carry coal dust or small pieces of coal away from the open top of coal trucks. The impact from fugitive coal dust is considered to be insignificant due to the fugitive dust control measures implemented at the site.
7.2.9 Cumulative Hydrologic Impact Assessment (CHIA)

Information is provided in this application that will allow DOGM to update a Cumulative Hydrologic Impact Assessment if necessary.

7.30 Operation Plan

7.3.1 General Requirements

This permit application includes an operation plan which addresses the following:

- Groundwater and Surface Water Protection and Monitoring Plan
- Design Criteria and Plans
- Performance Standards
- Reclamation Plan.

7.3.1.1 Hydrologic-Balance Protection

**Groundwater Protection.** As indicated in Section 7.2.8.3, no significant potential exists for acid- or toxic-forming materials to be present in the permit area. If these materials are found to be present, they will be handled in accordance with Section 7.3.1.3. In this manner, BRCW will manage operations to prevent or control discharges of pollutants to the groundwater.

**Surface Water Protection.** A runoff control plan has been implemented to minimize, to the extent possible, additional contributions of suspended solids to streamflow outside the permit area, and otherwise prevent water pollution. BRCW will maintain adequate runoff- and sediment-control facilities to protect local surface waters.
7.3.1.2 Water Monitoring

**Groundwater Monitoring.** The prior owner installed one groundwater monitoring well within the permit area during the fourth quarter of 2008. Monitoring of this well will occur as outlined in Section 7.2.3.

**Surface Water Monitoring.** No streams exist within permit area. The closest perennial stream (Miller Creek) is located about 2000 feet south of the permit area. Therefore, only storm water will be monitored where it discharges from the sedimentation ponds. Monitoring of these discharges will be conducted in accordance with the requirements of the UPDES permit.

7.3.1.3 Acid- and Toxic-Forming Materials

As noted in Section 7.2.8.3, no significant potential exists for acid- or toxic-forming materials to be present at the site or to adversely affect water quality, vegetation, public health, and safety of workers and the public. To further minimize the potential for surface- and groundwater contamination, BRCW will sample all coal and coal waste that remains on site after an inactive period of 30 days. BRCW will collect one sample for every 2,000 yd$^3$ of the on-site material, composite these samples for the like material, and have this sample analyzed for acid-and toxic-forming materials in accordance with Tables 7 and 8 of DOGM’s Guidelines for the Analysis of Topsoil and Overburden. Material that is verified to contain acid- and toxic-forming materials will be processed no longer than one month following the receipt of verifying analyses of the BRCW samples.

7.3.1.4 Transfer of Wells

No wells exist at the facility.
7.3.1.5 Discharges

Two UPDES discharges are associated with the Wellington Dry-Coal Cleaning Facility—one for each sedimentation pond.

7.3.1.6 Stream Buffer Zones

The facility is not located within 100 feet of any perennial or intermittent stream channels. Thus, no buffer zones have been designated.

7.3.1.7 Cross Sections and Maps

The locations of water rights for current users of surface water in the general area are provided on Figure 7-3. Discharges associated with the sedimentation ponds are located as presented on this figure.

7.3.1.8 Water Rights and Replacement

BRCW will replace the water supply of an owner of interest in real property who obtains all or part of his or her supply of water for domestic, agricultural, industrial, or other legitimate use from an underground or surface source, where the supply has been adversely impacted by contamination, diminution, or interruption proximately resulting from activities conducted by BRCW in the permit area.

7.3.2 Sediment Control Measures

The existing sediment control measures within the permit area have been designed, constructed, and maintained to prevent additional contributions of sediment to streams or to runoff outside the permit area. In addition, they have been designed to meet applicable effluent
limitations, and minimize erosion. The structures to be used for the runoff control at the site include diversion channels, sedimentation ponds, containment berms, silt fences, and road diversions and culverts.

7.3.2.1 Siltation Structures

The siltation structures within the permit area consist of the sedimentation ponds described in Section 7.3.2.2.

7.3.2.2 Sedimentation Ponds

Two sedimentation ponds store precipitation runoff from the facility. Ordinarily, runoff collected in these ponds is allowed to evaporate or percolate into the ground. Sediment that accumulates in the ponds will be removed as needed. Runoff may be pumped out of the sediment ponds and used for dust suppression in accordance with the air quality permit.

Compliance Requirements. All sedimentation ponds will be maintained until the site is reclaimed or transferred to a future landowner. The sedimentation ponds were designed to contain sediment in addition to the runoff resulting from the 10-year, 24-hour storm event. The spillways for the sedimentation ponds were designed to adequately pass the peak flow resulting from the 25-year, 6-hour precipitation event.

MSHA Requirements. The sedimentation ponds at the site do not meet the size criteria of MSHA requirements defined in 30 CFR 77.216.

7.3.2.3 Diversions

The objective of the runoff control plan is to isolate, to the maximum degree possible, runoff from disturbed areas. All diversion ditches are maintained with adequate erosion protection.
in the ditch sections where flow velocities are great enough that a ditch lining is necessary. Adequate ditch capacities are maintained in all ditch sections. Culverts are kept free of debris. Detailed diversion design is presented in Section 7.4.2.

### 7.3.2.4 Road Drainage

Road drainage facilities include diversion ditches, culverts, and containment berms. Additional road drainage design information is presented in Section 7.4.2. All road drainage diversions will be maintained and repaired as needed following the occurrence of a large storm event. Culvert inlets and outlets will be kept clear of sediment and other debris.

### 7.3.3 Impoundments

#### 7.3.3.1 General Plans

Two sedimentation ponds operate at the facility as described in Section 7.3.2.2.

**Certification.** All maps and cross sections of the sedimentation ponds have been prepared by or under the direction of and certified by a qualified, registered, professional engineer.

**Maps and Cross Sections.** The topography and cross sections for the sedimentation ponds are located on Plate 7-1. The geometry of drainage channels and the sedimentation ponds were measured in the field, and placed on the map using an aerial photograph of the site.

**Narrative.** A description of each sedimentation pond is presented in Sections 7.3.2.2 and 7.4.2 of this document.

**Subsidence Survey Results.** Since no mining occurs at the site, a subsidence survey is not presented.
Hydrologic Impact. The hydrologic and geologic information required to assess the hydrologic impacts of the impoundments can be found in Section 7.2.4 and Chapter 6, respectively.

Design Plans and Construction Schedule. No additional impounding structures are proposed for the facility at this time. Designs of all existing structures are described in this document.

7.3.3.2 Permanent and Temporary Impoundments

Requirements. Impoundments at the facility consist of the two sedimentation ponds. These ponds will be retained following closure of the site for use by the future landowner to control runoff from the property. They have been designed and constructed using current, prudent, engineering practices. Since they have been constructed below grade, they are considered to be stable. Specific hydrologic design criteria for each impoundment are presented in Section 7.4.3. Each impoundment will be inspected regularly based on the schedule contained in Section 5.1.4.3. The sedimentation ponds meet the requirements for retention as permanent impoundments as indicated below:

- R645-301-733.221: The future use of the ponds would be for runoff and sediment control. The ponds were designed in accordance with the requirements of the R645 rules, which requirements are consistent with the storm-water control requirements of the Utah Division of Water Quality. Thus, the size and configuration of the impoundments is adequate for their future intended use as storm-water control structure.
- R645-301-733.222: The ponds have been designed to meet the water-quality requirements of the R645 rules, which rules are consistent with Utah and federal water-quality standards for storm-water control structures. Hence, discharges from the ponds will meet applicable effluent limitations and will not degrade the quality of receiving waters below applicable Utah and federal water-quality standards.
- R645-301-733.223: The ponds will function in the future as runoff-control structures. As such, their operation is independent of water-level fluctuations.
• R645-301-733.224: The ponds are designed as runoff- and sediment-control structures. It is not intended that they be accessed by water users, either now or in the future.
• R645-301-733.225: The effect of the ponds on the quantity and quality of water in the general area is discussed in Section 7.2.8.3 of this application. Beneficial effects to water quality and insignificant effects on water quantity will continue in the future.
• R645-301-733.226: The ponds were designed to serve as storm-water control structures. This is accomplished by retaining sediment and detaining runoff on site to minimize the effects of site development on adjacent lands. The ponds are suitable to serve these functions in the future.

**Hazard Notifications.** The sedimentation ponds will be examined for structural weakness and erosion at least four times per year.

### 7.3.4 Discharge Structures

The discharge structures at the site include the spillways on the sedimentation ponds. These discharge structures are described in Section 7.4.4.

### 7.3.5 Disposal of Excess Spoil

No excess spoil is generated at the facility.

### 7.3.6 Coal Mine Waste

No coal mine waste is stored at the facility.

### 7.3.7 Nonecoal Mine Waste

Non-coal mine waste is not stored or disposed of on site (see Chapter 5).
7.3.8 Temporary Casing and Sealing of Wells

The future groundwater monitoring well at the facility will be constructed in compliance with R645-301-748.

7.40 Design Criteria and Plans

7.4.1 General Requirements

This section includes site-specific plans that incorporate minimum design criteria for the control of drainage from disturbed areas. Refer to Appendix 7-6 for a description of the hydrologic design methods used to design the sedimentation ponds and diversion structures at the facility.

7.4.2 Sediment Control Measures

7.4.2.1 General Requirements

Design. Existing sediment control measures have been designed, constructed and maintained to:

- Prevent additional contributions of sediment to stream flow or to runoff outside the permit area,
- Meet the effluent limitations defined in R645-301-751, and
- Minimize erosion to the extent possible.

Measures and Methods. The sediment control measures at the facility include:

- Retention of sediment within the disturbed area
- Diversion of runoff using channels or culverts through disturbed areas to prevent additional erosion
• Provide straw bale dikes, riprap, dugout ponds, silt fencing, and other measures that reduce overland flow velocities, reduce runoff volumes or trap sediment.

7.4.2.2 Siltation Structures

General Requirements. Additional contributions of suspended solids and sediment to stream flow or runoff outside the permit area is being prevented to the extent possible using two sedimentation ponds as siltation structures. They are located in the southeast and southwest corners of the disturbed area. Each structure has been certified by a qualified registered professional engineer. They have been designed, constructed and maintained as described in Chapter 5 and Sections 7.3.3 and 7.4.3.

Sedimentation Ponds. The sedimentation ponds are designed to work individually. One pond receives runoff from the eastern portion of the disturbed area, and one pond receives runoff from the western portion of the disturbed area. Neither of the ponds is located within a perennial stream channel.

Sediment Storage Volume. The sedimentation ponds were designed to contain sediment in addition to runoff from the design storm event. The expected annual sediment volume reporting to each of the sedimentation ponds was calculated using a modified form of the Universal Soil Loss Equation developed specifically for conditions in Utah (Israelsen et al., 1984). As indicated in Table 7-2 and Appendix 7-7, the calculated annual sediment volume deposited in the eastern sedimentation pond is 333 cubic feet, and the calculated annual sediment volume deposited in the western sedimentation pond is 134 cubic feet.

The east and west sedimentation ponds have been constructed to store 16,930 and 12,730 cubic feet of sediment, respectively. These volumes correspond to approximately 51 and 95 years of average annual sediment storage for the east and west ponds, respectively. The practical effect of the substantial sediment storage life of the ponds will be to provide excess runoff storage during the period of facility operation. Based on a bottom elevation of 5,493.8 feet in the east

EarthFax Engineering, Inc.
sedimentation pond and 5,498.2 feet in the west sedimentation pond, the elevation in each sedimentation pond corresponding to the maximum sediment storage is 5,498.6 feet in the east pond (4.8 feet above the bottom) and 5,505.4 feet in the west pond (7.2 feet above the bottom). The 60% sediment cleanout elevations for the east and west sedimentation ponds are 5,497.3 feet and 5,503.4 feet, respectively (3.5 and 5.2 feet above the bottoms, respectively). Refer to Appendix 7-7 for sediment storage calculations.

**Detention Time.** Given the substantial storage volume of the ponds relative to standard site requirements, an adequate detention time will be provided in each pond to allow the effluent to meet UPDES limitations. Prior to discharge of pond water to the adjacent area, this water will be sampled to ensure that it meets the above-referenced effluent limitations. Water may be periodically pumped from the ponds and used for dust suppression within the permit area.

**Design Runoff Event.** The sedimentation ponds are designed to fully contain runoff resulting from the 10-year, 24-hour precipitation event. The drainage characteristics, including contributing area, runoff curve number, and hydraulic length were calculated as shown in Appendix 7-7. The runoff storage volumes for the design event were calculated to be 36,970 and 14,850 cubic feet for the east and west ponds, respectively. In order to contain runoff from the design precipitation event and the design sediment volume, the elevations of the spillways were located at 5,503.8 feet and 5,508.0 feet for the east and west sedimentation ponds, respectively.

**Sediment Removal.** Sediment will be removed from the when the sediment level reaches an elevation corresponding to 60% of the total sediment storage volume. As noted in Plate 7-1 and Appendix 7-7, the 60% clean-out elevation is 5,497.3 feet and 5,503.4 feet for the east and west sedimentation ponds, respectively. Sediment that contains a significant amount of coal will be processed at the coal cleaning facility. Sediment that contains an insignificant amount of coal will be blended with byproduct produced at the facility.
**Excessive Settlement.** The sedimentation ponds within the permit area were excavated into natural soil. Excessive settlement has not been observed and, given the excavated construction, is not anticipated in the future at either sedimentation pond.

**Embankment Material.** Sedimentation pond embankment materials are free of sod, large roots, frozen soil, and acid- or toxic forming coal-processing waste.

**Compaction.** During construction the sedimentation ponds, the limited embankments were compacted using standard construction practices.

**MSHA Sedimentation Ponds.** The sedimentation ponds at the site do not meet the size criteria of MSHA requirements defined in 30 CFR 77.216.

**Sedimentation Pond Spillways.** Each sedimentation pond is equipped with a swale on its downstream side that serves as a spillway. Each spillway is trapezoidal in cross section and measures approximately 2 feet deep and 1 foot wide with 1H:1V side slopes. These spillways were designed to safely discharge the peak flow resulting from the 25-year, 6-hour precipitation event (see Appendix 7-7). If the ponds spill, this water will discharge as overland flow, eventually reaching Miller Creek if it does not first infiltrate. The design spillway event was modeled using HydroCAD 8.5 computer software. Since the sedimentation ponds contain sufficient volume to contain several years' worth of sediment yield, it is likely that the ponds will not spill during BRCW operations.

In the eastern pond, the peak inflow during the 25-year, 6-hour precipitation was calculated to be 9.99 cubic feet per second ("cfs"), and the peak outflow through the spillway was calculated to be 2.29 cfs with a peak velocity of 2.01 feet per second ("fps"). Since the peak outflow velocity is less than approximately 5 fps, it is considered non-erosive, and erosion protection is not required. The peak stage during this event was calculated to be 5,504.3 feet (10.5 feet above the pond bottom).
In the western pond, the peak inflow during the 25-year, 6-hour precipitation was calculated to be 3.24 cfs, and the peak outflow was calculated to be 0.04 cfs with a peak velocity of 0.46 fps. Since the peak outflow velocity is less than approximately 5 fps, it is considered non-erosive, and erosion protection is not required. The peak stage during this event was calculated to be 5,508.03 feet (9.8 feet above the pond bottom).

**Other Treatment Facilities.** No other water treatment facilities are located within the permit area.

**Exemptions.** Two alternate sediment control areas exist at the locations shown on Plate 7-2. These areas will be bounded by a minimum 6-inch high berm or fiber roll as indicated, each installed on the inside of the facility fence. Calculations to support the design of these alternate sediment control areas are provided in Appendix 7-9.

The berm noted on Plate 7-2 is existing and was installed during site grading along the interior of the facility fence. This berm, which has the approximate dimensions noted on Plate 7-2, effectively keeps runoff from flowing off site to the property west of the facility. The berm will be maintained with a minimum height of 6 inches.

Fiber rolls will be installed at the location shown on Plate 7-2 in accordance with manufacturer’s instructions. Approximately half of the roll will extend below the ground surface and individual sections of fiber roll will be overlapped horizontally to preclude bypass of sediment. Each fiber roll will be staked into the ground on centers that do not exceed 4 feet. Although the junction point of the berm and fiber rolls may vary somewhat from that indicated on Plate 7-2, a barrier with a minimum height of 6 inches will be maintained in the indicated locations.
7.4.2.3 Diversions

General Requirements. The diversions within the permit area consist of drainage ditches and culverts. All diversions within the permit area have been designed to minimize adverse impacts to the hydrologic balance, to prevent material damage outside the permit area, and to assure the safety of the public. They have been designed, located, constructed, maintained, and used to:

- Be stable
- Provide protection against flooding and resultant damage to life and property
- Prevent, to the extent possible, additional contributions of suspended solids to stream flow outside the permit area
- Comply with all applicable local, state, and federal laws and regulations

Peak discharge rates from the drainages within the permit area were calculated for use in determining the adequacy of the existing diversion ditches and culverts. Since the diversions will remain in place for the future landowner following cessation of BRCW operations, runoff was calculated assuming permanent diversion structures based on the 100-year, 6-hour precipitation event of 1.74 inches. Curve numbers were based on those defined in Appendix 7-7. A description of the methods used to determine the peak discharge rates is presented in Appendix 7-8.

Watershed boundaries for the facility are presented on Plate 7-2. The disturbed area boundary is surrounded by a berm along the upstream edge and its sides in order to divert runoff around the site. Thus, the watersheds that drain the facility consist only of disturbed areas. The watershed contributing to the east sedimentation pond has been divided into five sub-watersheds which total 17.4 acres in area. The watershed contributing to the west sedimentation pond has been divided into three sub-watersheds which total 7.0 acres in area. The remaining 5.6 acres of the site are situated along the edges of the facility, outside of the diversion ditches, and is not disturbed. All of the area within the watersheds reporting to the ditches and the sedimentation ponds has been considered to be disturbed in the hydrology calculations.
The size and location of each existing diversion ditch and culvert were mapped using an aerial photograph of the site and verified in the field. All diversions are shown on Plate 7-2. The capacity and freeboard of each diversion ditch were determined based on the minimum ditch slope, while the maximum velocity and need for erosion protection were verified based on the maximum ditch slope. The capacity of each culvert was determined using the minimum culvert slope and the outlet velocity and riprap protection was verified using the culvert outlet slope. Slopes were measured from a pre-construction contour map of the site. A description of the methods used to determine diversion capacities, flow velocities, and erosion protection requirements is presented in Appendix 7-6. All diversion calculations are presented in Appendix 7-8.

**Diversion of Perennial and Intermittent Streams.** There are no diversions of perennial or intermittent streams at the facility.

**Diversion Ditches and Culverts.** A summary table of the geometry, channel slope, peak discharge, erosion protection, maximum flow velocity and minimum depth values for each diversion ditch and culvert at the facility is presented in Table 7-3. Diversion hydrology calculations are detailed in Appendix 7-8. Each ditch and culvert has been constructed to non-erosively convey the peak flow resulting from the 25-year, 6-hour precipitation event and to contain the flow resulting from the 100-year, 6-hour precipitation event. A description of the diversion ditches and culverts within the facilities area is presented below and in Table 7-2. The ditches are named according to the watersheds that they drain. Ditches prefixed by the letter "E" ultimately report to the east sedimentation pond, and ditches prefixed by the letter "W" ultimately report to the west sedimentation pond. Since some watersheds are drained by culverts instead of ditches, the ditches are not numbered strictly chronologically. Refer to Plate 7-2 for the locations of each watershed and diversion structure.

- **Ditch E-1 (Upper).** This ditch exists on the east edge of the permit area just within the permit area boundary. It conveys runoff from the northern portion and eastern
edge of the site southward toward the east sedimentation pond. It begins at the outlet of culvert C-1 and continues to the outlet of culvert C-2.

- **Ditch E-1 (Lower).** This ditch conveys runoff southward from the outlet of culvert C-2 to culvert C-7 at the inlet of the east sedimentation pond.

- **Ditch E-3.** This ditch conveys runoff from the southeastern corner of the inner yard to the east sedimentation pond.

- **Ditch E-4.** This ditch conveys runoff southward from the region between the top of the truck dump hopper embankment and the road on the east edge of the permit area.

- **Ditch E-5.** This ditch conveys runoff eastward along the southern edge of the permit area toward the east sedimentation pond. It captures runoff from the eastern watershed of the inner yard that is not captured by ditch E-3.

- **Ditch W-1 (Upper).** This ditch runs along the west edge of the permit area. It conveys runoff from the northern portion and western edge of the site southward toward the west sedimentation pond. It begins just west of the northwest corner of the yard access road and extends to the outlet of culvert C-3.

- **Ditch W-1 (Lower).** This ditch runs from the outlet of culvert C-3 to culvert C-5 at the inlet of the west sedimentation pond. It conveys runoff from the W-1 (Upper) Ditch and the W-2 Ditch into the west sedimentation pond.

- **Ditch W-2.** This ditch runs on the east side of the silo and its access road, and drains the area located to the east. It drains into culvert C-3, which feeds into Ditch W-1 (Lower).

- **Ditch W-3.** This ditch conveys runoff westward along the southern edge of the permit area toward the west sedimentation pond. It captures runoff from the area south of the perimeter access road that drains toward the west sedimentation pond.

- **Culvert C-1.** This culvert conveys runoff from watershed E-2 under the truck turnaround road in the northeastern corner of the site. It provides drainage for the area enclosed by the road embankments for the yard perimeter road and the truck turnaround.

- **Culvert C-2.** This culvert conveys runoff under the road in the southeastern corner of the permit area. It provides drainage for the area enclosed by the road embankments for watershed E-4, including the yard perimeter road and the truck dump hopper.
• **Culvert C-3.** This culvert conveys runoff under the road in the southwestern corner of the permit area. It provides a route for drainage from Ditch W-2 to travel under the road and into Ditch W-1 (Lower).

• **Culvert C-4.** This culvert is installed within Ditch W-1 (Lower) to allow vehicular access into the area south of the Loop Road.

• **Culvert C-5.** This culvert is installed at the inlet to the west sedimentation pond. Riprap with a minimum median diameter of 6 inches has been installed at the outlet of this culvert to provide erosion protection.

• **Culvert C-6.** This culvert is installed beneath the southeast corner of the Loop Road and extends a sufficient distance to allow vehicular access from the east to the area south of the road.

• **Culvert C-7.** This culvert is installed at the inlet to the east sedimentation pond. Riprap with a minimum median diameter of 10 inches has been installed at this outlet of this culvert to provide erosion protection.

### 7.4.2.4 Road Drainage

Roads at the facility include an access road that leads from Ridge Road into the main yard, a road around the perimeter of the main yard, and a truck turnaround north of the main yard. All of the roads have been constructed to include adequate drainage control with the use of diversion ditches, culverts, and containment berms. None of the roads are located in the channel of an intermittent or perennial stream. All roads have been located to minimize downstream sedimentation and flooding. Diversion ditches and culverts for all roads are described in Section 7.4.2.3 above.

### 7.4.3 Impoundments

The existing impoundments within the permit area consist of two sedimentation ponds along the southern boundary of the disturbed area. Pertinent information regarding these ponds is presented in Sections 7.3.2.2 and 7.4.2.2.
7.4.4 Discharge Structures

The discharge structures within the permit area consist of the spillways on each sedimentation pond. The spillways have been designed to safely pass the peak discharge resulting from the 25-year, 6-hour rainfall event, assuming starting pond storage equal to the 60% sediment cleanout volume and the 10-year, 24-hour runoff volume. Detailed information for each sedimentation pond is presented in Sections 7.3.2.2 and 7.4.2.2.

Each sedimentation pond is equipped with a swale on its downstream side that serves as a spillway. Small embankments have been constructed adjacent to the spillways. Each spillway is trapezoidal in cross section and measures approximately 2 feet deep and 3 feet wide with 1H:1V side slopes. The spillways are armored with rip rap ($D_{50} = 4$ inches). If they spill, this water will discharge as overland flow toward Miller Creek.

7.4.4.1 Erosion Protection

Each discharge structure was evaluated to determine the adequacy of the existing riprap and the hydraulic capacity of the structure during the 25-year, 6-hour precipitation event. The calculations for the discharge structures within the facilities area are presented in Appendix 7-7. Peak discharges from all of the discharge structures during their design events did not exceed 5 feet per second (fps). Thus, the flows are considered non-erosive.

7.4.4.2 Design Standards

All discharge structures within the permit area were designed and constructed according to standard engineering design procedures.
7.4.5 Disposal of Excess Spoil

No excess spoil is generated or disposed of within the permit area.

7.4.6 Coal Mine Waste

7.4.6.1 General Requirements

No coal mine waste is stored on site.

7.4.6.2 Refuse Piles

No refuse piles are located at the facility.

7.4.6.3 Impounding Structures

No impounding structures within the permit area have been constructed of coal mine waste or are used to impound coal mine waste.

7.4.6.4 Return of Coal Processing Waste to Underground Workings

No underground workings are located at this facility.

7.4.7 Disposal of Noncoal Mine Waste

Disposal of noncoal waste is discussed in Chapter 5.
7.4.8 Casing and Sealing of Wells

The groundwater monitoring well to be installed in the permit area will be cased and sealed at the surface to prevent potential acid or other toxic drainage from entering groundwater via the well. The surface will be completed with a lockable steel casing to protect the well and ensure the safety of people, livestock, wildlife, and machinery.

7.50 Performance Standards

All operations and reclamation will be conducted to minimize disturbance to the hydrologic balance within the permit and adjacent areas, prevent material damage to the hydrologic balance outside the permit area, and support approved post operations land uses.

7.5.1 Water Quality Standards and Effluent Limitations

Discharges of water from disturbed areas will be in compliance with all applicable Utah and federal water quality laws and regulations and with applicable effluent limitations for coal mining contained in 40 CFR Part 434. The area outside of the permit-area fence line will be inspected at least once each calendar quarter for the presence of wind-blown coal dust. Accumulations of coal dust more than ½-inch thick will be cleaned within seven days of discovery using shovels or vacuum trucks. Coal dust thus removed will be placed within the permit area at a location that drains to a sedimentation pond.

7.5.2 Sediment Control Measures

All sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 7.3.2, 7.4.2, and 7.6.0.
7.5.2.1 Siltation Structures and Diversions

Siltation structures and diversions will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 7.3.2, 7.4.2, and 7.6.3.

7.5.2.2 Road Drainage

All roads will be located, designed, constructed, reconstructed, used, maintained and reclaimed according to plans and designs presented in Sections 7.3.2.4, 7.4.2.4, and 7.6.2. All roads have been designed to:

- Control or prevent erosion and siltation by maintaining or stabilizing all exposed surfaces in accordance with current, prudent engineering practices;
- Control or prevent additional contributions of suspended solids to stream flow or runoff outside the permit area;
- Neither cause nor contribute to, directly or indirectly, the violation of effluent standards given under Section 7.5.1.
- Minimize the diminution to or degradation of the quality or quantity of surface- and ground-water systems;
- Refrain from significantly altering the normal flow of water in streambeds or drainage channels.

7.5.3 Impoundments and Discharge Structures

Impoundments and discharge structures will be located, maintained, constructed and reclaimed as described in Sections 7.3.3, 7.3.4, 7.4.3, 7.4.5, and 7.6.0.

7.5.4 Disposal of Excess Spoil, Coal Mine Waste and Noncoal Mine Waste

Handling and disposal of coal mine waste and noncoal mine waste is described in Sections 7.3.6, 7.3.7, 7.4.6, 7.4.7, 7.6.0 and Chapter 5.
7.5.5 Casing and Sealing of Wells

When no longer needed, the groundwater monitoring well in the permit area will be abandoned in accordance with R645-301-765 and the requirements of the Utah Division of Water Rights.

7.60 Reclamation

7.6.1 General Requirements

A detailed reclamation plan for the facility is presented in Section 5.40. In general, BRCW will ensure that all temporary structures are removed and reclaimed. Permanent diversions will be maintained properly and will meet the requirements of the approved reclamation plan for permanent structures and impoundments. BRCW will renovate the diversion structures if necessary to meet the requirements of R614-301 and R614-302 and to conform to the approved reclamation plan.

7.6.2 Roads

All site roads will be retained for use under the operational industrial land use.

7.6.2.1 Restoring the Natural Drainage Patterns

The facility does not interfere with natural drainage patterns that require restoration.

7.6.2.2 Reshaping Cut and Fill Slopes

No cut and fill slopes are located at the facility.
7.6.3 Siltation Structures

7.6.3.1 Maintenance of Siltation Structures

All siltation structures will be maintained in accordance with the approved reclamation plan.

7.6.3.2 Removal of Siltation Structures

It is anticipated that siltation structures at the site will be retained following reclamation, for use by the future landowner, in accordance with the reclamation plan presented in Section 5.40.

7.6.4 Structure Removal

A timetable for the removal of each structure is presented in Table 5-2.

