APPENDIX L

Drainage, Erosion, and Sediment Control Plan

Preliminary Draft Plan

Drainage, Erosion, and Sediment Control Plan

Palmdale Hybrid Power Plant

City of Palmdale, California

Submitted to the:
California Energy Commission

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SECTION 1

Introduction

This Preliminary Draft Drainage, Erosion, and Sediment Control Plan (DESCP) has been prepared in anticipation of the California Energy Commission's (CEC) approval of the proposed Palmdale Hybrid Power Project. The proposed Project consists of a hybrid of natural gas-fired combined-cycle generating equipment integrated with solar thermal generating equipment. The combined-cycle equipment will utilize two natural gas-fired combustion turbine generators (CTG), two heat recovery steam generators (HRSG) and one steam turbine generator (STG). The solar thermal equipment will utilize arrays of parabolic collectors to heat a working fluid. The hot working fluid will then be used to boil water to generate steam. The combined-cycle equipment is integrated thermally with the solar equipment at the HRSG and both utilize the single STG. The Project will have a nominal electrical output of 570 MW. The solar thermal input will provide approximately 10 percent of the peak power generated by the plant during the most energy demanding time of the day. The Project will be fueled with natural gas delivered via a new natural gas pipeline. The proposed plant is located in the City of Palmdale, Los Angeles County, California. In order to determine the potential impacts to water and soil resources from the construction and operation of the Palmdale Energy Center project, the Energy Commission requires a draft and final Drainage Erosion and Sediment Control Plan (DESCP). The DESCP will be updated and revised as the project moves from the preliminary to final design phases and will be a separate document from the Construction Storm Water Pollution Prevention Plan (SWPPP). The DESCP submitted prior to site mobilization must be designed and sealed by a professional engineer/erosion control specialist.

This draft DESCP is preliminary because it is prepared in advance of the final phase of construction planning and engineering design, during which the details regarding construction schedule and certain aspects of erosion control design will be finalized. This will take place after licensing and will be included in a future draft of the DESCP.

1.1 Drainage, Erosion, and Sediment Control Plan Elements

This draft DESCP outlines site management activities during site mobilization, excavation and construction, and includes the following elements:

Vicinity Map – A map at minimum scale 1"=100' indicating the location of all project elements with depictions of all significant geographic features including swales, storm drains, and sensitive areas.

Site Delineation – All areas subject to soil disturbance for the Palmdale project (project site, laydown/demolition areas, all linear facilities, landscaping areas, and any other project elements) are delineated showing boundary lines of all construction/demolition areas and the location of all existing and proposed structures, pipelines, roads, and drainage facilities.

Watercourses and Critical Areas – The DESCP shows the location of all nearby watercourses including swales, storm drains, and drainage ditches, as well as their proximity to the Palmdale project site.

Drainage – The DESCP provides a topographic site map at a scale of 1"=100' showing all existing, interim and proposed drainage systems and drainage area boundaries. On the map, spot elevations are shown where relatively flat conditions exist.

Clearing and Grading – The DESCP provides a delineation of all areas to be cleared of vegetation and areas to be preserved. The plan provides elevations, slopes, locations, and the extent of all proposed grading as shown by contours. Existing and proposed topography are tied together.

Best Management Practices – The DESCP describes the location, timing, and maintenance schedule of BMPs to be used. Final design and placement of the BMPs will take place during the final phase of construction planning after licensing.

1.2 Project Overview

Palmdale will be a 570 MW facility consisting of two natural gas-fired combustion turbine generators (CTG), two heat recovery steam generators (HRSG) and one steam turbine generator (STG) and will have solar thermal collectors on approximately two hundred fifty (250) acres of land adjacent to the power block. The site is located west of Air Force Base Plant 42, bordering Sierra Highway on west and Avenue M (Columbia Way) on the north, in the City of Palmdale, Los Angeles County, California. A Location Map is attached with all drawings at the end of this report. The parcel is a total of roughly six hundred fifty (650) acres undeveloped land. The land cover consists of sandy soil, various small brush and Joshua trees. The Project site, including the plant site and the solar field, will be located on east half of the available land and will occupy roughly three hundred seventy (300) acres. The remaining land, west of proposed solar field will be used for fill or as dump site for excess cut material and as lay down area, if required, during construction. An additional infiltration pond will be added to the west of the access road to contain the storm drainage from the remaining land. The City plans to develop this area into a business district in the future. The project site will be located in an area zoned for industrial uses and will comply with all local, state, and federal regulatory requirements associated with the protection of water quality and soil resources.

Figures 1-4, attached at the end of this report, show the project site plan, gas line, electric transmission line, and reclaimed water route. Palmdale will connect to the electrical transmission station through a transmission line leading away from the northeast corner of the Power Block and traveling north along the edge of the solar field. The Project will receive natural gas through a pipeline that travels east along East Avenue M (Columbia Way) before turning south along the eastern edge of the solar field and enters the Power Block in the northeast corner.

1.3 Watercourses and Critical Areas

The project is located within the Antelope-Fremont Valley watershed. Characteristics of the site are that only natural swales and natural low ponding areas exist and there are no drainage ditches or storm drains on the existing site. However, there is an irrigation channel along the Southern Pacific Railroad, but no water from the site enters the channel. The Amargosa River runs from south to north roughly a mile west of the project site.

1.4 Project Ownership

The City of Palmdale is the Project owner.

SECTION 2

Drainage

2.1 Pre-Development Drainage

The area available for the proposed improvement is surrounded by East Avenue M on the north, Southern Pacific Railroad and Sierra Highway on the west, Avenue M-12 on the south and the Air Force Base on east. All these boundary elements work as drainage barrier for the project area and separate it from the surrounding drainage basins. Therefore no runoff from the surrounding area enters the project area. However, a concrete channel, running between Sierra Highway and Southern Pacific Railroad, crosses the project area at the northwest corner and continues towards north crossing East Avenue M. It appears that no water from the site enters the channel. See drawings CM-218.

Out of total available land (roughly 650-acre), referred as "**Project Area**", only the east half (roughly 300 acres) will be developed for the power plant and the solar field, and is referred as "**Project Site**" in this report.

The existing topographic conditions of the Palmdale Project Area depict an average slope of one percent (-1%) towards north and northeast. Near the center of the site, there are multiple low spots where ponding occurs. The remaining water flows toward north and northeast. There is a shallow concrete box culvert, located west of the intersection of East Avenue M and Site 1 Road (entrance road for Air Force Base), crossing Avenue M at a skew angle. This culvert connects to a double grate inlet structure on the upstream side, located on the south edge of Avenue M, and discharges north of East Avenue M. However, silt accumulation has almost filled this inlet and the box, and it appears that the culvert is non-functional. Considering the topography of the existing site and the condition of the existing culvert at the northeast corner, it appears that the Project Area allows ponding at low spots within its boundary and does not discharge storm water except for major storm event. Preliminary drainage calculations confirm that a few low spots on Avenue M close to the northeast corner of the project site are subject to flooding during the 25-year storm event and greater. See drawings CM-220 and CM-221 for areas of potential flood during major storm events.

The Project Area is divided into eight sub-basins to analyze pre-development drainage condition. Existing topographic conditions and drainage areas are shown on drawings CM-217 to CM-229. A table on the plan sheet shows the discharges from each sub-basin for 2-year and 100-year storms. Pre-development drainage calculations are attached in Appendix B.

2.2 Post Development Drainage

The document TC-11 of the California Stormwater BMP Handbook – New Development and Redevelopment (California Stormwater BMP, 2003)1, serves the basis for the drainage design concept. The design intent of the proposed drainage is that the post development discharge from the Project Area shall not exceed the pre-development discharge for 100-year storm event. The infiltration basins are designed to contain the differential run-on between the pre-development and post development conditions for 100-year storm event. In

[1] California Stormwater BMP Handbook – New Development and Redevelopment. California, 2003.

this case, as there is no discharge from the project area for the existing condition, no discharge will leave the Project Area after the proposed improvement for 100-year storm event. The proposed infiltration basins are designed to retain the run-on from the entire Project Area for 100-year storm event. This will also help to capture any sediment flowing along with storm run-on during construction. The infiltration basins shall be protected from erosion by stabilizing the side slopes using Soil Sement or similar product.

It should be noted that the current design approach is based on preliminary assumptions and findings, and may require modifications during final design. However, the design concept will remain the same.

Based on conceptual layout of the proposed development, the Project Site has been divided into two main watersheds, the North Watershed and the South Watershed. The undeveloped part of the Project Area, the west part of the land (roughly 280 acres), is considered as a separate watershed. The proposed development does not allow storm water flow from this undeveloped part of the land through the solar field. The run-on from this watershed flows north along the west side of the proposed access road and is collected and retained in northwest infiltration basin near Avenue M (Columbia Way) and 10th Street East (Challenger Way) as shown on drawings CM-232 and CM-233 of conceptual drainage plans. The northwest infiltration basin is designed to contain the 100-year storm event.

North Watershed: The North Watershed includes roughly 127-acre of solar field north of the access road and roughly the northern half of the Power Block (roughly 13-acre) and drains to the north into north infiltration basin. The proposed grading for the post development condition directs flow towards the north and the run-on is contained in the proposed north infiltration basin.

South Watershed: The South Watershed includes roughly 175-acres of solar field south of the access road and the southern half of the Power Block area (roughly 12-acres) and drains to infiltration basins located on the south side of the access road and the south side of the Power Block area. The solar field of South Watershed is again divided into two major areas; eastern part drains to southeast infiltration basin and the western part drains to southwest infiltration basin.

Power Block: The Power Block Area is located approximately midway along the eastern edge of the project site. The Power Block area drains toward north and south by means of sheet flow, swales, inlets, and/or storm sewer pipes. The northern half of the Power Block drains towards the northeast corner of the Power Block area where the runoff enters a swale which flows to the north infiltration basin. The southern half of the Power Block drains into the southeast infiltration basin on the southern edge of the Power Block.

Solar Field: The Solar Field is graded at a -0.6 percent slope towards northeast resulting in -0.2 percent slope from west to east. The gentle slope keeps storm water flow velocity low, thus minimizing the amount of sediments picked up by the runoff. In addition, dust palliative product, such as Soil-Sement, shall be applied to stabilize the bare ground on solar field and to minimize the potential surface erosion.

The north infiltration basin, southeast infiltration basin and southwest infiltration basin in the Project Site are designed to contain the run-on for at least the 25-year storm event with the 100-year storm event backing up into the solar field to a depth no greater than 2 feet.

Table 2.1 shows precipitation and discharge data for 2-year and 100-year storm events for predevelopment and post development conditions for both the Power Block and Solar Field

areas. These data provide the basis for sizing the infiltration basins shown on drawings CM-233, CM-234, CM-237, and CM-238.

The peak flow rates shown on Table 2.1 were determined using a computer aided, watershed modeling software called Hydraflow Hydrographs 2007 by Intelisolve. This program utilizes the Natural Resources Conservation Service's TR-55 methods. Soil group information was obtained from the United States Department of Agriculture Natural Resources Conservation Service. The Solar Field area includes the roadway and the infiltration ponds for the solar field drainage. Rainfall data from NOAA is shown on Table 2.2. See drawing CM-217 for Pre-Development drainage areas. See Drawing CM-230 for Post-Development drainage areas.

Table 2.1:
Hydrologic Analysis for Predevelopment and Post Development Conditions

	Post-Development North Watershed		**Post-Development South Watershed**		**Post-Development Total**	**Pre-Development**
	Power Block	Solar Field	Power Block	Solar Field		
Areas Included	Power Block North	7.1, 7.2	Power Block South	8.1, 8.2	7.1, 7.2, 8.1, 8.2 Power Block North and South	4, 7,8,and part of 3, 5, 6
Acres	13 acres	150 acres	12 acres	195 acres	370 acres	370 acres
Curve Number	98	85	98	85	86 Weighted average	63
Discharge from Project 2-Yr Storm	0 cfs (cubic feet/sec)	0 cfs	0 cfs	0 cfs	0 cfs	0 cfs
Discharge from Project 100-Yr Storm	0 cfs	0 cfs	0 cfs	0 cfs	0 cfs	0 cfs

Table 2.2: Rainfall Data

Precipitation	**Inches**
2-Year 24-hour storm	1.39
100-Year 24 hour storm-	3.75

2.3 Erosion and Sediment Control

During Project construction, silt fence shall be installed to prevent sediments in storm water runoff from leaving the site. The silt fence depicted in drawing CM-245 and CM-246 shall be in place prior to any clearing or grading operations. Since the grading of the site will take place in phases, temporary silt fence shall be added around the perimeter of the phase area on the sides not bounded by the Project site silt fence. After silt fence is installed, the infiltration basins will be constructed first during Power Block grading. The largest amount of sediments will be produced during construction. Therefore, sediments, which have accumulated in the infiltration basins during construction, may need to be removed during and at the end of construction to ensure that the facility functions properly. Temporary and permanent ditches that carry runoff to the infiltration basins will be protected against erosion,

during construction, using flow check dams constructed of hay bales. As permanent storm sewer pipes and culverts are added during construction, they will be protected from receiving sediments using silt fence that will enclose the inlets.

Areas disturbed during construction, in the Power Block area, will be stabilized with straw or other suitable material until the final surface is established. The Solar Field will be stabilized with Soil Sement or a similar product. All construction entrances will have a granular area to remove soil from vehicle tires prior to leaving the site. Dust will be controlled during construction by watering the ground and using Soil Sement or a similar product to stabilize bare ground. All erosion control measures will be in accordance to Section 3 of the California Stormwater BMP Handbook – Construction.[2]

SECTION 3
Clearing and Grading

3.1 Areas to be Cleared and Graded
Palmdale site is located entirely within an undeveloped area. Brush and Joshua trees will need to be cleared before grading is performed.

3.2 Location of Disposal Areas, Fills, or Other Special Areas
It is anticipated that all excavated soil will be used onsite for grading and leveling purposes. In the event that some of the excavated soil will not be reused onsite, classification of the soil for disposal will be made on the basis of sampling. Sampling will be completed once the soil is excavated and stockpiled. Soil that is determined to be nonhazardous may be suitable for reuse at a construction site or may be disposed at a regional disposal facility, depending on the chemical quality.

3.3 Existing and Proposed Topography
The existing site depicts an average slope of 1% toward the north and northeast. Multiple low areas throughout the site allow for ponding. At completion of Palmdale, surface grading will direct storm water runoff off the site via overland flow at a typical slope of 0.6 percent and will be contained in infiltration ponds. The main plant area will be graded with moderate slopes for effective drainage.

3.4 Volumes of Cut and Fill
The conceptual grading of the project site, including the Power Block and the solar field, resulted 940,743 cubic yards of cut and 466,612 cubic yards of fill. The excess cut material of 475,000 cubic yards will be spread on adjacent land west of the proposed solar field. It is anticipated that it will not be necessary to haul dirt onto or off of the owner's property and onto public roads. There will be no topsoil removed from the site.

3.4.1 Gas Pipeline
The trench excavated for the short pipeline tie-in will be entirely refilled. No surplus soil is expected for such work.

3.4.2 Water Pipeline
The power plant will be connected to the future reclaimed water line running parallel to Sierra Highway as shown on figure 4, attached at the end of this report. The service line from the

[2] California Stormwater BMP, 2003.

plant will run north to the East Avenue M and then will run parallel to East Avenue M towards west to connect to the main line.

SECTION 4
Best Management Practices

The project has been designed to impact as small an area as possible at any given time, thereby limiting the amount of exposed, untreated soil. Construction is expected to proceed as expediently and efficiently as possible, thereby ensuring that as little soil is exposed for as short a time as possible. The following sections present standard construction Best Management Practices (BMPs), most of which are described in the California Storm Water Best Management Practice Handbook (2003) and the Caltrans Storm Water Quality Handbook (2003).