7.6.5 Permanent Casing and Sealing of Wells

When no longer needed, the groundwater monitoring well in the permit area will be abandoned in accordance with R645-301-765 and the requirements of the Utah Division of Water Rights.
REFERENCES


### TABLE 7-1

Results of Groundwater Analyses

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field Analyses (units as indicated)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth to water (ft)(^{(a)})</td>
<td>12.00</td>
<td>12.01</td>
<td>12.53</td>
<td>12.54</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>12.1</td>
<td>11.0</td>
<td>15.7</td>
<td>17.1</td>
</tr>
<tr>
<td>pH (std units)</td>
<td>7.40</td>
<td>7.13</td>
<td>6.71</td>
<td>6.90</td>
</tr>
<tr>
<td>Specific conductance (µS)</td>
<td>9,900</td>
<td>--</td>
<td>9,370</td>
<td>9,990</td>
</tr>
<tr>
<td><strong>Laboratory Analyses (mg/L)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicarbonate as CaCO(_3)</td>
<td>270</td>
<td>270</td>
<td>260</td>
<td>280</td>
</tr>
<tr>
<td>Calcium</td>
<td>390</td>
<td>370</td>
<td>390</td>
<td>410</td>
</tr>
<tr>
<td>Carbonate as CaCO(_3)</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Chloride</td>
<td>84</td>
<td>68</td>
<td>66</td>
<td>75</td>
</tr>
<tr>
<td>Iron, dissolved</td>
<td>&lt;0.050</td>
<td>&lt;0.050</td>
<td>0.97</td>
<td>0.92</td>
</tr>
<tr>
<td>Iron, total</td>
<td>300</td>
<td>5.6</td>
<td>0.27</td>
<td>5.6</td>
</tr>
<tr>
<td>Magnesium</td>
<td>270</td>
<td>270</td>
<td>260</td>
<td>270</td>
</tr>
<tr>
<td>Manganese, dissolved</td>
<td>0.57</td>
<td>0.60</td>
<td>0.58</td>
<td>0.50</td>
</tr>
<tr>
<td>Manganese, total</td>
<td>3.9</td>
<td>0.75</td>
<td>0.58</td>
<td>0.50</td>
</tr>
<tr>
<td>Nitrate/Nitrite as N</td>
<td>0.34</td>
<td>0.015</td>
<td>0.41</td>
<td>0.036</td>
</tr>
<tr>
<td>Potassium</td>
<td>36</td>
<td>26</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>Sodium</td>
<td>1,900</td>
<td>2,000</td>
<td>2,000</td>
<td>2,200</td>
</tr>
<tr>
<td>Sulfate</td>
<td>5,700</td>
<td>5,600</td>
<td>5,500</td>
<td>6,100</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>11,000</td>
<td>8,900</td>
<td>8,800</td>
<td>8,400</td>
</tr>
</tbody>
</table>

\(^{(a)}\) Measured as depth from ground surface
TABLE 7-2

Summary of Sedimentation Pond Data

<table>
<thead>
<tr>
<th></th>
<th>East Pond</th>
<th>West Pond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed bottom elevation (ft)</td>
<td>5,493.8</td>
<td>5,498.2</td>
</tr>
<tr>
<td>Assumed crest elevation (ft)</td>
<td>5,505.8</td>
<td>5,510.0</td>
</tr>
<tr>
<td>Total Storage Capacity (ft³)</td>
<td>53,900</td>
<td>36,070</td>
</tr>
<tr>
<td>Calculated Annual Sediment Volume (ft³)</td>
<td>333</td>
<td>134</td>
</tr>
<tr>
<td>10-Year, 24-Hour Precip. Runoff Volume (ft³)</td>
<td>36,970</td>
<td>14,850</td>
</tr>
<tr>
<td>Sediment Storage Capacity (ft³)</td>
<td>16,930</td>
<td>21,220</td>
</tr>
<tr>
<td>60% Sediment Storage Cleanout Volume (ft³)</td>
<td>10,160</td>
<td>12,730</td>
</tr>
<tr>
<td>Sediment Cleanout Elevation (ft)</td>
<td>5,498.6</td>
<td>5,505.4</td>
</tr>
<tr>
<td>Peak Stage of 10-Year, 24-Hour Precipitation Event Plus 60% Sediment Storage Capacity (ft)</td>
<td>5,503.0</td>
<td>5,506.4</td>
</tr>
<tr>
<td>Invert elevation of 3-foot wide armored spillway (ft)</td>
<td>5,503.7</td>
<td>5,508.0</td>
</tr>
<tr>
<td>Peak Pond Inflow Due to 25-Year, 6-Hour Precipitation Event (cfs)</td>
<td>9.24</td>
<td>2.70</td>
</tr>
<tr>
<td>Peak Pond Outflow due to 25-Year, 6-Hour Precipitation Event (cfs)</td>
<td>2.26</td>
<td>0.29</td>
</tr>
<tr>
<td>Peak Pond Outflow Velocity due to 25-Year, 6-Hour Precipitation Event (fps)</td>
<td>2.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Peak Stage of 25-Year, 6-Hour Precipitation Event Following a 10-Year, 24-Hour Precipitation Event with Pond Full to 60% of Sediment Storage Capacity (ft)</td>
<td>5,504.3</td>
<td>5,508.1</td>
</tr>
</tbody>
</table>

Notes:
- Refer to Appendix 7-7 for calculations related to sedimentation pond design
- Pond dimensions were surveyed by EIS Environmental and Engineering Consulting in November 2007. Absolute elevations were assumed by superimposing the survey data on the pre-construction topography provided by Mine and Mill Engineering. Each pond has a berm extending approximately 2 ft above the ground surface.
TABLE 7-3

Summary of Drainage Ditch and Culvert Data

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description</th>
<th>Peak Flow (cfs) $^{(a)}$</th>
<th>Max. Flow Depth (ft) $^{(b)}$</th>
<th>Max. Flow Velocity (fps) $^{(c)}$</th>
<th>Required Riprap D$_{50}$ (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ditches</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-1 Upper</td>
<td>Triangular, 1:1 sides, 1.5' deep</td>
<td>1.75</td>
<td>0.91</td>
<td>2.57</td>
<td>None</td>
</tr>
<tr>
<td>E-1 Lower</td>
<td>Triangular, 1.5:1 sides, 1.5' deep</td>
<td>1.75</td>
<td>0.73</td>
<td>2.62</td>
<td>None</td>
</tr>
<tr>
<td>E-3</td>
<td>Trapezoidal, 2.5:1 left, 1:1 right, 0.5' bottom, 1.5' deep</td>
<td>4.80</td>
<td>0.84</td>
<td>3.41</td>
<td>None</td>
</tr>
<tr>
<td>E-4</td>
<td>Triangular, 2:1 left, 1:1 right, 1.2' deep</td>
<td>1.16</td>
<td>0.60</td>
<td>2.12</td>
<td>None</td>
</tr>
<tr>
<td>E-5</td>
<td>Triangular, 4:1 sides, 1.0' deep</td>
<td>4.98</td>
<td>0.76</td>
<td>3.40</td>
<td>None</td>
</tr>
<tr>
<td>W-1 Upper</td>
<td>Triangular, 2:1 sides, 2.0' deep</td>
<td>1.50</td>
<td>0.65</td>
<td>2.60</td>
<td>None</td>
</tr>
<tr>
<td>W-1 Lower</td>
<td>Triangular, 2:1 sides, 2.0' deep</td>
<td>2.44</td>
<td>0.83</td>
<td>2.54</td>
<td>None</td>
</tr>
<tr>
<td>W-2</td>
<td>Trapezoidal, 1:1 left, 2:1 right, 2.0' bottom, 1.0' deep</td>
<td>2.79</td>
<td>0.51</td>
<td>3.20</td>
<td>None</td>
</tr>
<tr>
<td>W-3</td>
<td>Triangular, 4.5:1 left, 1:1 right, 1.0' deep</td>
<td>1.81</td>
<td>0.74</td>
<td>2.54</td>
<td>None</td>
</tr>
<tr>
<td><strong>Culverts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-1</td>
<td>Corrugated, 18&quot; diameter</td>
<td>1.40</td>
<td>0.35</td>
<td>4.46</td>
<td>None</td>
</tr>
<tr>
<td>C-2</td>
<td>Corrugated, 18&quot; diameter</td>
<td>0.63</td>
<td>0.24</td>
<td>3.45</td>
<td>None</td>
</tr>
<tr>
<td>C-3</td>
<td>Corrugated, 18&quot; diameter</td>
<td>2.23</td>
<td>0.49</td>
<td>4.51</td>
<td>None</td>
</tr>
<tr>
<td>C-4</td>
<td>Corrugated, 18&quot; diameter</td>
<td>1.17</td>
<td>0.44</td>
<td>2.76</td>
<td>None</td>
</tr>
<tr>
<td>C-5</td>
<td>Corrugated, 18&quot; diameter</td>
<td>2.70</td>
<td>0.34</td>
<td>9.02</td>
<td>6</td>
</tr>
<tr>
<td>C-6</td>
<td>Corrugated, 18&quot; diameter</td>
<td>4.80</td>
<td>0.83</td>
<td>4.83</td>
<td>None</td>
</tr>
<tr>
<td>C-7</td>
<td>Corrugated, 18&quot; diameter</td>
<td>9.24</td>
<td>0.69</td>
<td>11.54</td>
<td>10</td>
</tr>
</tbody>
</table>

$^{(a)}$ 25-yr, 6-hr event (see Appendix 7-7)
$^{(b)}$ Based on minimum channel slope (see Appendix 7-8)
$^{(c)}$ Based on maximum channel slope (see Appendix 7-8)
FIGURE 7.1. GENERALIZED AREA HYDROSTRATIGRAPHIC CROSS-SECTION

Adapted from Gloyn et al., 2003
FIGURE 7-2. MONITORING WELL LOCATION
APPENDIX 7-1

Monitoring Well Lithologic and Completion Log
**Monitor Well #1**

<table>
<thead>
<tr>
<th>Headwaters Incorporated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covol Engineered Fuels Facility</td>
</tr>
<tr>
<td>Wellington, UT</td>
</tr>
<tr>
<td>Project UC1091</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date Started</th>
<th>Dec 24, 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Completed</td>
<td>Dec 24, 2008</td>
</tr>
<tr>
<td>Hole Diameter</td>
<td>6&quot; auger</td>
</tr>
<tr>
<td>Drilling Method</td>
<td>Geoprobe Rig</td>
</tr>
<tr>
<td>Sampling Method</td>
<td>Grab</td>
</tr>
<tr>
<td>Company Rep.</td>
<td>C. Clement</td>
</tr>
<tr>
<td>Northing Coord.</td>
<td></td>
</tr>
<tr>
<td>Easting Coord.</td>
<td></td>
</tr>
<tr>
<td>Survey By</td>
<td></td>
</tr>
<tr>
<td>Logged By</td>
<td>B. Haller</td>
</tr>
</tbody>
</table>

---

**DESCRIPTION**

- **Monument**
- **Bentonite Seal**
- **Silica Sand Pack**

**Well Construction Information**

**WELL CONSTRUCTION**
- Date Compl.: December 2008
- Hole Diameter: 6"
- Drill. Method: Geoprobe Rig
- Company Rep.: C. Clement

**WELL CASING**
- Material: PVC
- Diameter: 2-inch
- Joints: Flush Joint

**WELL SCREEN**
- Material: PVC
- Diameter: 2-inch
- Joints: Flush Joint
- Opening: 0.010 Sclt

**SAND PACK**
- Type: Silica Sand
- Size: 20-40 Mesh

**ANNULUS SEAL**
- Type: Bentonite

**END CAP**
- Cap: PVC End Cap

**NOTES:**

---

INCORPORATED

August 31, 2009

Div. of Oil, Gas & Mining
APPENDIX 7-2

Water Rights Data
WATER RIGHTS (PLACE OF USE) in: Section 14 Township 15S Range 10E SL Base & Meridian

(The Division of Water Rights makes NO claims regarding the accuracy of this data!!!)

<table>
<thead>
<tr>
<th>POD</th>
<th>ST/TOR</th>
<th>TYPE</th>
<th>WATER USES</th>
</tr>
</thead>
<tbody>
<tr>
<td>POD</td>
<td>ST/TOR</td>
<td>TYPE</td>
<td>WATER USES</td>
</tr>
<tr>
<td>91-126</td>
<td>CERT</td>
<td>I</td>
<td>ISDMu</td>
</tr>
<tr>
<td>91-135</td>
<td>APP</td>
<td>I</td>
<td>ISDMu</td>
</tr>
<tr>
<td>91-2</td>
<td>CERT</td>
<td>I</td>
<td>ISDMu</td>
</tr>
<tr>
<td>91-3</td>
<td>CERT</td>
<td>S</td>
<td>ISDM</td>
</tr>
<tr>
<td>91-3294</td>
<td>DIL</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>91-3295</td>
<td>DIL</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>91-4271</td>
<td>TEMP</td>
<td>I</td>
<td>O</td>
</tr>
<tr>
<td>91-4950</td>
<td>CERT</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>91-4961</td>
<td>CERT</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>91-4962</td>
<td>CERT</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>91-4973</td>
<td>CERT</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>91-4986</td>
<td>CERT</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>91-4992</td>
<td>CERT</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>91-4999</td>
<td>CERT</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>91-5000</td>
<td>CERT</td>
<td>I</td>
<td>I</td>
</tr>
</tbody>
</table>

WR-CH-EX# POD ST/TOR TYPE WATER USES

NW  | NE  | SW  | SE  |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>N</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>N</td>
<td>N</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>W</td>
<td>E</td>
<td>W</td>
<td>E</td>
</tr>
<tr>
<td>W</td>
<td>E</td>
<td>W</td>
<td>E</td>
</tr>
</tbody>
</table>

SE4NE4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
SE4NW4, S2NW4, SW4, S2SE4, NE4SE4
<table>
<thead>
<tr>
<th>Parcel</th>
<th>Type</th>
<th>Status</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>91-5138</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5139</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5142</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5144</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5147</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5148</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5149</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5152</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5153</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5154</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5155</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5156</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5158</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5159</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-5160</td>
<td>S</td>
<td>CERT</td>
<td>I</td>
</tr>
<tr>
<td>91-88</td>
<td>S</td>
<td>WD</td>
<td>I</td>
</tr>
</tbody>
</table>

A total of **77 ENTRIES** were found with Place(s) of Use in:
Section 14, Township 15S, Range 10E, SL Base & Meridian

---

Utah Division of Water Rights  | 1594 West North Temple Suite 220, P.O. Box 146300, Salt Lake City, Utah 84114-6300  | 801-538-7240
Natural Resources | Contact | Disclaimer | Privacy Policy | Accessibility Policy

---

Div. of Oil, Gas & Mining  
Incorporated  
August 31, 2009
Search of Section 14, Township 15S, Range 10E, SL h&m Criteria:wrtypes=W,C,E podtypes=all status=U,A,P usetypes=all

<table>
<thead>
<tr>
<th>WR Number</th>
<th>Diversion Type/Location</th>
<th>Well Log Status</th>
<th>Priority</th>
<th>Uses</th>
<th>CFS</th>
<th>ACFT</th>
<th>Owner Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>91-3294</td>
<td>Point to Point</td>
<td>P</td>
<td>18690000</td>
<td>S</td>
<td>0.000</td>
<td>0.000</td>
<td>BONNIE JENSEN</td>
</tr>
</tbody>
</table>
91-3295  Point to Point  P  18690000 S  0.000 0.000
N660 W660 S4 14 15S  
10E SL
C/O T.N. JENSEN  
SACCO BROTHERS LAND AND LIVESTOCK  
RFD 1, BOX 152
WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 10/14/2008

WATER RIGHT: 91-3294 APPLICATION/CLAIM NO.: CERT. NO.: 

OWNERSHIP: 

NAME: Bonnie Jensen  ADDRESS: C/O T.N. Jensen  Price UT 84501 

DATES, ETC.:  

LAND OWNED BY APPLICANT? Yes  

FILED: | PRIORITY: 00/00/1869 | PUB BEGAN: | PUB ENDED: | NEWSPAPER:  
PROTEST END: | PROTESTED: [No] | HEARING HLD: | SE ACTION: [ ] | Action Date: | PROOF DUE:  
EXTENSION: | ELECT/PROOF: [ ] | ELECT/PROOF: | CERT/MWC: 06/06/1967 | LAF, ETC: | LAPS LETTER:  
RUSH LETTER: | RENOVATE: | RECON REQD: | TYPE: [ ]  
PD BOOK: [91-4] | MAP: [75D] | PUB DATE: |  
Type of Right: Diligence Claim  
Source of Info: Proposed Determination  
Status:  

LOCATION OF WATER RIGHT*** (Points of Diversion: Click on Location to access PLAT Program.)** MAP VIEWER**  

FLOW: SOURCE: Miller Creek  
COMMON DESCRIPTION:  

POINT OF DIVERSION -- POINT TO POINT: (1) Stockwatering directly on stream from a point at N 660 ft. W 660 ft. from S4 corner, Sec 14, T15S, R10E, SLBM, to a point at N 660 ft. W 660 ft. from S4 corner, Sec 14, T15S, R10E, SLBM.  
COMMENT: Administratively updated by State Engineer.  

USES OF WATER RIGHT******** EU -- Equivalent Livestock Unit (cow, horse, etc.) ******** EDU -- Equivalent Domestic Unit or 1 Family  
SUPPLEMENTAL GROUP NO. 614102. Water Rights Appurtenant to the following use(s): 91-160, 2280, 3250, 3292, 3294 3324  

STOCKWATER: Sole Supply: UNEVALUATED ELUs  Group Total: 300.0000  Div Limit: 8.4 acft.  PERIOD OF USE: 01/01 TO 12/31  
PLACE OF USE for STOCKWATERING**  

INCORPORATED  
August 31, 2009
WATER RIGHT: 91-3295
APPLICATION/CLAIM NO.: CERT. NO.:  

NAME: Sacco Brothers Land and Livestock
ADDR: RPO 1, Box 152
       Helper UT 84526

DATES, ETC.:  

LAND OWNED BY APPLICANT? Yes
FILED: ( PRIORITY: 00/00/1889) PUBL BEGIN: [ ] PUBL ENDED: [ ] IN Newspaper:
EXTENSION: [ ] ELEC/PROOF: [ ] ELEC/PROOF:
RUSH LETTER: (RENOVATE: [ ] RECON REQ: [ ] TYPE: [ ])
PD BOOK: [ 91-4 ] MAP [ 75b ] PUBL DATE: [ ]

Type of Right: Diligence Claim
Source of Info: Proposed Determination
Status:

LOCATION OF WATER RIGHT***(Points of Diversion: Click on Location to access FLAT Program.)**********MAP VIEWER***********

FLOW:

POINT OF DIVERSION -- POINT TO POINT:
(1) Stockwatering directly on stream from a point at N 660 ft, W 660 ft, from SE corner, Sec 14, T15S, R10E, SLIM, to a point at N 660 ft, W 660 ft, from SE corner, Sec 14, T15S, R10E, SLIM.

COMMENT: Administratively updated by State Engineer.

USES OF WATER RIGHT******** ELU -- Equivalent Livestock Unit (cow, horse, etc.) ******** RED -- Equivalent Domestic Unit or 1 Family

SUPPLEMENTAL GROUP NO. 614147. Water Rights Appurtenant to the following use(s):
91-723, 727, 728, 825, 1754
1755, 1756, 1757, 1809, 1810
1811, 2000, 2125, 2254, 2255
2256, 2258, 2261, 2262, 2262

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 100.0000 Div Limit: 2.8 acft. PERIOD OF USE: 01/01 TO 12/31

SUPPLEMENTAL GROUP NO. 614755. Water Rights Appurtenant to the following use(s):
91-723, 727, 728, 1754, 1755
1756, 1757, 1809, 1810, 1811
2000, 2125, 2254, 2255, 2256
2256, 2258, 2261, 2262, 2263

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 100.0000 Div Limit: 2.8 acft. PERIOD OF USE: 01/01 TO 12/31

SUPPLEMENTAL GROUP NO. 616103. Water Rights Appurtenant to the following use(s):
91-723, 727, 728, 825, 1754
1755, 1756, 1809, 1810, 1811
2000, 2125, 2254, 2255, 2256
2256, 2258, 2261, 2262, 2263

STOCKWATER: Sole Supply: UNEVALUATED ELUs Group Total: 100.0000 Div Limit: 2.8 acft. PERIOD OF USE: 01/01 TO 12/31

(Warning: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 10/14/2008
STOCKWATER: Sole Supply: UNEVALUATED ELUs  Group Total: 100,000  Div Limit:  PERIOD OF USE: 01/01 TO 12/31
Stockwatering Water User's Claim No 925 is limited to the requirements of 80

PLACE OF USE for STOCKWATERING

| NORTH-WEST | NORTH-EAST | SOUTH-WEST | SOUTH-EAST |
| NW NE SW SE | NW NE SW SE | NW NE SW SE | NW NE SW SE |

END OF DATA
APPENDIX 7-3

Utah Pollutant Discharge Elimination System Permit
January 08, 2007

Mr. Keith Thompson
Vice President
Covol Engineered Fuels, LC
10653 South River Front Parkway, Suite 300
South Jordan, Utah 84095

Dear Mr. Thompson:

Subject: Utah Pollutant Discharge Elimination System (UPDES) Multi-Sector General Permit for Storm Water Discharges Associated with Industrial Activity, Coverage No. UTR000685.

Our office received your “notice of intent” (NOI) for Covol Engineered Fuels, LC to obtain coverage under the UPDES Multi-Sector General Permit for Storm Water Discharges Associated with Industrial Activity, General Permit No. UTR000000 on November 30, 2006. The received NOI is for the Covol Fuels facility located at, 1865 West Ridge Road, Wellinton, Utah, Carbon County. This letter confirms your coverage under the general permit; the permit coverage number for the facility is No. UTR000685. Please use this number in any future correspondence associated with this project.

This coverage is effective January 01, 2007 and expires at midnight, December 31, 2011.

The permit requires a Storm Water Pollution Prevention Plan (SWP3). Maintaining a current copy of the SWP3 at the site is a requirement of the permit. Monitoring is also required as outlined in appendix II requirements. Please review these requirements if you are not familiar with them. A copy of the general permit and appendix requirements can be found on our website at http://www.waterquality.utah.gov/updes/stormwater.htm.

Storm water discharge monitoring report (SWDMR) forms are enclosed for your convenience. These forms may be used to record visual and/or analytical monitoring results.

As the agency charged with the administration of issuing UPDES Permits, we are
continuously looking for ways to improve our quality of service to you. Please take a few moments to complete the enclosed questionnaire, and return it in the enclosed, self-addressed, postage paid, envelope. The results will be used to improve our quality and responsiveness and give us feedback on customer satisfaction.

If you have any questions concerning this letter or your permit coverage please do not hesitate to contact me by phone at (801) 538-9325 or by e-mail at mmgeorge@utah.gov. Thank you.

Sincerely,

Mike George, Environmental Scientist
Permits & Compliance Section

Enclosure

U:\WQ\PERMITS\mgeorge\wp\storm water\group 4\covel\fuels2007.doc
APPENDIX 7-4

Storm Water Pollution Prevention Plan
STORM WATER POLLUTION PREVENTION PLAN
(Revision 2 – 11/03/05)

and

NOI Storm Water Discharges Associated with Construction Activities

and

NOI Multi-Sector General Permit (MSGP) for Storm Water Discharges Associated with Industrial Activities

COVOL ENGINEERED FUELS, LC

PREPARED BY:
EIS Environmental & Engineering Consulting
DECEMBER 2004
# TABLE OF CONTENTS

Section 1.0 General Site Information ........................................................................................................1

Storm Water Pollution Prevention Plan ........................................................................................................2

Section 2.0 Content of Plan ..........................................................................................................................2

Section 2.1.1 Pollution Prevention Team ....................................................................................................2

Section 2.2.1 Site Map ....................................................................................................................................2

Section 2.2.2 Material Inventory ................................................................................................................3

   Description of Potential Pollutant Sources ...............................................................................................3

Table: Potential Pollution Source, Potential Pollutants, Likelihood of Contact ........................................3

Drainage ....................................................................................................................................................3

Section 2.3.1 Best Management Identifications (BMP) ..............................................................................4

   Table: BMPs, Brief Description of Activities, Implementation of BMP ..................................................4

Section 2.4.1 Employee Training ................................................................................................................4

# LIST OF APPENDICES

Appendix A - Drawings

Appendix B - NOI-Storm Water Discharges Associated with Construction Activities

Appendix C - NOI-Multi-Sector General Permit for Storm Water Discharges Associated with Industrial Activities

Appendix D - Guidelines Associated with Storm Water Discharge from Construction Activities

Appendix E - NOT-Notice of Termination for Storm Water Discharges Associated with Construction Activity Under the UPDES General Permit

INCORPORATED

August 31, 2009

Div. of Oil, Gas & Mining
Section 1.0 General Site Information

COVOL Engineered Fuels, LC (COVOL) is planning to construct and operate a new coal cleaning facility in Carbon County, Utah. The new facility will be located in Section 14, Township 15 South, Range 10 East, Salt Lake Base & Meridian. This facility will be located approximately five miles south of Price, Utah. Refer to the attached Location Map in Appendix A. The facility lies in an undeveloped, rural area on a 30 acre site. Approximately 15 acres will be used for this new operation. The adjacent land on the east, west, and south remains undeveloped. Across the road to the west are coal transfer facilities where coal is stored, loaded, and unloaded for shipment. Across the road and to the north is Carbon County Lumber Company.

The site slopes to the southeast and the surrounding ground consists of native soil with sparse vegetation. The soil is classified as Persayo-Badland Association Soils, which consist of gently sloping and rolling hills, well drained, moderately fine textured and medium textured soils over shale. The area receives approximately 9.5-inches of precipitation annually. The regional groundwater flow is east toward the Price River which lies approximately two miles northeast of the facility. Refer to the Location Map in Appendix A.

This site was previously permitted by Terra Systems Incorporated (TSI). In compliance with the provisions of the Utah Water Quality Act, Title 19, Chapter 5, Utah Code Annotated 1953, TSI was issued a General Storm Water UPDES Permit UTR101090 on August 20, 2003, for this Wellington Plant Site. COVOL has purchased this site from TSI and will use different processing techniques. COVOL will receive coal from various sources around the Carbon/Emery area. COVOL will take this coal with varying qualities and by using air jigs will improve the final quality. The cleaning facility will be divided into three areas: feedstock material handling and storage systems, coal cleaning equipment, and finished product material handling and storage system. It is anticipated that this facility will process approximately 1,500,000 ton per year.

Feedstock Handling
Incoming coal trucks will be weighed at the truck scale and dump their loads at the truck dump hopper. Refer to the Site Plan in Appendix A. This high ash coal will be moved via conveyors and dumped in the inventory pile with a radial stacker. The radial stacker will be positioned to segregate and pile multiple sources/qualities of coal.

Coal Cleaning
High ash coal will be fed into the feed hopper via a rubber-tired front end loader. This material will be transported by conveyor to a screen for separation. Coarse or oversized material can be processed through the crusher to be sized to 2” minus. The feed streams (coarse and fine) are then fed into an air jig separation unit where the coal is separated from the rock and ash using air and vibration to perform the separation. The air jig is covered by a hood connected to a bag house (one bag house for each air jig) to prevent any fugitive dust particles from escaping into the atmosphere. Finished product is transferred to an inventory pile or silo via one set of conveyors and the byproduct is transferred to a pile via another set of conveyors. The bag house dust can be combined either with the byproduct stream or the finished product stream depending on the required specifications.
**Finished Product Handling**

The finished product may be stored in the silo which is situated over the site haul road. A designated amount of product stored in the silo will be charged into trucks to be shipped to its final destination. Alternately, finished material from a segregated finished product pile may be fed into the product silo via the feed/blending hoppers or be loaded directly into trucks, for transportation, via the truck ramp and hopper.

**Storm Water Pollution Prevention Plan**

It has been determined that the permittee has a regulated storm water discharge as per UAC R317.8. Therefore, conditions governing storm water discharges apply. The permittee shall develop a storm water pollution plan. The receiving water for this facility is the Price River. Refer to Appendix D for Guidelines Associated with Storm Water Discharge from Construction Activities.

**Section 2.0 Content of Plan**

**Section 2.1.1 Pollution Prevention Team**

The facility will be operated two shifts per day. Each shift will have three employees, a shift foreman and two operators. During each shift the pollution prevention team at the facility will be comprised of these three individuals.

The shift foreman will be responsible to coordinate a spill response, oversee good housekeeping and best management practices. His responsibilities will also include monitoring, if required, and ensuring compliance with aforementioned permit. The on shift operators will be required to inspect and maintain all diversion and appurtenant structures to ensure proper control and treatment of storm water runoff prior to leaving the site.

All employees will be properly trained in their various areas and will be given the proper notification numbers and contact personnel to comply with the requirements of the permit. Refer to Section 2.4.1 Employee Training.

**Section 2.2.1 Site Map**

Included in Appendix A is a Site Map showing the proposed surface facilities. Additional features on the map include storm water flow directions, berm, and sediment pond locations. Final engineering on this facility is presently being completed. Surface contours will be modified to direct all surface flows towards the sediment ponds located in the southeast and southwest corners of the project. An earthen berm will be constructed to contain all runoff from the site. All surface structures will be located inside the berm. This will prevent any potential contamination from leaving the site.

**Section 2.2.2 Material Inventory**
Description of Potential Pollutant Sources

The potential sources which may reasonably be expected to add pollutants to storm water discharges from the site are those disturbed areas which facilitate the operation. The surface facilities are shown on the Site Plan drawing. The Potential Pollution Sources are listed in the following table.

<table>
<thead>
<tr>
<th>Potential Pollution Source</th>
<th>Potential Pollutants</th>
<th>Likelihood of Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck Dump</td>
<td>Coal Fines, Equipment Fuels and Fluids</td>
<td>Low potential, No known spill or leak</td>
</tr>
<tr>
<td>Coal Storage Area</td>
<td>Coal Fines, Equipment Fuels and Fluids</td>
<td>Low potential, No known spill or leak</td>
</tr>
<tr>
<td>Front End Loader</td>
<td>Equipment Fuels and Fluids</td>
<td>Low potential, No known spill or leak</td>
</tr>
<tr>
<td>Conveyor Belt</td>
<td>Coal Fines, Lubricant</td>
<td>Low potential, No known spill or leak</td>
</tr>
<tr>
<td>Silo</td>
<td>Coal Fines, Lubricant</td>
<td>Low potential, No known spill or leak</td>
</tr>
</tbody>
</table>

All runoff will be contained by the berm surrounding the site. This runoff will report to the sediment ponds. Coal fines in the storage areas are very fine-grained, therefore some storm events could potentially cause enough surface flow to transport the fines to the sediment ponds.

Drainage

The Site Plan drawing provides the drainage direction and the location of the proposed sediment ponds and berms. Berms will be constructed to prevent storm water from leaving the site. Runoff from Ridge Road (County Road) will be diverted around the property. The sediment ponds will remove pollutants from storm water runoff and will discharge to the south, if necessary. After construction both the berms and sediment ponds will be inspected on a quarterly basis to insure that they are operating correctly.

Section 2.3.1 Best Management Identifications (BMP)
<table>
<thead>
<tr>
<th>BMPs</th>
<th>Brief Description of Activities</th>
<th>Implementation of BMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Housekeeping</td>
<td>Pick-up Trash, Use of absorbent materials to clean up minor spills. Training of staff in cleanup procedures.</td>
<td>Training of staff during annual training or as needed.</td>
</tr>
<tr>
<td>Preventative Maintenance</td>
<td>Maintain sediment control measures. Maintain equipment and machinery. Maintain fuel stations, coal pile and surface drainage.</td>
<td>Inspect and Maintain contours to drain to sediment controls</td>
</tr>
<tr>
<td>Inspections</td>
<td>Quarterly inspection of runoff control measures.</td>
<td>Quarterly Inspections or as needed after storm events.</td>
</tr>
<tr>
<td>Spill Prevention Response</td>
<td>Fuel tanks will be contained. Absorbent materials available for spill clean up.</td>
<td>Clean up or maintain as needed.</td>
</tr>
<tr>
<td>Sediment and Erosion Control</td>
<td>Inspection of ponds and berms, at least quarterly or after/during storm event greater than .5 inches.</td>
<td>Sample ponds during runoff event if ponds are discharging or will discharge. Clean ponds when necessary.</td>
</tr>
<tr>
<td>Management of Runoff</td>
<td>Off site runoff diverted around disturbed and storage areas. Disturbed and storage areas treated by sediment ponds or berm.</td>
<td>Inspect, maintain and repair as needed.</td>
</tr>
</tbody>
</table>

**Section 2.4.1 Employee Training**

Training topics will include, but not be limited to Spill Prevention and Response, Spill Reporting Procedures, Good Housekeeping, Material Management Practices, and Storm Water Sampling Procedures.

Employees will be provided training regarding the prevention and control of spillage of fuels and oils associated with machinery and equipment. Employees will be advised to not overfill fuel tanks while fueling equipment or vehicles. Employees will assist fuel vendors to watch tank gauges and not overfill bulk tanks.

**INCORPORATED**

**August 31, 2009**

**Div. of Oil, Gas & Mining**
APPENDIX A

DRAWINGS
APPENDIX B

NOI-STORM WATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES

INCORPORATED
August 31, 2009
Div. of Oil, Gas & Mining
STATE OF UTAH, DEPARTMENT OF ENVIRONMENTAL QUALITY, DIVISION OF WATER QUALITY
288 North 1460 West, P.O. Box 144870, Salt Lake City, Utah 84114-4870 (801)538-6146

NOI Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity Under the UPDES General Permit
No. UTR100000. SEE REVERSE FOR INSTRUCTIONS

Submission of this Notice of Intent constitutes notice that the party(s) identified in Section I of this form intends to be authorized by UPDES General Permit No. UTR100000 issued for storm water discharges associated with construction activity in the State of Utah. Becoming a permittee obligates such discharger to comply with the terms and conditions of the permit. ALL NECESSARY INFORMATION MUST BE PROVIDED ON THIS FORM.

I. OPERATOR INFORMATION

Name (Main operator): COVOL ENGINEERED FUELS, LC
Phone: 801-984-9400
Status of Owner/Operator: P
Address: 10653 S. RIVERFRONT PARKWAY
City: SOUTH JORDAN State: UT Zip: 84095
Contact Person: KEITH THOMPSON
Phone: 801-984-9400

Name (1st Co-permittee): ________________
Address: ________________________________
City: __________________ State: _______ Zip: _______
Contact Person: _________________________ Phone: ________________

Name (2nd Co-permittee): ________________
Address: ________________________________
City: __________________ State: _______ Zip: _______
Contact Person: _________________________ Phone: ________________

Name (3rd Co-permittee): COVOL ENGINEERED FUELS, LC
Phone: ________________
Address: ________________________________
City: __________________ State: _______ Zip: _______
Contact Person: _________________________ Phone: ________________

Please copy this form if you have more co-permittees than what is allowed on this form.

II. FACILITY SITE / LOCATION INFORMATION

Is the facility located on Indian Lands? (Y or N) N
Name: COVOL ENGINEERED FUELS, LC
Project No. (if any): ________________________________
Address: 1865 WEST RIDGE ROAD County: CARBON
City: WELLMONT State: UT Zip: 84542
Latitude: 39.31.27 Longitude: 110.45.58

INCORPORATED
August 31, 2009
Div. of Oil, Gas & Mining
III. SITE ACTIVITY INFORMATION

Municipal Separate Storm Sewer System (MS4) Operator Name: ________________________________

Receiving Water Body: PRICE RIVER

How far to the nearest water body? 2 MILES

List the Number of any other UPDES permits at the site: ____________________________

IV. TYPE OF CONSTRUCTION (Check all that apply)


8. □ Other (Please list) ________________________________

V. BEST MANAGEMENT PRACTICES

Identify proposed Best Management Practices (BMPs) to reduce pollutants in storm water discharges: (Check all that apply)


7. □ Other (Please list) ________________________________

VI. ADDITIONAL INFORMATION REQUIRED

A storm water pollution prevention plan has been prepared for this site and is to the best of my knowledge in Compliance with State

Project Start Date: 02/01/05  Completion Date: 08/01/05  Estimated Area to be Disturbed: (in Acres): 15 and/or Local Sediment and Erosion Plans and Requirements.

Y or N) Y (A pollution prevention plan is required to be on hand before submittal of the NOI)

VII. CERTIFICATION: I certify under penalty of law that I have read and understand the Part L.B. eligibility requirements for coverage under the general permit for storm water discharges from construction activities.

I further certify that to the best of my knowledge, all discharges and BMPs that have been scheduled and detailed in a pollution prevention plan will satisfy requirements of Part L.B., and Part III. of this permit.

I certify under penalty of law that this document and all attachments were prepared under the direction or supervision of those who have placed their signature below, in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Print Name (of responsible person for the main operator from first page): KEITH THOMPSON – V.P. COVOL ENGINEERED FUELS, L.C

Signature: ________________________________

Print Name (of responsible person for the 1st co-permittee from first page):

Signature: ________________________________

Print Name (of responsible person for the 2nd co-permittee from first page):

Signature: ________________________________

Print Name (of responsible person for 3rd co-permittee from first page): ________________________________

Signature: ________________________________

Amount of Permit Fee Enclosed: $100.00

INTEGRATED RESOURCE CORPORATION
Div. of Oil, Gas & Mining

August 31, 2009
APPENDIX C

NOI-MULTI-SECTOR GENERAL PERMIT FOR STORM WATER DISCHARGES
ASSOCIATED WITH INDUSTRIAL ACTIVITIES

INCORPORATED
August 31, 2009
Div. of Oil, Gas & Mining
STATE OF UTAH, DEPARTMENT OF ENVIRONMENTAL QUALITY, DIVISION OF WATER QUALITY
288 North 1460 West, P.O. Box 144970, Salt Lake City, Utah 84114-4870 (801) 338-6146

NOI
Notice of Intent (NOI) for Coverage Under the UPDES General Multi-Sector Storm Water Permit for Discharges Associated with Industrial Activity, Permit No. UTR000000.

INSTRUCTIONS ON BACK PAGE

Submission of this Notice of Intent constitutes notice that the party identified in Section I of this form intends to be authorized by a UPDES permit issued for storm water discharges associated with industrial activity in the State of Utah. Becoming a permittee obligates such discharger to comply with the terms and conditions of the permit. ALL NECESSARY INFORMATION MUST BE PROVIDED ON THIS FORM. A different NOI form is provided for construction activities disturbing over 5 acres.

I. FACILITY OPERATOR INFORMATION

Name: COVOL ENGINEERED FUELS, LC
Phone: 801-984-9400
Address: 10653 S. RIVERFRONT PARKWAY
City: SOUTH JORDAN State: U T Zip: 84095
Facility Contact Person: KEITH THOMPSON Phone: 801-984-9400
Facility Contact Person Title: VP COVOL ENGINEERED FUELS, LC

II. FACILITY SITE/LOCATION INFORMATION

Name: COVOL ENGINEERED FUELS, LC
Address: 1865 WEST RIDGE ROAD County: CARBON
City: WELLINGTON State: UT Zip: 84542
Latitude: 39 31 27 Longitude: 110 45 58 Section: 1 4 Township: 1 5 5 Range: 10 E
Site Contact Person: KEITH THOMPSON Phone: 801-984-9400
Site Contact Person Title: C E O

III. SITE ACTIVITY INFORMATION

Name of Municipality which Operates the Storm Sewer System:

Receiving Water Body: PRICE RIVER

Is there existing quantitative storm water discharge data? ☑ NO

Is the facility required to do analytical monitoring? (See permit conditions Part V. and Sector monitoring requirements.) ☑ Yes

Is the facility required to do visual monitoring? (See permit conditions near the end of applicable Sector(s); Appendix A to AD) ☑ Yes

Is the facility required to submit monitoring data or retain it on site? ☑ (Submit) ☑ (Retain on site)

Is This a New Facility, or is it an Existing Facility? ☑ (New) ☐ (Existing)

If This is an Existing Facility, and the Start-up Date was After Oct. 1992, Please Fill in the Start-up Month: ☑ Month (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec)

SIC or Designated Activity Code: Primary: 12 2nd: 3rd: 4th:

If You Have Other Existing UPDES Permits, Enter Permit #:

IV. SECTOR IDENTIFICATION: The General Multi-Sector Permit covers all industrial activity that is required by the following pages the sectors are listed with a description of the industrial activity that is covered by that sector. Please check which occur at your site. The sector covered in Appendix AD is the catch-all sector and should only be used if positively no other sector covers your industrial activity. If you should select AD, please call the Storm Water Coordinator at DWQ to discuss the need for choosing Sector AD (Non-Classified Facilities).

INCORPORATED
August 31, 2009
Div. of Oil, Gas & Mining
IV. SECTOR IDENTIFICATION: The General Multi-Sector Permit covers all industrial activity that is required by law to be covered by a storm water permit. On the following pages the sectors are listed with a description of the industrial activity that is covered by that sector. Please check each sector that covers industrial activities which occur at your facility. The sector covered in Appendix AD is the catch-all sector and should only be used if positively no other sector covers your industrial activity. If you should select AD, please call the Storm Water Coordinator at DWO to discuss the need for choosing Sector AD (Non-Classified Facilities).

- A. Timber Products Facilities — establishments [generally classified under Standard Industrial Classification (SIC) Major Group 24] that are engaged in cutting timber and pulpwood, merchant sawmills, lath mills, shingle mills, cooperage stock mills, planing mills, and plywood and veneer mills engaged in producing lumber and wood basic materials; and establishments engaged in wood preserving or in manufacturing finished articles made entirely of wood or related materials, except for wood kitchen cabinet manufacturers (SIC Code 2434), which are addressed under sector W.

- B. Paper and Allied Products Manufacturing Facilities — facilities engaged in the manufacture of pulps from wood and other cellulose fibers and from rags; the manufacture of paper and paperboard into converted products, such as paper coated off the paper machine, paper bags, paper boxes and envelopes; and establishments primarily engaged in manufacturing bags of plastic film and sheet. These paper facilities are commonly identified by Standard Industrial Classification (SIC) Major Group 26.

- C. Chemical and Allied Products Manufacturing Facilities — 1) Basic industrial inorganic chemicals (including SIC 281), 2) Plastic materials and synthetic resins, synthetic rubbers, and cellulose and other manmade fibers, except glass (including SIC 282), 3) Soap and other detergents and in producing glycerin from vegetable and animal fats and oils; specialty cleaning, polishing, and sanitation preparations; surface active preparations used as emulsifiers, wetting agents, and finishing agents, including sulfonated oils; and perfumery, cosmetics, and other toiletries (including SIC 284), 4) Paints (in paste and ready-mixed form); varnishes; lacquers; enamels and shellacs; putties, wood fillers, and sealers; paint and varnish removers; paint brush cleaners; and allied paint products (including SIC 285), 5) Industrial inorganic chemicals (including SIC 286), 6) Nitrogenous and phosphatic basic fertilizers, mixed fertilizer, pesticides, and other agricultural chemicals (including SIC 287), 7) Industrial and household adhesives, glues, coating compounds, sealants, and linoleum, tile, and rubber cements from vegetable, animal, or synthetic plastic materials; explosives; printing ink, including gravure ink, screen process ink, and lithographic; miscellaneous chemical preparations, such as fatty acids, essential oils, gelatin (except vegetable), sizes, bluing, laundry soaps, writing and stamp pad ink, industrial compounds, such as boiler and heat insulating compounds, metal, oil, and water treatment compounds, waterproofing compounds, and chemical supplies for foundries (including facilities with SIC 289), 8) Ink and paints, including china painting enamels, india ink, drawing ink, platinum paints for burnt wood or leather work, paints for china painting, artists' paints and artists' water colors (SIC 3952, limited to those listed for others see sector V), 9) Medicinal chemicals and pharmaceutical products, including the grading and milling of botanicals (including SIC 283).

- D. Asphalt Paving, Roofing Materials, and Lubricant Manufacturing Facilities — 1) facilities engaged in manufacturing asphalt paving and roofing materials, including those facilities commonly identified by Standard Industrial Classification (SIC) codes 2951 and 2952, 2) portable asphalt plant facilities (also commonly identified by SIC code 2951), 3) facilities engaged in manufacturing lubricating oils and greases, excluding those facilities classified as SIC code 2992. Not covered are: 1) petroleum refining facilities, including those that manufacture asphalt or rubber products and that are classified as SIC code 2911 (see sector I), 2) oil recycling facilities (see sector N), and 3) fats and oils rendering (see sector U).

- E. Glass, Clay, Cement, Concrete, and Gypsum Product Manufacturing Facilities — manufacturing flat, pressed, or blown glass or glass containers; manufacturing hydraulic cement; manufacturing clay products including tile and brick; manufacturing of pottery and porcelain electrical supplies; manufacturing concrete products; manufacturing gypsum products; nonferrous refractories; and grinding or otherwise treating minerals and earths. This section generally includes the following types of manufacturing operations: flat glass, (SIC code 3211); glass containers, (SIC code 3221); pressed and blown glass, not elsewhere classified, (SIC code 3229); glass products made of purchased glass (SIC code 3231) where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water; hydraulic cement (SIC code 3241); brick and structural clay tile; (SIC code 3251); ceramic wall and floor tile, (SIC code 3252); glass Specialty products not otherwise classified (SIC code 3329); vitreous china plumbing fixtures, and china and earthenware fittings and bathroom accessories (SIC code 3361); vitreous china table and kitchen articles (SIC code 3362); fine china ware table and kitchen articles (SIC code 3363); porcelain electrical supplies (SIC code 3264); pottery products, (SIC code 3269); concrete block and brick, (SIC code 3271); concrete products, except block and brick (SIC code 3272); ready-mix concrete, (SIC code 3273); lime and quicklime, (SIC code 3274); gypsum products, (SIC code 3275); cut stone and stone products (SIC code 3281); abrasive products, (SIC code 3291); asbestos products (SIC code 3292); minerals, and earths, ground or otherwise treated (SIC code 3295); mineral wool (SIC code 3296); nonferrous refractories, (SIC code 3297); and nonmetallic mineral products not elsewhere classified (SIC code 3299).

- F. Primary Metals Facilities — coking operations, sintering plants, blast furnaces, smelting operations, rolling mills, casting operations, heat treating, extruding, drawing, or forging of any types of ferrous and nonferrous scrap, and ore. Coverage includes the following types of facilities: 1) Steel works, blast furnaces, and rolling and finishing mills including: steel wire drawing and steel nails and spikes; cold-rolled steel sheet, strip, and bars; and steel pipes and tubes (SIC code 331), 2) Iron and steel foundries, including: gray and ductile iron, malleable steel, steel investment, and steel foundries not elsewhere classified (SIC code 332), 3) Primary smelting and refining of nonferrous metals (SIC code 333), 4) Secondary smelting and refining of nonferrous metals (SIC code 334), 5) Rolling, drawing, and extruding of nonferrous metals, including: rolling, drawing, and extruding of copper; rolling, drawing, and extruding of nonferrous metals, except copper and aluminum; and drawing and insulating of nonferrous wire (SIC code 335), 6) Nonferrous foundries (castings), including: aluminum die-castings, nonferrous die-castings, iron castings, aluminum foundries, copper foundries, nonferrous foundries, except copper and aluminum (SIC code 336), 7) Miscellaneous primary metal products, not elsewhere classified, including: metal heat treating, and primary metal products, not elsewhere classified (SIC code 339).

- G. Metal Mines (Ore Mining and Dressing) — active and inactive metal mining and ore dressing facilities [Standard Industrial Classification (SIC) Major Group 10] if the storm water has come into contact with, or is contaminated by, any overburden, raw material, intermediate product, finished product, byproduct, or waste product located on the site of the operation. SIC Major Group 10 includes establishments primarily engaged in mining, developing mines, or exploring for metallic minerals (ores) and also includes all ore dressing and beneficiating operations, whether performed at mills operated in conjunction with the mines served or at mills, such as custom mills, operated separately. For the purposes of this part of the permit, the term "metal mining" includes all ore mining and/or dressing and beneficiating operations, whether performed at mills operated in conjunction with the mines served or at mills, such as custom mills, operated separately. All storm water discharges from inactive metal mining facilities and the storm water discharges from the following areas of active, and temporarily inactive, metal mining facilities are only consistent with the conditions of the permit: topsoil piles; offsite haul/access roads if off active area; onsite haul roads if not constructed of waste rock or if spent ore and mine water is not used for dust control; runoff from tailings dams/dikes when not constructed of waste rock/tailings and no process fluids are present; concentration building, if no contact with material piles; mill site, if no contact with material piles; chemical storage area; dock facility, if no excessive contact with waste product; explosive storage; reclaimed areas released from reclamation bonds prior to December 1976; and partially/ inadequately reclaimed areas or areas not released from reclamation bonds. Not covered are: 1) active metal mining facilities that are subject to the effluent limitation guidelines for the Ore Mining and Dressing Point Source Pollution Category (40 CFR Part 440). Coverage under this permit does not include acid drainage or contaminated springs or seeps at active facilities, temporarily inactive facilities, or inactive facilities. Also see permit conditions, Limitations on Coverage, Part I.B.3. 2) Storm water discharges associated with an industrial activity that the Executive Secretary has determined to be, or may reasonably be expected to be, contributing to a violation of a water quality standard, 3) Storm water discharges associated with an industrial activity from inactive mining operations occurring on Federal lands where an operator cannot be identified.

- H. Coal Mines and Coal Mine-Related Facilities — coal mining-related areas (SIC Major Group 12) if they are covered by the conditions of this permit. Not covered are: inactive mining activities occurring on Federal lands where an operator cannot be identified. [40 CFR Part 434. Not covered are: inactive mining activities occurring on Federal lands where an operator cannot be identified.

- I. Oil and Gas Extraction Facilities — oil and gas facilities listed under Standard Industrial Classification (SIC) under UAC R317-8.3(2)(a)(3). These include oil and gas exploration, production, processing, or treatment operations, contaminated by contact with or that has come into contact with any overburden raw material, intermediate products, if the resulting oil and gas facility is engaged in one of the following activities:

INCORPORATED

August 31, 2009

Div. of Oil, Gas & Mining
on the site of such operations." Industries in SIC Major Group 13 include the extraction and production of crude oil, natural gas, oil sands and shale; the production of hydrocarbon liquids and natural gas from coal; and associated oil field service, supply and repair industries. This section also covers petroleum refineries listed under SIC code 2921. Contaminated storm water discharges from petroleum refining or drilling operations that are subject to nationally established BAT or BPT guidelines found at 40 CFR 419 and 435 respectively are not included. Not that areas eligible for coverage at petroleum refineries will be very limited because the term "contaminated runoff," as defined under 40 CFR 419.11 includes "...runoff which comes in contact with any raw material, intermediate product, finished product, by-product or waste product located on petroleum refinery property." Areas at petroleum refineries which may be eligible for permit coverage, provided discharges from these areas are not co-mingled with "contaminated runoff," include; vehicle and equipment maintenance, fire extinguishing, and firefighting areas. Most areas at refineries will not be eligible for coverage including: raw material, intermediate product, by-product, waste material, chemical, and material storage areas; loading and unloading areas; transmission pipelines, and, processing areas. Not covered are: Inactive oil and gas operations occurring on Federal lands where an operator cannot be identified are not covered by this permit.

J. Mineral Mining and Processing Facilities — active and inactive mineral mining and processing facilities (generally identified by Standard Industrial Classification (SIC) Major Group 14). Not covered are: 1) facilities associated with industrial activity which are subject to an existing effluent limitation guideline (40 CFR Part 436), 2) inactive mineral mining activities occurring on Federal lands where an operator cannot be identified are not eligible for coverage under this permit.

K. Hazardous Waste Treatment Storage or Disposal Facilities — facilities that treat, store, or dispose of hazardous wastes, including those that are operating under the Resource Conservation and Recovery Act, or RCRA. Disposal facilities that have been properly closed and capped, and have no significant materials exposed to storm water, are considered inactive and do not require permits (UIC R317-B-3.8(6)(c)).

L. Landfills and Land Application Sites — waste disposal at landfills, land application sites, and open dumps that receive or have received industrial wastes. Open dumps are solid waste disposal units that are not in compliance with State/Federal criteria established under RCRA Subtitle D. Not covered are: inactive landfills, land application sites, and open dumps occurring on Federal lands where an operator cannot be identified.

M. Automobile Salvage Yards — facilities engaged in dismantling or wrecking used motor vehicles for parts recycling or resale and for scrap (SIC Code 5015).

N. Scrap Recycling and Waste Recycling Facilities — facilities that are engaged in the processing, reclaiming and wholesale distribution of scrap and waste materials such as ferrous and nonferrous metals, paper, plastic, cardboard, glass, animal hides (these types of activities are typically identified as SIC code 5093). Facilities that are engaged in reclaiming and recycling liquid wastes such as used oil, antifreeze, mineral spirits, and industrial solvents (also identified as SIC code 5093) are also covered under this section. Separate permit requirements have been established for recycling facilities that only receive source-separated recyclable materials primarily from nonindustrial and residential sources (also identified as SIC 5093) (e.g., common consumer products including paper, newspaper, glass, cardboard, plastic containers, aluminum and tin cans). This includes recycling facilities commonly referred to as material recovery facilities (MRF). MRFs.

O. Steam Electric Power Generating Facilities — steam electric power generating facilities, including coal handling areas. Non-storm water discharges subject to effluent limitations guidelines are not covered by this permit. Storm water discharges from coal pile runoff subject to numeric limitations are eligible for coverage under this permit, but are subject to the limitations established by 40 CFR 423. Not covered are: ancillary facilities such as fleet centers, gas turbine stations, and substation that are not contiguous to a steam electric power generating facility or are not covered by this permit. Heat capture co-generation facilities are not covered by this permit; however, dual fuel co-generation facilities are included.

P. Vehicle Maintenance or Equipment Cleaning areas at Motor Freight Transportation Facilities, Passenger Transportation Facilities, Petroleum Bulk Oil Stations and Terminals, the United States Postal Service, or Railroad Transportation Facilities — ground transportation facilities and rail transportation facilities (generally identified by Standard Industrial Classification (SIC) codes 44, 41, 42, 43, and 5171), that have vehicle and equipment maintenance shops (vehicle and equipment rehabilitation; mechanical repairs; painting, fueling and lubrication) and/or equipment cleaning operations are eligible for coverage under this section. Also covered under this section are facilities found under SIC code 4221-4225 (public warehousing and storage) that do not have vehicle and equipment maintenance shops and/or equipment cleaning operations but have areas (exclusive of access roads and rail lines) where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products or industrial machinery are exposed to storm water.

Q. Vehicle Maintenance Areas and Equipment Cleaning Areas of Water Transportation Facilities — water transportation facilities that have vehicle (vessel) maintenance shops and/or equipment cleaning operations. The water transportation industry includes facilities engaged in foreign or domestic transport of freight or passengers in deep sea or inland waters; marine cargo handling operations; ferry operations; towing and tugboat services; and marinas (facilities commonly identified by SIC code Major Group 44).

R. Ship or Boat Building and Repair Yards — facilities engaged in ship building and repairing and boat building and repairing (SIC code 373).

S. Vehicle Maintenance Areas, Equipment Cleaning Areas or Airport Deicing Operations located at Air Transportation Facilities — establishments and/or facilities including airports, air terminals, air carriers, flying fields, and establishments engaged in servicing or maintaining airports and/or aircraft (generally classified under Standard Industrial Classification (SIC) code 45) which have vehicle maintenance shops, material handling facilities, equipment cleaning operations or airport and/or aircraft deicing/anti-icing operations. For the purpose of this permit, the term "deicing" is defined as the process to remove frost, snow, or ice and "anti-icing" is the process which prevents the accumulation of frost, snow, or ice. Only those portions of the facility or establishment that are either involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, or deicing/anti-icing operations are addressed under this section.

T. Wastewater Treatment Works — treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including lands dedicated to the disposal of sewage sludge that are located within the confines of the facility with a design flow of 1.0 MGD or more, or required to have an approved pretreatment program under 40 CFR Part 403.

U. Food and Kindred Products Facilities — food and kindred products processing facilities (commonly identified by Standard Industrial Classification (SIC) code 20), including; meat products; dairy products; canned, frozen and preserved fruits, vegetables, and food specialties; grain mill products; bakery products; sugar and confectionery products; fats and oils; beverages; and miscellaneous food preparations and kindred products and tobacco products manufacturing (SIC Code 21), except for storm water discharges identified under paragraph 1.B.3. where industrial plant yards; material handling sites; refuse sites; sites used for application or disposal of process wastewaters; sites used for storage and maintenance of material handling equipment; sites used for residential treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; and storage areas for raw material and intermediate and finished products are exposed to storm water and areas where industrial activity has taken place in the past and significant materials remain. For the purposes of this paragraph, material handling activities include the storage, handling, processing, and transportation of any raw material, intermediate product, finished product, by-product, or waste product.

INCORPORATED

August 31, 2009

Div. of Oil, Gas & Mining
V. Textile Mills, Apparel and other Fabric Product Manufacturing Facilities — Textile Mill Products, of and regarding facilities and establishments engaged in the preparation of fiber and subsequent manufacturing of yarn, thread, braid, twine, and cordage, the manufacturing of broad woven fabrics, narrow woven fabrics, knit fabrics, and carpets and rugs from yarn; processes involved in the dyeing and finishing of fibers, yarn fabrics, and knit apparel; the integrated manufacturing of knit apparel and other finished articles of yarn; the manufacturing of felt goods (wool), lace goods, nonwoven fabrics; miscellaneous textiles, and other apparel products (generally described by SIC codes 22 and 23). This section also covers facilities engaged in manufacturing finished leather and artificial leather products (SIC 31, except 3111).

W. Furniture and Fixture Manufacturing Facilities — facilities involved in the manufacturing of: wood kitchen cabinets (generally described by SIC code 2434); household furniture (generally described by SIC code 251); office furniture (generally described by SIC code 252); public buildings and related furniture (generally described by SIC code 253); partitions, shelving, lockers, and office and store fixtures (generally described by SIC code 254); and miscellaneous furniture and fixtures (generally described by SIC code 259).

X. Printing and Publishing Facilities — newspaper, periodical, and book publishing or publishing and printing (SIC Codes 2711-2731); book printing (SIC Code 2732); miscellaneous publishing (SIC Code 2741); commercial printing, lithographic (SIC Code 2752); commercial printing, gravure (SIC Code 2754); commercial printing, not elsewhere classified (SIC Code 2759); manifold business forms, greeting cards, bankbooks, looseleaf binders and devices, bookbinding and related work, and typesetting (SIC Codes 2761-2791); and, plate making and related services (SIC Code 2796).

Y. Rubber and Miscellaneous Plastic Product Manufacturing Facilities — rubber and miscellaneous plastic products manufacturing facilities (SIC major group 30) and miscellaneous manufacturing industries, except jewelry, silverware, and plated ware (SIC major group 39, except 39).

Z. Leather Tanning and Finishing Facilities — leather tanning, currying and finishing (commonly identified by Standard Industrial Classification (SIC) code 3111). Discharges from facilities that make fertilizer solely from leather scraps and leather dust are also covered under this section.

AA. Facilities That Manufacture Metal Products including Jewelry, Silverware and Plated Ware — fabricated metals industry listed below, except for electrical related industries; fabricated metal products, except machinery and transportation equipment, SIC 34, and jewelry, silverware, and plated ware (SIC Code 391).

AB. Facilities That Manufacture Transportation Equipment, Industrial or Commercial Machinery — transportation equipment, industrial or commercial machinery manufacturing facilities (commonly described by SIC Major Group 35 except SIC 357, and SIC Major Group 37, except SIC 373). Common activities include: industrial plant yards; material handling sites; refuse sites; sites used for application or disposal of process wastewaters; sites used for storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas for raw material and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water.

AC. Facilities That Manufacture Electronic and Electrical Equipment and Components, Photographic and Optical Goods — facilities that manufacture electronic and other electrical equipment and components, except computer equipment (SIC major group 36); measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks (SIC major group 38) and computer and office equipment (SIC code 357).

AD. Non-Classified Facilities — facilities that meet the definition of storm water associated with industrial activity (UAC R317-8.38(6)(c) & (d), except for construction activities as defined under UAC R317-8.38(6)(d)(10) but, can not be classified in another industrial sector (i.e., sectors A to AC), and are not excluded from permit coverage elsewhere in this permit; or, the Executive Secretary has designated as needing a storm water permit under UAC R317-8.38(1)(a)5. Should conditions at a facility covered by this section change and industrial activities in another section(s) contained in sectors A to AC apply, the facility shall comply with any and all applicable monitoring and pollution prevention plan requirements of the other section(s) in addition to those contained in this section. The monitoring and pollution prevention plan terms and conditions of this permit are additive for industrial activities being conducted at the same industrial facility (co-located industrial activities). The operator of the facility shall determine which monitoring and pollution prevention plan section(s) of this permit (if any) are applicable to the facility.

V. CERTIFICATION: I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Print Name: KEITH THOMPSON

Signature:  

Amount of Permit Fee Excluded: $ 200.00

INCORPORATED

August 31, 2009

Div. of Oil, Gas & Mining
Guidelines Associated with Storm Water Discharge from Construction Activities

Prevent a mixture of non storm water discharge with construction storm water discharge.

All discharges under this permit must be made up entirely of storm water, unless the mixed discharge meets UPDES standards which include TDS, TSS, pH, Total Iron. Water discharges may not contain detergents, oils, greases, toxic or hazardous materials, or solvents.

If storm water containing any of the following components is released from the site, the plant manager or foreman must be notified immediately.

Detergents
Oils
Greases
Toxic or hazardous materials, or
Solvents
Concrete
Asphalt

The plant manager must immediately notify the Division of Water Quality of the release, if the release is in excess of established reportable quantities.
(801) 538-6146 OR (801) 536-4123 (24 Hour Number)

Erosion and Sediment Controls

Erosion and Sediment Controls must be constructed and maintained during construction activities.
Sediment will be removed at a sufficient frequency to minimize offsite impacts.
Sediment will be removed from berms and ponds when the designed capacity has been reduced by 50%.

Stabilization Practices

Preserve existing vegetation.
Incorporate seeding, mulching, geotextiles, and other appropriate measures to stabilize disturbed soils.
Divert flows from exposed soils with silt fences, earth dikes, swales, sediment traps or basins.

INCORPORATED
August 31, 2009
Div. of Oil, Gas & Mining
Inspections

Qualified personnel will inspect disturbed areas of the construction site at least once every fourteen days (14), before anticipated storm events and within 24 hours of a storm event that is 0.5 inches or greater. Unless site is in an arid period, then inspections shall be conducted at least once every month.

Inspections shall include:

- Drainage Systems
- Sediment Control Measures
- Erosion
- Offsite Sediment Tracking by Vehicles

Inspection Reports will include:

- Inspectors Name, Date of Inspection, Major Observations,
- Actions Taken to Repair Sediment Structures, Incidents of Non Compliance

Reports will be retained for three years (3) after the completion of the construction project.
APPENDIX E

NOTICE OF TERMINATION FOR STORM WATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITY

INCORPORATED
August 31, 2009
Div. of Oil, Gas & Mining
Notice of Termination (NOT) for Storm Water Discharges Associated with Construction Activity
Under the UPDES General Permit No. UTR100000.

I. Permit Information

| UPDES Storm Water General Permit Number: | UTR101090 |
| Check Here if You are No Longer the Operator of the Facility: | X |
| Check Here if the Storm Water Discharge is Being Terminated: |

II. Facility Operator Information

| Name: | TERRA SYSTEMS INC |
| Phone: | 435-637-2470 |
| Address: | P. O. BOX 1673 |
| City: | PRICE |
| State: | UT |
| Zip: | 84501 |

III. Facility Site/Location Information

| Name: | TERRA SYSTEMS INC |
| Address: | 1865 WEST RIDGE ROAD |
| County: | CARBON |
| City: | WELLINGTON |
| State: | UT |
| Zip: | 84542 |
| Latitude: | 39 31 27 |
| Longitude: | 110 45 58 |

IV. Certification: I certify under penalty of law that either: (a) all storm water discharges associated with construction activity from the portion of the identified facility where I was an operator have ceased or have been eliminated; or (b) I am no longer an operator at the construction site and a new operator has assumed operational control for those portions of the construction site where I previously had operational control. I understand that by submitting this notice of termination, I am no longer authorized to discharge storm water associated with construction activity under this general permit, and that discharging pollutants in storm water associated with construction activity to waters of the State is unlawful under the State of Utah Water Quality Act where the discharge is not authorized by a UPDES permit. I also understand that the submittal of this notice of termination does not release an operator from liability for any violations of this permit or the Water Quality Act.

| Print Name: | CLAYTON TIMOTHY |
| Signature: | [Signature] |

Date: 12/30/09

INCORPORATED
August 31, 2009
Div. of Oil, Gas & Mining
APPENDIX 7-5

Spill Prevention, Control and Countermeasure Plan
SPILL PREVENTION CONTROL AND COUNTERMEASURE PLAN

COVOL ENGINEERED FUELS, LC
1865 WEST RIDGE ROAD
WELLINGTON, UT 84542

ORIGINAL DATE OF PLAN/P.E. CERTIFICATION: November 2005

INCORPORATED
August 31, 2009
Div. of Oil, Gas & Mining
# TABLE OF CONTENTS

1. FACILITY OWNER AND OPERATOR ............................................................................. 1  
   A. Corporate Headquarters, Address, and Telephone ............................................. 1  
   B. Facility Operator, Address, and Telephone ...................................................... 1 
2. FACILITY CONTACT(S) .................................................................................................. 1 
3. FACILITY CONFORMANCE [112.7(a)]............................................................................. 1  
   A. Conformance [112.7(a)(1)] .................................................................................... 1  
   B. Deviation From Requirements [112.7(a)(2)] .......................................................... 1  
   C. Facility Description [112.7(a)(3)] .......................................................................... 1  
   D. Reporting Procedure [112.7(a)(4)] ....................................................................... 5  
   E. Response Plan [112.7(a)(5)] ................................................................................. 6 
4. POTENTIAL SPILL PREDICTIONS, VOLUMES, RATES, AND CONTROL [112.7(b)] ........................................................................................................... 6 
5. DRAINAGE CONTROL DIVERSION STRUCTURE AND CONTAINMENT [112.7(c)] ........................................................................................................... 6 
6. DRAINAGE CONTROL [112.8(b)] .................................................................................... 7 
   A. Facility Drainage Systems and Equipment ............................................................ 7  
   B. Final Discharge of Drainage ................................................................................ 7 
7. BULK STORAGE TANKS AND SECONDARY CONTAINMENT [112.8(c)] ............. 7  
   A. Tank Compatibility ................................................................................................. 7 
   B. Containment Construction and Volume for Storage Tanks .................................... 7 
   C. Containment Area Inspection and Drainage of Stormwater ............................... 8 
   D. Corrosion Protection of Buried Metallic Storage Tanks ..................................... 8 
   E. Corrosion Protection of Partially Buried Metallic Storage Tanks ....................... 8 
   F. Aboveground Tank Periodic Inspection ................................................................. 8 
   G. Control of Leakage through Internal Heating Coils ............................................. 8 
   H. Good Engineering Practices .................................................................................. 8 
   I. Observation of Disposal Facilities for Effluent Discharge .................................. 9 
   J. Visible Oil Leaks from Tank Seams and Gaskets ................................................. 9 
   K. Appropriate Positions of Mobile Oil Storage Tanks ............................................ 9 
8. FACILITY TRANSFER OPERATIONS [112.8(d)] ............................................................ 9  
   A. Buried Piping Installation Protection and Examination ........................................ 9 
   B. Not-In-Service and Standby Service Terminal Connections ................................ 9 
   C. Pipe Supports Design ......................................................................................... 9 
   D. Aboveground Valve and Pipeline Examination ................................................ 9 
   E. Vehicle Traffic ...................................................................................................... 10 
9. PRACTICALITY OF INSTALLATION OF REQUIRED STRUCTURES [112.7(d)] ....... 10 
10. INSPECTIONS, TESTS, AND RECORDS [112.7(e)] ...................................................... 10
11. PERSONNEL TRAINING AND DISCHARGE PREVENTION PROCEDURES [112.7(f)] 10
   A. Personnel Instructions [112.7(f)(1)] .............................................................. 10
   B. Designated Person Accountable for Spill Prevention [112.7(f)(2)] ............... 10
   C. Spill Prevention Briefings [112.7(f)(3)] ..................................................... 10

12. SITE SECURITY [112.7(g)] .................................................................................. 10
   A. Fencing [112.7(g)(1)] ................................................................................. 10
   B. Flow Valves Locked [112.7(g)(2)] .............................................................. 11
   C. Starter Controls Locked [112.7(g)(3)] ......................................................... 11
   D. Pipeline Loading/Unloading Connections Securely Capped [112.7(g)(4)] ...... 11
   E. Lighting Adequate to Detect Spills [112.7(g)(5)] ....................................... 11

13. FACILITY LOADING/UNLOADING OPERATIONS [112.7(h)] ............................ 11
   A. Secondary Containment for Vehicles Adequate [112.7(h)(1)] ..................... 11
   B. Warning System for Vehicles [112.7(h)(2)] .............................................. 11
   C. Vehicles Examined for Lowermost Drainage Outlets Before Leaving [112.7(h)(3)] .............................................................. 12

14. BRITTLE FRACTURE EVALUATION [112.7(i)] ................................................. 12

15. ADDITIONAL REQUIREMENTS FROM STATE RULES AND REGULATIONS [112.7(j)] 12

LIST OF FIGURES

FIGURE 3-1 Facility Site Map

LIST OF APPENDICES

APPENDIX A Secondary Containment Volume Calculations
APPENDIX B Drainage Discharge Report Form
APPENDIX C Facility Inspection Checklist
APPENDIX D Certification of the Applicability of the Substantial Harm Criteria Checklist
APPENDIX E Spill Reporting Procedures and Spill Reporting Form
APPENDIX F Completed Forms and Checklists
1. FACILITY OWNER AND OPERATOR

A. Corporate Headquarters, Address, and Telephone:

Headwaters Incorporated
10653 So. River Front Parkway, Suite 300
Salt Lake City, Utah 84095
(801) 984-9400

B. Facility Operator, Address, and Telephone:

Covol Engineered Fuels, LC
1865 West Ridge Road
Wellington, UT 84542
Telephone: (435) 613-1631

2. FACILITY CONTACT(S):

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mike Gipson</td>
<td>Plant Manager</td>
<td>(435) 613-1631</td>
</tr>
</tbody>
</table>

3. FACILITY CONFORMANCE [112.7(a)]:

A. Conformance [112.7 (a)(1)]

The facility intends to comply with the requirements of this Section. Details regarding the compliance with the requirements of Section 112.7 (a) are contained in this SPCC Plan.