These resource handbooks provide comprehensive details on BMP implementation and will be obtained and reviewed by managers for all construction contractors that may have an impact on implementation of the DESCP.

The following sections present the recommended construction BMPs for stormwater pollution prevention at the construction laydown areas, plant site, solar field and linear facilities. Each section provides information on BMP implementation as it relates to the activity being performed. BMPs that may have an impact on implementation of the DESCP will be reviewed by managers and construction contractors. While performing the work, the contractors may implement additional control measures if necessary.

4.1 General Erosion Control Measures

The project has been designed to impact as small an area as possible at any given time, thereby limiting the amount of exposed, untreated soil. BMPs will be used to help maintain water quality, protect property from erosion damage, and prevent accelerated soil erosion or dust generation. Temporary erosion control measures will be implemented before construction begins and they will be evaluated and maintained during construction. These measures typically include revegetation, mulching, physical stabilization, dust suppression, berms, ditches, and sediment barriers. These measures will be removed from the site after the completion of construction.

A mitigation monitoring plan will be developed in conjunction with CEC Staff to set performance standards and monitor the effectiveness of BMPs. This plan will address the timing and methods of such measures, as well as reporting and response requirements.
Personnel will receive training to conduct their jobs properly and recognize and report abnormal/adverse situations so that they can be quickly corrected.

The following general control measures may be used during various phases of the project:

- Proper scheduling and sequencing of activities (SS-1)
- Preservation of existing vegetation (EC-2)
- Silt fences and fiber rolls (SE-1 and SE-5)
- Soil Binders (EC-5)
- Drainage swales (EC-9)
- Straw mulch (SS-6)
- Placement of geotextiles, plastic covers, and erosion control blankets/mats (SS-7)
- Placement of hydro seeding (EC-4), mulching (EC-6), or geotextile/erosion control blankets (EC-7) on slopes

- Gravel bag berm (SE-6)
- Street sweeping (SE-7)
- Sandbag barrier (SE-8)
- Storm drain inlet protection (SE-10)
- Stockpile management (WM-3)
- Dust control (WE-1)
- Solid and hazardous waste management (WM-5 and WM-6)
- Sanitary and septic waste management (WM-9)
- Vehicle and equipment maintenance (NS-10)
- Vehicle and equipment fueling (NS-9)
- Spill prevention and control (WM-4)
- Infiltration Basins (TC-11)
- Employee and contractor training

4.1.1 Access Road, Entrance and Parking, and Laydown Areas

During construction, primary access to the Palmdale site will be from an entrance on Avenue M (Columbia Way). The entrance will be maintained to limit sediment tracking and creation of dust. The parking and laydown areas will be stabilized with coarse gravel. All surfaces will be regularly watered to reduce generation of dust, but will not be excessively watered so as to generate runoff. Silt fencing will be used at edges of these areas, as necessary to minimize sediment discharging into swales or ditches.

All construction equipment will be maintained to control leaks and spills, and fueling will only be conducted within contained areas. Any contaminated soils resulting from spills will be dug up as quickly as possible, and then removed from the site for proper disposal.

The following BMPs are recommended for construction access areas:

- Silt fencing (SE-1)
- Stabilizing entrances and surfaces with coarse aggregate (TC-1 and TC- -2)
- Compacting access road surfaces (TC-2)
- Proper scheduling and sequencing of activities (SS-1)
- Street sweeping and vacuuming (SE-7)
- Placement of hydro seeding (SS-4), mulching (SS-6), or geotextile/erosion control blankets (SS-7).
- Dust control (WE-1)
- Temporary drains and swales (SS-9)
- Hay/straw bale barriers (SE-9)
- Vehicle and equipment cleaning (NS-8)
- Establishing vehicle and equipment fueling (NS-9) and maintenance areas (NS-10)

4.1.2 Palmdale Site and Linear Facilities

The project site is currently somewhat rolling, dusty ground with sand cover. During construction the site will be surrounded by silt fences. These sediment barriers will be used to control sediments transported by runoff, and will remain after construction till all the permanent erosion control measures are installed and the soil is stabilized.

The project linear facilities will be constructed within the rights-of-way of Avenue M (Columbia Way) and Site 1 Road. Temporary erosion control might include asphalt patching in the streets until permanent paving can be completed.

During construction, temporary erosion control may include outlet protection and hay or straw bale barriers. The following BMPs will be considered during site and linear facilities constructions:

- Preservation of existing vegetation (SS-2)
- Temporary drains and swales (SS-9)
- Petroleum-absorbing fabric (WM-4)
- Check dams (SE-4)
- Fiber rolls (SE-5)
- Hay/straw bale barriers (SE-9)
- Sediment basins (SE-2)
- Outlet protection (SS-10)

4.1.3 Foundations

During construction of the foundations, a concrete washout area will be required. Dumping of excess concrete and washing out of delivery vehicles shall be prohibited at other locations onsite. Notices shall be posted to inform all drivers.

The following BMPs will be considered during the construction of foundations:

- Solid waste management (WM-5)
- Concrete waste management (WM-8)

4.1.4 Site Stabilization and Demobilization

As construction nears completion, areas used for parking, storage and laydown will be cleared and stabilized. Areas that will continue to be used for parking or storage will have permanent storm water collection and conveyance structures provided.

4.2 Other Controls

4.2.1 Material Handling and Storage

There will be a variety of chemicals stored and used during the construction and operation of the Palmdale Hybrid Power Project. Chemicals will be stored in appropriate chemical storage facilities. Bulk chemicals will be stored in storage tanks and other chemicals will be stored in returnable delivery containers. Chemical storage and chemical feed areas will be designed to contain leaks and spills. Berm and drain piping design will allow a full-tank capacity spill without overflowing the berms. For multiple tanks located within the same bermed area, the capacity of the largest single tank will determine the volume of the bermed area and drain piping. Secondary containment will hold 100% for a single tank, 100% of the largest tank if multiple tanks are contained with the same secondary containment structure , 150% of the largest tank if a UST, or 10% of total volume if greater, plus the volume from 25-year, 24 hour storm if exposed to rainfall.

Drain piping for volatile chemicals shall be trapped and isolated from other drains to eliminate noxious or toxic vapors. After neutralization, if required, water collected from the chemical storage areas will be directed to the cooling tower basin. The aqueous ammonia storage area will have spill containment and ammonia vapor detection equipment.

Safety showers and eyewashes will be provided in the vicinity of all chemical storage and use areas. Hose connections will be provided near the chemical storage and feed areas to flush spills and leaks to the plant wastewater collection system. Approved personal protective equipment will be used by plant personnel during chemical spill containment and cleanup activities. In case of a chemical spill or accidental release, personnel will be

properly trained in the handling of these chemicals and instructed in the procedures to follow. Adequate supplies of absorbent material will be stored onsite for spill cleanup.

The following BMPs will be considered for material handling and storage:

- Solid waste management (WM-5)
- Vehicle and equipment refueling (NS-9)
- Vehicle and equipment maintenance (NS-10)
- Material delivery and storage (WM-1)
- Material use (WM-2)
- Concrete waste management (WM-8)
- Stockpile Management (WM-03)

4.2.2 Solid and Hazardous Waste Management

Wastewater: Wastewater generated during construction will include sanitary waste, storm water runoff, equipment washdown water, and water from excavation dewatering during construction (if dewatering is required). Depending on the chemical quality of these wastewaters, they will be classified as hazardous or nonhazardous. Sanitary waste will be collected in portable, self-contained toilets. Storm water runoff will be managed in accordance with a storm water management permit, which will be obtained prior to the start of construction. Equipment washdown water will be contained at designated wash areas and will be disposed of offsite. Excavation dewatering water will be contained in portable tanks and sampled prior to disposal offsite. Water used for dust control and soil compaction during construction will not result in discharge.

Hazardous Waste: Most of the hazardous waste generated during construction will consist of liquid waste, such as water from excavation dewatering, flushing and cleaning fluids, passivating fluid (to prepare pipes for use), and solvents. Some hazardous solid waste, such as welding materials and dried paint, may also be generated.

Flushing and cleaning waste liquid will be generated as pipes are cleaned and flushed. The volume of flushing and cleaning liquid waste generated is estimated to be one to two times the internal volume of the pipes cleaned. The quantity of welding, solvent, and paint waste is expected to be minimal. Wastewaters generated during construction could be considered hazardous.

The construction contractor will be considered the generator of hazardous construction waste and will be responsible for proper handling of hazardous waste in compliance with all applicable federal, state, and local laws and regulations. This responsibility includes licensing, personnel training, accumulation limits and times, and reporting and recordkeeping.

The hazardous waste will be collected in satellite accumulation containers near the points of generation. It will be moved daily to the contractor's 90-day hazardous waste storage area located at the site construction laydown area. The waste will be removed from the site by a certified hazardous waste collection company and delivered to an authorized hazardous waste management facility, before expiration of the 90-day storage limit.

The following BMPs will be considered at the designated storage locations:

- Cover or store hazardous materials indoors, if possible (WM-1)
- Material delivery and storage (WM-1)
- Material use (WM-2)
- Spill prevention and control (WM-4)

- Solid waste management (WM-5)
- Hazardous waste management (WM-6)
- Use of covered dumpsters and containers for waste (WM-5)

4.2.2.1 Potential Contaminated Soil

It is unlikely that contaminated soil will be encountered during construction. However, operators and construction personnel will be asked to report unusual conditions to the appropriate personnel and the area and/or material will be properly contained during investigative actions. If soils require temporary stockpiling, piles will be covered with plastic sheeting or tarps that are secured safely with sand bags and bermed with hay bales or silt fencing to prevent runoff from leaving the area. If required, samples will be collected and sent to a certified analytical laboratory for characterization. If contamination is detected, the waste will be handled and properly disposed of in an authorized waste management facility.

4.2.3 Groundwater/Dewatering Controls

Based on a preliminary geotechnical report, it is anticipated the construction phase of Palmdale will not require groundwater removal. Storm water is expected to result in only several days of dewatering during construction, and this will be in accordance with BMPs. With an unusual storm year, this could be as many as 5 to 10 days.

If any contamination is detected via odors or visible sheens, the collected storm water will be handled and properly disposed in a manner consistent with federal, state, and local regulations. The following control methods will be considered for groundwater/dewatering controls, as necessary:

- Dewatering operations (NS-2)
- Hazardous waste management (WM-6)

4.2.4 Offsite Vehicle Tracking

Because sediment reaching public roads generally has a clear path to wetlands and water bodies, controls will be in place to minimize or eliminate soils from being tracked off the project site from vehicles. The site will have paved access roads and entrances/exits made of coarse aggregate to limit the amount of material adhering to tires. These areas will be inspected daily and cleaned as necessary using manual or mechanical street sweepers. The following control methods will be considered for offsite vehicle tracking, as necessary:

- Stabilized construction entrance/exit (TC-1)
- Stabilized construction roadway (TC-2)
- Entrance/exit tire wash (TC-3)

4.2.5 Dust Suppression and Control

During construction of the project site and the related linear facilities, dust erosion control measures will be implemented to minimize the wind-blown loss of soil. Reclaimed water of a quality equal to or better than existing surface runoff will be sprayed on the soil in construction areas to control dust during revegetation.
The following control method will be considered for dust suppression, as necessary:

- Wind erosion control (WE-1)