The facility is new as of November 2005 and has not experienced any leaks or spill events. Should the facility experience spills they will be documented, reported according to applicable regulations and discussed in future updates of this plan.

B. Deviation from Requirements [112.7 (a)(2)]

The Facility does not plan to deviate from the requirements of Section 112.7 (a); therefore no variance is being requested.

C. Facility Description [112.7 (a)(3)]

Covol Engineered Fuels, LC operates a coal cleaning facility at 1865 West Ridge Road, Wellington, Utah. The facility produces coal-related products for commercial sale.

The facility has an area for feedstock handling and storage, an area containing coal cleaning equipment and an area for finished product storage. The facility is fenced with locked gate access.

In order to facilitate processing operations an aboveground storage tank within a secondary containment structure has been installed at a centralized location. Equipment maintenance needs will be taken care of offsite. Used oil will not be accumulated on site. There are no
underground oil storage tanks (UST) at this facility. The overall facility layout is shown in Figure 3-1, Facility Site Map, including the petroleum product storage area.

**Facility Product Storage Inventory (Typical Volumes) [112.7(a)(3)(i)]:**

### ABOVEGROUND STORAGE

<table>
<thead>
<tr>
<th>Tank ID No.</th>
<th>Contents</th>
<th>Volume (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tank No. 1</td>
<td>Diesel Fuel</td>
<td>8,500</td>
</tr>
<tr>
<td>Drums/Containers (number varies)</td>
<td>Oil and Grease</td>
<td>5 to 55 per drum/container</td>
</tr>
</tbody>
</table>

- **Total Fixed Storage Volume:** 8,500 gallons
- **Variable Storage Volume:** Up to 500 gallons
- **Total Storage Volume:** 9,000 gallons

**Discharge Prevention Measures [112.7(a)(3)(ii)]**

A secondary containment has been constructed for the single diesel storage tank and another for the storage of various sized drums and containers, to prevent any spilled petroleum products in storage from reaching water of the United States. In addition, berms, culverts, ditches and detention ponds constructed to control stormwater runoff would also prevent oil from leaving the site. See Section 13 for loading and unloading procedures.

**Discharge and Drainage Controls [112.7(a)(3)(iii)]**

The nearest water body is the Price River, approximately two miles east of the Facility.

Berms, drainage ditches, and culverts direct operational area drainage into detention ponds. These detention ponds have the potential to receive and hold operational drainage and an unexpected release of oil from equipment or the oil storage areas. Figure 3-1 shows the facility layout and surface drainage direction of flow.

The Facility has been designed whereby drainage from undisturbed watershed areas is diverted away from the operational area with the use of berms, culverts, and diversion ditches.

**Countermeasures [112.7(a)(3)(iv)]**

Ideally, spill prevention measures would prevent a spill from occurring at the facility. However, a spill may still occur. Using the procedures listed below minor spills that are confined to small areas will be cleaned up as part of the ordinary operating procedure.

Procedures to follow in the event of a spill:

- Terminate source of flow - plugging and/or closing valve(s).
- Confine spill - berming, and trenching.
- Prevent from entering waterway.
- Notify Plant Manager or Plant Supervisor.
- Clean up - Absorb liquid with absorptive material before removing contaminated soil and
other media.

- Disposal - Dispose of absorbent material and contaminated media only after conferring with the Plant Manager.
- Report – Complete the facility Spill Reporting Form (Appendix E), report clean-up activities identify cause and determine remedial action. Evaluate whether or not the spill must be reported to EPA Region 8 (for two or more spills in excess of 42 gallons each within a 12 month period or a single spill in excess of 1,000 gallons).

**Direct Countermeasures**

Direct countermeasures outlined below have been designed to mitigate the possibility of oil reaching a waterway. Employees will undertake these countermeasures immediately and especially when there is danger of oil entering a waterway or in case of a spill of significant size. Countermeasures include the necessary action to terminate the source of the flow of oil.

Dig a trench or dike, build a berm, use appropriate oil-absorbent materials or do whatever else is necessary to confine the area or to stop oil from entering a waterway. After this is accomplished, immediately initiate the reporting procedure. After the countermeasures and reporting functions have been accomplished, cleanup will begin as detailed below:

**Who to Contact for Cleanup**

In the case of small spill less than 10 gallons and confined to the facility area, the cleanup operation will be conducted by Plant employees under the direction of the Plant Manager.

In the case of a spill over 10 gallons, the Plant Manager and the Regional Environmental Manager must be notified. If the Plant Manager decides outside help is required the Plant Manager can contact one of the following contactors.

- Nielson Construction
  750 East Ridge Road
  Price, Utah 84501
  (435) 636-8514

- Rocky Mountain Excavation
  6065 East North Coal Creek Road
  Wellington, Utah 84542
  (435) 637-9322

**Cleanup Materials and Equipment**

Spill control equipment at the facility includes absorbent pads and booms, granular absorbent material, shovels, and various earth moving equipment. A spill kit containing absorbent materials will be placed adjacent to the containment area.

**Clean-up Procedures**

For a spill on gravel or soil, it may be possible to absorb some of the liquid with absorptive material before removing the gravel or soil. All contaminated gravel or soil must be removed...
and discarded properly.

A spill on solid surfaces may be collected with absorptive materials and then cleaned thoroughly with rags. Sufficient quantities of absorbent material will be maintained adjacent to the containment area and other cleanup equipment will be available at the facility to accomplish cleanup.

Disposal of Contaminated Materials [112.7(a)(3)(v)]

When cleaning up diesel or oil, all spent cleanup material such as rags, absorbents, blankets, booms, and etc., must be disposed of in accordance with company's approved procedures.

Contact List and Phone Numbers [112.7(a)(3)(vi)]

When a petroleum spill in excess of 10 gallons is detected the following company personnel will be notified:

- Plant Manager, (435) 613-1631
- Plant Supervisor, (435) 613-1631
- Steven Van Ootegham, Regional Environmental Manager, (801) 984-3777

Reportable Spill Under 110 or 112

According to SPCC rule Section 112.4 (a) facilities that store, transfer, use or consume oil and oil productions (112.1(b) are accountable to report spills or releases of oil that enters into or upon the navigable water of the United States or adjoining shorelines in harmful quantities.

A spill becomes reportable to the appropriate regulatory agency whenever a SPCC regulated facility has a:

(1) discharge of more than 1,000 U.S. gallons of oil in a single discharge as described in 112.1(b)

or

(2) discharge of more than 42 gallons of oil as described in 112.1(b) in each of 2 discharges within any 12-month period.

The following agencies will be verbally notified in the event of a spill of oil that may be harmful as defined in 40 CFR 110 and 112. Verbal notification to the agencies must be made within 24 hours of a legally reportable spill. In Utah, legally reportable spills are reported to:

U.S. Environmental Protection Agency
Denver Place, Suite 1300
999 18th Street
Denver, CO 80202-2413
Permits and Technical Support Branch
These agencies may require follow-up written reports depending on the magnitude and quantity of the spill. The Regional Environmental Manager will be responsible for coordinating agency(s) notification and correspondence with regulatory agency(s) following an incident.

The National Response Center requires notification if a discharge of oil causes a discoloration or “sheen” on the surface of water, violates water quality standards or causes a sludge or emulsion to be deposited beneath the surface or on the adjoining shorelines.

National Response Center (800) 424-8802 or (202)267-2675

A spill is defined as a discharge of oil in harmful quantities into navigable water of the United States or adjoining shorelines. (40CFR 112.2) Harmful Quantity means any discharge of oil into or upon waters of the United States that may be harmful to the public health or welfare of the United State, including discharges of oil that violate applicable water quality standards or cause a film or sheen upon or discoloration of the surface of the water or adjoining shoreline or cause sludges or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines. (40 CFR 110.3).

Not Reportable Under 110 or 112

Small spills not reportable under 40 CFR 110 and 112 will be cleaned up as noted above.

D. Reporting Procedure [112.7 (a)(4)]

A spill becomes reportable to the appropriate regulatory agency whenever a SPCC regulated facility has a:

(1) discharge of more than 1,000 U.S. gallons of oil in a single discharge as described in 112.1(b)

or

(2) discharge of more than 42 gallons of oil as described in 112.1(b) in each of 2 discharges within any 12-month period.

When reporting discharges, the following information should be provided to the agencies:

The Company name, address and phone number.
E. Response Plan [112.7 (a)(5)]

The procedures to be used when responding to a spill are contained in Section 3 and Appendix E.

4. POTENTIAL SPILL PREDICTIONS, VOLUMES, RATES, AND CONTROL [112.7 (b)]

The potential for a spill or releases to leave the property is slight due to the redundant controls and the size of the facility relative to the volumes stored on site and the porous nature of the soils at the site. The initial control for Tank #1 is the tank’s secondary containment. The initial control for the various oil containers stored at the facility is the secondary containment. Backup containment exists in the berms, diversion/drainage ditches, and detention ponds at the facility. The location and layout of facility’s prevention measures are shown on Figure 3-1.

POTENTIAL SPILL PREDICTIONS, VOLUMES, RATES AND CONTROL [112.7(b)]

<table>
<thead>
<tr>
<th>Source</th>
<th>#1 Diesel Tank</th>
<th>#2 Various Containers (5 to 55 gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Failure</td>
<td>Rupture, Hose, Valve Failure</td>
<td>Rupture/puncture</td>
</tr>
<tr>
<td>Volume (Gallons)</td>
<td>8,500</td>
<td>55</td>
</tr>
<tr>
<td>Rate (Gallons/hour)</td>
<td>Variable – event dependent</td>
<td>Variable – event dependent</td>
</tr>
<tr>
<td>Direction of Flow</td>
<td>Containment or Southwest</td>
<td>Containment or Southwest</td>
</tr>
<tr>
<td>Net Secondary Containment (Gallons)</td>
<td></td>
<td>67.3</td>
</tr>
</tbody>
</table>

5. DRAINAGE CONTROL DIVERSION STRUCTURES AND CONTAINMENT [112.7 (c)]

The diesel storage tank and other oil containers are enclosed within a steel secondary containment structure. The containment structures are capable of holding the volume of the
largest oil container within each structure, plus the 25-year, 24-hour storm precipitation event for uncovered containment areas (approximately 2.2 inches of precipitation). The containment structures will have drains with locking valves.

6. **DRAINAGE CONTROL [112.8(b)]**

   A. **Facility Drainage Systems and Equipment**

   The initial control for the diesel tank is its secondary containment. Backup containment exists in the berms, diversion/drainage ditches, and detention ponds for the facilities. The tank containment has no connections to a sewer system.

   To maintain containment capacity, when no oil sheen is present, the operator will manually drain or pump water from the secondary containment to one of the detention ponds. The required information associated with each drainage event will be recorded. When oil sheen is present the content of the containment structure will be collected by a licensed recycling or disposal company.

   Surface water drainage reports to one of the two detention ponds, which provides control and treatment prior to release from the site. When oil is present, it will be collected with absorbent materials (pads, booms, etc.) or skimmed off for disposal or recycling at a licensed facility.

   B. **Final Discharge of Drainage**

   Prior to discharge, runoff from the facility reports to one of the detention ponds. The ponds are equipped with a spillway, which acts as an outlet control structure to provide detention time prior to final discharge. Drainage features are shown on Figure 3-1.

   The detention ponds are checked periodically during normal operations and during storm events. If present, oil is removed with absorbent booms or pads or skimmed off for disposal or recycling at a licensed facility.

7. **BULK STORAGE TANKS AND SECONDARY CONTAINMENT [112.8(c)]**

   A. **Tank Compatibility**

   The storage tank is constructed of carbon steel with painted exterior and is compatible with the material stored inside. The tank conforms to all applicable building and fire codes.

   B. **Containment Volume for Storage Tanks**

   The containment structure is capable of containing the volume in the largest tank/container within the containment area plus the 25-year, 24-hour storm precipitation event. The net volume for secondary containment structures is shown in Table 4-1. Calculation sheets for the net volume of the secondary containment are contained in Appendix A.

   Secondary containment protection for service trucks, equipment, fueling facilities, loading/unloading areas are provided by berms, drainage/diversion ditches, and detention ponds.
C. Containment Area Inspection and Drainage of Stormwater

When required prior to manually draining or pumping accumulated water from the secondary containment, the operator will perform a careful visual examination of accumulated water for oil or oil sheen. Further requirements for draining of secondary containment areas by the operators are contained on the Drainage Discharge Report Form in Appendix B. Record keeping requirements for these forms are discussed in Section 6, Part E.

The ponds are all constructed and operated as described above. The ponds are inspected periodically and during storm events. If oil is present, it is removed with the use of absorbent materials (pads, booms, etc.) or skimmed off for off-site disposal.

D. Corrosion Protection of Buried Metallic Storage Tanks

Not applicable - No underground storage tanks or buried oil conveyance piping.

E. Corrosion Protection of Partially Buried Metallic Storage Tanks

Not applicable - No partially buried storage tanks.

F. Aboveground Tank Periodic Inspection

Users/operators visually observe tanks, supports, and foundations for signs of deterioration and/or leaks which might cause a release or accumulation of hydrocarbons within the tank’s secondary containment. Concerns are reported to the Plant Manager or Plant Supervisor. Visible leaks from tank seams, rivets, or bolts that may lead to accumulation of oil within the secondary containment are repaired.

Fifty-five gallon drums and five-gallon cans on-site are observed for excessive external corrosion on a regular basis. Formal inspection of drums includes moving the drum so that all exterior surfaces can be observed. Any drum with rust blisters or flakes of rust is replaced.

Fixed storage tanks and secondary containment structures are inspected annually following the Facility Inspection Checklist contained in Appendix C. Record keeping requirements for these forms are discussed in Section 10.

G. Control of Leakage Through Internal Heating Coils

Not applicable.

H. Good Engineering Practices

Each container to be filled is inspected manually to ensure sufficient volume prior to the start of the filling process. The supplier and/or facility personnel will monitor the tank and gauges
during the entire filling process of bulk storage containers to ensure it is not over filled
(40CFR112.8(c)(8)(iv).

I. Observation of Disposal Facilities for Effluent Discharge

Secondary containment structures are routinely observed during operation and are inspected
annually. Any oil present is removed prior to manual draining or pumping by using absorbent
materials (pads, booms, etc.) or skimmed for off-site disposal.

System failure will require shut down by supplier or facility operator until the problem can be
corrected. A release during loading/unloading or from a service truck will drains to the detention
ponds where it will be collected and removed as discussed in Section 6, Part A.

J. Visible Oil Leak Corrections from Tank Seams and Gaskets

Visible oil leaks from tank seams, rivets, or bolts that may lead to accumulation of oil within the
secondary containment is reported to the Plant Manager of Plant Supervisor and repaired by
plant personnel. If repairs cannot be made immediately, temporary repairs are performed until
permanent repairs are made. Plant personnel will clean up oil released following completion of
the repairs.

K. Appropriate Positions of Mobile Oil Storage Tanks

Not Applicable.

8. FACILITY TRANSFER OPERATIONS [112.8(d)]

Not Applicable. No buried or aboveground pipeline.

A. Buried Piping Installation Protection and Examination

Not Applicable.

B. Not-In-Service and Standby Service Terminal Connections

Loading and unloading terminal connections to storage tanks are capped when not in use. There are no out of service lines at this facility.

C. Pipe Supports Design

Steel pipe supports, where required, are anchored to the localized secondary containment
floors and walls. Pipelines are short and contained within the containment structure. This
eliminates the need for expansion loops.

D. Aboveground Valve and Pipeline Examination

Users/operators visually observe piping and valves for signs of deterioration and/or leaks when
in use. Any sign of deterioration or leakage that might cause a release or accumulation of oil
inside a containment area is reported to the Plant Manager or Plant Supervisor. Visible leaks at flanges, valves, or fittings, which may lead to accumulation of oil in the secondary containment, are promptly repaired.

Valves are inspected annually by following the Facility Inspection Checklist contained in Appendix C. Record keeping requirements for these forms are discussed in Section 10.

E. Vehicle Traffic

The tank is aboveground, anchored, and contained within a secondary containment structure. The tank location and containment assist in protecting the tank from vehicular traffic.

9. PRACTICALITY OF INSTALLATION OF REQUIRED STRUCTURES [112.7(d)]

Secondary containment is practical and currently in use for all storage tanks and oil containers at this facility.

10. INSPECTIONS, TESTS AND RECORDS [112.7(e)]

In addition to annual inspections, the storage tanks and corresponding secondary containment systems containing petroleum product are inspected by an engineer every five years in conjunction with the review and re-certification of this SPCC plan. Inspection of the loading/unloading facilities and security features are also included. These inspections are documented and signed by the inspector on the Facility Inspection Checklist. Blank checklists are contained in Appendix C and completed checklists are maintained for three years in Appendix F.

11. PERSONNEL TRAINING AND SPILL PREVENTION PROCEDURES [112.7(f)]

A. Personnel instructions [112.7(f)(1)]

All new employees are trained in spill prevention and are made familiar with the SPCC Plan as part of their initial training. Regular refresher safety training also addresses spill prevention and response. Training records for personnel are maintained at the facility.

B. Designated Person Accountable for Spill Prevention [112.7(f)(2)]

The Plant Manager is the designated responsible person accountable for spill prevention.

C. Spill Prevention Briefings [112.7(f)(3)]

Spill prevention issues are regular topics at safety meetings, thus fulfilling the requirement of annual spill prevention briefings. In the event of a spill, spill prevention policies would be reviewed following the spill response. The spill response process will be reviewed and suggestions for improvement discussed.

12. SITE SECURITY [112.7(g)]
A. **Fencing [112.7(g)(1)]**

The Facility is fenced and gated. The gate to the facility remains open during operating hours and shut and locked when the facility is not in operation.

B. **Flow Valves Locked [112.7(g)(2)]**

All drain valves permitting an outward flow of fuel from storage tanks and local secondary containment drains have on-off type valves that remain securely locked in the closed position when not in use.

C. **Starter Controls Locked [112.7(g)(3)]**

The facility has a fixed tank storage area with a fueling station for equipment. The fueling station has manual locks to control fueling.

D. **Pipeline Loading/Unloading Connections Securely Capped [112.7(g)(4)]**

All loading and unloading connections on storage tanks are capped with threaded or cam type caps. These caps are removed only during filling or draining operations and are replaced at the end of the operation.

E. **Lighting Adequate to Detect Spills [112.7(g)(5)]**

The facility has yard lights sufficient to illuminate storage, maintenance, and fueling areas. These yard lights are sufficient to observe any release, vandalism, or equipment problems during nighttime operations.

13. **FACILITY LOADING/UNLOADING OPERATIONS [112.7(h)]**

Loading/unloading procedures for supplier tank trucks meet or exceed the minimum requirements and regulations of the Department of Transportation as set forth in 40 CFR 112.7. No rail tank cars are used at this facility.

Though the loading/unloading area does not have localized secondary containment the area is provided secondary containment by the berms, drainage/diversion ditches, and detention ponds that protect the operational facility as previously discussed in Sections 3 and 6.

A. **Secondary Containment for Vehicles Adequate [112.7(h)(1)]**

The tank truck loading/unloading areas are unpaved. These areas do not have localized secondary containment features. However, all areas drain to a detention pond. This pond has sufficient volume to store the entire contents of the largest single compartment of a tanker truck servicing the facility (approximately 10,000 gallons) or piece of equipment being fueled (approximately 175 gallons) except in the event of a 25-year storm event. In the event of a 25-year 24-hour storm, absorbent booms will be deployed at the pond overflow spillway to provide capture and additional storage for oil products.
B. Warning System for Vehicles [112.7(h)(2)]

Warning and instructions for loading/unloading are posted on all tank truck, including instructions for disconnecting all flexible transfer lines. Supplier personnel are present during all loading/unloading of storage tanks. Operating personnel are present during all fueling operations for equipment. These personnel assure all lines are properly connected and disconnected as necessary.

C. Vehicles Examined for Lowermost Drainage Outlets Before Leaving [112.7(h)(3)]

Prior to the departure of any tank truck from the loading/unloading areas, the lower most drain and all outlets of the tank truck will be checked for leakage. If necessary, valves and fittings will be tightened, adjusted, or replaced to prevent leakage during transit. Supplier personnel present during the loading/unloading operation will ensure these procedures are followed.

14. BRITTLE FRACTURE EVALUATION [112.7(i)]

If a tank at the facility is repaired, modified, experiences a change in service or fails, the tank will be evaluated for the risk of brittle fracture or other means of failure. If a risk of failure exists appropriate action will be taken.

15. ADDITIONAL REQUIREMENTS FROM STATE RULES AND REGULATIONS [112.7(j)]

The State of Utah does not have any additional regulations related to oil spill prevention beyond that which are currently found in the Federal Regulations. This SPCC Plan has been prepared based on the Federal Regulations and as such it addresses all pertinent Utah Regulations.
**Professional Engineer Certification:**

I hereby certify:

I am familiar with the requirements of 40 CFR Part 112:

- I have visited and examined the facility;
- The plan has been prepared in accordance with good engineering practice, including consideration of applicable industry standards, and with the requirements of part 40 CFR 112;
- Procedures for required inspections and testing have been established; and the plan is adequate for the facility.

____________________________________
Printed Name of Registered Professional Engineer

____________________________________
Signature of Registered Professional Engineer

____________________________________
Date

(Seal)

Registration Number
SPILL PREVENTION CONTROL AND COUNTERMEASURE COMPLIANCE PLAN REVIEW RECORD

In accordance with 40 CFR 112.5(b), a review and evaluation of this SPCC Plan is conducted at least once every five years. As a result of this review and evaluation, Covol Engineered Fuels, LC will amend the SPCC Plan within six months of the review if the plan is ineffective. Any amendment to the SPCC Plan shall be certified by a Professional Engineer within six months after a change in the facility design, construction, operation, or maintenance occurs which materially affects the facility’s potential for the discharge of oil into or upon the navigable water of the United States or adjoining shorelines.

Review Dates                  Signature

1. No later than: November 2010*  ______________________________________

2. No later than: November 2015*  ______________________________________

3. No later than: November 2020*  ______________________________________

4. No later than: November 2025*  ______________________________________

- SPCC Plan reviewed, amended and certified by a Registered Professional Engineer per 40 CFR112.3 (d).
CERTIFICATION

Facility: Covol Engineered Fuels, LC
1865 West Ridge Road
Wellington, UT 84542
Telephone: (435) 613-1631

Owner: Headwaters Incorporated
10653 So. River Front Parkway
South Jordan, UT 84095
Telephone: (801) 984-9400

Management Approval:

This Spill Prevention Control and Countermeasure Plan (SPCC) was prepared to satisfy the requirements of 40 CFR Part 112. I approve of this plan and have the authority to commit the necessary resources to fully implement this Plan, which will be put into practice as described. Covol Engineered Fuels, LC is committed to the prevention of discharges of oil to navigable waters and the environment, and maintains the highest standards for spill prevention control and countermeasures through regular review, updating, and implementation of this Spill Prevention Control and Countermeasure Plan.

Printed Name

Title

Signature

Date

INCORPORATED

August 31, 2009

Div. of Oil, Gas & Mining
APPENDIX 7-6

Hydrologic Design Methods
HYDROLOGIC DESIGN METHODS
FOR THE COVOL
DRY-COAL CLEANING FACILITY

1.0 INTRODUCTION

The purpose of this report is to present the methodology used during hydrologic calculations for the main facilities area of the COVOL Dry-Coal Cleaning Facility Complex. The hydrologic calculations performed include runoff volumes and peak discharges, sediment storage calculations, existing sedimentation pond capacity, and existing diversion structure adequacy. The adequacy of existing erosion control methods is also addressed.

This report is divided into six sections including the introduction. The methods for determining runoff volumes and peak discharge rates are presented in Section 2.0. A discussion of the sedimentation ponds is contained in Section 3.0. Sections 4.0 and 5.0 describe diversion structures and methods of erosion protection. References are presented in Section 6.0.
2.0 RUNOFF CALCIFICATIONS

The disturbed area boundaries and watersheds at the facility are shown on Plate 7-2 of the permit application.

Data obtained from these watersheds were input to a computer modeling program called HydroCAD 8.5 developed by HydroCAD Software Solutions to generate runoff hydrographs which were used for the design of drainage diversions and inflow/outflow hydrographs for the sedimentation ponds. HydroCAD models runoff using the rainfall-runoff function and triangular unit hydrograph of the U.S. Soil Conservation Service (1972). The SCS Type B rainfall distribution was used to generate the hydrographs for the 6-hour precipitation events.

The design calculations for diversion structures were verified based on the 100-year, 6-hour storm event. The design calculations for the sedimentation ponds design storm capacity were verified using the 10-year, 24-hour storm event. The design calculations for the sedimentation pond outlet structure capacity were verified using the 25-year, 6-hour storm event.

According to the U.S. Soil Conservation Service (1972), the algebraic and hydrologic relations between storm rainfall, soil moisture storage, and runoff can be expressed by the equations,

\[ Q = \frac{(P - 0.2S)^2}{P + 0.8S} \]  

and

\[ S = \frac{1000}{CN - 10} \]

where
- \( Q \) = direct runoff volume (inches)
- \( S \) = watershed storage factor (inches)
- \( P \) = rainfall depth (inches)
- \( CN \) = runoff curve number (dimensionless)
It should be noted that (a) Equation (1) is valid only for P ≥ 0.2S (otherwise Q = 0), (b) Equation (2), as stated, is in inches, with the values of 1000 and 10 carrying the dimensions of inches, although metric conversions are possible, and (c) CN is only a convenient transformation of S to establish a scale of 0 to 100 and has no intrinsic meaning.

The curve numbers for disturbed and undisturbed areas at the facility were based on published values for sites with similar conditions (Mockus, 1969). An average curve number of 87 was assumed for the disturbed area, which corresponds to dirt roads for hydrologic soil group C.

The translation of the runoff depth to an outflow hydrograph is accomplished in the codes using the triangular unit hydrograph of the U.S. Soil Conservation Service (1972). This unit hydrograph is shown in Figure 1 along with a typical curvilinear hydrograph. It is characterized by its time to peak ($T_p$), recession time ($T_r$), time of base ($T_b$), and the relations between these parameters (i.e., $T_r = 1.67T_p$, $T_b = 2.67T_p$). Thus, from the geometry of a triangle, the incremental runoff ($Q$) can be defined by the equation,

$$Q = \frac{(2.67T_p)(q_p)}{2}$$

or

$$q_p = \frac{0.75(Q)}{T_p}$$

where $q_p = \text{peak flow rate (dimensioned according to Q and T)}$

When Q is expressed in inches and $T_p$ in hours, $q_p$ will be in inches per hour. The flow at any time $0 < t < T_r$ may be determined by simple linear proportioning of the triangular unit hydrograph. The time to peak is related to the familiar expression time of concentration ($T_c$) by the equation,
\[ T_c + t = 1.7T_p \]  

(5)

in which the factor 1.7 is an empirical finding cited by the U.S. Soil Conservation Service (1972).

The time of concentration may be estimated by several formulas. For this report, \( T_c \) was determined from the following equations (U.S. Soil Conservation Service, 1972):

\[ L = \frac{0.8(S+1)^{0.7}}{1900Y^{0.5}} \]  

(6)

and

\[ T_c = 1.67L \]  

(7)

where

- \( L \) = watershed lag (hours)
- \( l \) = hydraulic length of the watershed, or distance along the main channel to the watershed divide (feet)
- \( S \) = watershed storage factor defined in Equation (2)
- \( Y \) = average watershed slope (percent)
- \( T_c \) = time of concentration (hours)

The precipitation values for the design storm events were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation Frequency Map (NOAA, 2006). The precipitation data are presented in Table 1.
3.0 SEDIMENTATION PONDS

3.1 Pond Capacity

The capacity of each pond is designed based on runoff and sediment storage volumes. The ponds are designed to completely contain the 10-year, 24-hour storm at the required sediment storage capacity. Division of Oil, Gas and Mining regulations (2006), R614-301-742.221.31 and 742.221.36 require that adequate sediment control be provided and maintained by periodic sediment removal.

3.1.1 Runoff Volume. The runoff calculations for those watersheds contributing to the sediment trap and sedimentation pond were performed as described in Section 2.0. Each analysis was conducted for the 10-year, 24-hour storm event presented in Table 1.

3.1.2 Sediment Storage. The required sediment storage volumes for the sedimentation ponds were based on a modified version of the Soil Conservation Service (SCS) Universal Soil Loss Equation (USL) developed specifically for Utah by Isrealsen et al. (1984). The equation determines the expected annual weight of soil erosion per acre of land based on precipitation, soil erodibility, slope lengths and steepnesses, and erosion controls at the site.

3.2 Spillway Analysis

The sedimentation ponds are constructed with spillways that will pass the peak runoff from the 25-year, 6-hour storm event presented in Table 1. The spillways are constructed as rip-rap lined trapezoidal channels. The spillways for the sedimentation pond are presented on Plate 7-1 of the permit application. The discharge capacities of the spillways were modeled with HydroCAD 8.5, which employs the methodology described below.
The discharge capacity of the rip-rapped overflow spillways was calculated using a method developed by the U.S. Soil conservation Service (1968) and expanded by Haan et al. (1994) for broad-crested weirs. According to this methodology, the critical specific energy head ($H_{ec}$) is determined for selected values of the energy head of water in the pond ($H_p$). The discharge capacity of the spillway is then calculated for the standard 100-foot wide rectangular section from the equation,

$$q_r = (0.544)(g^{0.5})(H_{ec}^{1.5})(100)$$  \hspace{1cm} (8)

where $q_r$ = discharge for standard 100-foot rectangular section (cubic feet per second) and all other parameters have been previously defined. The flow is then corrected for a trapezoidal section using the equation.

$$q = [(1.5b + zH_{ec})/150](q_r)$$  \hspace{1cm} (9)

where $q$ = corrected discharge (cubic feet per second)

- $b$ = bottom width of channel (feet)
- $z$ = channel side slope (run over rise - dimensionless)
4.0 DIVERSION STRUCTURES

4.1 Diversion Ditches

The location of diversion ditches are presented on Plate 7-2 of the permit application. The ditches are labeled based on a description of the area drained.

Diversions were designed to convey runoff from a disturbed drainage area. Some ditch sections are rip-rapped with rock to reduce erosion. Ditches are routinely maintained by removing sediment and replacing rip-rap when necessary.

The ditch capacity and flow velocity was calculated using HydroCAD 8.5, which uses the Manning and continuity equations (see Haan et al., 1994):

\[ V = \frac{1.486}{n} R^{0.67} S^{0.50} \]  \hspace{1cm} (10)

and

\[ Q = A V \]  \hspace{1cm} (11)

where
- \( V \) = velocity (feet per second)
- \( R \) = hydraulic radius (feet)
- \( S \) = hydraulic slope (feet per foot)
- \( n \) = roughness coefficient
- \( Q \) = discharge (cubic feet per second)
- \( A \) = flow area (square feet)

Peak discharges for the undisturbed drainage areas were calculated as described in Section 2.0. Values of Manning’s Roughness Coefficient required for the solution of Equation (10) were obtained by comparing local conditions with tabulated values provided by Haan et al. (1994). An average roughness coefficient of 0.035 was representative of most ditches.
The diversion ditch geometries were measured in the field and approximated with trapezoidal or triangular ditch cross sections. The hydraulic slope of each ditch was either measured in the field or approximated from the topographic base maps (scale: 1"=50'). The capacity of each ditch was verified using a minimum slope value and solving for the depth of flow. The maximum flow velocity for each ditch was calculated using the maximum ditch slope measured from the topographic base maps. All of the calculated flow velocities were 5 feet per second or less, and thus were considered acceptable for unlined ditches without erosion protection.

4.2 Culverts

The location of diversion culverts are presented on Plate 7-2 of the permit application. The culverts are labeled based on a description of the area drained. The location, size, and slope of each culvert were verified in the field.

Peak discharges for the 100-year, 6-hour storm event were calculated as described in Section 2.0. The adequacy of each culvert was determined using a nomograph prepared by the U.S. Department of Transportation (1977). This nomograph for circular culverts with inlet control is presented in Figure 2. Based on the known culvert size, entrance type, and peak discharge, the headwater depth/diameter ratio was determined from the nomograph. If this value was 1.0 or less, the culvert was considered adequate to pass the design discharge rate. If the ratio was greater than 1.0, a closer inspection of the culvert geometry and entrance was necessary.

Exit velocities from each circular culvert were modeled with HydroCAD 8.5. A roughness coefficient of 0.020 was used for the calculations which can be considered typical for corrugated polyethylene pipe (Haan et al., 1994).
5.0 RIPRAPP PROTECTION

The use of riprap to line drainage ditches, culvert outlets or spillways is required when flow velocities exceed approximately 5 feet per second. Calculations to determine the adequacy of existing riprap sections are based on a method defined by the U.S. Department of Transportation (1978).

The size of stone needed to protect a diversion channel or spillway from erosion by a current moving parallel to the channel is determined by the use of Figure 3. The size of stone \( k \) is determined by a trial-and-error method which consists of first estimating a stone size.

Using the peak velocity in the ditch, enter Figure 3 and read the stone size for the channel side slope (not the hydraulic slope, unless it is steeper than the side slope of the ditch). The stone size from Figure 3 is the 50 percent (median) size, by weight, of a well-graded mass of stone with a unit weight of 165 pounds per cubic foot. If the stone size from Figure 3 agrees with the assumed stone size, it is correct. If not, the procedure is repeated until agreement is achieved.
6.0 REFERENCES


Utah Division of Oil, Gas and Mining. 2006. Utah Coal Mining Regulations. Utah Division of Oil, Gas and Mining. Salt Lake City, Utah.
TABLE 1

Precipitation Data for the COVOL Dry-Coal Cleaning Facility

<table>
<thead>
<tr>
<th>Frequency (years)</th>
<th>Duration (hours)</th>
<th>Precipitation (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>24</td>
<td>1.57</td>
</tr>
<tr>
<td>100</td>
<td>6</td>
<td>1.74</td>
</tr>
<tr>
<td>25</td>
<td>6</td>
<td>1.29</td>
</tr>
</tbody>
</table>

FIGURE 1. CURVILINEAR AND TRIANGULAR UNIT HYDROGRAPHS.

Source: NRCS National Engineering Handbook, Part 630
FIGURE 3. RIPRAP SIZING CHART
APPENDIX 7-7
Sedimentation Pond Hydrology Calculations
## Watershed Hydrology Model Summaries

**Coval Engineered Fuels**

**Wellington Dry-Coal Cleaning Facility**

### Watersheds Reporting to East Sedimentation Pond

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Area (ft²)</th>
<th>Avg. Slope (%)</th>
<th>Curve Number</th>
<th>Hydraulic Length (ft)</th>
<th>10-Year, 24-Hour Storm Runoff Volume (ft³)</th>
<th>25-Year, 6-Hour Storm Runoff Volume (ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-1</td>
<td>88,103</td>
<td>0.021</td>
<td>87</td>
<td>1,752</td>
<td>4,290</td>
<td>2,902</td>
</tr>
<tr>
<td>E-2</td>
<td>66,123</td>
<td>0.021</td>
<td>87</td>
<td>581</td>
<td>3,220</td>
<td>2,178</td>
</tr>
<tr>
<td>E-3</td>
<td>28,991</td>
<td>0.03</td>
<td>87</td>
<td>1,091</td>
<td>14,120</td>
<td>9,552</td>
</tr>
<tr>
<td>E-4</td>
<td>29,947</td>
<td>0.25</td>
<td>87</td>
<td>561</td>
<td>1,458</td>
<td>986</td>
</tr>
<tr>
<td>E-5</td>
<td>285,103</td>
<td>0.025</td>
<td>87</td>
<td>925</td>
<td>13,882</td>
<td>9,391</td>
</tr>
</tbody>
</table>

### Watersheds Reporting to West Sedimentation Pond

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Area (ft²)</th>
<th>Avg. Slope (%)</th>
<th>Curve Number</th>
<th>Hydraulic Length (ft)</th>
<th>10-Year, 24-Hour Storm Runoff Volume (ft³)</th>
<th>25-Year, 6-Hour Storm Runoff Volume (ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-1</td>
<td>105,474</td>
<td>0.025</td>
<td>87</td>
<td>1,297</td>
<td>5,136</td>
<td>3,474</td>
</tr>
<tr>
<td>W-2</td>
<td>128,724</td>
<td>0.025</td>
<td>87</td>
<td>635</td>
<td>6,268</td>
<td>4,240</td>
</tr>
<tr>
<td>W-3</td>
<td>70,836</td>
<td>0.027</td>
<td>87</td>
<td>447</td>
<td>3,449</td>
<td>2,333</td>
</tr>
</tbody>
</table>

**Note:** Curve Number assumed to be 87, which corresponds to a dirt road designation for Hydrologic Soil Group C (National Engineering Handbook, Section 4, Chapter 9)

Refer to attached HydroCAD 8.5 output for additional information
SEDIMENT YIELD CALCULATIONS
COVOL ENGINEERED FUELS
WELLINGTON DRY-COAL CLEANING FACILITY

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Area (sq ft)</th>
<th>R</th>
<th>K</th>
<th>LS</th>
<th>VM</th>
<th>A (tons/ac/yr)</th>
<th>Density (pcf)</th>
<th>Annual Sediment Volume (cubic ft/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Pond</td>
<td>759,267</td>
<td>8</td>
<td>0.37</td>
<td>0.24</td>
<td>1.48</td>
<td>1.051</td>
<td>110</td>
<td>333</td>
</tr>
<tr>
<td>West Pond</td>
<td>305,033</td>
<td>8</td>
<td>0.37</td>
<td>0.24</td>
<td>1.48</td>
<td>1.051</td>
<td>110</td>
<td>134</td>
</tr>
</tbody>
</table>

Notes
A = R K LS VM, after Isrealson et al, 1984
R is the rainfall factor, and is taken from a map in Isrealson et al., 1984
K is the soil erodibility factor for the Persayo-Chipeta Complex, as published by the NRCS
LS is the topographic factor, which is based on the length and steepness of the slope at the site. A slope length of 100 feet and a simple slope steepness of 2.5% was used. The value of LS was taken from Isrealson et al., 1984, Table 2.
VM is the erosion control factor, which was taken to be 1.48, which is the value for compacted fill as specified by Isrealson, et al., 1984, Table 3.
Density assumed to be 110 pcf
Reference:
EAST POND STAGE VS. STORAGE

Note: Elevations are based on pre-construction topography at the site and are thus considered approximate. The dimensions and geometry of the sedimentation pond were surveyed by EIS Environmental and Engineering Consultants in November 2007. The bottom of the sedimentation pond was measured to be 10.2 feet below the surrounding ground surface, which is at an elevation of approximately 5,504.0 feet.
Note: Elevations are base on pre-construction topography at the site and are thus considered approximate. The dimensions and geometry of the sedimentation pond were surveyed by EIS Environmental and Engineering Consultants in November 2007. The bottom of the sedimentation pond was measured to be 9.8 feet below the surrounding ground surface, which is at an elevation of approximately 5,508.0 feet.
### Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>759,267</td>
<td>87</td>
<td>(E-1,E-2,E-3,E-4,E-5)</td>
</tr>
<tr>
<td>759,267</td>
<td></td>
<td>TOTAL AREA</td>
</tr>
</tbody>
</table>
### Soil Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>Soil Group</th>
<th>Subcatchment Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>HSG A</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG B</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG C</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG D</td>
<td></td>
</tr>
<tr>
<td>759,267</td>
<td>Other</td>
<td>E-1, E-2, E-3, E-4, E-5</td>
</tr>
<tr>
<td>759,267</td>
<td>TOTAL AREA</td>
<td></td>
</tr>
</tbody>
</table>
**HydroCAD**

**Prepared by EarthFax Engineering, Inc.**

**HydroCAD® 8.50 s/n 003900 © 2007 HydroCAD Software Solutions LLC**

---

**INCORPORATED JANUARY 18, 2011**

**DIVISION OIL, GAS & MINING**

---

**10yr-24hr East Pond**

**Type II 24-hr Rainfall = 1.57”**

**Printed 9/17/2010 12:43:26 PM**

---

**Time span = 0.00-30.00 hrs, dt = 0.05 hrs, 601 points**

Reach routing by SCS TR-20 method, UH=SCS

Pond routing by Stor-Ind method

---

**Subcatchment E-1: Watershed E-1**

- **Runoff Area:** 88,103 sf
- **Runoff Depth:** 0.58”
- **Flow Length:** 1,752’
- **Slope:** 0.0210’
- **Tc:** 27.1 min
- **CN:** 87
- **Runoff:** 1.05 cfs
  - **4,290 cf**

**Subcatchment E-2: Watershed E-2**

- **Runoff Area:** 86,123 sf
- **Runoff Depth:** 0.58”
- **Flow Length:** 581’
- **Slope:** 0.0210’
- **Tc:** 11.2 min
- **CN:** 87
- **Runoff:** 1.28 cfs
  - **3,220 cf**

**Subcatchment E-3: Watershed E-3**

- **Runoff Area:** 289,991 sf
- **Runoff Depth:** 0.58”
- **Flow Length:** 1,091’
- **Slope:** 0.0300’
- **Tc:** 15.5 min
- **CN:** 87
- **Runoff:** 4.81 cfs
  - **14,120 cf**

**Subcatchment E-4: Watershed E-4**

- **Runoff Area:** 29,947 sf
- **Runoff Depth:** 0.58”
- **Flow Length:** 561’
- **Slope:** 0.2500’
- **Tc:** 3.2 min
- **CN:** 87
- **Runoff:** 0.78 cfs
  - **1,458 cf**

**Subcatchment E-5: Watershed E-5**

- **Runoff Area:** 285,103 sf
- **Runoff Depth:** 0.58”
- **Flow Length:** 925’
- **Slope:** 0.0250’
- **Tc:** 14.9 min
- **CN:** 87
- **Runoff:** 4.82 cfs
  - **13,882 cf**

**Reach C1: Culvert C-1**

- **Avg. Depth:** 0.33’
- **Max Vel:** 4.37 fps
- **Inflow:** 1.28 cfs
  - **3,220 cf**
- **Outflow:** 1.27 cfs
  - **3,220 cf**

**Reach C2: Culvert C-2**

- **Avg. Depth:** 0.23’
- **Max Vel:** 3.34 fps
- **Inflow:** 0.59 cfs
  - **1,458 cf**
- **Outflow:** 0.58 cfs
  - **1,459 cf**

**Reach C6: Culvert C-6**

- **Avg. Depth:** 0.83’
- **Max Vel:** 4.82 fps
- **Inflow:** 4.81 cfs
  - **14,120 cf**
- **Outflow:** 4.73 cfs
  - **14,120 cf**

**Reach C7: Culvert C-7**

- **Avg. Depth:** 0.73’
- **Max Vel:** 11.79 fps
- **Inflow:** 9.98 cfs
  - **36,970 cf**
- **Outflow:** 9.98 cfs
  - **36,970 cf**

**Reach E1DL: Lower E-1 Ditch**

- **Avg. Depth:** 0.73’
- **Max Vel:** 2.50 fps
- **Inflow:** 2.00 cfs
  - **8,968 cf**
- **Outflow:** 1.98 cfs
  - **8,968 cf**

**Reach E1DU: Upper E-1 Ditch**

- **Avg. Depth:** 0.86’
- **Max Vel:** 2.35 fps
- **Inflow:** 1.93 cfs
  - **7,510 cf**
- **Outflow:** 1.73 cfs
  - **7,509 cf**

**Reach E3D: E-3 Ditch**

- **Avg. Depth:** 0.78’
- **Max Vel:** 3.17 fps
- **Inflow:** 4.73 cfs
  - **14,120 cf**
- **Outflow:** 4.58 cfs
  - **14,120 cf**

**Reach E4D: E-4 Ditch**

- **Avg. Depth:** 0.48’
- **Max Vel:** 1.80 fps
- **Inflow:** 0.78 cfs
  - **1,458 cf**
- **Outflow:** 0.59 cfs
  - **1,458 cf**

**Reach E5D: E-5 Ditch**

- **Avg. Depth:** 0.72’
- **Max Vel:** 2.00 fps
- **Inflow:** 4.82 cfs
  - **13,882 cf**
- **Outflow:** 4.11 cfs
  - **13,882 cf**

**Pond EP: East Sed Pond**

- **Peak Elev:** 5,501.61’
- **Storage:** 36,970 cf
  - **Inflow:** 9.98 cfs
  - **36,970 cf**
  - **Outflow:** 0.00 cfs
  - **0 cf**

---

**Total Runoff Area = 759,267 sf**

**Runoff Volume = 36,970 cf**

**Average Runoff Depth = 0.58”**

**100.00% Pervious = 759,267 sf**

**0.00% Impervious = 0 sf**
Summary for Subcatchment E-1: Watershed E-1

Runoff = 1.05 cfs @ 12.22 hrs, Volume = 4,290 cf, Depth = 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr Rainfall = 1.57"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>88,103</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
<tr>
<td>88,103</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment E-1: Watershed E-1

Hydrograph

Type II 24-hr Rainfall = 1.57"
Runoff Area = 88,103 sf
Runoff Volume = 4,290 cf
Runoff Depth = 0.58"
Flow Length = 1,752'
Slope = 0.0210 /
Tc = 27.1 min
CN = 87
Summary for Subcatchment E-2: Watershed E-2

Runoff = 1.28 cfs @ 12.04 hrs, Volume = 3,220 cf, Depth = 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr Rainfall = 1.57"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>66,123</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.2</td>
<td>581</td>
<td>0.0210</td>
<td>0.86</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment E-2: Watershed E-2

Hydrograph

Type II 24-hr
Rainfall = 1.57"
Runoff Area = 66,123 sf
Runoff Volume = 3,220 cf
Runoff Depth = 0.58"
Flow Length = 581'
Slope = 0.0210 '/'
Tc = 11.2 min
CN = 87
Summary for Subcatchment E-3: Watershed E-3

Runoff = 4.81 cfs @ 12.09 hrs, Volume= 14,120 cf, Depth= 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=1.57"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 289,991</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.5</td>
<td>1,091</td>
<td>0.0300</td>
<td>1.17</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment E-3: Watershed E-3

Hydrograph

Type II 24-hr Rainfall=1.57"
Runoff Area=289,991 sf
Runoff Volume=14,120 cf
Runoff Depth=0.58"
Flow Length=1,091'
Slope=0.0300 '/'
Tc=15.5 min
CN=87
Summary for Subcatchment E-4: Watershed E-4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.78 cfs @ 11.94 hrs, Volume= 1,458 cf, Depth= 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=1.57"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>29,947</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
<tr>
<td>29,947</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>561</td>
<td>0.2500</td>
<td>2.96</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment E-4: Watershed E-4

Hydrograph

Type II 24-hr
Rainfall=1.57"
Runoff Area=29,947 sf
Runoff Volume=1,458 cf
Runoff Depth=0.58"
Flow Length=561'
Slope=0.2500 '/'
Tc=3.2 min
CN=87
Summary for Subcatchment E-5: Watershed E-5

Runoff = 4.82 cfs @ 12.08 hrs, Volume = 13,882 cf, Depth = 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr Rainfall = 1.57"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 285,103</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

Tc | Length | Slope | Velocity | Capacity | Description |
---|--------|-------|----------|----------|-------------|
14.9 | 925 | 0.0250 | 1.04 | | Lag/CN Method, |

Subcatchment E-5: Watershed E-5

Type II 24-hr Rainfall = 1.57"
Runoff Area = 285,103 sf
Runoff Volume = 13,882 cf
Runoff Depth = 0.58"
Flow Length = 925'
Slope = 0.0250 '/'
Tc = 14.9 min
CN = 87
Summary for Reach C1: Culvert C-1

[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 66,123 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 1.28 cfs @ 12.04 hrs, Volume = 3,220 cf
Outflow = 1.27 cfs @ 12.04 hrs, Volume = 3,220 cf, Atten = 0%, Lag = 0.2 min

Routing by Stor-Ind+Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Max. Velocity = 4.37 fps, Min. Travel Time = 0.2 min
Avg. Velocity = 1.51 fps, Avg. Travel Time = 0.4 min

Peak Storage = 12 cf @ 12.04 hrs, Average Depth at Peak Storage = 0.33'
Bank-Full Depth = 1.50', Capacity at Bank-Full = 11.83 cfs

18.0" Diameter Pipe, n = 0.020 Corrugated PE, corrugated interior
Length = 40.0' Slope = 0.0300 '/'
Inlet Invert = 5,520.70', Outlet Invert = 5,519.50'

Reach C1: Culvert C-1

Inflow Area = 66,123 sf
Avg. Depth = 0.33'
Max Vel = 4.37 fps
D = 18.0"
n = 0.020
L = 40.0'
S = 0.0300 '/'
Capacity = 11.83 cfs
Summary for Reach C2: Culvert C-2

[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach E4D outlet invert by 0.23' @ 12.10 hrs

Inflow Area = 29,947 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow  = 0.59 cfs @ 12.08 hrs, Volume= 1,458 cf
Outflow = 0.58 cfs @ 12.08 hrs, Volume= 1,459 cf, Atten= 2%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 3.34 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.12 fps, Avg. Travel Time= 0.6 min

Peak Storage= 7 cf @ 12.08 hrs, Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 11.32 cfs

18.0" Diameter Pipe, n= 0.020 Corrugated PE, corrugated interior
Length= 40.0' Slope= 0.0275 '/'
Inlet Invert= 5,509.80', Outlet Invert= 5,508.70'

Reach C2: Culvert C-2

Inflow Area=29,947 sf
Avg. Depth=0.23'
Max Vel=3.34 fps
D=18.0"
n=0.020
L=40.0'
S=0.0275 '/'
Capacity=11.32 cfs
Summary for Reach C6: Culvert C-6

[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 289,991 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 4.81 cfs @ 12.09 hrs, Volume = 14,120 cf
Outflow = 4.73 cfs @ 12.11 hrs, Volume = 14,120 cf, Attenuation = 2%, Lag = 1.2 min

Routing by Stor-Ind + Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Max. Velocity = 4.82 fps, Min. Travel Time = 0.7 min
Avg. Velocity = 1.76 fps, Avg. Travel Time = 1.9 min

Peak Storage = 199 cf @ 12.10 hrs, Average Depth at Peak Storage = 0.83'
Bank-Full Depth = 1.50', Capacity at Bank-Full = 8.19 cfs

18.0" Diameter Pipe, n = 0.025 Corrugated metal
Length = 200.0' Slope = 0.0225 '/'
Inlet Invert = 5,514.00', Outlet Invert = 5,509.50'

Reach C6: Culvert C-6

Hydrograph

Inflow Area = 289,991 sf
Avg. Depth = 0.83'
Max Vel = 4.82 fps
D = 18.0"
n = 0.025
L = 200.0'
S = 0.0225 '/'
Capacity = 8.19 cfs
Summary for Reach C7: Culvert C-7

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach E1DL OUTLET depth by 1.20' @ 10.30 hrs
[62] Warning: Exceeded Reach E3D OUTLET depth by 1.08' @ 12.35 hrs
[62] Warning: Exceeded Reach E5D OUTLET depth by 1.25' @ 12.30 hrs

Inflow Area = 759,267 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow rate = 9.98 cfs @ 12.21 hrs, Volume = 36,970 cf
Outflow rate = 9.98 cfs @ 12.21 hrs, Volume = 36,970 cf, Atten = 0%, Lag = 0.0 min

Routing by Stor-Ind+Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Max. Velocity = 11.79 fps, Min. Travel Time = 0.0 min
Avg. Velocity = 4.03 fps, Avg. Travel Time = 0.1 min

Peak Storage = 17 cf @ 12.21 hrs, Average Depth at Peak Storage = 0.73'
Bank-Full Depth = 1.50', Capacity at Bank-Full = 21.16 cfs

18.0'' Diameter Pipe, n = 0.025 Corrugated metal
Length = 20.0' Slope = 0.1500 '/'
Inlet Invert = 5,505.00', Outlet Invert = 5,502.00'

Reach C7: Culvert C-7

Hydrograph

Inflow Area = 759,267 sf
Avg. Depth = 0.73'
Max Vel = 11.79 fps
D = 18.0''
n = 0.025
L = 20.0'
S = 0.1500 '/'
Capacity = 21.16 cfs
Summary for Reach E1DL: Lower E-1 Ditch

[62] Warning: Exceeded Reach C2 OUTLET depth by 0.59' @ 12.30 hrs
[61] Hint: Exceeded Reach E1DU outlet invert by 0.73' @ 12.25 hrs

Inflow Area = 184,173 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 2.00 cfs @ 12.20 hrs, Volume= 8,968 cf
Outflow = 1.98 cfs @ 12.26 hrs, Volume= 8,968 cf, Atten= 1%, Lag= 3.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.50 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 4.9 min

Peak Storage= 228 cf @ 12.23 hrs, Average Depth at Peak Storage= 0.73'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 13.67 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 1.5 '/' Top Width= 4.50'
Length= 287.0' Slope= 0.0171 '/'
Inlet Invert= 5,508.70', Outlet Invert= 5,503.80'

Inflow Area=184,173 sf
Avg. Depth=0.73'
Max. Vel=2.50 fps
n=0.035
L=287.0'
S=0.0171 '/'
Capacity=13.67 cfs
Summary for Reach E1DU: Upper E-1 Ditch

[52] Warning: Exceeded Reach C1 OUTLET depth by 0.65' @ 12.25 hrs

Inflow Area = 154,226 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 1.93 cfs @ 12.07 hrs, Volume= 7,510 cf
Outflow = 1.73 cfs @ 12.24 hrs, Volume= 7,509 cf, Atten= 10%, Lag= 10.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.35 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 0.93 fps, Avg. Travel Time= 12.9 min

Peak Storage= 534 cf @ 12.15 hrs, Average Depth at Peak Storage= 0.86'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 7.67 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 1.0 '/' Top Width= 3.00'
Length= 720.0' Slope= 0.0150 '/'
Inlet Invert= 5,519.50', Outlet Invert= 5,508.70'

Reach E1DU: Upper E-1 Ditch

Inflow Area=154,226 sf
Avg. Depth=0.86'
Max Vel=2.35 fps
n=0.035
L=720.0'
S=0.0150 '/'
Capacity=7.67 cfs
Summary for Reach E3D: E-3 Ditch

Warning: Exceeded Reach C6 OUTLET depth by 0.08' @ 12.30 hrs

| Inflow Area | 289,991 sf, 0.00% Impervious | Inflow Depth = 0.58" |
| Inflow       | 4.73 cfs @ 12.11 hrs, Volume= 14,120 cf |
| Outflow      | 4.58 cfs @ 12.15 hrs, Volume= 14,120 cf, Atten= 3%, Lag= 2.8 min |

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.17 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.24 fps, Avg. Travel Time= 3.8 min

Peak Storage= 414 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.78'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 21.95 cfs

0.50' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 2.5 1.0 '/' Top Width= 5.75'
Length= 283.0' Slope= 0.0194 '/'
Inlet Invert= 5,509.50', Outlet Invert= 5,504.00'

Reach E3D: E-3 Ditch

Hydrograph

Inflow Area=289,991 sf
Avg. Depth=0.78'
Max Vel=3.17 fps
n=0.035
L=283.0'
S=0.0194 '/'
Capacity=21.95 cfs
Summary for Reach E4D: E-4 Ditch

Inflow Area = 29,947 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 0.78 cfs @ 11.94 hrs, Volume= 1,458 cf
Outflow = 0.59 cfs @ 12.08 hrs, Volume= 1,458 cf, Atten= 25%, Lag= 8.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.80 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 0.65 fps, Avg. Travel Time= 14.4 min

Peak Storage= 190 cf @ 11.99 hrs, Average Depth at Peak Storage= 0.48'
Bank-Full Depth= 1.20', Capacity at Bank-Full= 7.21 cfs

0.00' x 1.20' deep channel, n= 0.035
Side Slope Z-value= 2.0 1.0 '/' Top Width= 3.60'
Length= 561.0' Slope= 0.0159 '/'
Inlet invert= 5,518.70', Outlet Invert= 5,509.80'

Reach E4D: E-4 Ditch

Inflow Area=29,947 sf
Avg. Depth=0.48'
Max Vel=1.80 fps
n=0.035
L=561.0'
S=0.0159 '/'
Capacity=7.21 cfs
Summary for Reach E5D: E-5 Ditch

Inflow Area = 285,103 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 4.82 cfs @ 12.08 hrs, Volume = 13,882 cf
Outflow = 4.11 cfs @ 12.25 hrs, Volume = 13,882 cf, Atten = 15%, Lag = 10.5 min

Routing by Stor-Ind+Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Max. Velocity = 2.00 fps, Min. Travel Time = 6.2 min
Avg. Velocity = 0.69 fps, Avg. Travel Time = 17.9 min

Peak Storage = 1,534 cf @ 12.15 hrs, Average Depth at Peak Storage = 0.72'
Bank-Full Depth = 1.00', Capacity at Bank-Full = 10.01 cfs

0.00' x 1.00' deep channel, n = 0.035
Side Slope Z-value = 4.0' '/' Top Width = 8.00'
Length = 746.0' Slope = 0.0091 '/'
Inlet Invert = 5,510.60', Outlet Invert = 5,503.80'

Reach E5D: E-5 Ditch

Hydrograph

Inflow Area = 285,103 sf
Avg. Depth = 0.72'
Max Vel = 2.00 fps
n = 0.035
L = 746.0'
S = 0.0091 '/'
Capacity = 10.01 cfs
Summary for Pond EP: East Sed Pond

Inflow Area = 759,267 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 9.98 cfs @ 12.21 hrs, Volume= 36,970 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 5,501.61' @ 30.00 hrs Surf.Area= 7,938 sf Storage= 36,970 cf

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

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>5,493.80'</td>
<td>56,820 cf</td>
<td>Custom Stage Data (Prismatic) Listed below (Recalc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5,493.80</td>
<td>2,550</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5,494.80</td>
<td>2,601</td>
<td>2,576</td>
<td>2,576</td>
</tr>
<tr>
<td>5,495.80</td>
<td>3,214</td>
<td>2,908</td>
<td>5,483</td>
</tr>
<tr>
<td>5,496.80</td>
<td>3,909</td>
<td>3,562</td>
<td>9,045</td>
</tr>
<tr>
<td>5,497.80</td>
<td>4,637</td>
<td>4,273</td>
<td>13,318</td>
</tr>
<tr>
<td>5,498.80</td>
<td>5,425</td>
<td>5,031</td>
<td>18,349</td>
</tr>
<tr>
<td>5,499.80</td>
<td>6,243</td>
<td>5,834</td>
<td>24,183</td>
</tr>
<tr>
<td>5,500.80</td>
<td>7,158</td>
<td>6,701</td>
<td>30,883</td>
</tr>
<tr>
<td>5,501.80</td>
<td>8,125</td>
<td>7,642</td>
<td>38,525</td>
</tr>
<tr>
<td>5,502.80</td>
<td>9,087</td>
<td>8,606</td>
<td>47,131</td>
</tr>
<tr>
<td>5,503.80</td>
<td>10,291</td>
<td>9,689</td>
<td>56,820</td>
</tr>
</tbody>
</table>

Pond EP: East Sed Pond

Hydrograph

Inflow Area=759,267 sf
Peak Elev=5,501.61'
Storage=36,970 cf
Drainage Diagram for 10yr-24hr West Pond

Prepared by EarthFax Engineering, Inc., Printed 9/17/2010
HydroCAD® 8.50  s/n 003900  © 2007 HydroCAD Software Solutions LLC
### Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>305,034</td>
<td>87</td>
<td>(W-1,W-2,W-3)</td>
</tr>
<tr>
<td>305,034</td>
<td></td>
<td>TOTAL AREA</td>
</tr>
</tbody>
</table>
### Soil Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>Soil Group</th>
<th>Subcatchment Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>HSG A</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG B</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG C</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG D</td>
<td></td>
</tr>
<tr>
<td>305,034</td>
<td>Other</td>
<td>W-1, W-2, W-3</td>
</tr>
<tr>
<td>305,034</td>
<td>TOTAL AREA</td>
<td></td>
</tr>
</tbody>
</table>
### 10yr-24hr West Pond

**Prepared by EarthFax Engineering, Inc.**

**HydroCAD® 8.50 s/n 003900 © 2007 HydroCAD Software Solutions LLC**

**Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points**

Runoff by SCS TR-20 method, UH=SCS

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<table>
<thead>
<tr>
<th>Subcatchment</th>
<th>Watershed</th>
<th>Runoff Area</th>
<th>Impervious</th>
<th>Runoff Depth</th>
<th>Flow Length</th>
<th>Slope</th>
<th>Tc</th>
<th>CN</th>
<th>Runoff</th>
<th>Inflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-1</td>
<td>W-1</td>
<td>105,474 sf</td>
<td>0.00%</td>
<td>0.58&quot;</td>
<td>1,297'</td>
<td>0.0250</td>
<td>19.5</td>
<td>87</td>
<td>1.54 cfs</td>
<td>5,136 cf</td>
</tr>
<tr>
<td>W-2</td>
<td>W-2</td>
<td>128,724 sf</td>
<td>0.00%</td>
<td>0.58&quot;</td>
<td>635'</td>
<td>0.0250</td>
<td>11.0</td>
<td>87</td>
<td>2.50 cfs</td>
<td>6,268 cf</td>
</tr>
<tr>
<td>W-3</td>
<td>W-3</td>
<td>70,836 sf</td>
<td>0.00%</td>
<td>0.58&quot;</td>
<td>447'</td>
<td>0.0270</td>
<td>8.0</td>
<td>87</td>
<td>1.55 cfs</td>
<td>3,449 cf</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach C3: Culvert C-3</th>
<th>Avg. Depth=0.43'</th>
<th>Max Vel=5.28 fps</th>
<th>Inflow=2.22 cfs</th>
<th>6,268 cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>D=18.0&quot;</td>
<td>n=0.020</td>
<td>L=40.0'</td>
<td>S=0.0325'</td>
<td>Capacity=12.31 cfs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach C4: Culvert C-4</th>
<th>Avg. Depth=0.46'</th>
<th>Max Vel=2.83 fps</th>
<th>Inflow=1.28 cfs</th>
<th>5,136 cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>D=18.0&quot;</td>
<td>n=0.025</td>
<td>L=80.0'</td>
<td>S=0.0138'</td>
<td>Capacity=6.41 cfs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach C5: Culvert C-5</th>
<th>Avg. Depth=0.36'</th>
<th>Max Vel=9.32 fps</th>
<th>Inflow=3.02 cfs</th>
<th>14,852 cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>D=18.0&quot;</td>
<td>n=0.025</td>
<td>L=20.0'</td>
<td>S=0.1950'</td>
<td>Capacity=24.12 cfs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach W1DL: Lower W-1 Ditch</th>
<th>Avg. Depth=0.82'</th>
<th>Max Vel=2.02 fps</th>
<th>Inflow=2.74 cfs</th>
<th>11,403 cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=0.035</td>
<td>L=320.0'</td>
<td>S=0.0088'</td>
<td>Capacity=29.49 cfs</td>
<td>Outflow=2.68 cfs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach W1DU: Upper W-1 Ditch</th>
<th>Avg. Depth=0.56'</th>
<th>Max Vel=2.04 fps</th>
<th>Inflow=1.54 cfs</th>
<th>5,136 cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=0.035</td>
<td>L=963.0'</td>
<td>S=0.0145'</td>
<td>Capacity=38.02 cfs</td>
<td>Outflow=1.28 cfs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach W2D: W-2 Ditch</th>
<th>Avg. Depth=0.26'</th>
<th>Max Vel=1.99 fps</th>
<th>Inflow=2.50 cfs</th>
<th>6,268 cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=0.035</td>
<td>L=500.0'</td>
<td>S=0.0158'</td>
<td>Capacity=23.56 cfs</td>
<td>Outflow=2.22 cfs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reach W3D: W-3 Ditch</th>
<th>Avg. Depth=0.52'</th>
<th>Max Vel=2.02 fps</th>
<th>Inflow=1.55 cfs</th>
<th>3,449 cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=0.035</td>
<td>L=160.0'</td>
<td>S=0.0156'</td>
<td>Capacity=8.65 cfs</td>
<td>Outflow=1.45 cfs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pond WP: West Sed Pond</th>
<th>Peak Elev=5,503.96'</th>
<th>Storage=14,852 cf</th>
<th>Inflow=3.02 cfs</th>
<th>14,852 cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=0.035</td>
<td>L=0.00'</td>
<td>S=0.015'</td>
<td>Capacity=0.00 cfs</td>
<td>Outflow=0.00 cfs</td>
</tr>
</tbody>
</table>