Figures

Figure 1: Site Location

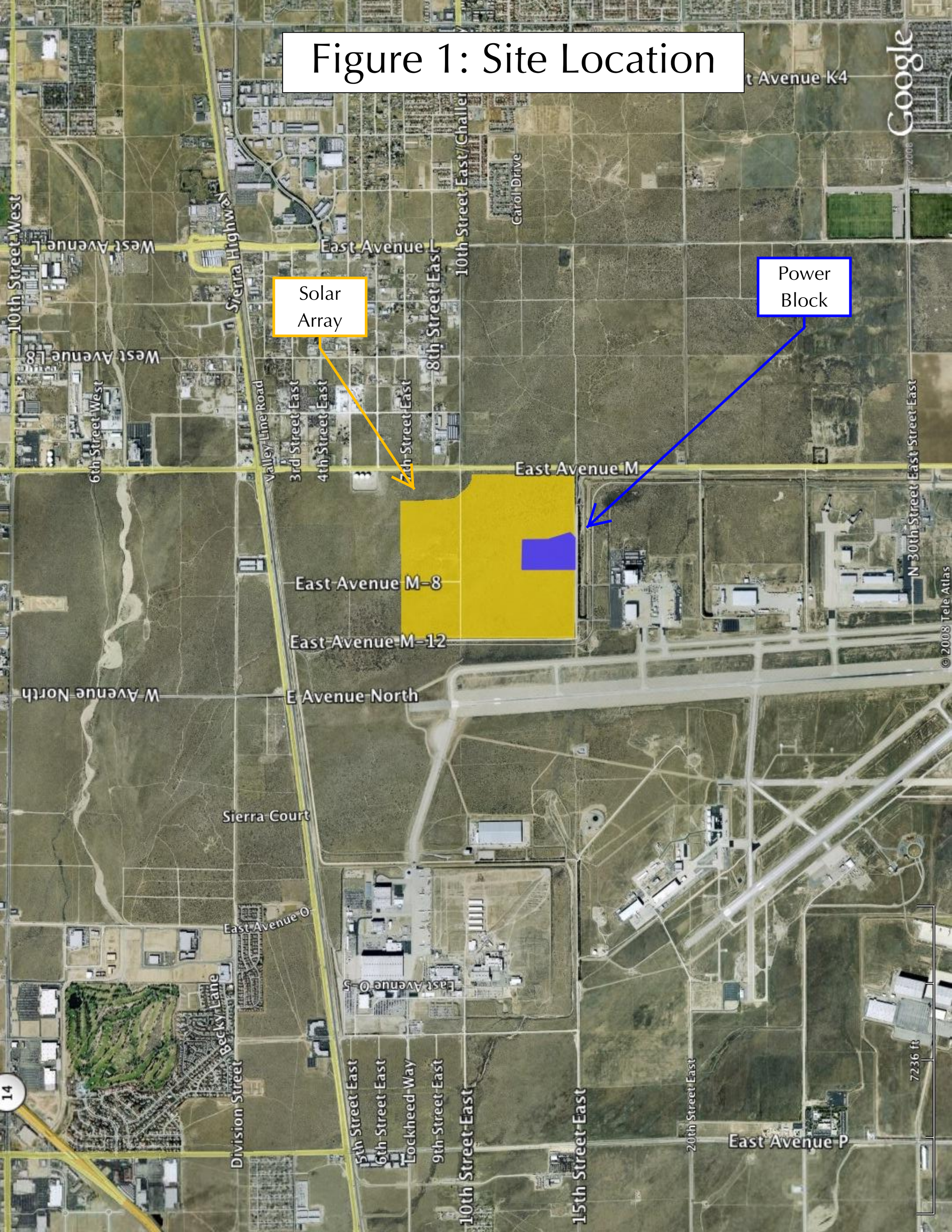


Figure 2: Gas Route

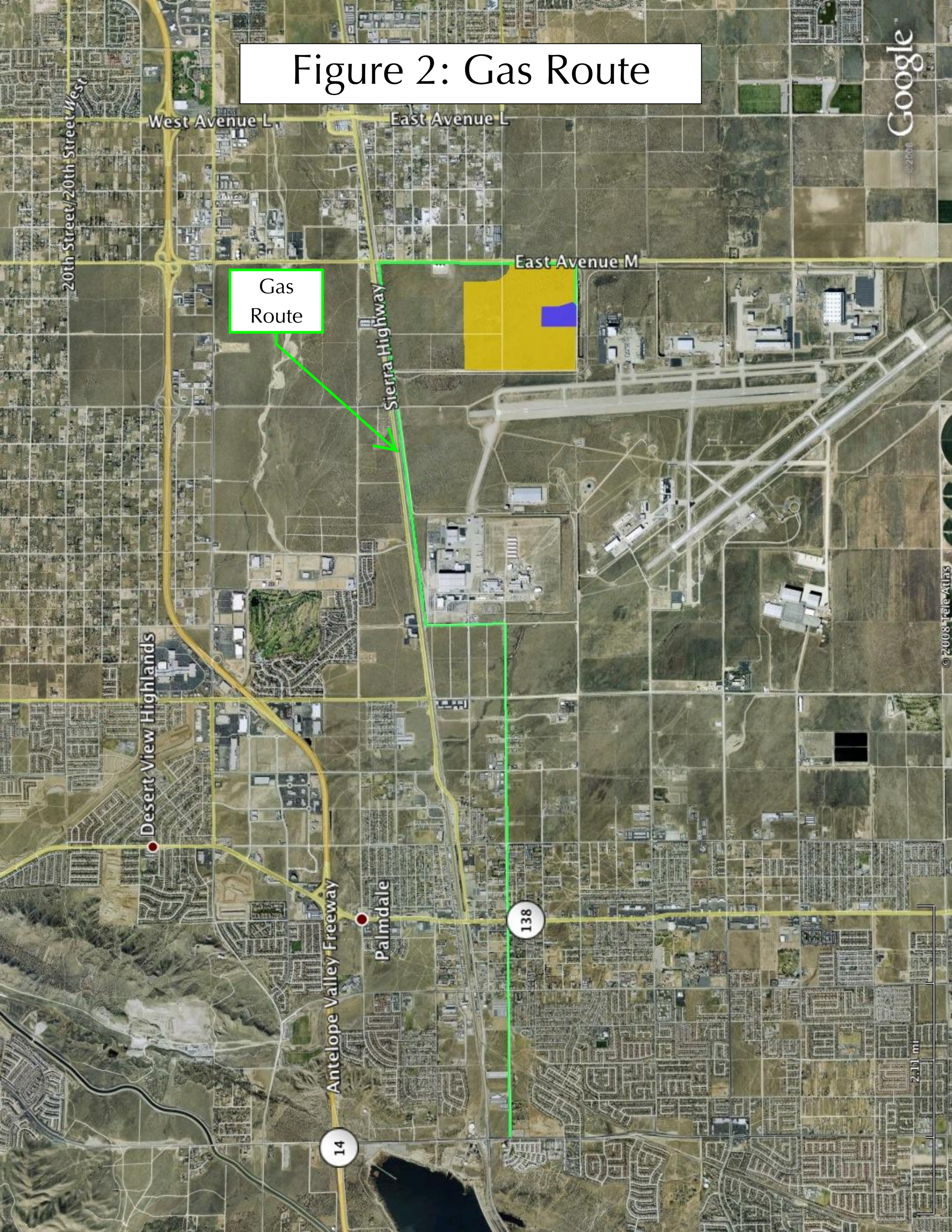
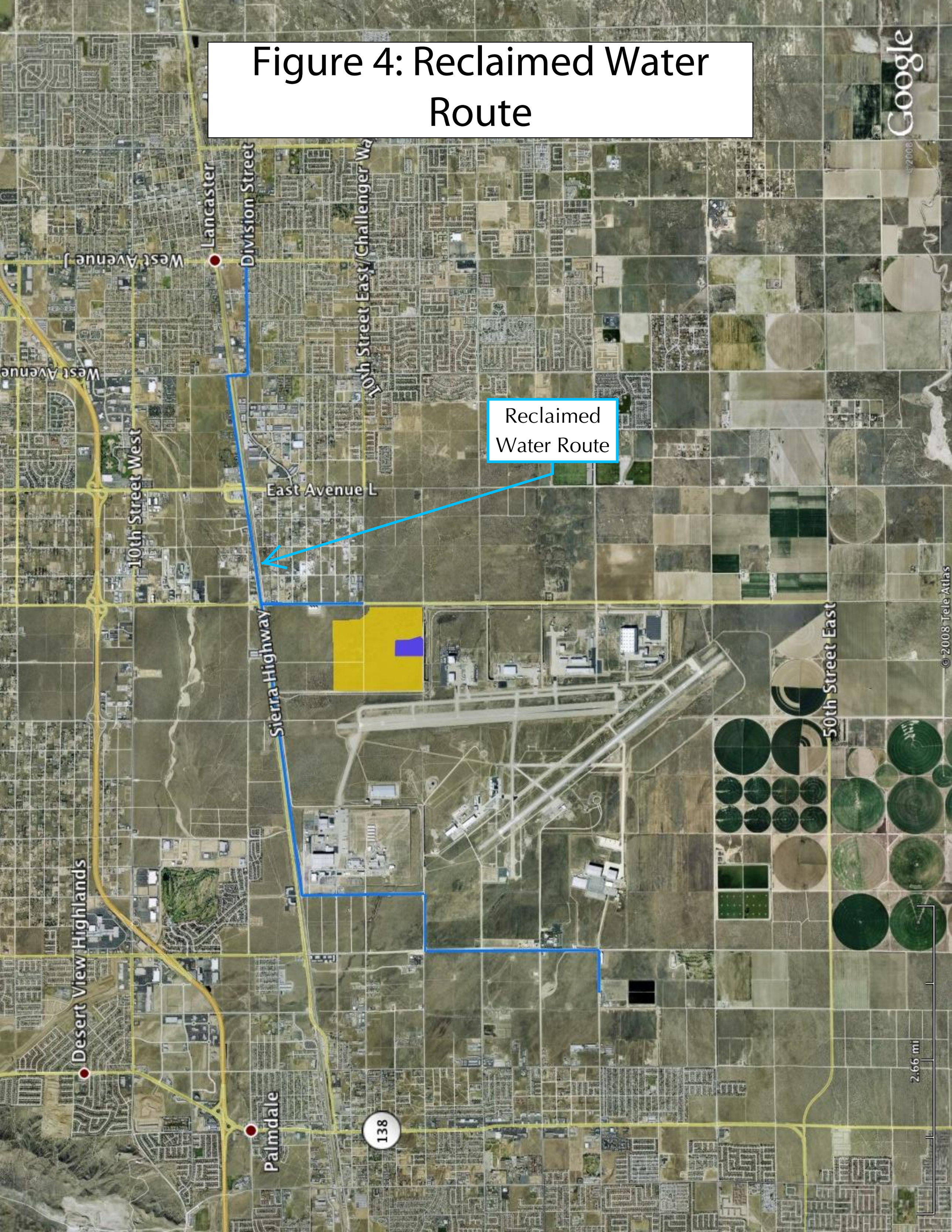
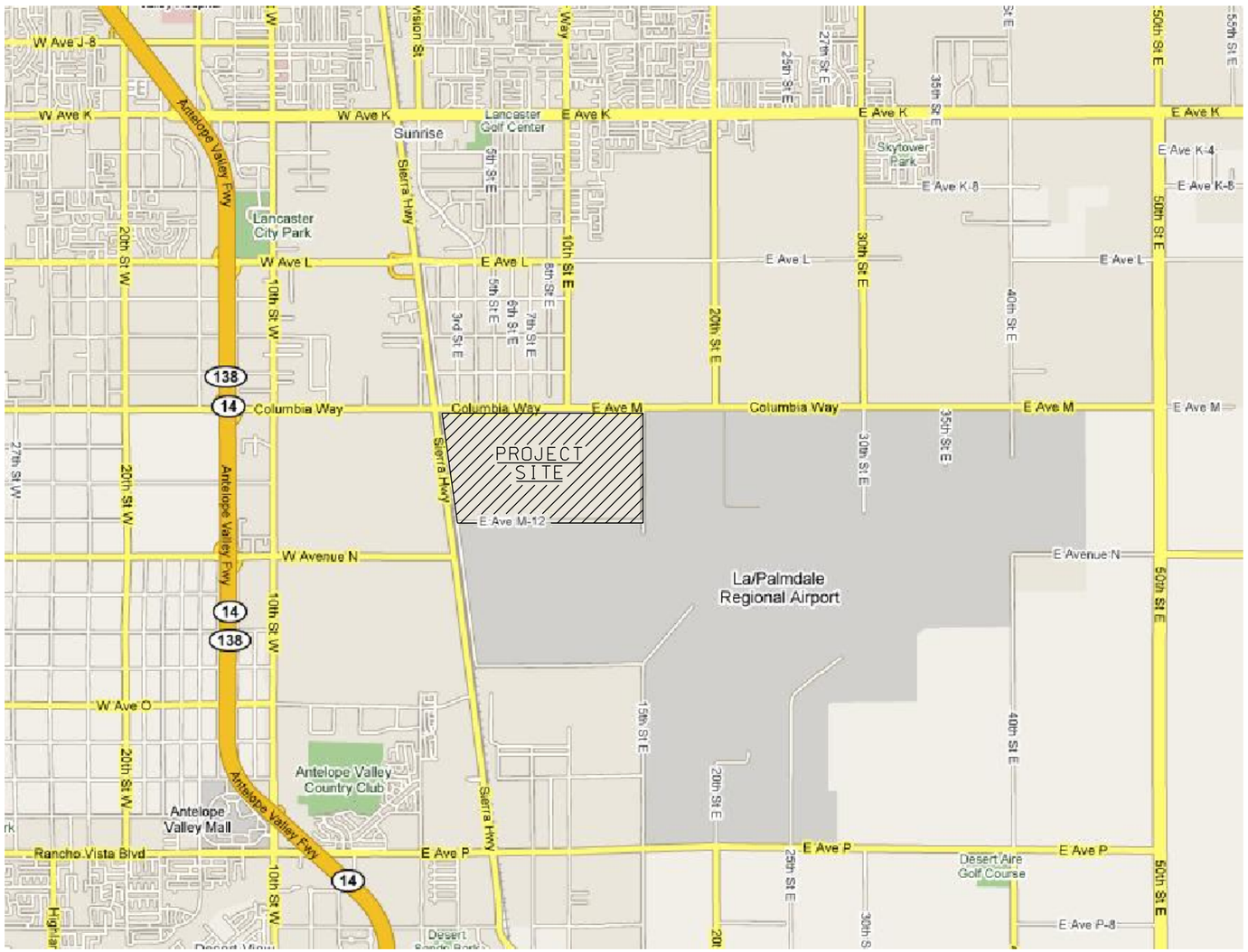


Figure 3: Transmission Route

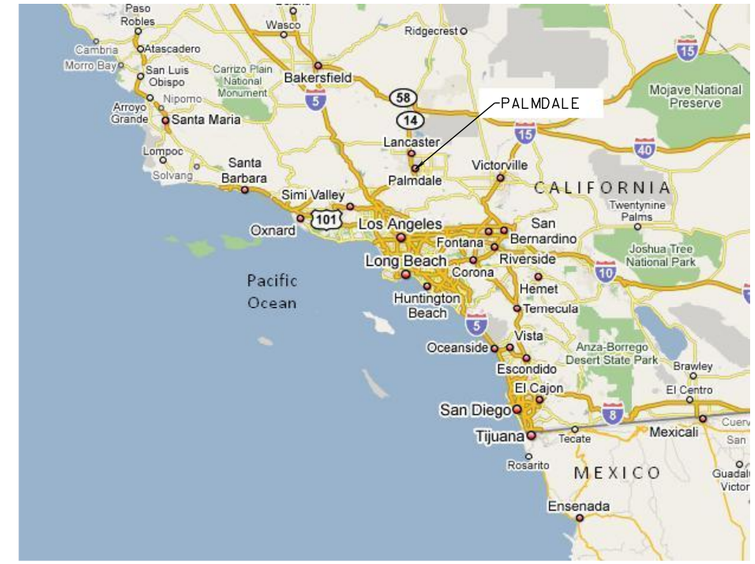
Figure 4: Reclaimed Water Route



Drawings



SITE LOCATION MAP
N.T.S.



LOCATION MAP
N.T.S.

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

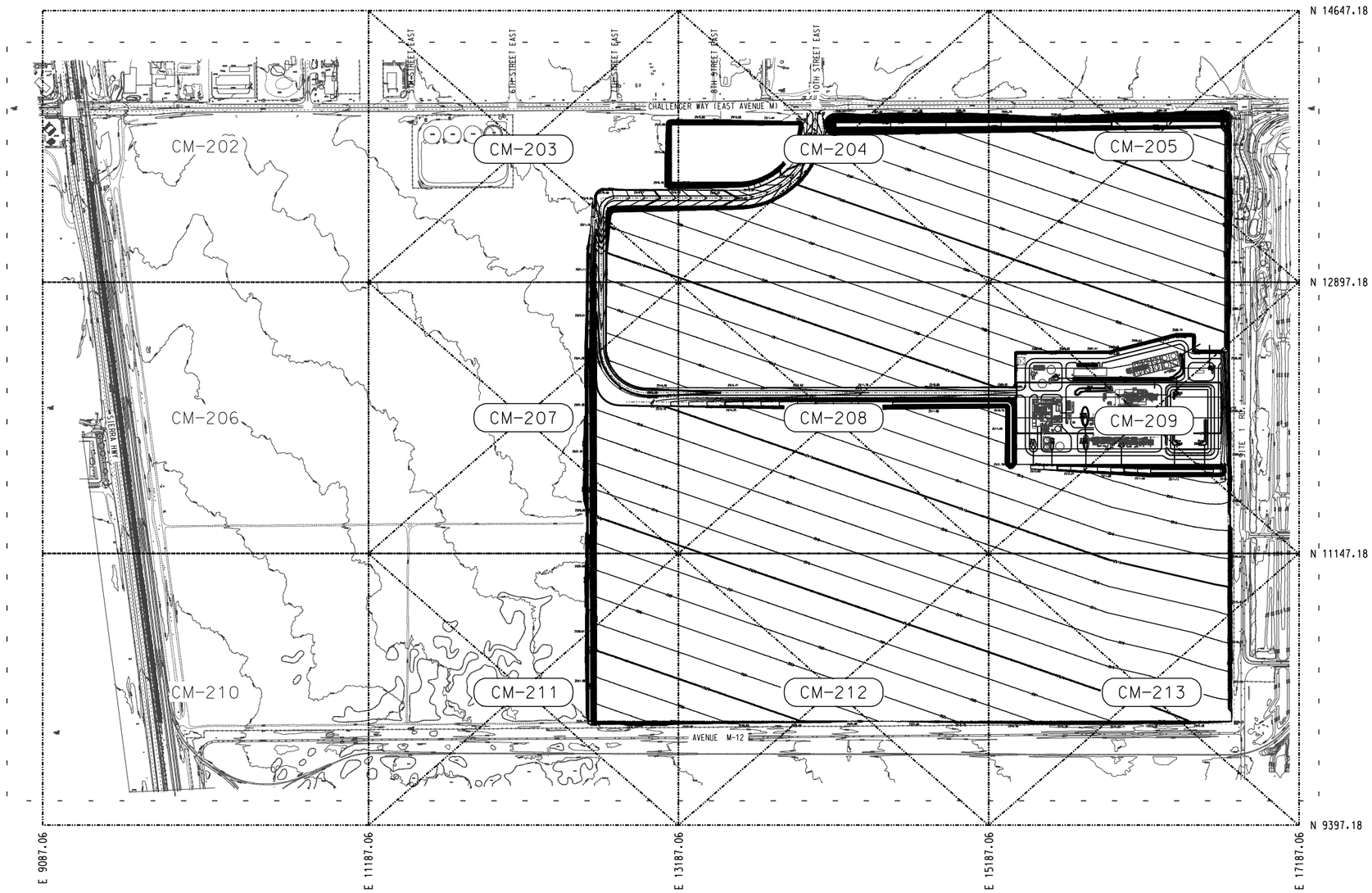
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