**Total Runoff Area = 305,034 sf**  **Runoff Volume = 14,853 cf**  **Average Runoff Depth = 0.58"**

**100.00% Pervious = 305,034 sf**  **0.00% Impervious = 0 sf**
Summary for Subcatchment W-1: Watershed W-1

Runoff = 1.54 cfs @ 12.13 hrs, Volume = 5,136 cf, Depth = 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr Rainfall = 1.57"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>105,474</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.5</td>
<td>1,297</td>
<td>0.0250</td>
<td>1.11</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment W-1: Watershed W-1

Hydrograph

Type II 24-hr Rainfall = 1.57"
Runoff Area = 105,474 sf
Runoff Volume = 5,136 cf
Runoff Depth = 0.58"
Flow Length = 1,297'
Slope = 0.0250 '/'
Tc = 19.5 min
CN = 87

Runoff = 2.50 cfs @ 12.04 hrs, Volume = 6,268 cf, Depth = 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr Rainfall = 1.57"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>128,724</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.0</td>
<td>635</td>
<td>0.0250</td>
<td>0.96</td>
<td>Lag/CN Method,</td>
<td></td>
</tr>
</tbody>
</table>

Subcatchment W-2: Watershed W-2

Hydrograph

Type II 24-hr Rainfall = 1.57"
Runoff Area = 128,724 sf
Runoff Volume = 6,268 cf
Runoff Depth = 0.58"
Flow Length = 635'
Slope = 0.0250 '/'
Tc = 11.0 min
CN = 87
Summary for Subcatchment W-3: Watershed W-3

Runoff = 1.55 cfs @ 12.00 hrs, Volume= 3,449 cf, Depth= 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=1.57"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 70,836</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>447</td>
<td>0.0270</td>
<td>0.93</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment W-3: Watershed W-3

Hydrograph

Type II 24-hr Rainfall=1.57"
Runoff Area=70,836 sf
Runoff Volume=3,449 cf
Runoff Depth=0.58"
Flow Length=447'
Slope=0.0270 '/'
Tc=8.0 min
CN=87
Summary for Reach C3: Culvert C-3

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach W2D OUTLET depth by 0.22' @ 12.20 hrs

Inflow Area = 128,724 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 2.22 cfs @ 12.15 hrs, Volume = 6,268 cf
Outflow = 2.21 cfs @ 12.15 hrs, Volume = 6,268 cf, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.28 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.70 fps, Avg. Travel Time= 0.4 min

Peak Storage= 17 cf @ 12.15 hrs, Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 12.31 cfs

18.0' Diameter Pipe, n= 0.020
Length= 40.0' Slope= 0.0325 '/'
Inlet Invert= 5,512.10', Outlet Invert= 5,510.80'

Reach C3: Culvert C-3

Hydrograph

Inflow Area=128,724 sf
Avg. Depth=0.43'
Max Vel=5.28 fps
D=18.0''
n=0.020
L=40.0'
S=0.0325 '/'
Capacity=12.31 cfs
Summary for Reach C4: Culvert C-4

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach W1DU OUTLET depth by 1.20' @ 0.00 hrs

Inflow Area = 105,474 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 1.28 cfs @ 12.36 hrs, Volume = 5,136 cf
Outflow = 1.28 cfs @ 12.37 hrs, Volume = 5,136 cf, Atten= 1%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity = 2.83 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 0.96 fps, Avg. Travel Time= 1.4 min

Peak Storage = 36 cf @ 12.36 hrs, Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 6.41 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 80.0' Slope= 0.0138 '/'
Inlet Invert= 5,512.00', Outlet Invert= 5,510.90'

Reach C4: Culvert C-4

Hydrograph

Inflow Area= 105,474 sf
Avg. Depth= 0.46'
Max Vel= 2.83 fps
D=18.0"
 n=0.025
 L=80.0'
 S=0.0138 '/'
Capacity= 6.41 cfs
Summary for Reach C5: Culvert C-5

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach W1DL OUTLET depth by 1.90' @ 10.55 hrs
[62] Warning: Exceeded Reach W3D OUTLET depth by 1.98' @ 12.30 hrs

Inflow Area = 305,034 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 3.02 cfs @ 12.25 hrs, Volume = 14,852 cf
Outflow = 3.02 cfs @ 12.25 hrs, Volume = 14,852 cf, Atten = 0%, Lag = 0.1 min

Routing by Stor-Ind+Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Max. Velocity = 9.32 fps, Min. Travel Time = 0.0 min
Avg. Velocity = 3.45 fps, Avg. Travel Time = 0.1 min

Peak Storage = 6 cf @ 12.25 hrs, Average Depth at Peak Storage = 0.36'
Bank-Full Depth = 1.50', Capacity at Bank-Full = 24.12 cfs

18.0" Diameter Pipe, n = 0.025 Corrugated metal
Length = 20.0' Slope = 0.1950 '/'
Inlet Invert = 5,509.90', Outlet Invert = 5,506.00'

Inflow Area = 305,034 sf
Avg. Depth = 0.36'
Max Vel = 9.32 fps
D = 18.0"
n = 0.025
L = 20.0'
S = 0.1950 '/'
Capacity = 24.12 cfs
Summary for Reach W1DL: Lower W-1 Ditch

[62] Warning: Exceeded Reach C3 OUTLET depth by 0.50' @ 12.40 hrs
[62] Warning: Exceeded Reach C4 OUTLET depth by 0.39' @ 12.15 hrs

Inflow Area = 234,198 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 2.74 cfs @ 12.18 hrs, Volume = 11,403 cf
Outflow = 2.68 cfs @ 12.27 hrs, Volume = 11,403 cf, Atten= 2%, Lag= 5.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.02 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 7.0 min

Peak Storage= 426 cf @ 12.22 hrs, Average Depth at Peak Storage= 0.82'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 29.49 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 320.0' Slope= 0.0088 '/'
Inlet Invert= 5,510.80', Outlet Invert= 5,508.00'

Reach W1DL: Lower W-1 Ditch

Hydrograph

Inflow Area=234,198 sf
Avg. Depth=0.82'
Max Vel=2.02 fps
n=0.035
L=320.0'
S=0.0088 '/'
Capacity=29.49 cfs
Summary for Reach W1DU: Upper W-1 Ditch

Inflow Area = 105,474 sf, 0.00% Impervious, Inflow Depth = 0.58"  
Inflow = 1.54 cfs @ 12.13 hrs, Volume = 5,136 cf  
Outflow = 1.28 cfs @ 12.36 hrs, Volume = 5,136 cf, Atten = 17%, Lag = 13.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Max. Velocity= 2.04 fps, Min. Travel Time= 7.9 min  
Avg. Velocity = 0.78 fps, Avg. Travel Time = 20.8 min

Peak Storage= 612 cf @ 12.22 hrs, Average Depth at Peak Storage= 0.56'  
Bank-Full Depth= 2.00', Capacity at Bank-Full= 38.02 cfs

0.00' x 2.00' deep channel, n= 0.035  
Side Slope Z-value= 2.0  
Top Width= 8.00'  
Length= 963.0'  
Slope= 9.914'  
Inlet Invert= 5,524.80', Outlet Invert= 5,510.80'

Reach W1DU: Upper W-1 Ditch

Hydrograph

Inflow Area=105,474 sf  
Avg. Depth=0.56'  
Max Vel=2.04 fps  
n=0.035  
L=963.0'  
S=0.0145 '/'  
Capacity=38.02 cfs
Summary for Reach W2D: W-2 Ditch

Inflow Area = 128,724 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 2.50 cfs @ 12.04 hrs, Volume = 6,268 cf
Outflow = 2.22 cfs @ 12.15 hrs, Volume = 6,268 cf, Atten = 11%, Lag = 6.8 min

Routing by Stor-Ind+Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Max. Velocity = 1.99 fps, Min. Travel Time = 4.2 min
Avg. Velocity = 0.50 fps, Avg. Travel Time = 16.7 min

Peak Storage = 568 cf @ 12.08 hrs, Average Depth at Peak Storage = 0.26'
Bank-Full Depth = 1.00', Capacity at Bank-Full = 23.56 cfs

4.00' x 1.00' deep channel, n = 0.035
Side Slope Z-value = 2.0 1.0 '/' Top Width = 7.00'
Length = 500.0'  Slope = 0.0158 '/'
Inlet Invert = 5,520.00', Outlet Invert = 5,512.10'

Reach W2D: W-2 Ditch

Hydrograph

Inflow Area = 128,724 sf
Avg. Depth = 0.26'
Max Vel = 1.99 fps
n = 0.035
L = 500.0'
S = 0.0158 '/'
Capacity = 23.56 cfs
Summary for Reach W3D: W-3 Ditch

Inflow Area = 70,836 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 1.55 cfs @ 12.00 hrs, Volume = 3,449 cf
Outflow = 1.45 cfs @ 12.04 hrs, Volume = 3,449 cf, Atten= 6%, Lag= 2.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.02 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 0.78 fps, Avg. Travel Time= 3.4 min

Peak Storage= 118 cf @ 12.02 hrs, Average Depth at Peak Storage= 0.52'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 8.65 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 4.5 1.0 '/' Top Width= 5.50'
Length= 160.0' Slope= 0.0156 '/'
Inlet Invert= 5,510.50', Outlet Invert= 5,508.00'

Reach W3D: W-3 Ditch

Hydrograph

Inflow Area=70,836 sf
Avg. Depth=0.52'
Max Vel=2.02 fps
n=0.035
L=160.0'
S=0.0156 '/'
Capacity=8.65 cfs
Summary for Pond WP: West Sed Pond

Inflow Area = 305,034 sf, 0.00% Impervious, Inflow Depth = 0.58"
Inflow = 3.02 cfs @ 12.25 hrs, Volume = 14,852 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume = 0 cf, Atten = 100%, Lag = 0.0 min

Routing by Stor-Ind method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Peak Elev = 5,503.96' @ 30.00 hrs  Surf.Area = 4,030 sf  Storage = 14,852 cf

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

Volume  Invert  Avail.Storage  Storage Description
#1  5,498.23'  36,065 cf  17.00'W x 78.00'L x 9.77'H Prismatoid  Z=2.0

Pond WP: West Sed Pond

Hydrograph

Inflow Area = 305,034 sf
Peak Elev = 5,503.96'
Storage = 14,852 cf
### Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>759,267</td>
<td>87</td>
<td>(E-1,E-2,E-3,E-4,E-5)</td>
</tr>
<tr>
<td>759,267</td>
<td></td>
<td>TOTAL AREA</td>
</tr>
</tbody>
</table>
## Soil Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>Soil Group</th>
<th>Subcatchment Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>HSG A</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG B</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG C</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG D</td>
<td></td>
</tr>
<tr>
<td>759,267</td>
<td>Other</td>
<td>E-1, E-2, E-3, E-4, E-5</td>
</tr>
<tr>
<td>759,267</td>
<td>TOTAL AREA</td>
<td></td>
</tr>
</tbody>
</table>
Time span = 0.00-30.00 hrs, dt = 0.05 hrs, 601 points
Reach routing by SCS TR-20 method, UH=SCS
Runoff routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: Watershed E-1
- Runoff Area = 88,103 sf
- 0.00% Impervious
- Runoff Depth = 0.40"
- Flow Length = 1,752' Slope = 0.0210 ' Tc = 27.1 min CN = 87 Runoff = 0.98 cfs 2,902 cf

Subcatchment E-2: Watershed E-2
- Runoff Area = 66,123 sf
- 0.00% Impervious
- Runoff Depth = 0.40"
- Flow Length = 581' Slope = 0.0300 ' Tc = 15.5 min CN = 87 Runoff = 1.42 cfs 2,178 cf

Subcatchment E-3: Watershed E-3
- Runoff Area = 289,991 sf
- 0.00% Impervious
- Runoff Depth = 0.40"
- Flow Length = 1,091' Slope = 0.0300 ' Tc = 15.5 min CN = 87 Runoff = 4.88 cfs 9,552 cf

Subcatchment E-4: Watershed E-4
- Runoff Area = 29,947 sf
- 0.00% Impervious
- Runoff Depth = 0.40"
- Flow Length = 561' Slope = 0.2500 ' Tc = 3.2 min CN = 87 Runoff = 1.16 cfs 986 cf

Subcatchment E-5: Watershed E-5
- Runoff Area = 285,103 sf
- 0.00% Impervious
- Runoff Depth = 0.40"
- Flow Length = 925' Slope = 0.0250 ' Tc = 14.9 min CN = 87 Runoff = 4.98 cfs 9,391 cf

Reach C1: Culvert C-1
- Avg. Depth = 0.35' Max Vel = 4.46 fps Inflow = 1.42 cfs 2,178 cf
- D = 18.0" n = 0.020 L = 40.0' S = 0.0300 ' Capacity = 11.83 cfs Outflow = 1.40 cfs 2,178 cf

Reach C2: Culvert C-2
- Avg. Depth = 0.24' Max Vel = 3.45 fps Inflow = 0.65 cfs 986 cf
- D = 18.0" n = 0.020 L = 40.0' S = 0.0275 ' Capacity = 11.32 cfs Outflow = 0.63 cfs 986 cf

Reach C6: Culvert C-6
- Avg. Depth = 0.83' Max Vel = 4.83 fps Inflow = 4.88 cfs 9,552 cf
- D = 18.0" n = 0.025 L = 200.0' S = 0.0225 ' Capacity = 8.19 cfs Outflow = 4.80 cfs 9,552 cf

Reach C7: Culvert C-7
- Avg. Depth = 0.69' Max Vel = 11.54 fps Inflow = 9.25 cfs 25,010 cf
- D = 18.0" n = 0.025 L = 20.0' S = 0.1500 ' Capacity = 21.16 cfs Outflow = 9.24 cfs 25,010 cf

Reach E1DL: Lower E-1 Ditch
- Avg. Depth = 0.69' Max Vel = 2.42 fps Inflow = 1.75 cfs 6,068 cf
- n = 0.035 L = 287.0' S = 0.0171 ' Capacity = 13.67 cfs Outflow = 1.74 cfs 6,068 cf

Reach E1DU: Upper E-1 Ditch
- Avg. Depth = 0.82' Max Vel = 2.28 fps Inflow = 1.75 cfs 5,080 cf
- n = 0.035 L = 720.0' S = 0.0150 ' Capacity = 7.67 cfs Outflow = 1.53 cfs 5,080 cf

Reach E3D: E-3 Ditch
- Avg. Depth = 0.79' Max Vel = 3.18 fps Inflow = 4.80 cfs 9,552 cf
- n = 0.035 L = 283.0' S = 0.0194 ' Capacity = 21.95 cfs Outflow = 4.62 cfs 9,552 cf

Reach E4D: E-4 Ditch
- Avg. Depth = 0.50' Max Vel = 1.83 fps Inflow = 1.16 cfs 986 cf
- n = 0.035 L = 561.0' S = 0.0159 ' Capacity = 7.21 cfs Outflow = 0.65 cfs 986 cf

Reach E5D: E-5 Ditch
- Avg. Depth = 0.70' Max Vel = 1.98 fps Inflow = 4.98 cfs 9,391 cf
- n = 0.035 L = 748.0' S = 0.0091 ' Capacity = 10.01 cfs Outflow = 3.89 cfs 9,391 cf

Pond EP: East Sed Pond
- Peak Elev = 5,504.26' Storage = 61,684 cf Inflow = 9.24 cfs 25,010 cf Outflow = 2.26 cfs 18,184 cf

Total Runoff Area = 759,267 sf
Runoff Volume = 25,009 cf
Average Runoff Depth = 0.40"
100.00% Pervious = 759,267 sf
0.00% Impervious = 0 sf
### Summary for Subcatchment E-1: Watershed E-1

Runoff = 0.98 cfs @ 3.34 hrs, Volume = 2,902 cf, Depth = 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

**Type II 24-hr 6.00 hrs Rainfall=1.29"**

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 88,103</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cf)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.1</td>
<td>1,752</td>
<td>0.0210</td>
<td>1.08</td>
<td>Lag/CN Method,</td>
<td></td>
</tr>
</tbody>
</table>

**Subcatchment E-1: Watershed E-1**

**Hydrograph**

- Type II 24-hr 6.00 hrs
- Rainfall=1.29"
- Runoff Area=88,103 sf
- Runoff Volume=2,902 cf
- Runoff Depth=0.40"
- Flow Length=1,752'
- Slope=0.0210 '
- Tc=27.1 min
- CN=87
Summary for Subcatchment E-2: Watershed E-2

Runoff = 1.42 cfs @ 3.12 hrs, Volume = 2,178 cf, Depth = 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall = 1.29"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>66,123</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.2</td>
<td>581</td>
<td>0.0210</td>
<td>0.86</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment E-2: Watershed E-2

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall = 1.29"
Runoff Area = 66,123 sf
Runoff Volume = 2,178 cf
Runoff Depth = 0.40"
Flow Length = 581'
Slope = 0.0210 '/
Tc = 11.2 min
CN = 87
Summary for Subcatchment E-3: Watershed E-3

Runoff = 4.88 cfs @ 3.18 hrs, Volume= 9,552 cf, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall=1.29"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>289,991</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

Tc | Length | Slope | Velocity | Capacity | Description |
---|--------|-------|----------|----------|-------------|
15.5 | 1,091 | 0.0300 | 1.17 | Lag/CN Method, |

Subcatchment E-3: Watershed E-3

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall=1.29"
Runoff Area=289,991 sf
Runoff Volume=9,552 cf
Runoff Depth=0.40"
Flow Length=1,091'
Slope=0.0300 '/'
Tc=15.5 min
CN=87
Summary for Subcatchment E-4: Watershed E-4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.16 cfs @ 3.01 hrs, Volume = 986 cf, Depth = 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs

Type II 24-hr 6.00 hrs Rainfall = 1.29"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>29,947</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

Tc Length Slope Velocity Capacity Description
(min) (feet) (ft/ft) (ft/sec) (cfs) Lag/CN Method,

3.2 561 0.2500 2.96

Subcatchment E-4: Watershed E-4

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall = 1.29"
Runoff Area = 29,947 sf
Runoff Volume = 986 cf
Runoff Depth = 0.40"
Flow Length = 561'
Slope = 0.2500 '/'
Tc = 3.2 min
CN = 87
**Summary for Subcatchment E-5: Watershed E-5**

Runoff = 4.98 cfs @ 3.17 hrs, Volume = 9,391 cf, Depth = 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Type II 24-hr 6.00 hrs Rainfall=1.29"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 285,103</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.9</td>
<td>925</td>
<td>0.0250</td>
<td>1.04</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

**Subcatchment E-5: Watershed E-5**

Hydrograph

Type II 24-hr 6.00 hrs Rainfall=1.29"
Runoff Area=285,103 sf
Runoff Volume=9,391 cf
Runoff Depth=0.40"
Flow Length=925'
Slope=0.0250 '/
Tc=14.9 min
CN=87
Summary for Reach C1: Culvert C-1

[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 66,123 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 1.42 cfs @ 3.12 hrs, Volume= 2,178 cf
Outflow = 1.40 cfs @ 3.12 hrs, Volume= 2,178 cf, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.46 fps, Min. Travel Time= 0.1 min
Avg. Velocity= 1.99 fps, Avg. Travel Time= 0.3 min

Peak Storage= 13 cf @ 3.12 hrs, Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 11.83 cfs

18.0" Diameter Pipe, n= 0.020, Corrugated PE, corrugated interior
Length= 40.0' Slope= 0.0300 '/'
Inlet Invert= 5,520.70', Outlet Invert= 5,519.50'

Reach C1: Culvert C-1

Hydrograph

Inflow Area=66,123 sf
Avg. Depth=0.35'
Max Vel=4.46 fps
D=18.0"
n=0.020
L=40.0'
S=0.0300 '/'
Capacity=11.83 cfs
Summary for Reach C2: Culvert C-2

[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach E4D outlet invert by 0.24' @ 3.15 hrs

Inflow Area = 29,947 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 0.65 cfs @ 3.16 hrs, Volume= 986 cf
Outflow = 0.63 cfs @ 3.16 hrs, Volume= 988 cf, Atten= 3%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 3.45 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 0.5 min

Peak Storage= 7 cf @ 3.16 hrs, Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 11.32 cfs

18.0" Diameter Pipe, n= 0.020 Corrugated PE, corrugated interior
Length= 40.0' Slope= 0.0275 '/'
Inlet Invert= 5,509.80', Outlet Invert= 5,508.70'

Inflow Area=29,947 sf
Avg. Depth=0.24'
Max Vel=3.45 fps
D=18.0"
n=0.020
L=40.0'
S=0.0275 '/'
Capacity=11.32 cfs
Summary for Reach C6: Culvert C-6

[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 289,991 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 4.88 cfs @ 3.18 hrs, Volume= 9,552 cf
Outflow = 4.80 cfs @ 3.20 hrs, Volume= 9,552 cf, Attenuation = 2%, Lag = 1.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity = 4.83 fps, Min. Travel Time = 0.7 min
Avg. Velocity = 2.13 fps, Avg. Travel Time = 1.6 min

Peak Storage = 202 cf @ 3.19 hrs, Average Depth at Peak Storage = 0.83'
Bank-Full Depth = 1.50', Capacity at Bank-Full = 8.19 cfs

18.0" Diameter Pipe, n = 0.025, Corrugated metal
Length = 200.0', Slope = 0.0225 '/'
Inlet Invert = 5,514.00', Outlet Invert = 5,509.50'

Reach C6: Culvert C-6

Hydrograph

Inflow Area = 289,991 sf
Avg. Depth = 0.83'
Max. Vel = 4.83 fps
D = 18.0"
n = 0.025
L = 200.0'
S = 0.0225 '/'
Capacity = 8.19 cfs
Summary for Reach C7: Culvert C-7

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach E1D OUTLET depth by 1.21' @ 3.30 hrs
[62] Warning: Exceeded Reach E3D OUTLET depth by 1.07' @ 3.45 hrs
[62] Warning: Exceeded Reach E5D OUTLET depth by 1.24' @ 3.40 hrs

Inflow Area = 759,267 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 9.25 cfs @ 3.32 hrs, Volume= 25,010 cf
Outflow = 9.24 cfs @ 3.32 hrs, Volume= 25,010 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 11.54 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.86 fps, Avg. Travel Time= 0.1 min

Peak Storage= 16 cf @ 3.32 hrs, Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 21.16 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 20.0' Slope= 0.1500 '/'
Inlet Invert= 5,505.00', Outlet Invert= 5,502.00'

Reach C7: Culvert C-7

Hydrograph

Inflow Area=759,267 sf
Avg. Depth=0.69'
Max Vel=11.54 fps
D=18.0"
n=0.025
L=20.0'
S=0.1500 '/'
Capacity=21.16 cfs

Time (hours)
Summary for Reach E1DL: Lower E-1 Ditch

[62] Warning: Exceeded Reach C2 OUTLET depth by 0.56' @ 3.40 hrs
[61] Hint: Exceeded Reach E1DU outlet invert by 0.69' @ 3.35 hrs

Inflow Area = 184,173 sf, 0.00% Impervious, Inflow Depth = 0.40" 
Inflow = 1.75 cfs @ 3.33 hrs, Volume= 6,068 cf
Outflow = 1.74 cfs @ 3.40 hrs, Volume= 6,068 cf, Atten= 1%, Lag= 4.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.42 fps, Min. Travel Time= 2.0 min
Avg. Velocity= 0.89 fps, Avg. Travel Time= 5.4 min

Peak Storage= 207 cf @ 3.36 hrs, Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 13.67 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 1.5' Top Width= 4.50'
Length= 287.0' Slope= 0.0171 '/'
Inlet Invert= 5,508.70', Outlet Invert= 5,503.80'

Reach E1DL: Lower E-1 Ditch

Inflow Area=184,173 sf
Avg. Depth=0.69'
Max Vel.=2.42 fps
n=0.035
L=287.0'
S=0.0171 '/'
Capacity=13.67 cfs
Summary for Reach E1DU: Upper E-1 Ditch

[62] Warning: Exceeded Reach C1 OUTLET depth by 0.62' @ 3.40 hrs

Inflow Area = 154,226 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 1.75 cfs @ 3.16 hrs, Volume= 5,080 cf
Outflow = 1.53 cfs @ 3.37 hrs, Volume= 5,080 cf, Atten= 12%, Lag= 12.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.28 fps, Min. Travel Time= 5.3 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 14.2 min

Peak Storage= 485 cf @ 3.27 hrs, Average Depth at Peak Storage= 0.82'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 7.67 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 1.0 '/' Top Width= 3.00'
Length= 720.0' Slope= 0.0150 '/'
Inlet Invert= 5,519.50', Outlet Invert= 5,508.70'

Reach E1DU: Upper E-1 Ditch

Hydrograph

Inflow Area=154,226 sf
Avg. Depth=0.82'
Max Vel=2.28 fps
n=0.035
L=720.0'
S=0.0150 '/'
Capacity=7.67 cfs
Summary for Reach E3D: E-3 Ditch

[62] Warning: Exceeded Reach C6 OUTLET depth by 0.07' @ 3.35 hrs

Inflow Area = 289,991 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 4.80 cfs @ 3.20 hrs, Volume= 9,552 cf
Outflow = 4.62 cfs @ 3.25 hrs, Volume= 9,552 cf, Atten= 4%, Lag= 3.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.18 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.36 fps, Avg. Travel Time= 3.5 min

Peak Storage= 421 cf @ 3.22 hrs, Average Depth at Peak Storage= 0.79'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 21.95 cfs

0.50' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 2.5 1.0 '/' Top Width= 5.75'
Length= 283.0' Slope= 0.0194 '/'
Inlet Invert= 5,509.50', Outlet Invert= 5,504.00'

Reach E3D: E-3 Ditch

Hydrograph

Inflow Area=289,991 sf
Avg. Depth=0.79'
Max Vel=3.18 fps
n=0.035
L=283.0'
S=0.0194://'
Capacity=21.95 cfs
Summary for Reach E4D: E-4 Ditch

Inflow Area = 29,947 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 1.16 cfs @ 3.01 hrs, Volume= 986 cf
Outflow = 0.65 cfs @ 3.16 hrs, Volume= 986 cf, Atten= 44%, Lag= 8.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.83 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 0.64 fps, Avg. Travel Time= 14.6 min

Peak Storage= 207 cf @ 3.07 hrs, Average Depth at Peak Storage= 0.50'
Bank-Full Depth= 1.20', Capacity at Bank-Full= 7.21 cfs

0.00' x 1.20' deep channel, n= 0.035
Side Slope Z-value= 2.0 1.0' Top Width= 3.60'
Length= 561.0' Slope= 0.0159 '/'
Inlet Invert= 5,518.70', Outlet Invert= 5,509.80'

Reach E4D: E-4 Ditch

Hydrograph

Inflow Area=29,947 sf
Avg. Depth=0.50'
Max Vel=1.83 fps
n=0.035
L=561.0'
S=0.0159 '/'
Capacity=7.21 cfs
Summary for Reach E5D: E-5 Ditch

Inflow Area = 285,103 sf, 0.00% Impervious, Inflow Depth = 0.40"  
Inflow = 4.98 cfs @ 3.17 hrs, Volume= 9,391 cf  
Outflow = 3.89 cfs @ 3.36 hrs, Volume= 9,391 cf, Attenuation= 22%, Lag= 11.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Max. Velocity= 1.98 fps, Min. Travel Time= 6.3 min  
Avg. Velocity = 0.54 fps, Avg. Travel Time= 23.0 min

Peak Storage= 1,475 cf @ 3.26 hrs, Average Depth at Peak Storage= 0.70'  
Bank-Full Depth= 1.00', Capacity at Bank-Full= 10.01 cfs

0.00' x 1.00' deep channel, n= 0.035  
Side Slope Z-value= 4.0 '/' Top Width= 8.00'  
Length= 746.0' Slope= 0.0091 '/'  
Inlet Invert= 5,510.60', Outlet Invert= 5,503.80'

Reach E5D: E-5 Ditch
Hydrograph

Inflow Area=285,103 sf  
Avg. Depth=0.70'  
Max Vel=1.98 fps  
n=0.035  
L=746.0'  
S=0.0091 '/'  
Capacity=10.01 cfs
Summary for Pond EP: East Sed Pond

Warning: Exceeded Reach C7 OUTLET depth by 1.96' @ 4.15 hrs

Inflow Area = 759,267 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 9.24 cfs @ 3.32 hrs, Volume= 25,010 cf
Outflow = 2.26 cfs @ 3.92 hrs, Volume= 18,184 cf, Atten= 76%, Lag= 36.3 min
Primary = 2.26 cfs @ 3.92 hrs, Volume= 18,184 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Starting Elev= 5,503.00' Surf.Area= 9,328 sf Storage= 48,972 cf
Peak Elev= 5,504.26' @ 3.92 hrs Surf.Area= 10,660 sf Storage= 61,684 cf (12,712 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 75.7 min (316.4 - 240.7)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>5,493.80'</td>
<td>78,991 cf</td>
<td>Custom Stage Data (Prismatic) Listed below (Recalc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5,493.80</td>
<td>2,550</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5,494.80</td>
<td>2,601</td>
<td>2,576</td>
<td>2,576</td>
</tr>
<tr>
<td>5,495.80</td>
<td>3,214</td>
<td>2,908</td>
<td>5,483</td>
</tr>
<tr>
<td>5,496.80</td>
<td>3,909</td>
<td>3,562</td>
<td>9,045</td>
</tr>
<tr>
<td>5,497.80</td>
<td>4,637</td>
<td>4,273</td>
<td>13,318</td>
</tr>
<tr>
<td>5,498.80</td>
<td>5,425</td>
<td>5,031</td>
<td>18,349</td>
</tr>
<tr>
<td>5,499.80</td>
<td>6,243</td>
<td>5,834</td>
<td>24,183</td>
</tr>
<tr>
<td>5,500.80</td>
<td>7,158</td>
<td>6,701</td>
<td>30,883</td>
</tr>
<tr>
<td>5,501.80</td>
<td>8,125</td>
<td>7,642</td>
<td>38,525</td>
</tr>
<tr>
<td>5,502.80</td>
<td>9,087</td>
<td>8,606</td>
<td>47,131</td>
</tr>
<tr>
<td>5,503.80</td>
<td>10,291</td>
<td>9,689</td>
<td>56,820</td>
</tr>
<tr>
<td>5,505.80</td>
<td>11,880</td>
<td>22,171</td>
<td>78,991</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device</th>
<th>Routing</th>
<th>Invert</th>
<th>Outlet Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Primary</td>
<td>5,503.70'</td>
<td>2.0' long x 3.0' breadth Broad-Crested Rectangular Weir</td>
</tr>
</tbody>
</table>

Primary OutFlow Max= 2.25 cfs @ 3.92 hrs HW= 5,504.26' (Free Discharge)

1 = Broad-Crested Rectangular Weir (Weir Controls 2.25 cfs @ 2.00 fps)
Pond EP: East Sed Pond

Hydrograph

Inflow Area=759,267 sf
Peak Elev=5,504.26'
Storage=61,684 cf
## Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>305,034</td>
<td>87</td>
<td>(W-1,W-2,W-3)</td>
</tr>
<tr>
<td>305,034</td>
<td></td>
<td>TOTAL AREA</td>
</tr>
</tbody>
</table>
# Soil Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>Soil Group</th>
<th>Subcatchment Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>HSG A</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG B</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG C</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG D</td>
<td></td>
</tr>
<tr>
<td>305,034</td>
<td>Other</td>
<td>W-1, W-2, W-3</td>
</tr>
<tr>
<td>305,034</td>
<td>TOTAL AREA</td>
<td></td>
</tr>
</tbody>
</table>
Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment W-1: Watershed W-1
Runoff Area=105,474 sf  0.00% Impervious  Runoff Depth=0.40'
Flow Length=1,297' Slope=0.0250' Tc=19.5 min CN=87  Runoff=1.50 cfs 3,474 cf

Subcatchment W-2: Watershed W-2
Runoff Area=128,724 sf  0.00% Impervious  Runoff Depth=0.40'
Flow Length=635' Slope=0.0250' Tc=11.0 min CN=87  Runoff=2.79 cfs 4,240 cf

Subcatchment W-3: Watershed W-3
Runoff Area=70,836 sf  0.00% Impervious  Runoff Depth=0.40'
Flow Length=447' Slope=0.0270' Tc=8.0 min CN=87  Runoff=1.81 cfs 3,471 cf

Reach C3: Culvert C-3
Avg. Depth=0.49' Max Vel=4.51 fps Inflow=2.24 cfs 4,240 cf
D=18.0'' n=0.025 L=40.0' S=0.0325' Capacity=9.85 cfs Outflow=2.23 cfs 4,240 cf

Reach C4: Culvert C-4
Avg. Depth=0.44' Max Vel=2.76 fps Inflow=1.18 cfs 3,474 cf
D=18.0'' n=0.025 L=80.0' S=0.0138' Capacity=6.41 cfs Outflow=1.17 cfs 3,474 cf

Reach C5: Culvert C-5
Avg. Depth=0.34' Max Vel=9.02 fps Inflow=2.70 cfs 10,047 cf
D=18.0'' n=0.025 L=20.0' S=0.1950' Capacity=24.12 cfs Outflow=2.70 cfs 10,047 cf

Reach W1DL: Lower W-1 Ditch
Avg. Depth=0.78' Max Vel=1.95 fps Inflow=2.44 cfs 7,714 cf
n=0.035 L=320.0' S=0.0088' Capacity=29.49 cfs Outflow=2.35 cfs 7,714 cf

Reach W1DU: Upper W-1 Ditch
Avg. Depth=0.55' Max Vel=2.00 fps Inflow=1.50 cfs 3,474 cf
n=0.035 L=963.0' S=0.0145' Capacity=38.02 cfs Outflow=1.18 cfs 3,474 cf

Reach W2D: W-2 Ditch
Avg. Depth=0.26' Max Vel=2.00 fps Inflow=2.79 cfs 4,240 cf
n=0.035 L=500.0' S=0.0158' Capacity=23.56 cfs Outflow=2.24 cfs 4,240 cf

Reach W3D: W-3 Ditch
Avg. Depth=0.56' Max Vel=2.13 fps Inflow=1.81 cfs 2,333 cf
n=0.035 L=160.0' S=0.0156' Capacity=8.65 cfs Outflow=1.66 cfs 2,333 cf

Pond WP: West Sed Pond
Peak Elev=5,508.11' Storage=36,065 cf Inflow=2.70 cfs 10,047 cf
Outflow=0.29 cfs 411 cf

Total Runoff Area = 305,034 sf  Runoff Volume = 10,047 cf  Average Runoff Depth = 0.40'
100.00% Pervious = 305,034 sf  0.00% Impervious = 0 sf
Summary for Subcatchment W-1: Watershed W-1

Runoff = 1.50 cfs @ 3.23 hrs, Volume= 3,474 cf, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall=1.29"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>105,474</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.5</td>
<td>1,297</td>
<td>0.0250</td>
<td>1.11</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment W-1: Watershed W-1

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall=1.29"
Runoff Area=105,474 sf
Runoff Volume=3,474 cf
Runoff Depth=0.40"
Flow Length=1,297'
Slope=0.0250 '/'
Tc=19.5 min
CN=87

Runoff = 2.79 cfs @ 3.12 hrs, Volume= 4,240 cf, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall=1.29"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>128,724</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.0</td>
<td>635</td>
<td>0.0250</td>
<td>0.96</td>
<td>Lag/CN Method,</td>
<td></td>
</tr>
</tbody>
</table>

Subcatchment W-2: Watershed W-2

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall=1.29"
Runoff Area=128,724 sf
Runoff Volume=4,240 cf
Runoff Depth=0.40"
Flow Length=635'
Slope=0.0250 '/'
Tc=11.0 min
CN=87
Summary for Subcatchment W-3: Watershed W-3

Runoff = 1.81 cfs @ 3.08 hrs, Volume= 2,333 cf, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall=1.29"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>70,836</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>447</td>
<td>0.0270</td>
<td>0.93</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment W-3: Watershed W-3

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall=1.29"
Runoff Area=70,836 sf
Runoff Volume=2,333 cf
Runoff Depth=0.40"
Flow Length=447'
Slope=0.0270 '/'
Tc=8.0 min
CN=87
Summary for Reach C3: Culvert C-3

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach W2D OUTLET depth by 0.26' @ 3.25 hrs

Inflow Area = 128,724 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 2.24 cfs @ 3.25 hrs, Volume= 4,240 cf
Outflow = 2.23 cfs @ 3.25 hrs, Volume= 4,240 cf, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.51 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.47 fps, Avg. Travel Time= 0.5 min
Peak Storage= 20 cf @ 3.25 hrs, Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 9.85 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 40.0' Slope= 0.0325 '/'
Inlet Invert= 5,512.10', Outlet Invert= 5,510.80'

Reach C3: Culvert C-3

Inflow Area=128,724 sf
Avg. Depth=0.49'
Max Vel=4.51 fps
D=18.0"
n=0.025
L=40.0'
S=0.0325 '/'
Capacity=9.85 cfs
Summary for Reach C4: Culvert C-4

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach W1DU OUTLET depth by 1.20' @ 0.00 hrs

Inflow Area = 105,474 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow  = 1.18 cfs @ 3.47 hrs, Volume= 3,474 cf
Outflow = 1.17 cfs @ 3.49 hrs, Volume= 3,474 cf, Atten= 1%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.76 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 0.92 fps, Avg. Travel Time= 1.4 min

Peak Storage= 34 cf @ 3.48 hrs, Average Depth at Peak Storage= 0.44'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 6.41 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 80.0' Slope= 0.0138 '/'
Inlet Invert= 5,512.00', Outlet Invert= 5,510.90'

Reach C4: Culvert C-4

Hydrograph
Summary for Reach C5: Culvert C-5

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach W1DL OUTLET depth by 2.03' @ 3.05 hrs
[62] Warning: Exceeded Reach W3D OUTLET depth by 1.96' @ 3.50 hrs

Inflow Area = 305,034 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 2.70 cfs @ 3.36 hrs, Volume= 10,047 cf
Outflow = 2.70 cfs @ 3.36 hrs, Volume= 10,047 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.02 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.48 fps, Avg. Travel Time= 0.1 min

Peak Storage= 6 cf @ 3.36 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 24.12 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 20.0' Slope= 0.1950 '/'
Inlet Invert= 5,509.90', Outlet Invert= 5,506.00'

Reach C5: Culvert C-5

Inflow Area=305,034 sf
Avg. Depth=0.34'
Max Vel=9.02 fps
D=18.0"
n=0.025
L=20.0'
S=0.1950 '/'
Capacity=24.12 cfs
Summary for Reach W1DL: Lower W-1 Ditch

[62] Warning: Exceeded Reach C3 OUTLET depth by 0.45' @ 3.55 hrs
[62] Warning: Exceeded Reach C4 OUTLET depth by 0.45' @ 3.25 hrs

Inflow Area = 234,198 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 2.44 cfs @ 3.27 hrs, Volume= 7,714 cf
Outflow = 2.35 cfs @ 3.37 hrs, Volume= 7,714 cf, Atten= 4%, Lag= 6.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.95 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.65 fps, Avg. Travel Time= 8.3 min

Peak Storage= 384 cf @ 3.32 hrs, Average Depth at Peak Storage= 0.78'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 29.49 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 320.0' Slope= 0.0088 '/'
Inlet Invert= 5,510.80', Outlet Invert= 5,508.00'

Reach W1DL: Lower W-1 Ditch

Hydrograph

Inflow Area=234,198 sf
Avg. Depth=0.78'
Max Vel=1.95 fps
n=0.035
L=320.0'
S=0.0088 '/'
Capacity=29.49 cfs
Summary for Reach W1DU: Upper W-1 Ditch

Inflow Area = 105,474 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 1.50 cfs @ 3.23 hrs, Volume= 3,474 cf
Outflow = 1.18 cfs @ 3.47 hrs, Volume= 3,474 cf, Atten= 21%, Lag= 14.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.00 fps, Min. Travel Time= 8.0 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 22.8 min

Peak Storage= 572 cf @ 3.34 hrs, Average Depth at Peak Storage= 0.55'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 38.02 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 963.0' Slope= 0.0145 '/'
Inlet Invert= 5,524.80', Outlet Invert= 5,510.80'

Reach W1DU: Upper W-1 Ditch

Hydrograph

Inflow Area=105,474 sf
Avg. Depth=0.55'
Max Vel=2.00 fps
n=0.035
L=963.0'
S=0.0145 '/'
Capacity=38.02 cfs
Summary for Reach W2D: W-2 Ditch

Inflow Area = 128,724 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 2.79 cfs @ 3.12 hrs, Volume= 4,240 cf
Outflow = 2.24 cfs @ 3.25 hrs, Volume= 4,240 cf, Atten= 20%, Lag= 7.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.00 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 0.55 fps, Avg. Travel Time = 15.3 min

Peak Storage= 582 cf @ 3.17 hrs, Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 23.56 cfs

4.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 1.0 '/' Top Width= 7.00'
Length= 500.0' Slope= 0.0158 '/'
Inlet Invert= 5,520.00', Outlet Invert= 5,512.10'

Reach W2D: W-2 Ditch

Hydrograph

Inflow Area=128,724 sf
Avg. Depth=0.26'
Max Vel=2.00 fps
n=0.035
L=500.0'
S=0.0158 '/'
Capacity=23.56 cfs
Summary for Reach W3D: W-3 Ditch

Inflow Area = 70,836 sf, 0.00% Impervious, Inflow Depth = 0.40"
Inflow = 1.81 cfs @ 3.08 hrs, Volume= 2,333 cf
Outflow = 1.66 cfs @ 3.12 hrs, Volume= 2,333 cf, Atten= 8%, Lag= 2.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.13 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 0.88 fps, Avg. Travel Time= 3.0 min

Peak Storage= 137 cf @ 3.10 hrs, Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 8.65 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 4.5 1.0 '/' Top Width= 5.50'
Length= 160.0' Slope= 0.0156 '/'
Inlet Invert= 5,510.50', Outlet Invert= 5,508.00'

Reach W3D: W-3 Ditch

Hydrograph

Inflow Area=70,836 sf
Avg. Depth=0.56'
Max Vel=2.13 fps
n=0.035
L=160.0'
S=0.0156 '/'
Capacity=8.65 cfs
Summary for Pond WP: West Sed Pond

[93] Warning: Storage range exceeded by 0.11'
[85] Warning: Oscillations may require Finer Routing>1
[62] Warning: Exceeded Reach C5 OUTLET depth by 2.00' @ 6.20 hrs

Inflow Area = 305,034 sf, 0.00% Impervious, Inflow Depth = 0.40''
Inflow = 2.70 cfs @ 3.36 hrs, Volume = 10,047 cf
Outflow = 0.29 cfs @ 6.21 hrs, Volume = 411 cf, Atten= 89%, Lag= 170.9 min
Primary = 0.29 cfs @ 6.21 hrs, Volume = 411 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Starting Elev= 5,506.40' Surf.Area= 5,499 sf Storage= 26,424 cf
Peak Elev= 5,508.11' @ 6.21 hrs Surf.Area= 6,566 sf Storage= 36,065 cf (9,641 cf above start)

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= 152.4 min (396.6 - 244.3 )

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>5,498.23'</td>
<td>36,065 cf</td>
<td>17.00'W x 78.00'L x 9.77'H Prismatoid Z=2.0</td>
</tr>
</tbody>
</table>

Device Routing Invert Outlet Devices
#1 Primary 5,508.00' 3.0' long x 2.0' breadth Broad-Crested Rectangular Weir
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50
3.00 3.50
Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07
3.20 3.32

Primary OutFlow Max=0.24 cfs @ 6.21 hrs HW=5,508.10' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.24 cfs @ 0.81 fps)
Pond WP: West Sed Pond

Hydrograph

Inflow Area=305,034 sf
Peak Elev=5,508.11'
Storage=36,065 cf
APPENDIX 7-8

Drainage Channel and Culvert
Hydrology Calculations
Drainage Diagram for 100yr-6hr East Pond
Prepared by EarthFax Engineering, Inc., Printed 9/17/2010
HydroCAD® 8.50 s/n 003900 © 2007 HydroCAD Software Solutions LLC
### Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area  (sq-ft)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>759,267</td>
<td>87</td>
<td>(E-1,E-2,E-3,E-4,E-5)</td>
</tr>
<tr>
<td>759,267</td>
<td></td>
<td>TOTAL AREA</td>
</tr>
</tbody>
</table>
### Soil Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>Soil</th>
<th>Group</th>
<th>Subcatchment Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>HSG A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>759,267</td>
<td>Other</td>
<td></td>
<td>E-1, E-2, E-3, E-4, E-5</td>
</tr>
<tr>
<td>759,267</td>
<td></td>
<td></td>
<td>TOTAL AREA</td>
</tr>
</tbody>
</table>
Pond EP: East Sed Pond

Reach E5D:
Reach E4D:
Reach C7:
Reach E3:
Reach C2:
Subcatchment

G-JUC109102
Prepared by EarthFax Engineering, Inc.

HydroCAD® 8.50  s/n 003900 © 2007 HydroCAD Software Solutions LLC

East ditch and hydro calcs for 100-yr, 6-hr storm
Type II 24-hr 6.00 hrs Rainfall=1.74

Time span=00:00-30:00 hrs, dt=0.05 hrs, 601 points
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: Watershed E-1
Runoff Area=88,103 sf  0.00% Impervious  Runoff Depth=0.71"
Flow Length=1,752'  Slope=0.0210 '/'  Tc=27.1 min  CN=87  Runoff=1.88 cfs  5,195 cf

Subcatchment E-2: Watershed E-2
Runoff Area=66,123 sf  0.00% Impervious  Runoff Depth=0.71"
Flow Length=581'  Slope=0.0300 '/'  Tc=15.5 min  CN=87  Runoff=2.70 cfs  3,899 cf

Subcatchment E-3: Watershed E-3
Runoff Area=289,991 sf  0.00% Impervious  Runoff Depth=0.71"
Flow Length=1,091'  Slope=0.0300 '/'  Tc=15.5 min  CN=87  Runoff=9.41 cfs  17,098 cf

Subcatchment E-4: Watershed E-4
Runoff Area=29,947 sf  0.00% Impervious  Runoff Depth=0.71"
Flow Length=561'  Slope=0.2500 '/'  Tc=3.2 min  CN=87  Runoff=2.20 cfs  1,766 cf

Subcatchment E-5: Watershed E-5
Runoff Area=285,103 sf  0.00% Impervious  Runoff Depth=0.71"
Flow Length=925'  Slope=0.0250 '/'  Tc=14.9 min  CN=87  Runoff=9.49 cfs  16,810 cf

Reach C1: Culvert C-1
Avg. Depth=0.49'  Max Vel=5.39 fps  Inflow=2.70 cfs  3,899 cf
D=18.0"  n=0.020  L=40.0'  S=0.0300 '/'  Capacity=11.83 cfs  Outflow=2.68 cfs  3,899 cf

Reach C2: Culvert C-2
Avg. Depth=0.34'  Max Vel=4.20 fps  Inflow=1.27 cfs  1,766 cf
D=18.0"  n=0.020  L=40.0'  S=0.0275 '/'  Capacity=11.32 cfs  Outflow=1.24 cfs  1,769 cf

Reach C6: Culvert C-6
Avg. Depth=1.50'  Max Vel=5.26 fps  Inflow=9.41 cfs  17,098 cf
D=18.0"  n=0.025  L=200.0'  S=0.0225 '/'  Capacity=8.19 cfs  Outflow=8.50 cfs  17,098 cf

Reach C7: Culvert C-7
Avg. Depth=1.10'  Max Vel=13.53 fps  Inflow=18.87 cfs  44,770 cf
D=18.0"  n=0.025  L=20.0'  S=0.1500 '/'  Capacity=21.16 cfs  Outflow=18.86 cfs  44,770 cf

Reach E1DL: Lower E-1 Ditch
Avg. Depth=0.89'  Max Vel=2.87 fps  Inflow=3.44 cfs  10,862 cf
n=0.035  L=287.0'  S=0.0171 '/'  Capacity=13.67 cfs  Outflow=3.40 cfs  10,862 cf

Reach E1DU: Upper E-1 Ditch
Avg. Depth=1.06'  Max Vel=2.70 fps  Inflow=3.37 cfs  9,093 cf
n=0.035  L=720.0'  S=0.0150 '/'  Capacity=7.67 cfs  Outflow=3.02 cfs  9,093 cf

Reach E3: E-3 Ditch
Avg. Depth=1.02'  Max Vel=3.70 fps  Inflow=8.50 cfs  17,098 cf
n=0.035  L=283.0'  S=0.0194 '/'  Capacity=21.95 cfs  Outflow=8.44 cfs  17,098 cf

Reach E4: E-4 Ditch
Avg. Depth=0.65'  Max Vel=2.22 fps  Inflow=2.20 cfs  1,766 cf
n=0.035  L=561.0'  S=0.0159 '/'  Capacity=7.21 cfs  Outflow=2.17 cfs  1,766 cf

Reach E5: E-5 Ditch
Avg. Depth=0.91'  Max Vel=2.35 fps  Inflow=9.49 cfs  16,810 cf
n=0.035  L=746.0'  S=0.0091 '/'  Capacity=10.01 cfs  Outflow=7.79 cfs  16,810 cf

Pond EP: East Sed Pond
Peak Elev=5,502.54'  Storage=44,769 cf  Inflow=18.86 cfs  44,770 cf  Outflow=0.00 cfs  0 cf

Total Runoff Area = 759,267 sf  Runoff Volume = 44,768 cf  Average Runoff Depth = 0.71"
100.00% Pervious = 759,267 sf  0.00% Impervious = 0 sf
Summary for Subcatchment E-1: Watershed E-1

Runoff = 1.88 cfs @ 3.33 hrs, Volume = 5,195 cf, Depth = 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall = 1.74"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>88,103</td>
<td>87</td>
<td></td>
</tr>
</tbody>
</table>

88,103 Pervious Area

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.1</td>
<td>1,752</td>
<td>0.0210</td>
<td>1.08</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment E-1: Watershed E-1

Hydrograph

Type II 24-hr 6.00 hrs Rainfall = 1.74"
Runoff Area = 88,103 sf
Runoff Volume = 5,195 cf
Runoff Depth = 0.71"
Flow Length = 1,752'
Slope = 0.0210 '/'
Tc = 27.1 min
CN = 87
Summary for Subcatchment E-2: Watershed E-2

Runoff = 2.70 cfs @ 3.12 hrs, Volume = 3,899 cf, Depth = 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall = 1.74"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>66,123</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

Subcatchment E-2: Watershed E-2

Hydrograph:

Type II 24-hr 6.00 hrs
Rainfall = 1.74"
Runoff Area = 66,123 sf
Runoff Volume = 3,899 cf
Runoff Depth = 0.71"
Flow Length = 581'
Slope = 0.0210 '/'
Tc = 11.2 min
CN = 87

INCORPORATED
JANUARY 18, 2011
DIVISION OIL, GAS & MINING
Summary for Subcatchment E-3: Watershed E-3

Runoff = 9.41 cfs @ 3.17 hrs, Volume= 17,098 cf, Depth= 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Type II 24-hr 6.00 hrs Rainfall=1.74"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>289,991</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.5</td>
<td>1,091</td>
<td>0.0300</td>
<td>1.17</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment E-3: Watershed E-3

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall=1.74"
Runoff Area=289,991 sf
Runoff Volume=17,098 cf
Runoff Depth=0.71"
Flow Length=1,091'
Slope=0.0300 '/'
Tc=15.5 min
CN=87
Summary for Subcatchment E-4: Watershed E-4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.20 cfs @ 3.01 hrs, Volume= 1,766 cf, Depth= 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall=1.74"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>29,947</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>561</td>
<td>0.2500</td>
<td>2.96</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment E-4: Watershed E-4

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall=1.74"
Runoff Area=29,947 sf
Runoff Volume=1,766 cf
Runoff Depth=0.71"
Flow Length=561'
Slope=0.2500 '/'
Tc=3.2 min
CN=87
Summary for Subcatchment E-5: Watershed E-5

Runoff = 9.49 cfs @ 3.16 hrs, Volume = 16,810 cf, Depth = 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall = 1.74"

Area (sf) | CN | Description
---|---|---
285,103 | 87 | Pervious Area

Tc | Length | Slope | Velocity | Capacity | Description
---|---|---|---|---|---
14.9 | 925 | 0.0250 | 1.04 | Lag/CN Method, L

Subcatchment E-5: Watershed E-5

Type II 24-hr 6.00 hrs
Rainfall = 1.74"
Runoff Area = 285,103 sf
Runoff Volume = 16,810 cf
Runoff Depth = 0.71"
Flow Length = 925'
Slope = 0.0250 '/'
Tc = 14.9 min
CN = 87
Summary for Reach C1: Culvert C-1

[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 66,123 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 2.70 cfs @ 3.12 hrs, Volume = 3,899 cf
Outflow = 2.68 cfs @ 3.12 hrs, Volume = 3,899 cf, Attenuation = 1%, Lag = 0.2 min

Routing by Stor-Ind+Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Max. Velocity = 5.39 fps, Min. Travel Time = 0.1 min
Avg. Velocity = 2.26 fps, Avg. Travel Time = 0.3 min

Peak Storage = 20 cf @ 3.12 hrs, Average Depth at Peak Storage = 0.49'
Bank-Full Depth = 1.50', Capacity at Bank-Full = 11.83 cfs

18.0" Diameter Pipe, n = 0.020, Corrugated PE, corrugated interior
Length = 40.0', Slope = 0.0300 '/'
Inlet Invert = 5,520.70', Outlet Invert = 5,519.50'

Reach C1: Culvert C-1

Hydrograph

Inflow Area = 66,123 sf
Avg. Depth = 0.49'
Max Vel = 5.39 fps
D = 18.0"
n = 0.020
L = 40.0'
S = 0.0300 '/'
Capacity = 11.83 cfs
Summary for Reach C2: Culvert C-2

[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach E4D outlet invert by 0.33' @ 3.15 hrs

Inflow Area = 29,947 sf, 0.00% Impervious, Inflow Depth = 0.71''
Inflow = 1.27 cfs @ 3.13 hrs, Volume = 1,766 cf
Outflow = 1.24 cfs @ 3.14 hrs, Volume = 1,769 cf, Attenuation = 2%, Lag = 0.2 min

Routing by Stor-Ind+Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs / 2
Max. Velocity = 4.20 fps, Min. Travel Time = 0.2 min
Avg. Velocity = 1.42 fps, Avg. Travel Time = 0.5 min

Peak Storage = 12 cf @ 3.13 hrs, Average Depth at Peak Storage = 0.34'
Bank-Full Depth = 1.50', Capacity at Bank-Full = 11.32 cf

18.0'' Diameter Pipe, n = 0.020 Corrugated PE, corrugated interior
Length = 40.0' Slope = 0.0275 '/'
Inlet Invert = 5,509.80', Outlet Invert = 5,508.70'

Reach C2: Culvert C-2

Hydrograph

Inflow Area = 29,947 sf
Avg. Depth = 0.34'
Max Vel = 4.20 fps
D = 18.0''
n = 0.020
L = 40.0'
S = 0.0275 '/'
Capacity = 11.32 cfs
Summary for Reach C6: Culvert C-6

[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 115% of Manning's capacity
[76] Warning: Detained 202 cf (Pond w/culvert advised)

Inflow Area = 289.991 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 9.41 cfs @ 3.17 hrs, Volume= 17,098 cf
Outflow = 8.50 cfs @ 3.25 hrs, Volume= 17,098 cf, Atten= 10%, Lag= 4.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.26 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 2.39 fps, Avg. Travel Time= 1.4 min

Peak Storage= 354 cf @ 3.19 hrs, Average Depth at Peak Storage= 1.50'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 8.19 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 200.0' Slope= 0.0225 '
Inlet Invert= 5,514.00', Outlet Invert= 5,509.50'

Reach C6: Culvert C-6

Hydrograph

Inflow Area=289,991 sf
Avg. Depth=1.50'
Max Vel=5.26 fps
D=18.0"
n=0.025
L=200.0'
S=0.0225 '/
Capacity=8.19 cfs
Summary for Reach C7: Culvert C-7

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach E1DL OUTLET depth by 1.41' @ 3.30 hrs
[62] Warning: Exceeded Reach E3D OUTLET depth by 1.19' @ 3.35 hrs
[62] Warning: Exceeded Reach E5D OUTLET depth by 1.43' @ 3.30 hrs

Inflow Area = 759,267 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 18.87 cfs @ 3.30 hrs, Volume= 44,770 cf
Outflow = 18.86 cfs @ 3.30 hrs, Volume= 44,770 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.53 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 4.32 fps, Avg. Travel Time= 0.1 min

Peak Storage= 28 cf @ 3.30 hrs, Average Depth at Peak Storage= 1.10'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 21.16 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 20.0' Slope= 0.1500 '/'
Inlet Invert= 5,505.00', Outlet Invert= 5,502.00'

Reach C7: Culvert C-7

Hydrograph

Inflow Area=759,267 sf
Avg. Depth=1.10'
Max Vel=13.53 fps
D=18.0"
n=0.025
L=20.0'
S=0.1500 '/'
Capacity=21.16 cfs
Summary for Reach E1DL: Lower E-1 Ditch

[62] Warning: Exceeded Reach C2 OUTLET depth by 0.71' @ 3.35 hrs
[61] Hint: Exceeded Reach E1DU outlet invert by 0.89' @ 3.30 hrs

Inflow Area = 184,173 sf, 0.00% impervious, Inflow Depth = 0.71"
Inflow = 3.44 cfs @ 3.28 hrs, Volume= 10,862 cf
Outflow = 3.40 cfs @ 3.34 hrs, Volume= 10,862 cf, Attenuation= 1%, Lag= 3.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.87 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 4.9 min

Peak Storage= 344 cf @ 3.31 hrs, Average Depth at Peak Storage= 0.89'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 13.67 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 1.5' Top Width= 4.50'
Length= 287.0' Slope= 0.0171 '/'
Inlet Invert= 5,508.70', Outlet Invert= 5,503.80'

Reach E1DL: Lower E-1 Ditch

Hydrograph

Inflow Area=184,173 sf
Avg. Depth=0.89'
Max Vel=2.87 fps
n=0.035
L=287.0'
S=0.0171 '/'
Capacity=13.67 cfs
Summary for Reach E1DU: Upper E-1 Ditch

[62] Warning: Exceeded Reach C1 OUTLET depth by 0.78' @ 3.35 hrs

Inflow Area = 154,226 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 3.37 cfs @ 3.15 hrs, Volume = 9,093 cf
Outflow = 3.02 cfs @ 3.32 hrs, Volume = 9,093 cf, Atten = 10%, Lag = 10.0 min

Routing by Stor-Ind+Trans method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Max. Velocity = 2.70 fps, Min. Travel Time = 4.4 min
Avg. Velocity = 0.94 fps, Avg. Travel Time = 12.7 min

Peak Storage = 806 cf @ 3.23 hrs, Average Depth at Peak Storage = 1.06'
Bank-Full Depth = 1.50', Capacity at Bank-Full = 7.67 cfs

0.00' x 1.50' deep channel, n = 0.035
Side Slope Z-value = 1.0` Top Width = 3.00'
Length = 720.0' Slope = 0.0150 '/'
Inlet Invert = 5,519.50', Outlet Invert = 5,508.70'

Inflow Area = 154,226 sf
Avg. Depth = 1.06'
Max Vel = 2.70 fps
n = 0.035
L = 720.0'
S = 0.0150 '/'
Capacity = 7.67 cfs
Summary for Reach E3D: E-3 Ditch

[62] Warning: Exceeded Reach C6 OUTLET depth by 0.07' @ 3.35 hrs

Inflow Area = 289,991 sf, 0.00% impervious, Inflow Depth = 0.71"
Inflow  = 8.50 cfs @ 3.25 hrs, Volume= 17,098 cf
Outflow = 8.44 cfs @ 3.25 hrs, Volume= 17,098 cf, Attenuation= 1%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.70 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 1.52 fps, Avg. Travel Time = 3.1 min

Peak Storage= 656 cf @ 3.22 hrs, Average Depth at Peak Storage= 1.02'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 21.95 cfs

0.50' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 2.5 1.0 '/' Top Width= 5.75'
Length= 283.0' Slope= 0.0194 '/'
Inlet Invert= 5,509.50', Outlet Invert= 5,504.00'

Reach E3D: E-3 Ditch

Hydrograph

Inflow Area=289,991 sf
Avg. Depth=1.02'
Max Vel=3.70 fps
n=0.035
L=283.0'
S=0.0194 '/'
Capacity=21.95 cfs
Summary for Reach E4D: E-4 Ditch

Inflow Area = 29,947 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 2.20 cfs @ 3.01 hrs, Volume= 1,766 cf
Outflow = 1.27 cfs @ 3.13 hrs, Volume= 1,766 cf, Atten= 42%, Lag= 7.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.22 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 0.71 fps, Avg. Travel Time= 13.2 min

Peak Storage= 359 cf @ 3.06 hrs, Average Depth at Peak Storage= 0.65'
Bank-Full Depth= 1.20', Capacity at Bank-Full= 7.21 cfs

0.00' x 1.20' deep channel, n= 0.035
Side Slope Z-value= 2.0 1.0 '/' Top Width= 3.60'
Length= 561.0' Slope= 0.0159 '/'
Inlet Invert= 5,518.70', Outlet Invert= 5,509.80'

Reach E4D: E-4 Ditch

Hydrograph

Inflow Area=29,947 sf
Avg. Depth=0.65'
Max Vel=2.22 fps
n=0.035
L=561.0'
S=0.0159 '/'
Capacity=7.21 cfs
Summary for Reach E5D: E-5 Ditch

Inflow Area = 285,103 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 9.49 cfs @ 3.16 hrs, Volume= 16,810 cf
Outflow = 7.79 cfs @ 3.32 hrs, Volume= 16,810 cf, Atten= 18%, Lag= 9.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.35 fps, Min. Travel Time= 5.3 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 20.8 min

Peak Storage= 2,486 cf @ 3.24 hrs, Average Depth at Peak Storage= 0.91'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 10.01 cfs

0.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 4.0' Top Width= 8.00'
Length= 746.0' Slope= 0.0091 '/'
Inlet Invert= 5,510.60', Outlet Invert= 5,503.80'

Reach E5D: E-5 Ditch

Hydrograph

Inflow Area=285,103 sf
Avg. Depth=0.91'
Max Vel=2.35 fps
n=0.035
L=746.0'
S=0.0091 '/'
Capacity=10.01 cfs
Summary for Pond EP: East Sed Pond

[62] Warning: Exceeded Reach C7 OUTLET depth by 0.54' @ 29.95 hrs

Inflow Area = 759,267 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 18.86 cfs @ 3.30 hrs, Volume= 44,770 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 5,502.54' @ 30.00 hrs  Surf.Area= 8,833 sf  Storage= 44,769 cf

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

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>5,493.80'</td>
<td>56,820 cf</td>
<td>Custom Stage Data (Prismatic) Listed below (Recalc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5,493.80</td>
<td>2,550</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5,494.80</td>
<td>2,601</td>
<td>2,576</td>
<td>2,576</td>
</tr>
<tr>
<td>5,495.80</td>
<td>3,214</td>
<td>2,908</td>
<td>5,483</td>
</tr>
<tr>
<td>5,496.80</td>
<td>3,909</td>
<td>3,562</td>
<td>9,045</td>
</tr>
<tr>
<td>5,497.80</td>
<td>4,637</td>
<td>4,273</td>
<td>13,318</td>
</tr>
<tr>
<td>5,498.80</td>
<td>5,425</td>
<td>5,031</td>
<td>18,349</td>
</tr>
<tr>
<td>5,499.80</td>
<td>6,243</td>
<td>5,834</td>
<td>24,183</td>
</tr>
<tr>
<td>5,500.80</td>
<td>7,158</td>
<td>6,701</td>
<td>30,883</td>
</tr>
<tr>
<td>5,501.80</td>
<td>8,125</td>
<td>7,642</td>
<td>38,525</td>
</tr>
<tr>
<td>5,502.80</td>
<td>9,087</td>
<td>8,606</td>
<td>47,131</td>
</tr>
<tr>
<td>5,503.80</td>
<td>10,291</td>
<td>9,689</td>
<td>56,820</td>
</tr>
</tbody>
</table>
Pond EP: East Sed Pond

Inflow Area=759,267 sf
Peak Elev=5,502.54'
Storage=44,769 cf
### Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>305,034</td>
<td>87</td>
<td>(W-1,W-2,W-3)</td>
</tr>
<tr>
<td>305,034</td>
<td></td>
<td>TOTAL AREA</td>
</tr>
</tbody>
</table>
### Soil Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (sq-ft)</th>
<th>Soil Group</th>
<th>Subcatchment Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>HSG A</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG B</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG C</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>HSG D</td>
<td></td>
</tr>
<tr>
<td>305,034</td>
<td>Other</td>
<td>W-1, W-2, W-3</td>
</tr>
<tr>
<td>305,034</td>
<td>TOTAL AREA</td>
<td></td>
</tr>
</tbody>
</table>
Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment W-1: Watershed W-1  
Runoff Area=105,474 sf  0.00% Impervious  Runoff Depth=0.71"  
Flow Length=1,297'  Slope=0.0250'  Tc=19.5 min  CN=87  Runoff=2.88 cfs 6,219 cf

Subcatchment W-2: Watershed W-2  
Runoff Area=128,724 sf  0.00% Impervious  Runoff Depth=0.71"  
Flow Length=635'  Slope=0.0250'  Tc=11.0 min  CN=87  Runoff=5.32 cfs 7,590 cf