LOCATION MAP

	by	date
DESIGNED	SAG	04-21-08
DRAWN	SAG	04-21-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-200



400 0 400 800

SCALE IN FEET

SCALE: 1" = 400'

N

– PRELIMINARY –
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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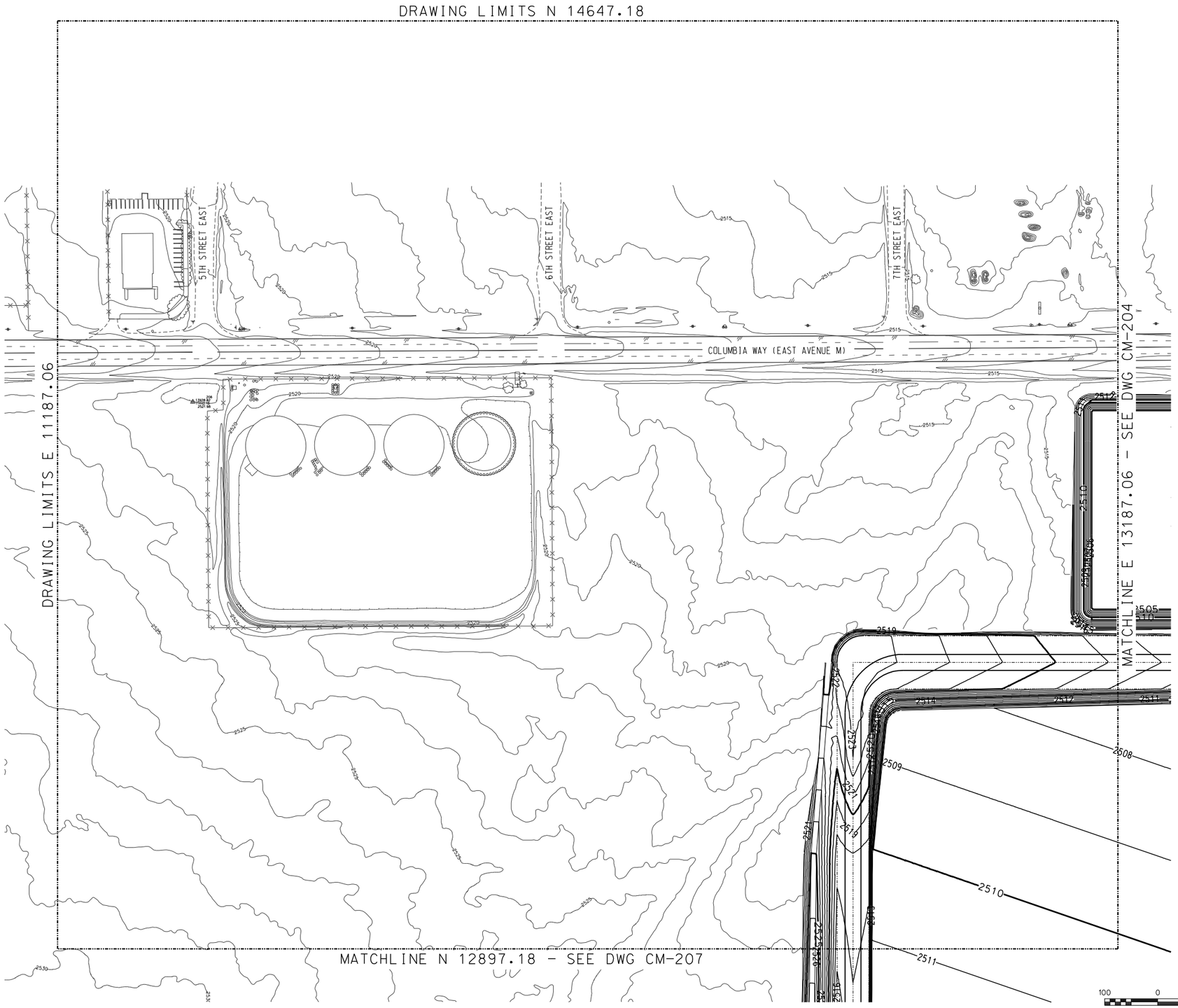
Lenexa, Kansas 66214

VICINITY KEY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER

2007-021-CM-201



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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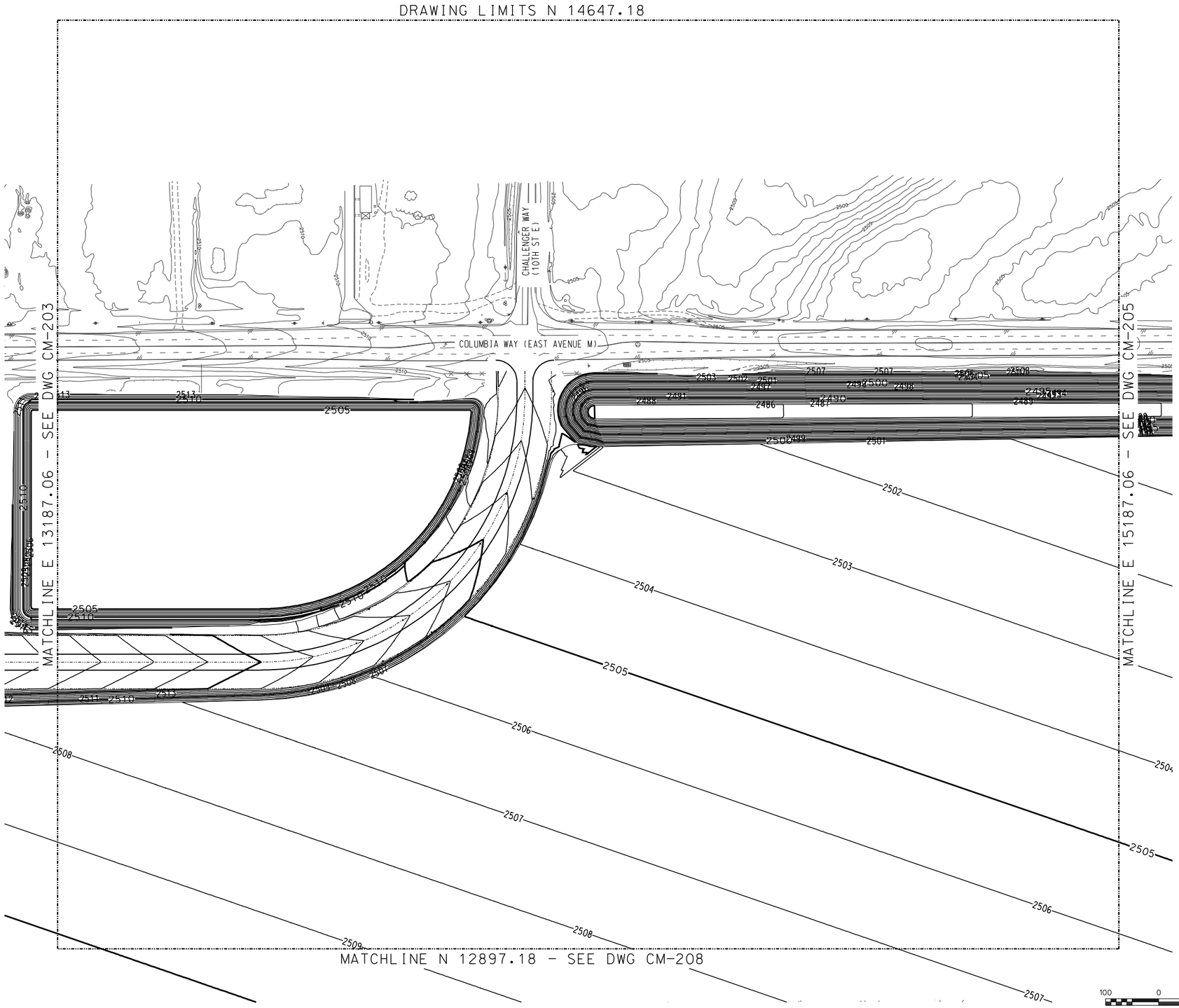
8455 Lenexa Drive
Lenexa, Kansas 66214

VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-203



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

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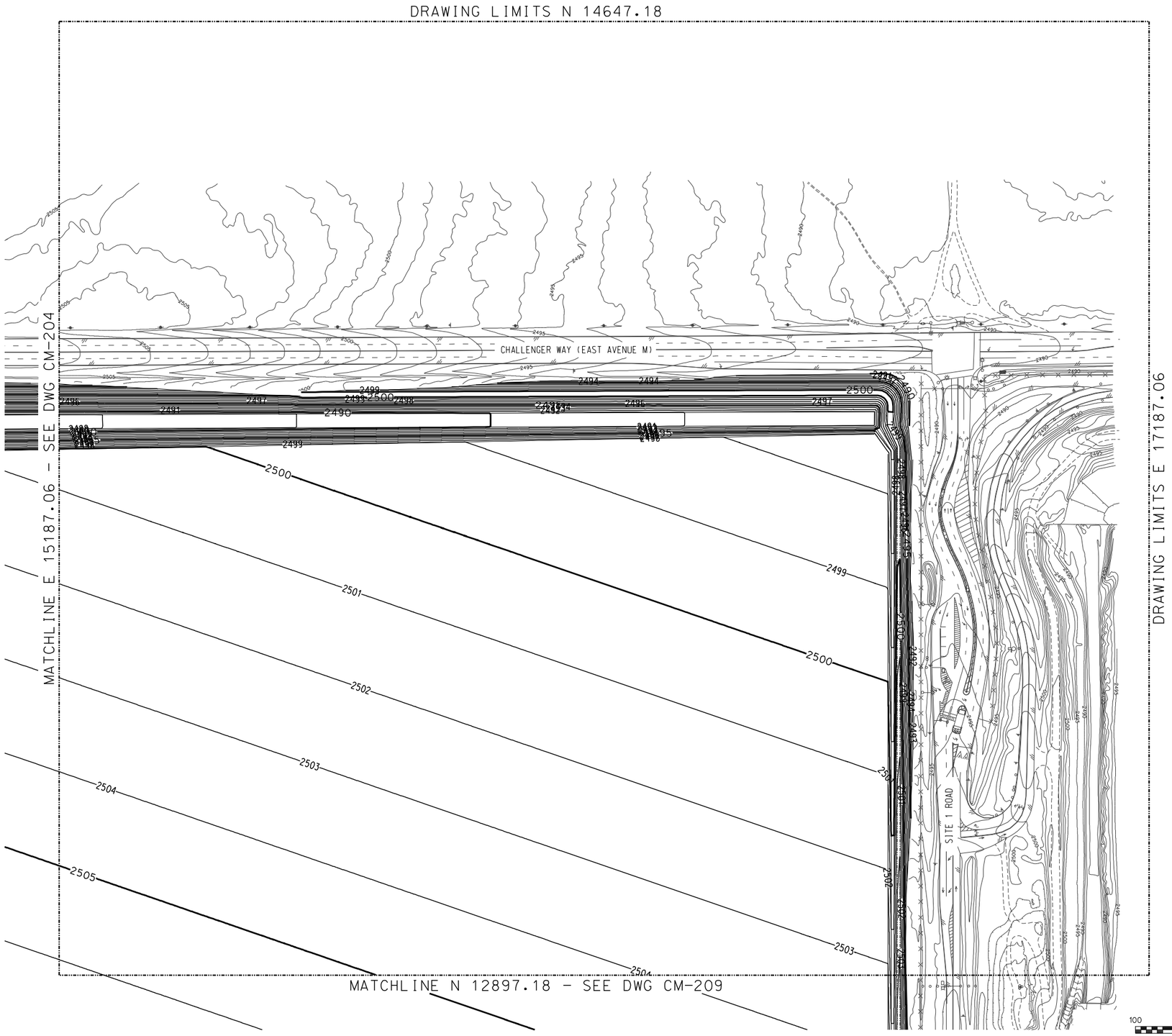
Lenexa, Kansas 66214

VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER

2007-021-CM-204



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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PALMDALE COMBINED CYCLE
POWER PROJECT

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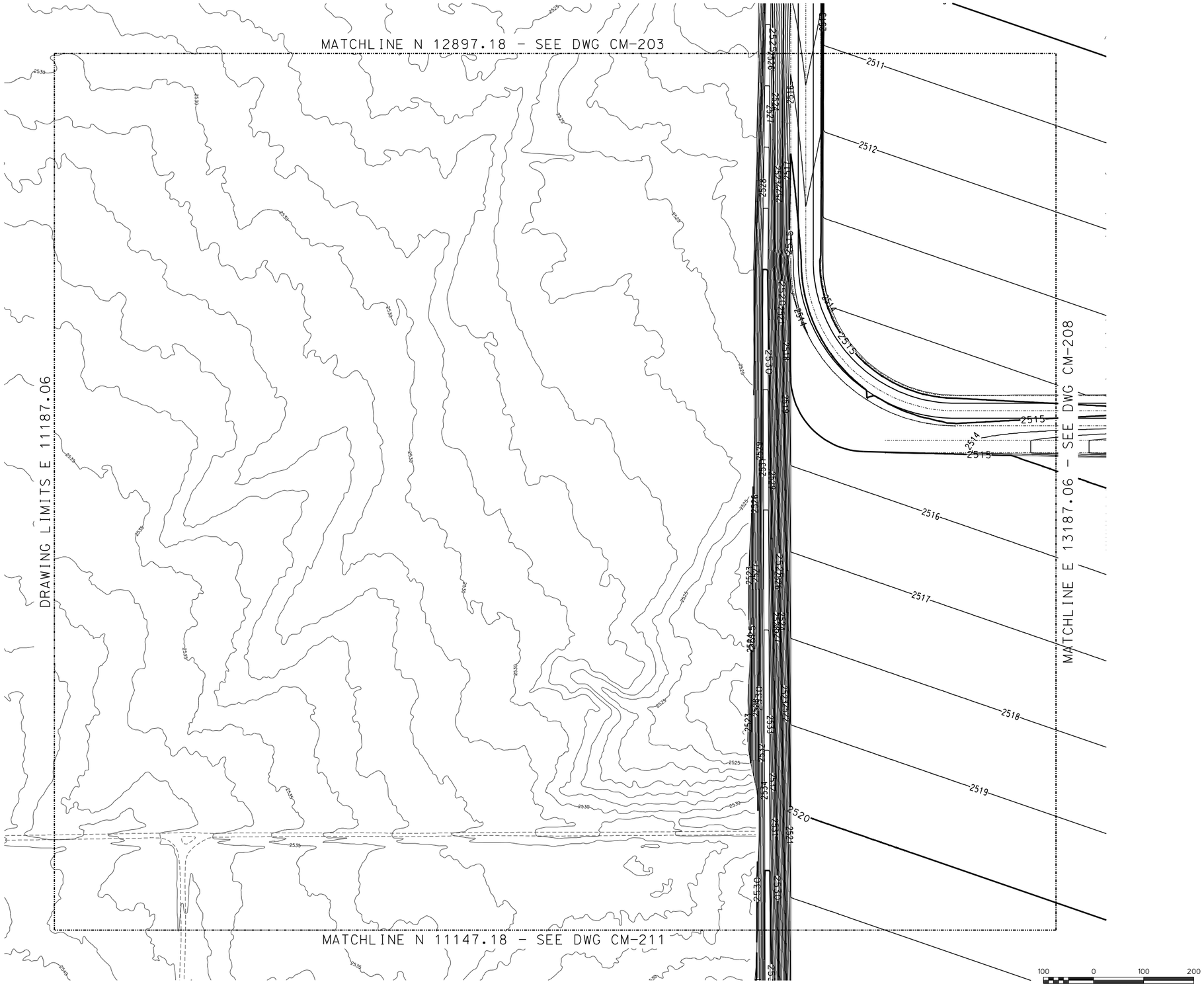
Lenexa, Kansas 66214

VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-205



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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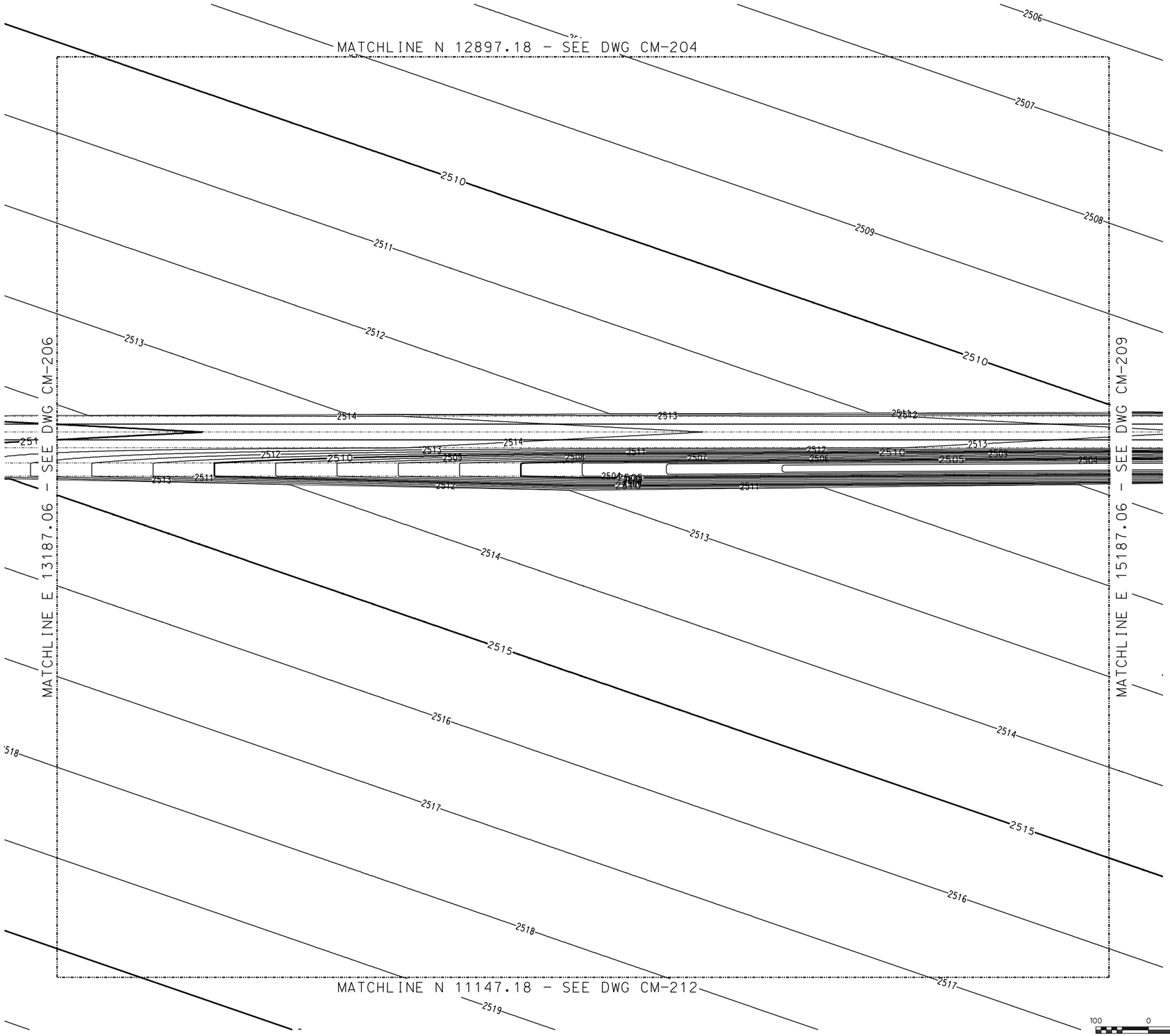
Lenexa, Kansas 66214

VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER

2007-021-CM-207



100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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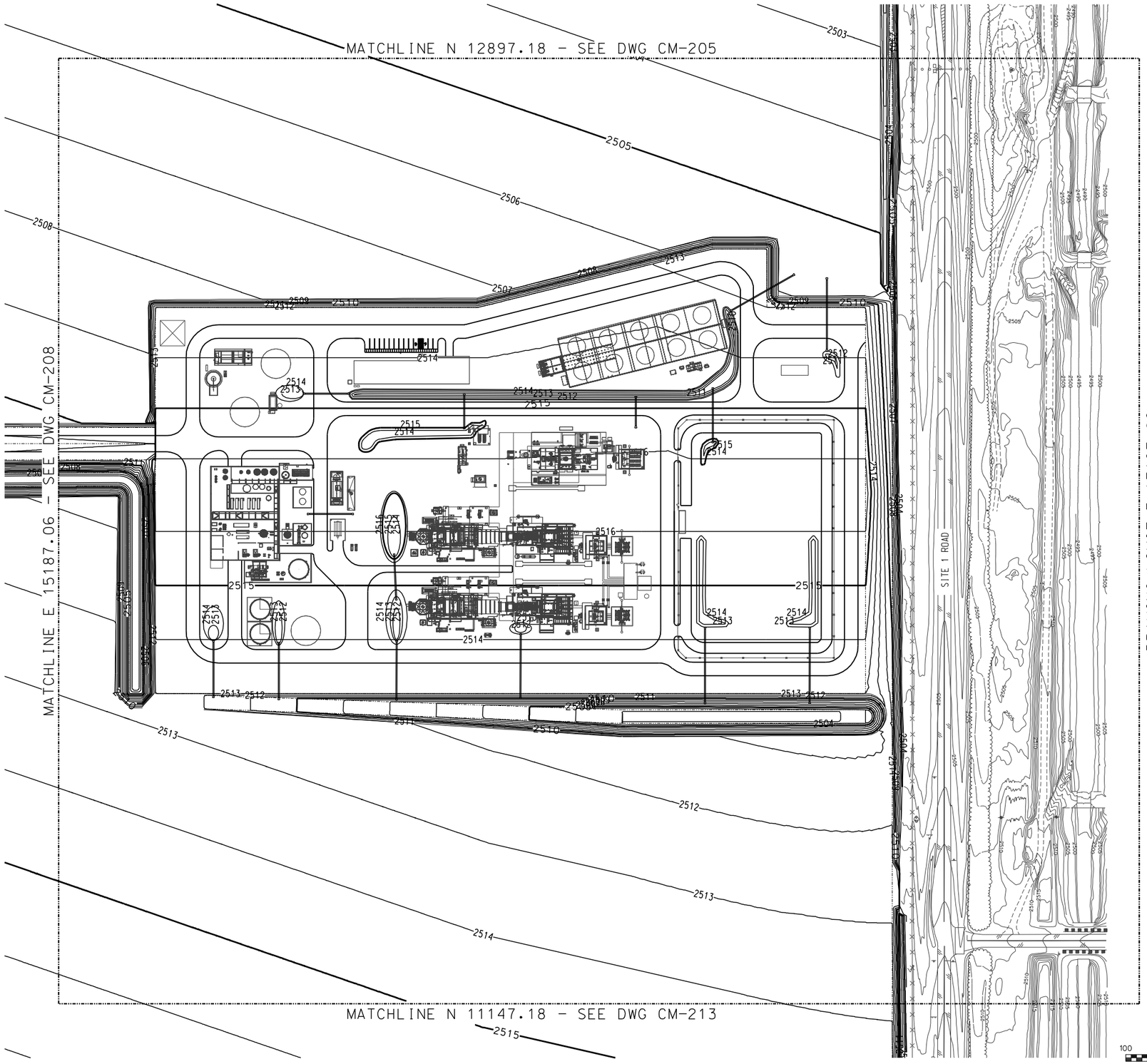
Lenexa, Kansas 66214

VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-208



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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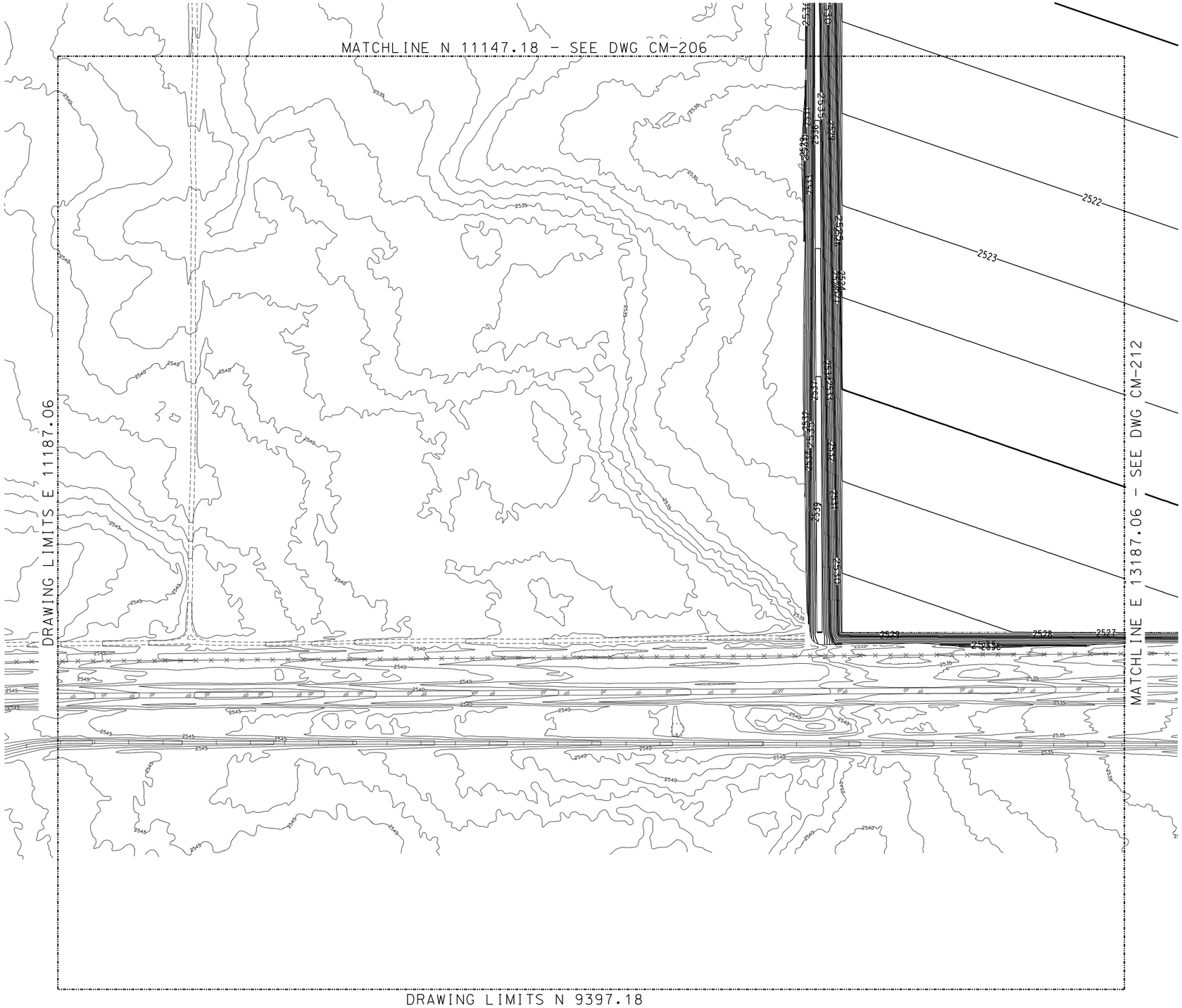
Lenexa, Kansas 66214

VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER

2007-021-CM-209



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SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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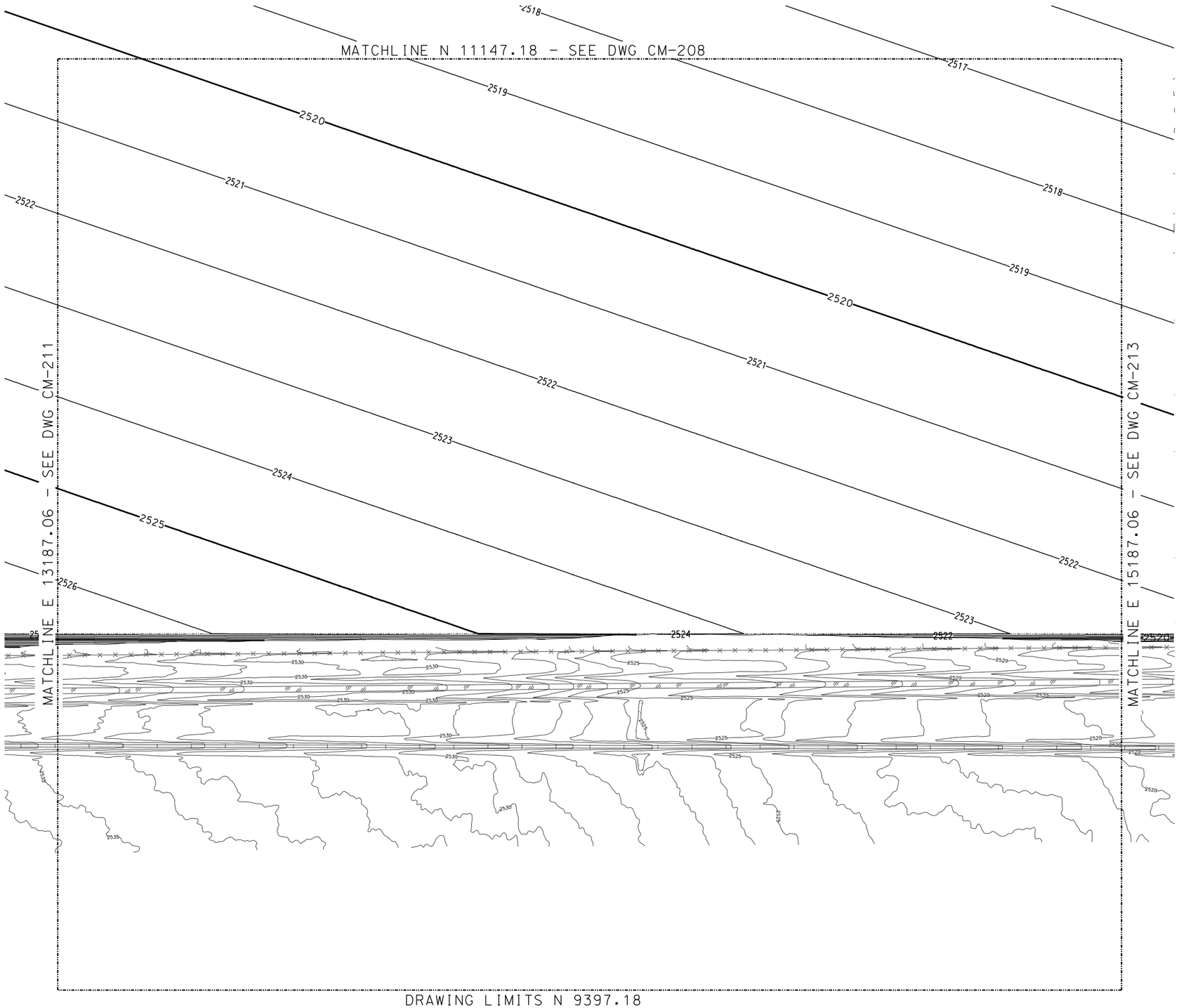
8455 Lenexa Drive
Lenexa, Kansas 66214

VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-211



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SCALE IN FEET
SCALE: 1" = 100'-0"

N

– PRELIMINARY –
NOT FOR CONSTRUCTION

REV.	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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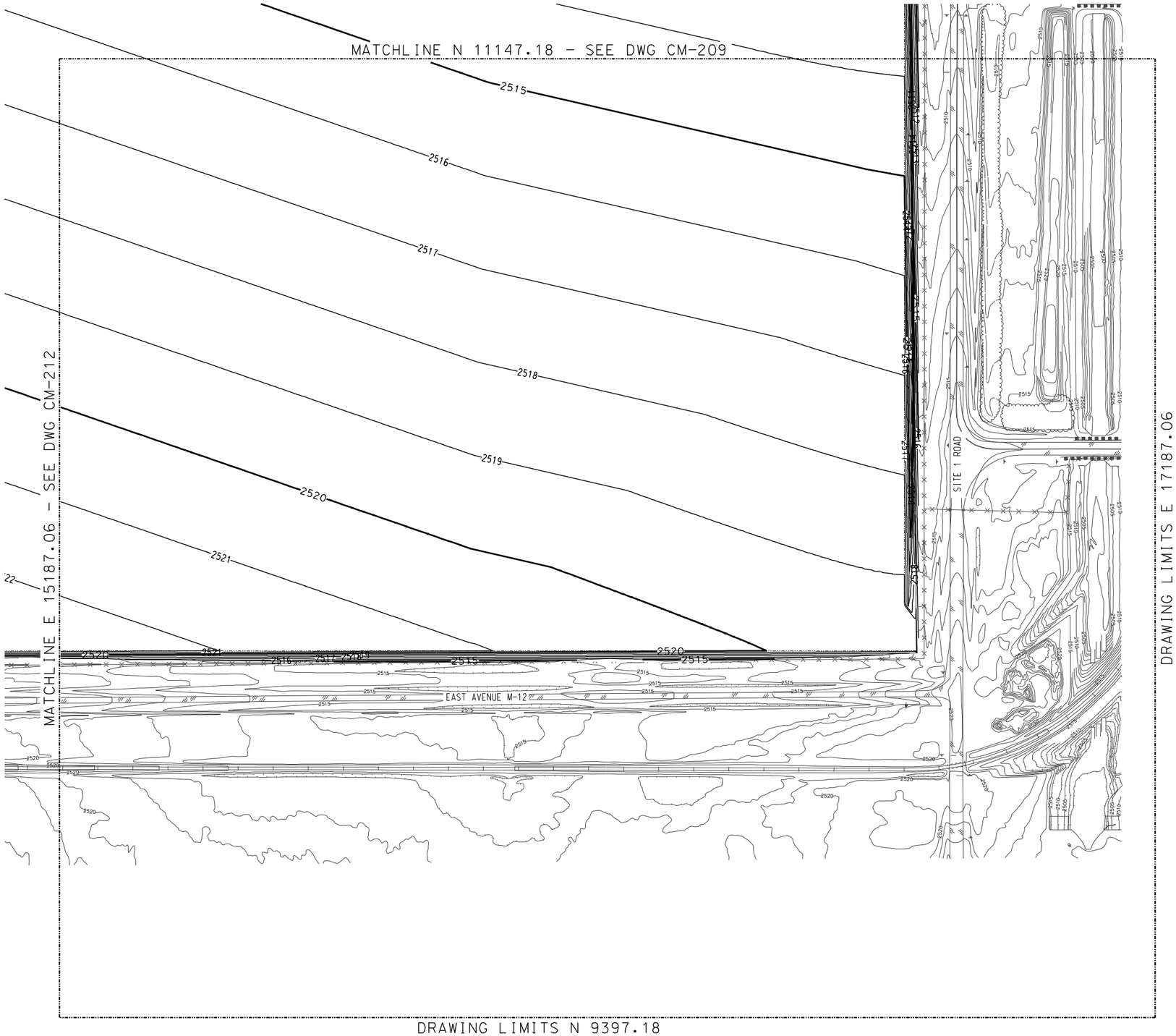
8455 Lenexa Drive
Lenexa, Kansas 66214

VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-212



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SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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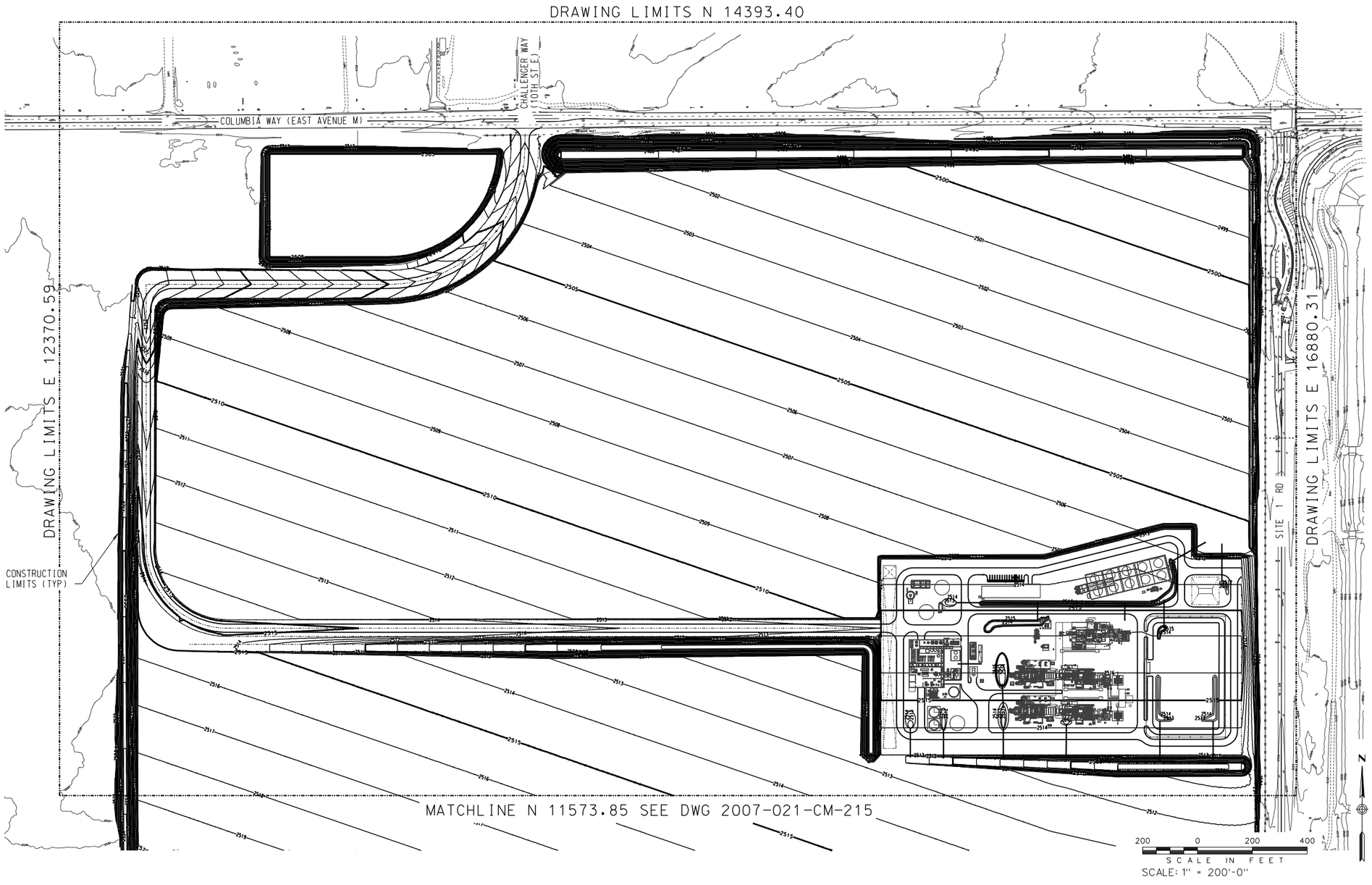
VICINITY MAP

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-213



– PRELIMINARY –
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

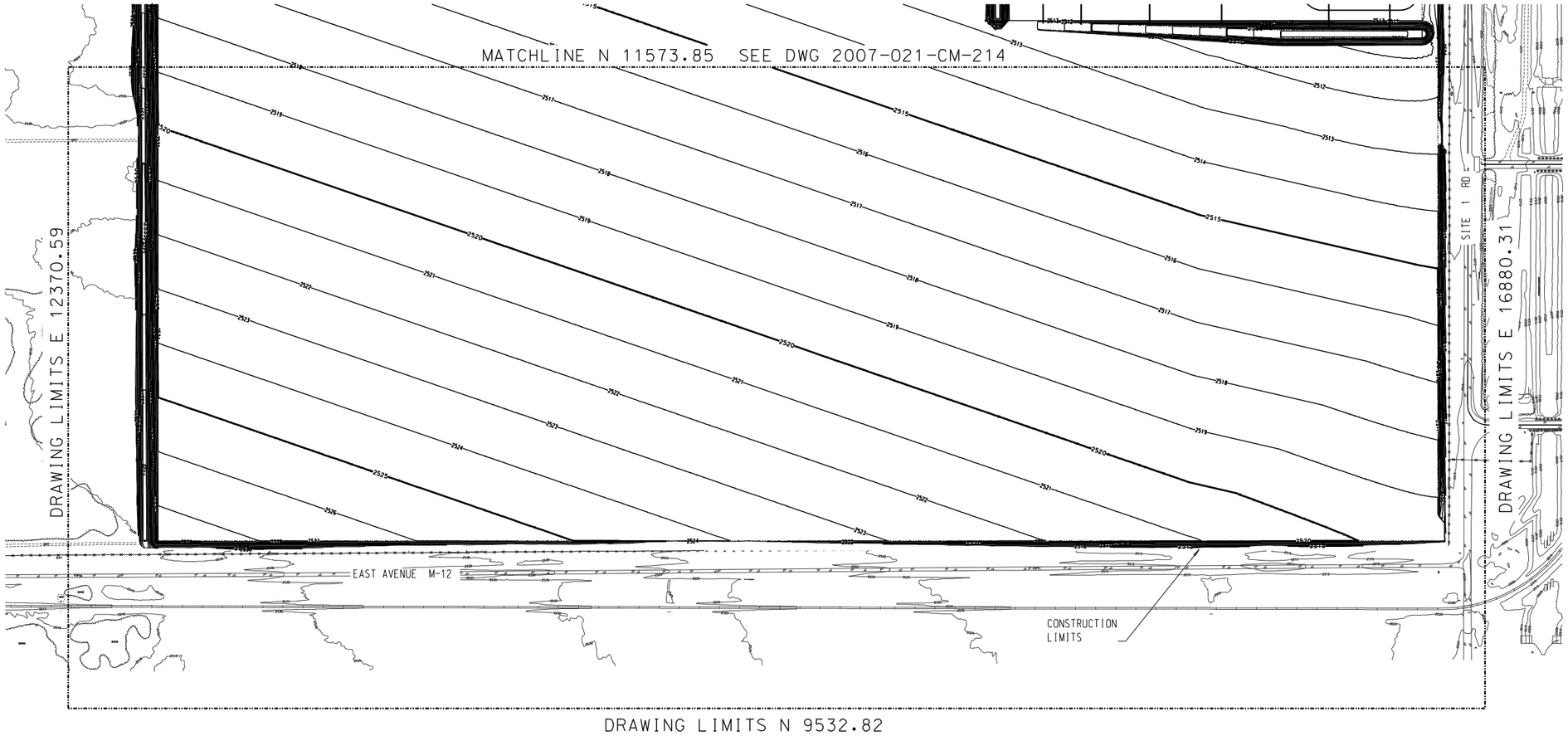
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

SITE DELINEATION

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER

2007-021-CM-214



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

SITE DELINEATION

	by	date
DESIGNED	SAG	06-05-08
DRAWN	SAG	06-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-215

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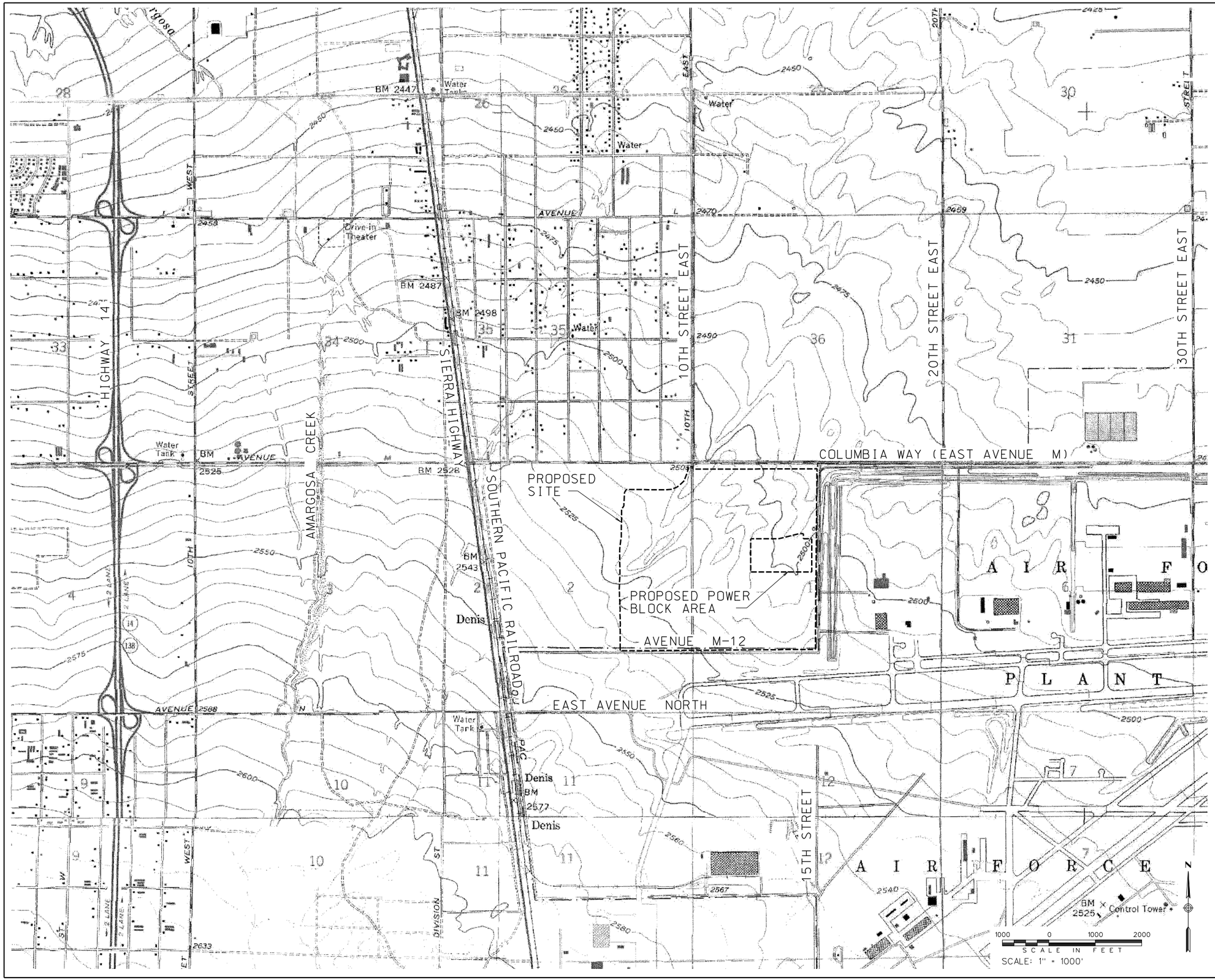
SCALE IN FEET
SCALE: 1" = 200'-0"