Subcatchment W-3: Watershed W-3  
Runoff Area=70,836 sf  0.00% Impervious  Runoff Depth=0.71"  
Flow Length=447'  Slope=0.0270'  Tc=8.0 min  CN=87  Runoff=3.52 cfs 4,177 cf

Reach C3: Culvert C-3  
Avg. Depth=0.64'  Max Vel=6.47 fps  Inflow=4.68 cfs  7,590 cf  
D=18.0"  n=0.020  L=40.0'  S=0.0325'  Capacity=12.31 cfs  Outflow=4.65 cfs  7,590 cf

Reach C4: Culvert C-4  
Avg. Depth=0.63'  Max Vel=3.35 fps  Inflow=2.37 cfs  6,219 cf  
D=18.0"  n=0.025  L=80.0'  S=0.0137'  Capacity=6.41 cfs  Outflow=2.35 cfs  6,219 cf

Reach C5: Culvert C-5  
Avg. Depth=0.49'  Max Vel=11.15 fps  Inflow=5.67 cfs  17,985 cf  
D=18.0"  n=0.025  L=20.0'  S=0.1950'  Capacity=24.12 cfs  Outflow=5.67 cfs  17,985 cf

Reach W1DL: Lower W-1 Ditch  
Avg. Depth=1.03'  Max Vel=2.35 fps  Inflow=5.01 cfs  13,809 cf  
D=18.0"  n=0.035  L=320.0'  S=0.0088'  Capacity=29.49 cfs  Outflow=4.90 cfs  13,809 cf

Reach W1DU: Upper W-1 Ditch  
Avg. Depth=0.71'  Max Vel=2.38 fps  Inflow=2.88 cfs  6,219 cf  
D=18.0"  n=0.035  L=963.0'  S=0.0145'  Capacity=38.02 cfs  Outflow=2.37 cfs  6,219 cf

Reach W2D: W-2 Ditch  
Avg. Depth=0.40'  Max Vel=2.58 fps  Inflow=5.32 cfs  7,590 cf  
D=18.0"  n=0.035  L=500.0'  S=0.0158'  Capacity=6.65 cfs  Outflow=3.21 cfs  4,177 cf

Reach W3D: W-3 Ditch  
Avg. Depth=0.71'  Max Vel=2.50 fps  Inflow=3.52 cfs  4,177 cf  
D=18.0"  n=0.035  L=160.0'  S=0.0156'  Capacity=8.66 cfs  Outflow=3.21 cfs  4,177 cf

Pond WP: West Sed Pond  
Peak Elev=5,504.70'  Storage=17,985 cf  Inflow=5.67 cfs  17,985 cf  Outflow=0.00 cfs  0 cf

Total Runoff Area = 305,034 sf  Runoff Volume = 17,985 cf  Average Runoff Depth = 0.71"  
100.00% Pervious = 305,034 sf  0.00% Impervious = 0 sf

INCORPORATED  
JANUARY 18, 2011  
DIVISION OIL, GAS & MINING
Summary for Subcatchment W-1: Watershed W-1

Runoff = 2.88 cfs @ 3.22 hrs, Volume = 6,219 cf, Depth = 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall = 1.74"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>105,474</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

Tc 19.5 Length 1,297 Slope 0.0250 Velocity 1.11 Capacity 1.11 Description Lag/CN Method,

Subcatchment W-1: Watershed W-1

Type II 24-hr 6.00 hrs Rainfall = 1.74"
Runoff Area = 105,474 sf
Runoff Volume = 6,219 cf
Runoff Depth = 0.71"
Flow Length = 1,297'
Slope = 0.0250 '/'
Tc = 19.5 min
CN = 87

Runoff = 5.32 cfs @ 3.11 hrs, Volume = 7,590 cf, Depth = 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall=1.74"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>128,724</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>128,724</td>
<td></td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc</th>
<th>Length</th>
<th>Slope</th>
<th>Velocity</th>
<th>Capacity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.0</td>
<td>635</td>
<td>0.0250</td>
<td>0.96</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment W-2: Watershed W-2

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall=1.74"
Runoff Area=128,724 sf
Runoff Volume=7,590 cf
Runoff Depth=0.71"
Flow Length=635'
Slope=0.0250 '/'
Tc=11.0 min
CN=87
Summary for Subcatchment W-3: Watershed W-3

Runoff = 3.52 cfs @ 3.07 hrs, Volume= 4,177 cf, Depth= 0.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs Rainfall=1.74"

<table>
<thead>
<tr>
<th>Area (sf)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>70,836</td>
<td>87</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>447</td>
<td>0.0270</td>
<td>0.93</td>
<td></td>
<td>Lag/CN Method,</td>
</tr>
</tbody>
</table>

Subcatchment W-3: Watershed W-3

Hydrograph

Type II 24-hr 6.00 hrs
Rainfall=1.74"
Runoff Area=70,836 sf
Runoff Volume=4,177 cf
Runoff Depth=0.71"
Flow Length=447'
Slope=0.0270 '/
Tc=8.0 min
CN=87
Summary for Reach C3: Culvert C-3

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach W2D OUTLET depth by 0.29' @ 3.25 hrs

Inflow Area = 128,724 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 4.68 cfs @ 3.21 hrs, Volume= 7,590 cf
Outflow = 4.65 cfs @ 3.21 hrs, Volume= 7,590 cf, Attenuation= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.47 fps, Min. Travel Time= 0.1 min
Avg. Velocity= 1.96 fps, Avg. Travel Time= 0.3 min

Peak Storage= 29 cf @ 3.21 hrs, Average Depth at Peak Storage= 0.64'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 12.31 cfs

18.0" Diameter Pipe, n= 0.020
Length= 40.0' Slope= 0.0325 '/'
Inlet Invert= 5,512.10', Outlet Invert= 5,510.80'

Reich C3: Culvert C-3

Hydrograph

Inflow Area=128,724 sf
Avg. Depth=0.64'
Max Vel=6.47 fps
D=18.0"

n=0.020
L=40.0'
S=0.0325 '/'
Capacity=12.31 cfs
Summary for Reach C4: Culvert C-4

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach W1DU OUTLET depth by 1.20' @ 0.00 hrs

Inflow Area = 105,474 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 2.37 cfs @ 3.43 hrs, Volume= 6,219 cf
Outflow = 2.35 cfs @ 3.44 hrs, Volume= 6,219 cf, Atten= 1%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.35 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.03 fps, Avg. Travel Time= 1.3 min

Peak Storage= 57 cf @ 3.43 hrs, Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 6.41 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 80.0' Slope= 0.0137 '/'
Inlet Invert= 5,512.00', Outlet Invert= 5,510.90'

Reach C4: Culvert C-4

Hydrograph

Inflow Area=105,474 sf
Avg. Depth=0.63'
Max Vel=3.35 fps
D=18.0"
n=0.025
L=80.0'
S=0.0137 '/'
Capacity=6.41 cfs
Summary for Reach C5: Culvert C-5

[52] Hint: Inlet/Outlet conditions not evaluated
[62] Warning: Exceeded Reach WIDL OUTLET depth by 1.92' @ 2.70 hrs
[62] Warning: Exceeded Reach W3D OUTLET depth by 2.02' @ 3.45 hrs

Inflow Area = 305,034 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 5.67 cfs @ 3.30 hrs, Volume= 17,985 cf
Outflow = 5.67 cfs @ 3.30 hrs, Volume= 17,985 cf, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity = 11.15 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.89 fps, Avg. Travel Time= 0.1 min

Peak Storage= 10 cf @ 3.30 hrs, Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 24.12 cfs

18.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 20.0' Slope= 0.1950 '/'
Inlet Invert= 5,509.90', Outlet Invert= 5,506.00'

Reach C5: Culvert C-5

Hydrograph

Inflow Area=305,034 sf
Avg. Depth=0.49'
Max Vel=11.15 fps
D=18.0"
n=0.025
L=20.0'
S=0.1950 '/'
Capacity=24.12 cfs
Summary for Reach W1DL: Lower W-1 Ditch

[62] Warning: Exceeded Reach C3 OUTLET depth by 0.60' @ 3.50 hrs
[62] Warning: Exceeded Reach C4 OUTLET depth by 0.60' @ 3.20 hrs

Inflow Area = 234,198 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 5.01 cfs @ 3.23 hrs, Volume= 13,809 cf
Outflow = 4.90 cfs @ 3.32 hrs, Volume= 13,809 cf, Atten= 2%, Lag= 5.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.35 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.71 fps, Avg. Travel Time= 7.5 min

Peak Storage= 672 cf @ 3.27 hrs, Average Depth at Peak Storage= 1.03'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 29.49 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 ', Top Width= 8.00'
Length= 320.0' Slope= 0.0088 ''
Inlet Invert= 5,510.80', Outlet Invert= 5,508.00'

Reach W1DL: Lower W-1 Ditch

Hydrograph

Inflow Area=234,198 sf
Avg. Depth=1.03'
Max Vel=2.35 fps
n=0.035
L=320.0'
S=0.0088 '/'
Capacity=29.49 cfs
Summary for Reach W1DU: Upper W-1 Ditch

Inflow Area = 105,474 sf, 0.00% Impervious, Inflow Depth = 0.71"
Inflow = 2.88 cfs @ 3.22 hrs, Volume= 6,219 cf
Outflow = 2.37 cfs @ 3.43 hrs, Volume= 6,219 cf, Atten= 18%, Lag= 12.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.38 fps, Min. Travel Time= 6.7 min
Avg. Velocity = 0.77 fps, Avg. Travel Time= 20.8 min

Peak Storage= 971 cf @ 3.31 hrs, Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 38.02 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 963.0' Slope= 0.0145 '/'
Inlet Invert= 5,524.80', Outlet Invert= 5,510.80'

Reach W1DU: Upper W-1 Ditch

Hydrograph

Inflow Area=105,474 sf
Avg. Depth=0.71'
Max Vel=2.38 fps
n=0.035
L=963.0'
S=0.0145 '/
Capacity=38.02 cfs
**Summary for Reach W2D: W-2 Ditch**

- **Inflow Area** = 128,724 sf, 0.00% Impervious, **Inflow Depth** = 0.71"
- **Inflow** = 5.32 cfs @ 3.11 hrs, **Volume** = 7,590 cf
- **Outflow** = 4.68 cfs @ 3.21 hrs, **Volume** = 7,590 cf, **Atten** = 12%, **Lag** = 5.9 min

Routing by Stor-Ind+Trans method, **Time Span** = 0.00-30.00 hrs, **dt** = 0.05 hrs

- **Max. Velocity** = 2.58 fps, **Min. Travel Time** = 3.2 min
- **Avg. Velocity** = 0.62 fps, **Avg. Travel Time** = 13.3 min

- **Peak Storage** = 918 cf @ 3.16 hrs, **Average Depth at Peak Storage** = 0.40'
- **Bank-Full Depth** = 1.00', **Capacity at Bank-Full** = 23.56 cfs

- **4.00' x 1.00' deep channel**, **n** = 0.035
- **Side Slope Z-value** = 2.0, **Top Width** = 7.00'
- **Length** = 500.0', **Slope** = 0.0158 '/'
- **Inlet Invert** = 5,520.00', **Outlet Invert** = 5,512.10'

---

**Reach W2D: W-2 Ditch**

**Inflow Area** = 128,724 sf

**Avg. Depth** = 0.40'

**Max Vel** = 2.58 fps

**n** = 0.035

**L** = 500.0'

**S** = 0.0158 '/'

**Capacity** = 23.56 cfs

---

**INTEGRATED HYDRAULIC DESIGN SERVICES INCORPORATED**

**JANUARY 18, 2011**

**DIVISION OIL, GAS & MINING**
West ditch and culvert hydro calcs for 100-yr, 6-hr storm

Type II 24-hr 6.00 hrs Rainfall=1.74"
**Summary for Pond WP: West Sed Pond**

Inflow Area = 305,034 sf, 0.00% Impervious, Inflow Depth = 0.71"

Inflow = 5.67 cfs @ 3.30 hrs, Volume = 17,985 cf

Outflow = 0.00 cfs @ 0.00 hrs, Volume = 0 cf, Atten = 100%, Lag = 0.0 min

Routing by Stor-Ind method, Time Span = 0.00-30.00 hrs, dt = 0.05 hrs

Peak Elev = 5,504.70' @ 29.95 hrs  Surf.Area = 4,455 sf  Storage = 17,985 cf

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

<table>
<thead>
<tr>
<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>5,498.23'</td>
<td>36,065 cf</td>
<td>17.00'W x 78.00'L x 9.77'H Prismatoid Z=2.0</td>
</tr>
</tbody>
</table>

**Pond WP: West Sed Pond**

**Hydrograph**

Inflow Area = 305,034 sf
Peak Elev = 5,504.70'
Storage = 17,985 cf
Upper E-1, Min Slope
Worksheet for Triangular Channel

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
</tr>
<tr>
<td>Slope</td>
</tr>
<tr>
<td>Left Side Slope</td>
</tr>
<tr>
<td>Right Side Slope</td>
</tr>
<tr>
<td>Discharge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
</tr>
<tr>
<td>Flow Area</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
</tr>
<tr>
<td>Top Width</td>
</tr>
<tr>
<td>Critical Depth</td>
</tr>
<tr>
<td>Critical Slope</td>
</tr>
<tr>
<td>Velocity</td>
</tr>
<tr>
<td>Velocity Head</td>
</tr>
<tr>
<td>Specific Energy</td>
</tr>
<tr>
<td>Froude Number</td>
</tr>
<tr>
<td>Flow Type</td>
</tr>
</tbody>
</table>
### Upper E-1, Max Slope
#### Worksheet for Triangular Channel

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
</tr>
<tr>
<td>Slope</td>
</tr>
<tr>
<td>Left Side Slope</td>
</tr>
<tr>
<td>Right Side Slope</td>
</tr>
<tr>
<td>Discharge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
</tr>
<tr>
<td>Flow Area</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
</tr>
<tr>
<td>Top Width</td>
</tr>
<tr>
<td>Critical Depth</td>
</tr>
<tr>
<td>Critical Slope</td>
</tr>
<tr>
<td>Velocity</td>
</tr>
<tr>
<td>Velocity Head</td>
</tr>
<tr>
<td>Specific Energy</td>
</tr>
<tr>
<td>Froude Number</td>
</tr>
<tr>
<td>Flow Type</td>
</tr>
</tbody>
</table>

---

**INCORPORATED**

**JANUARY 18, 2011**

**DIVISION OIL, GAS & MINING**
# Lower E-1, Min Slope

## Worksheet for Triangular Channel

### Project Description

<table>
<thead>
<tr>
<th>Worksheet</th>
<th>Triangular Channel - 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Element</td>
<td>Triangular Channel</td>
</tr>
<tr>
<td>Method</td>
<td>Manning's Formula</td>
</tr>
<tr>
<td>Solve For</td>
<td>Channel Depth</td>
</tr>
</tbody>
</table>

### Input Data

<table>
<thead>
<tr>
<th>Mannings Coefficient</th>
<th>0.035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>0.013000 ft/ft</td>
</tr>
<tr>
<td>Left Side Slope</td>
<td>1.50 H : V</td>
</tr>
<tr>
<td>Right Side Slope</td>
<td>1.50 H : V</td>
</tr>
<tr>
<td>Discharge</td>
<td>1.75 cfs</td>
</tr>
</tbody>
</table>

### Results

<table>
<thead>
<tr>
<th>Depth</th>
<th>0.73 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Area</td>
<td>0.8 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>2.63 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>2.19 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.61 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.033882 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>2.19 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.07 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.80 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>0.64</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Subcritical</td>
</tr>
</tbody>
</table>

---

INCORPORATED
JANUARY 18, 2011
DIVISION OIL, GAS & MINING
Lower E-1, Max Slope
Worksheet for Triangular Channel

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
</tr>
<tr>
<td>Slope</td>
</tr>
<tr>
<td>Left Side Slope</td>
</tr>
<tr>
<td>Right Side Slope</td>
</tr>
<tr>
<td>Discharge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
</tr>
<tr>
<td>Flow Area</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
</tr>
<tr>
<td>Top Width</td>
</tr>
<tr>
<td>Critical Depth</td>
</tr>
<tr>
<td>Critical Slope</td>
</tr>
<tr>
<td>Velocity</td>
</tr>
<tr>
<td>Velocity Head</td>
</tr>
<tr>
<td>Specific Energy</td>
</tr>
<tr>
<td>Froude Number</td>
</tr>
<tr>
<td>Flow Type</td>
</tr>
</tbody>
</table>

---

INTEGRATED HYDROLOGICAL DESIGN SERVICES

INCORPORATED
JANUARY 18, 2011
DIVISION OIL, GAS & MINING
### E-3, Min Slope

**Worksheet for Trapezoidal Channel**

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
</tr>
<tr>
<td>Slope</td>
</tr>
<tr>
<td>Left Side Slope</td>
</tr>
<tr>
<td>Right Side Slope</td>
</tr>
<tr>
<td>Bottom Width</td>
</tr>
<tr>
<td>Discharge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
</tr>
<tr>
<td>Flow Area</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
</tr>
<tr>
<td>Top Width</td>
</tr>
<tr>
<td>Critical Depth</td>
</tr>
<tr>
<td>Critical Slope</td>
</tr>
<tr>
<td>Velocity</td>
</tr>
<tr>
<td>Velocity Head</td>
</tr>
<tr>
<td>Specific Energy</td>
</tr>
<tr>
<td>Froude Number</td>
</tr>
<tr>
<td>Flow Type</td>
</tr>
</tbody>
</table>

**INTEGRATED HYDROLOGY FLOWMASTER CHANNELS FM2**

**INCORPORATED**

**JANUARY 18, 2011**

**DIVISION OIL, GAS & MINING**
# E-3, Max Slope

## Worksheet for Trapezoidal Channel

<table>
<thead>
<tr>
<th>Project Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
<td>Trapezoidal Channel - 1</td>
</tr>
<tr>
<td>Flow Element</td>
<td>Trapezoidal Channel</td>
</tr>
<tr>
<td>Method</td>
<td>Manning's Formula</td>
</tr>
<tr>
<td>Solve For</td>
<td>Channel Depth</td>
</tr>
</tbody>
</table>

## Input Data

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
<td>0.035</td>
</tr>
<tr>
<td>Slope</td>
<td>0.023000 ft/ft</td>
</tr>
<tr>
<td>Left Side Slope</td>
<td>2.50 H : V</td>
</tr>
<tr>
<td>Right Side Slope</td>
<td>1.00 H : V</td>
</tr>
<tr>
<td>Bottom Width</td>
<td>0.50 ft</td>
</tr>
<tr>
<td>Discharge</td>
<td>4.80 cfs</td>
</tr>
</tbody>
</table>

## Results

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>0.76 ft</td>
</tr>
<tr>
<td>Flow Area</td>
<td>1.4 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>3.64 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>3.18 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.73 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.028443 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>3.41 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.18 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.95 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>0.90</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Subcritical</td>
</tr>
</tbody>
</table>

---

INTEGRATOR

JANUARY 18, 2011
DIVISION OIL, GAS & MINING
**E-4, Constant Slope**  
**Worksheet for Triangular Channel**

<table>
<thead>
<tr>
<th><strong>Project Description</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Worksheet</strong></td>
</tr>
<tr>
<td><strong>Flow Element</strong></td>
</tr>
<tr>
<td><strong>Method</strong></td>
</tr>
<tr>
<td><strong>Solve For</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Input Data</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mannings Coefficient</strong></td>
</tr>
<tr>
<td><strong>Slope</strong></td>
</tr>
<tr>
<td><strong>Left Side Slope</strong></td>
</tr>
<tr>
<td><strong>Right Side Slope</strong></td>
</tr>
<tr>
<td><strong>Discharge</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Results</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depth</strong></td>
</tr>
<tr>
<td><strong>Flow Area</strong></td>
</tr>
<tr>
<td><strong>Wetted Perimeter</strong></td>
</tr>
<tr>
<td><strong>Top Width</strong></td>
</tr>
<tr>
<td><strong>Critical Depth</strong></td>
</tr>
<tr>
<td><strong>Critical Slope</strong></td>
</tr>
<tr>
<td><strong>Velocity</strong></td>
</tr>
<tr>
<td><strong>Velocity Head</strong></td>
</tr>
<tr>
<td><strong>Specific Energy</strong></td>
</tr>
<tr>
<td><strong>Froude Number</strong></td>
</tr>
<tr>
<td><strong>Flow Type</strong></td>
</tr>
</tbody>
</table>

---

**INTEGRATED TECHNOLOGIES, INC.**

**INTEGRATED TECHNOLOGIES, INC.**

**JANUARY 18, 2011**

**DIVISION OIL, GAS & MINING**

---

Project Engineer: Tom Suchoski

EarthFax Engineering Inc

37 Brookside Road  Waterbury, CT 06708 USA  (203) 755-1666

---

Page 1 of 1
E-5, Min Slope
Worksheet for Triangular Channel

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
</tr>
<tr>
<td>Slope</td>
</tr>
<tr>
<td>Left Side Slope</td>
</tr>
<tr>
<td>Right Side Slope</td>
</tr>
<tr>
<td>Discharge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
</tr>
<tr>
<td>Flow Area</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
</tr>
<tr>
<td>Top Width</td>
</tr>
<tr>
<td>Critical Depth</td>
</tr>
<tr>
<td>Critical Slope</td>
</tr>
<tr>
<td>Velocity</td>
</tr>
<tr>
<td>Velocity Head</td>
</tr>
<tr>
<td>Specific Energy</td>
</tr>
<tr>
<td>Froude Number</td>
</tr>
<tr>
<td>Flow Type</td>
</tr>
</tbody>
</table>

INCORPORATED
JANUARY 18, 2011
DIVISION OIL, GAS & MINING
### Project Description

<table>
<thead>
<tr>
<th>Worksheet</th>
<th>Triangular Channel - 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Element</td>
<td>Triangular Channel</td>
</tr>
<tr>
<td>Method</td>
<td>Manning's Formula</td>
</tr>
<tr>
<td>Solve For</td>
<td>Channel Depth</td>
</tr>
</tbody>
</table>

### Input Data

<table>
<thead>
<tr>
<th>Mannings Coefficient</th>
<th>0.035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>0.033000 ft/ft</td>
</tr>
<tr>
<td>Left Side Slope</td>
<td>4.00 H : V</td>
</tr>
<tr>
<td>Right Side Slope</td>
<td>4.00 H : V</td>
</tr>
<tr>
<td>Discharge</td>
<td>4.98 cfs</td>
</tr>
</tbody>
</table>

### Results

<table>
<thead>
<tr>
<th>Depth</th>
<th>0.60 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Area</td>
<td>1.5 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>4.99 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>4.84 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.63 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.027371 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>3.40 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.18 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.78 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>1.09</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Supercritical</td>
</tr>
</tbody>
</table>

---

INCORPORATED

**JANUARY 18, 2011**

**DIVISION OIL, GAS & MINING**
# Upper W-1, Min Slope
## Worksheet for Triangular Channel

**Project Description**

<table>
<thead>
<tr>
<th>Worksheet</th>
<th>Triangular Channel - 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Element</td>
<td>Triangular Channel</td>
</tr>
<tr>
<td>Method</td>
<td>Manning's Formula</td>
</tr>
<tr>
<td>Solve For</td>
<td>Channel Depth</td>
</tr>
</tbody>
</table>

**Input Data**

<table>
<thead>
<tr>
<th>Mannings Coefficient</th>
<th>0.035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>0.009100 ft/ft</td>
</tr>
<tr>
<td>Left Side Slope</td>
<td>2.00 H : V</td>
</tr>
<tr>
<td>Right Side Slope</td>
<td>2.00 H : V</td>
</tr>
<tr>
<td>Discharge</td>
<td>1.50 cfs</td>
</tr>
</tbody>
</table>

**Results**

<table>
<thead>
<tr>
<th>Depth</th>
<th>0.65 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Area</td>
<td>0.8 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>2.91 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>2.60 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.51 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.032636 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>1.78 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.05 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.70 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>0.55</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Subcritical</td>
</tr>
</tbody>
</table>

---

**INTEGRATED**

**JANUARY 18, 2011**

**DIVISION OIL, GAS & MINING**
## Upper W-1, Max Slope

### Worksheet for Triangular Channel

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

### Input Data

<table>
<thead>
<tr>
<th>Mannings Coefficient</th>
<th>0.035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>0.025000 ft/ft</td>
</tr>
<tr>
<td>Left Side Slope</td>
<td>2.00 H : V</td>
</tr>
<tr>
<td>Right Side Slope</td>
<td>2.00 H : V</td>
</tr>
<tr>
<td>Discharge</td>
<td>1.50 cfs</td>
</tr>
</tbody>
</table>

### Results

<table>
<thead>
<tr>
<th>Depth</th>
<th>0.54 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Area</td>
<td>0.6 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>2.40 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>2.15 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.51 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.032635 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>2.60 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.10 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.64 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>0.88</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Subcritical</td>
</tr>
</tbody>
</table>

---

INCORPORATED
JANUARY 18, 2011
DIVISION OIL, GAS & MINING
## Lower W-1, Min Slope
### Worksheet for Triangular Channel

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

### Input Data

| Mannings Coefficient | 0.035 |
| Slope | 0.006700 ft/ft |
| Left Side Slope | 2.00 H : V |
| Right Side Slope | 2.00 H : V |
| Discharge | 2.44 cfs |

### Results

| Depth | 0.83 ft |
| Flow Area | 1.4 ft² |
| Wetted Perimeter | 3.69 ft |
| Top Width | 3.30 ft |
| Critical Depth | 0.62 ft |
| Critical Slope | 0.030586 ft/ft |
| Velocity | 1.79 ft/s |
| Velocity Head | 0.05 ft |
| Specific Energy | 0.88 ft |
| Froude Number | 0.49 |
| Flow Type | Subcritical |

---

**INCORPORATED**  
**JANUARY 18, 2011**  
DIVISION OIL, GAS & MINING
## Lower W-1, Max Slope
### Worksheet for Triangular Channel

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

### Input Data

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manning's Coefficient</td>
<td>0.035</td>
</tr>
<tr>
<td>Slope</td>
<td>0.01700</td>
</tr>
<tr>
<td>Left Side Slope</td>
<td>2.00 H : V</td>
</tr>
<tr>
<td>Right Side Slope</td>
<td>2.00 H : V</td>
</tr>
<tr>
<td>Discharge</td>
<td>2.44 cfs</td>
</tr>
</tbody>
</table>

### Results

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>0.69 ft</td>
</tr>
<tr>
<td>Flow Area</td>
<td>1.0 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>3.10 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>2.77 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.62 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.030586 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>2.54 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.10 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.79 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>0.76</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Subcritical</td>
</tr>
</tbody>
</table>

---

EarthFax Engineering Inc
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Project Engineer: Tom Suchoski
FlowMaster v6.0 [614e]

G:\...\hydrology\flowmaster\channels.fm2
09/17/10 02:51:12 PM © Haestad Methods, Inc.

INTEGRATED SOLUTIONS, INC.
JANUARY 18, 2011
DIVISION OIL, GAS & MINING
W-2, Min Slope
Worksheet for Trapezoidal Channel

<table>
<thead>
<tr>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
</tr>
<tr>
<td>Slope</td>
</tr>
<tr>
<td>Left Side Slope</td>
</tr>
<tr>
<td>Right Side Slope</td>
</tr>
<tr>
<td>Bottom Width</td>
</tr>
<tr>
<td>Discharge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
</tr>
<tr>
<td>Flow Area</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
</tr>
<tr>
<td>Top Width</td>
</tr>
<tr>
<td>Critical Depth</td>
</tr>
<tr>
<td>Critical Slope</td>
</tr>
<tr>
<td>Velocity</td>
</tr>
<tr>
<td>Velocity Head</td>
</tr>
<tr>
<td>Specific Energy</td>
</tr>
<tr>
<td>Froude Number</td>
</tr>
<tr>
<td>Flow Type</td>
</tr>
</tbody>
</table>

INCORPORATED
JANUARY 18, 2011
DIVISION OIL, GAS & MINING
# W-2, Max Slope

## Worksheet for Trapezoidal Channel

### Project Description

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet</td>
</tr>
<tr>
<td>Flow Element</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Solve For</td>
</tr>
</tbody>
</table>

### Input Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
<td>0.035</td>
</tr>
<tr>
<td>Slope</td>
<td>0.033000 ft/ft</td>
</tr>
<tr>
<td>Left Side Slope</td>
<td>1.00 H:V</td>
</tr>
<tr>
<td>Right Side Slope</td>
<td>2.00 H:V</td>
</tr>
<tr>
<td>Bottom Width</td>
<td>2.00 ft</td>
</tr>
<tr>
<td>Discharge</td>
<td>2.79 cfs</td>
</tr>
</tbody>
</table>

### Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>0.35 ft</td>
</tr>
<tr>
<td>Flow Area</td>
<td>0.9 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>3.26 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>3.04 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.36 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.029556 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>3.20 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.16 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.51 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>1.05</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Supercritical</td>
</tr>
</tbody>
</table>

---

**INCORPORATED**

**JANUARY 18, 2011**

**DIVISION OIL, GAS & MINING**
Worksheet for Triangular Channel

### Project Description

<table>
<thead>
<tr>
<th>Worksheet</th>
<th>Triangular Channel - 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Element</td>
<td>Triangular Channel</td>
</tr>
<tr>
<td>Method</td>
<td>Manning's Formula</td>
</tr>
<tr>
<td>Solve For</td>
<td>Channel Depth</td>
</tr>
</tbody>
</table>

### Input Data

- **Mannings Coefficient**: 0.035 ft/ft
- **Slope**: 0.003300 ft/ft
- **Left Side Slope**: 4.50 H : V
- **Right Side Slope**: 1.00 H : V
- **Discharge**: 1.81 cfs

### Results

<table>
<thead>
<tr>
<th>Depth</th>
<th>0.74 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Area</td>
<td>1.5 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>4.48 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>4.09 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.49 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.032311 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>1.19 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.02 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.77 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>0.34</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Subcritical</td>
</tr>
</tbody>
</table>

**Flow Type**: Subcritical
# Project Description

<table>
<thead>
<tr>
<th>Worksheet</th>
<th>Triangular Channel - 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Element</td>
<td>Triangular Channel</td>
</tr>
<tr>
<td>Method</td>
<td>Manning's Formula</td>
</tr>
<tr>
<td>Solve For</td>
<td>Channel Depth</td>
</tr>
</tbody>
</table>

## Input Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mannings Coefficient</td>
<td>0.035</td>
</tr>
<tr>
<td>Slope</td>
<td>0.025000 ft/ft</td>
</tr>
<tr>
<td>Left Side Slope</td>
<td>4.50 H : V</td>
</tr>
<tr>
<td>Right Side Slope</td>
<td>1.00 H : V</td>
</tr>
<tr>
<td>Discharge</td>
<td>1.81 cfs</td>
</tr>
</tbody>
</table>

## Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>0.51 ft</td>
</tr>
<tr>
<td>Flow Area</td>
<td>0.7 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>3.07 ft</td>
</tr>
<tr>
<td>Top Width</td>
<td>2.80 ft</td>
</tr>
<tr>
<td>Critical Depth</td>
<td>0.49 ft</td>
</tr>
<tr>
<td>Critical Slope</td>
<td>0.032310 ft/ft</td>
</tr>
<tr>
<td>Velocity</td>
<td>2.54 ft/s</td>
</tr>
<tr>
<td>Velocity Head</td>
<td>0.10 ft</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>0.61 ft</td>
</tr>
<tr>
<td>Froude Number</td>
<td>0.89</td>
</tr>
<tr>
<td>Flow Type</td>
<td>Subcritical</td>
</tr>
</tbody>
</table>

---

INTEGRATED

JANUARY 18, 2011
DIVISION OIL, GAS & MINING
APPENDIX 7-9

Alternate Sediment Control Area Calculations
COVOL WELLINGTON PLANT
ASCAL DETERMINATION

ASCAL-1
Bone yard with minimally-disturbed ground
Partially vegetated with weeds

\[
\begin{align*}
CN &= 80 \\
P_{10,24} &= 1.57 \text{ in} \\
Q &= 0.321 \text{ in} \\
A_{r2} &= 2.38 \text{ ac} \\
&= 2770 \text{ ft}^2
\end{align*}
\]

\[A_{r2 \text{ of elev.} 5510 \text{ contour inside fence}} = 5540 \text{ ft}^2\]
The above runoff will be contained with a fiber roll with a height of 2.6 inches.

ASCAL-2
Conditions as above

\[
\begin{align*}
CN &= 80 \\
P_{10,24} &= 1.57 \text{ in} \\
Q &= 0.321 \text{ in} \\
A_{r2} &= 0.12 \text{ ac} \\
&= 140 \text{ ft}^2
\end{align*}
\]

\[A_{r2 \text{ of elev.} 5508 \text{ contour inside fence}} = 610 \text{ ft}^2\]
The above runoff will be contained if the fiber roll has a height of 2.6 inches.