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

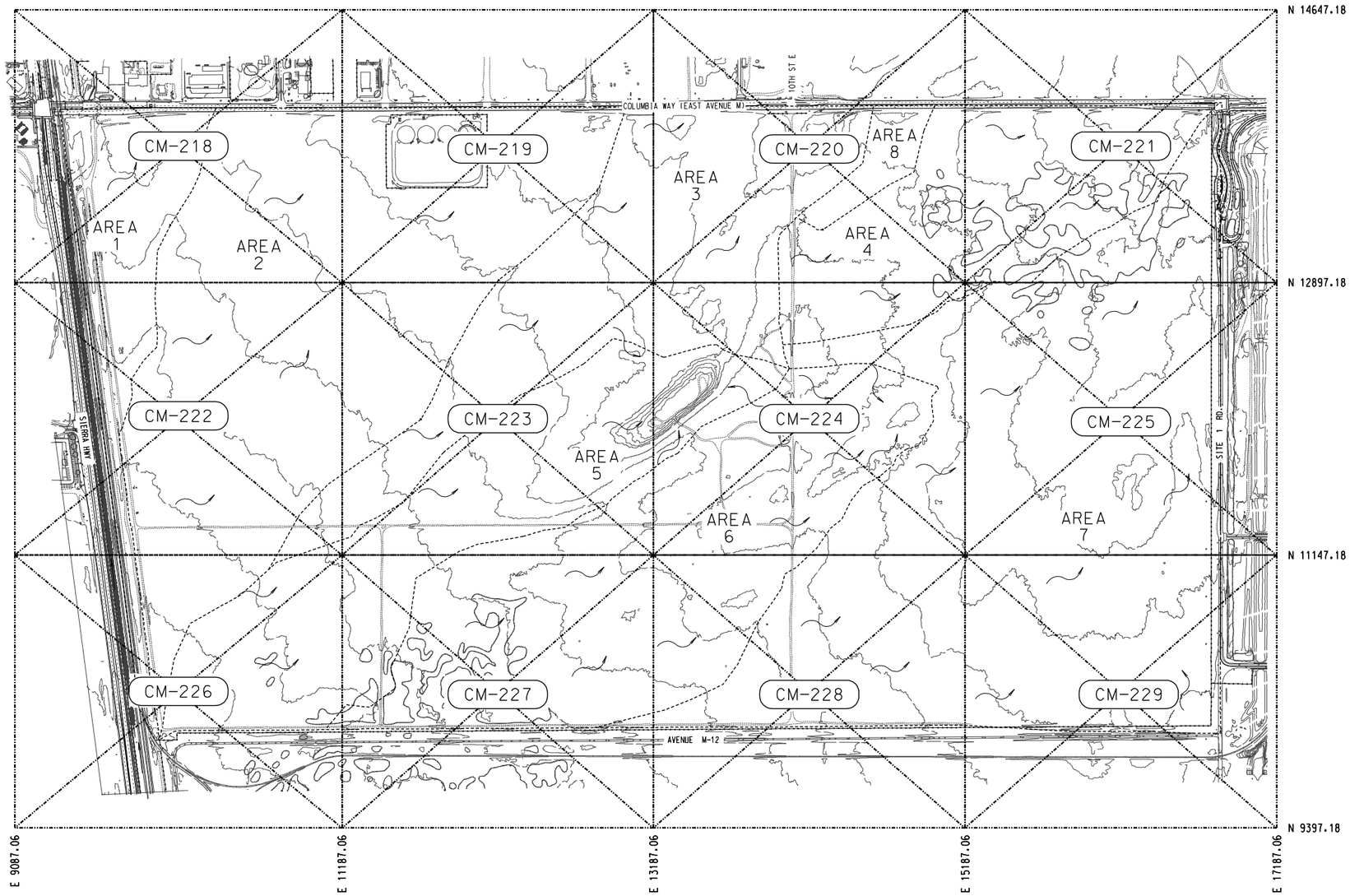
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

WATER COURSES AND CRITICAL AREAS

	by	date
DESIGNED	SAG	05-21-08
DRAWN	SAG	05-21-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-216

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



400 0 400 800
SCALE IN FEET
SCALE: 1" = 400'

N

– PRELIMINARY –
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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Kiewit

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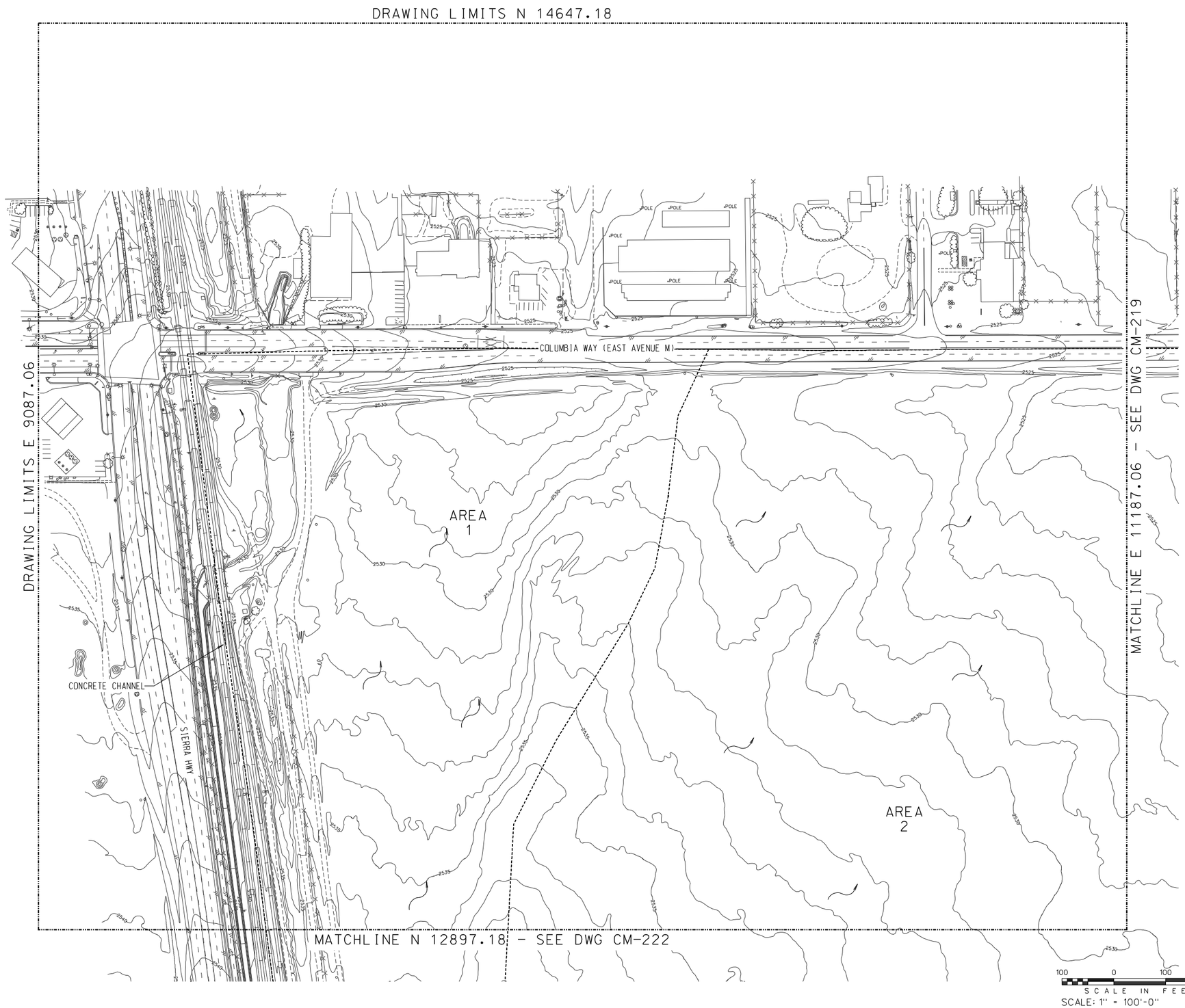
Lenexa, Kansas 66214

PRE DEVELOPEMENT DRAINAGE

	by	date
DESIGNED	SAG	05-21-08
DRAWN	SAG	05-21-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-217

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

Kiewit

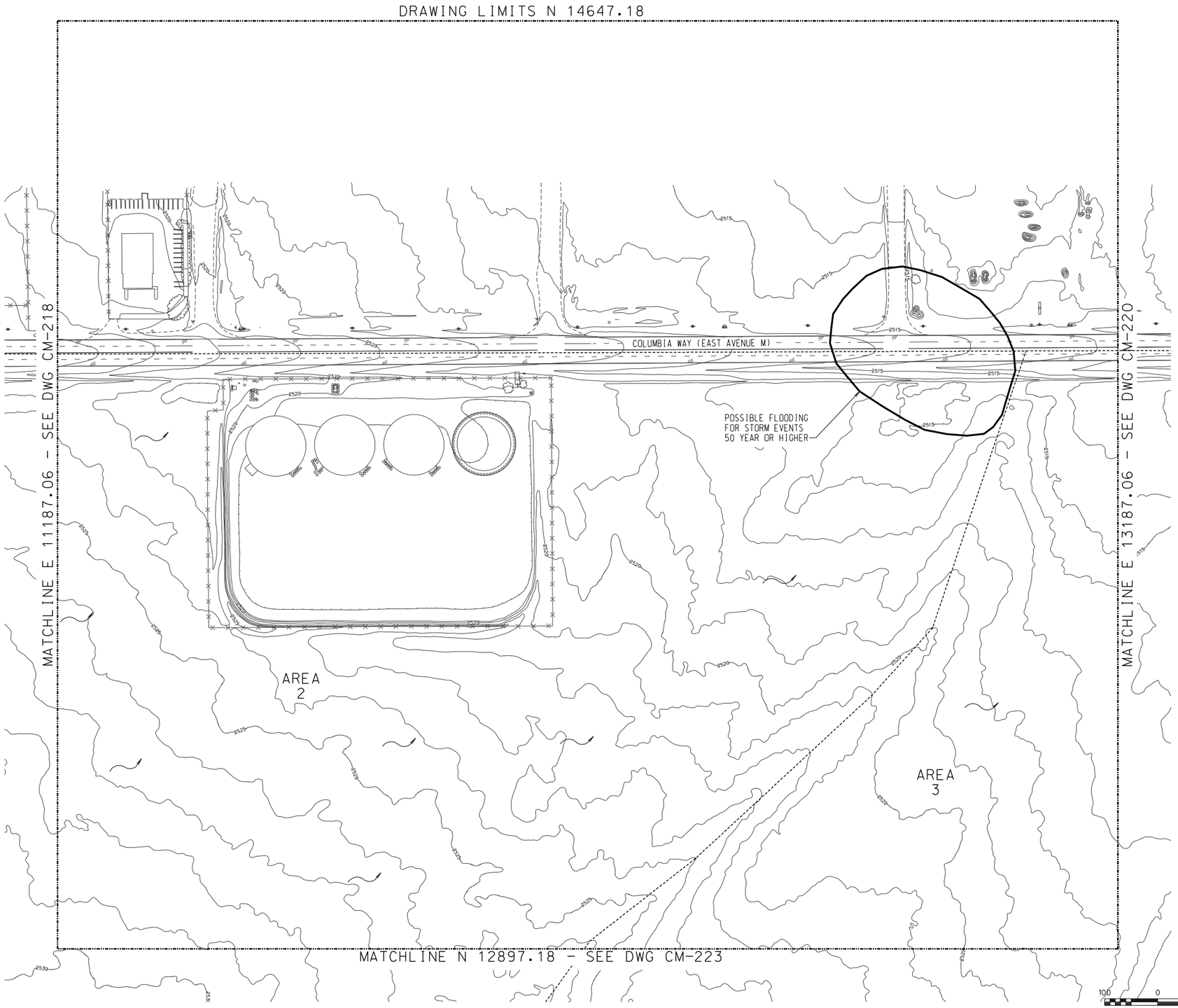
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-218

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV.	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

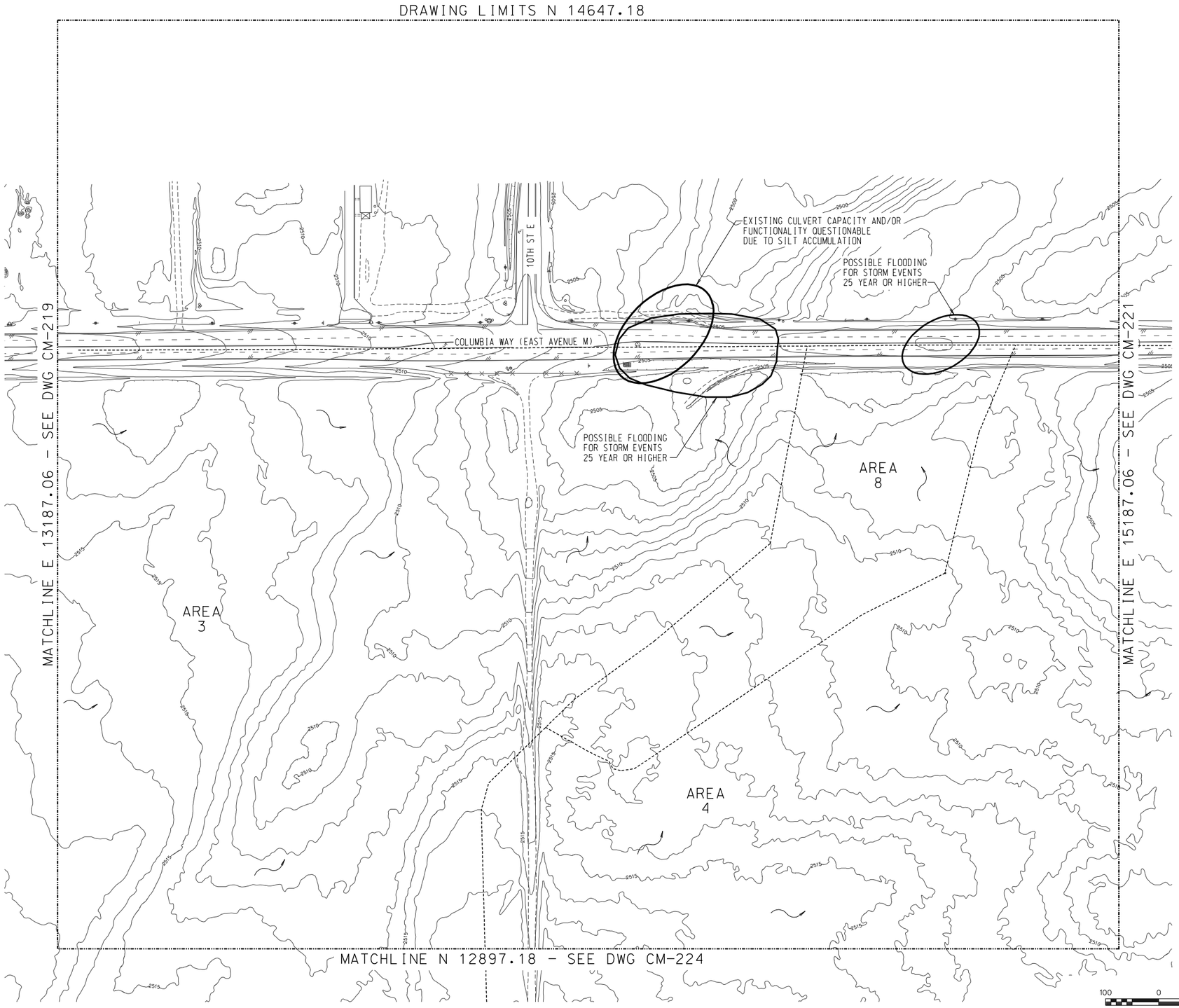
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-219



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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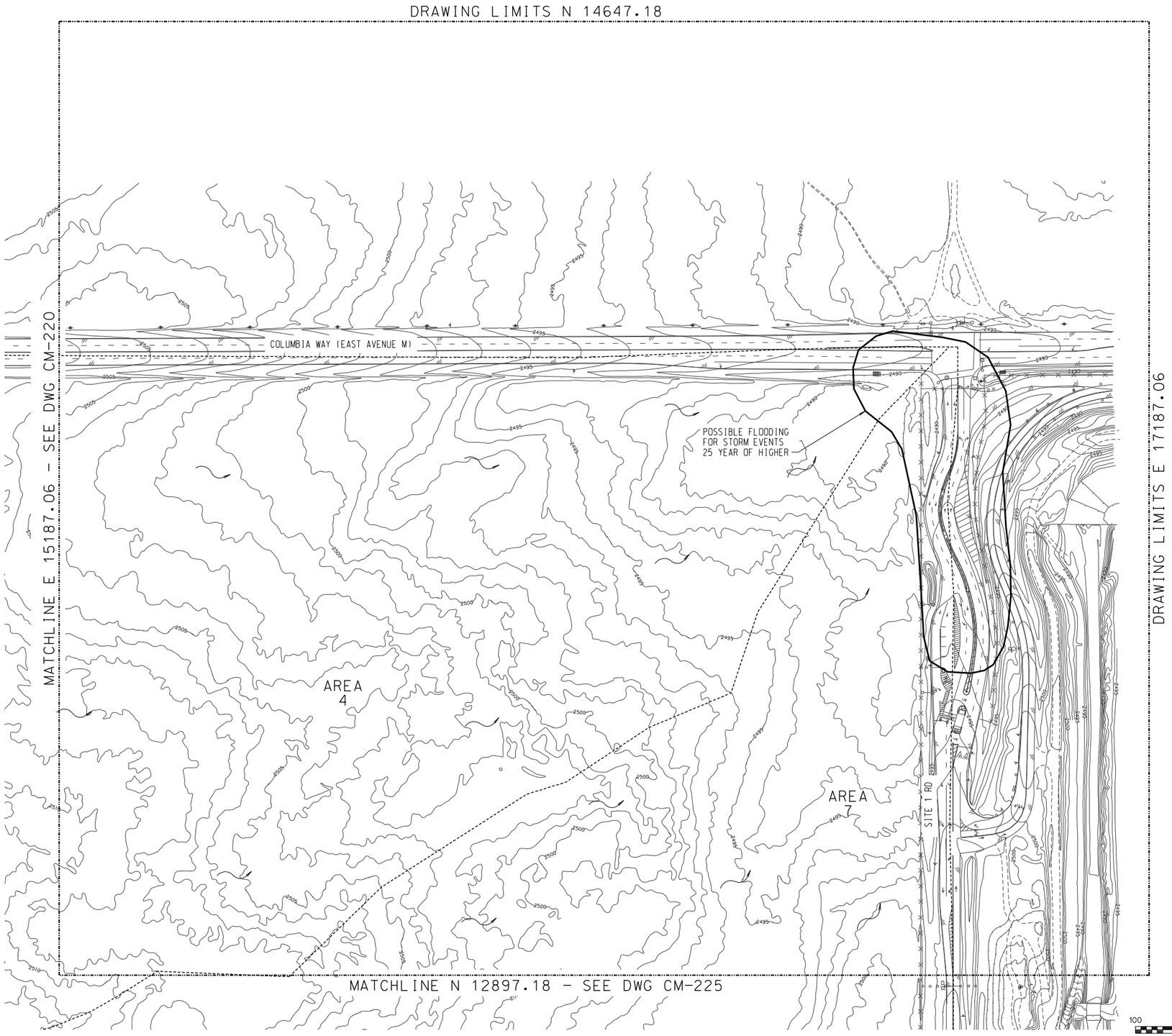
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-220

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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PALMDALE COMBINED CYCLE
POWER PROJECT

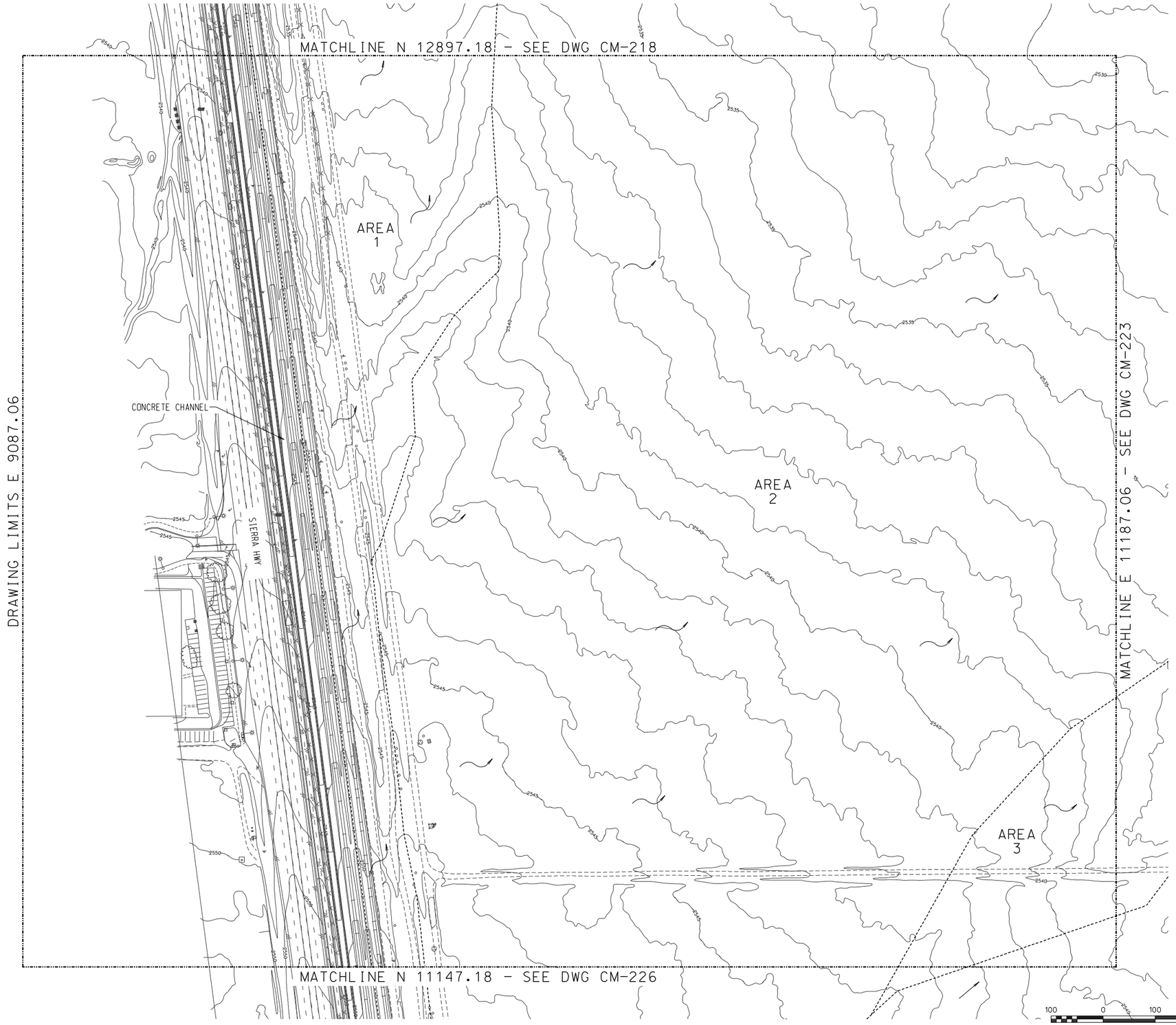
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-221



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

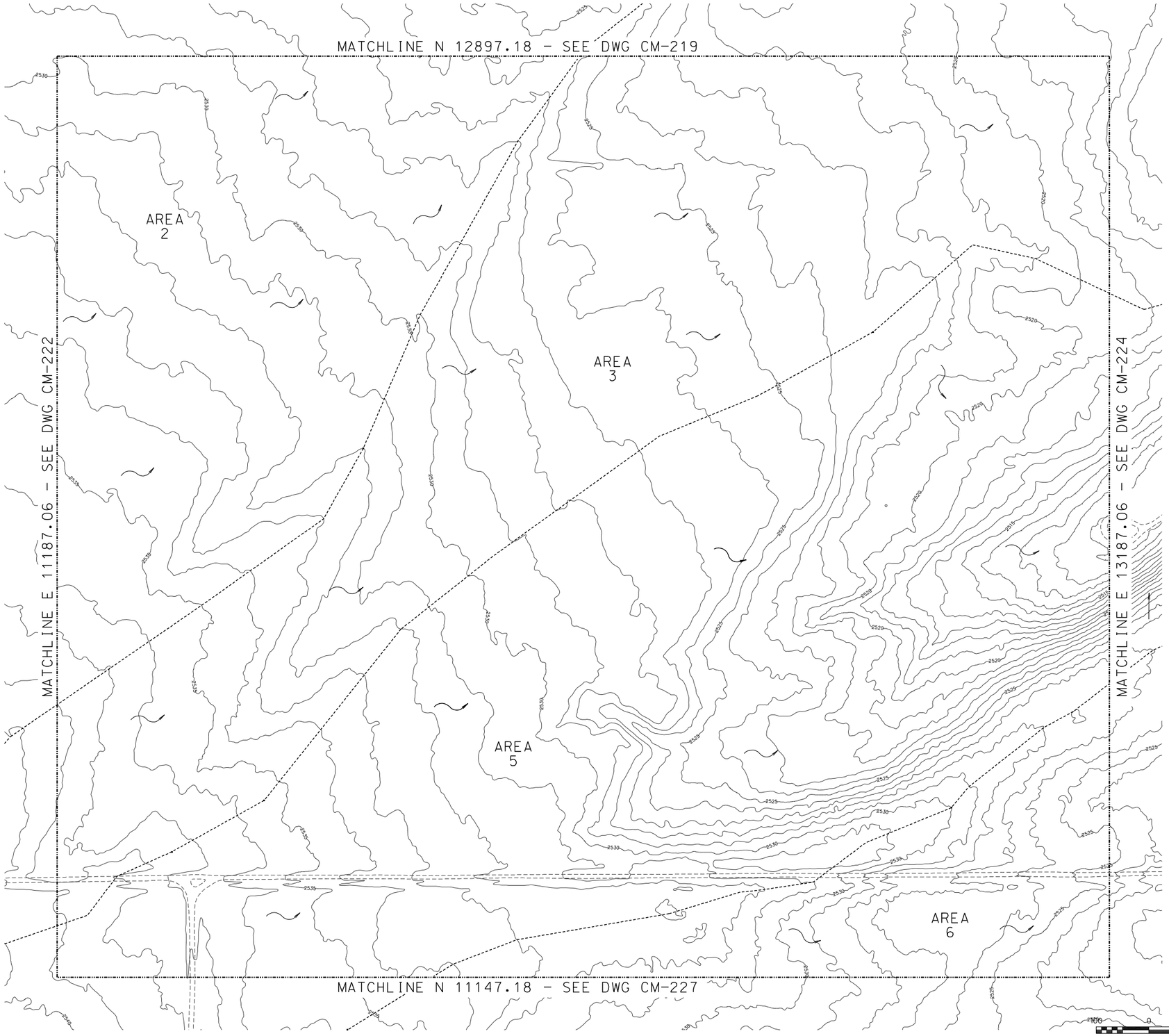
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-222



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

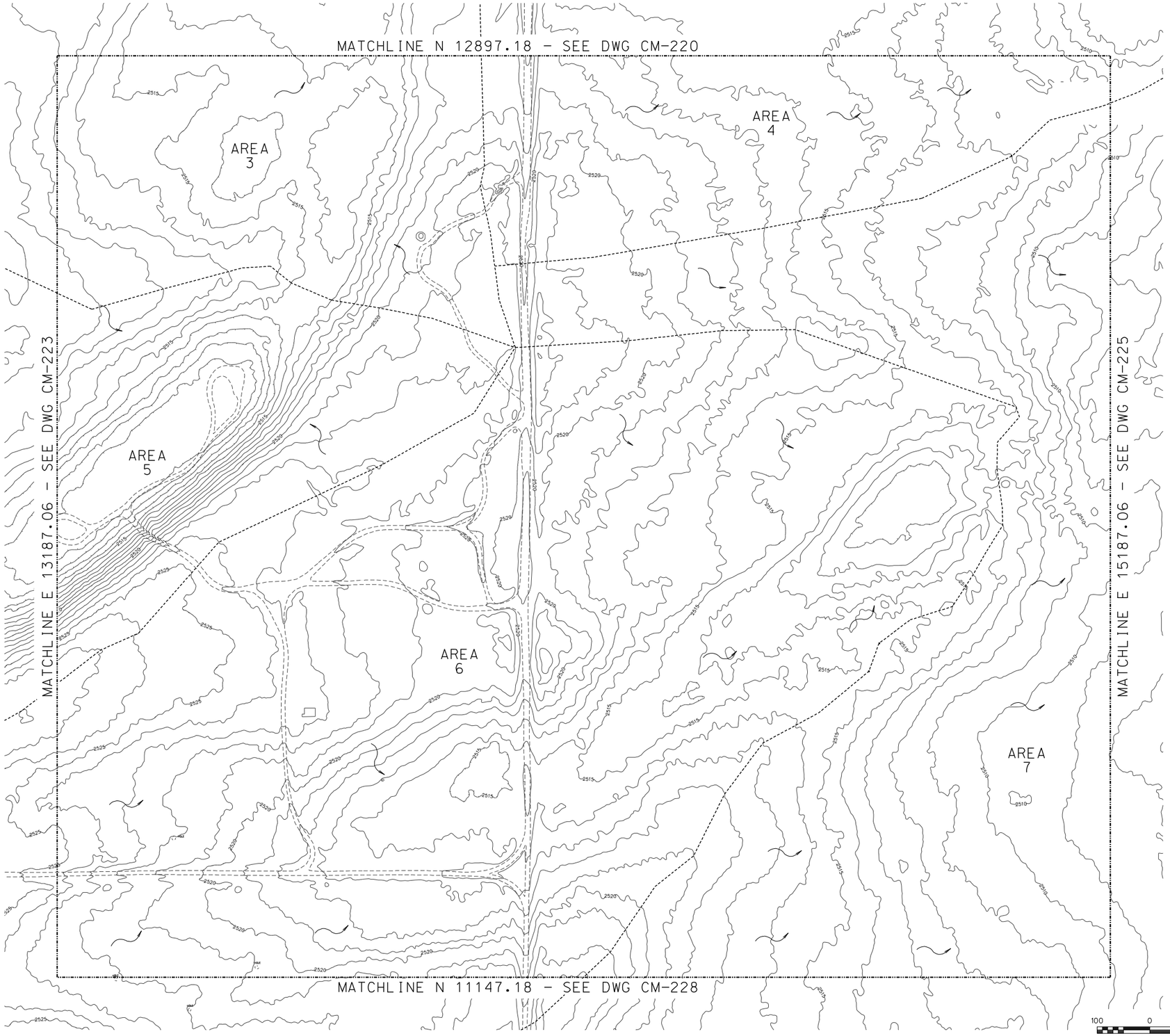
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-223



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

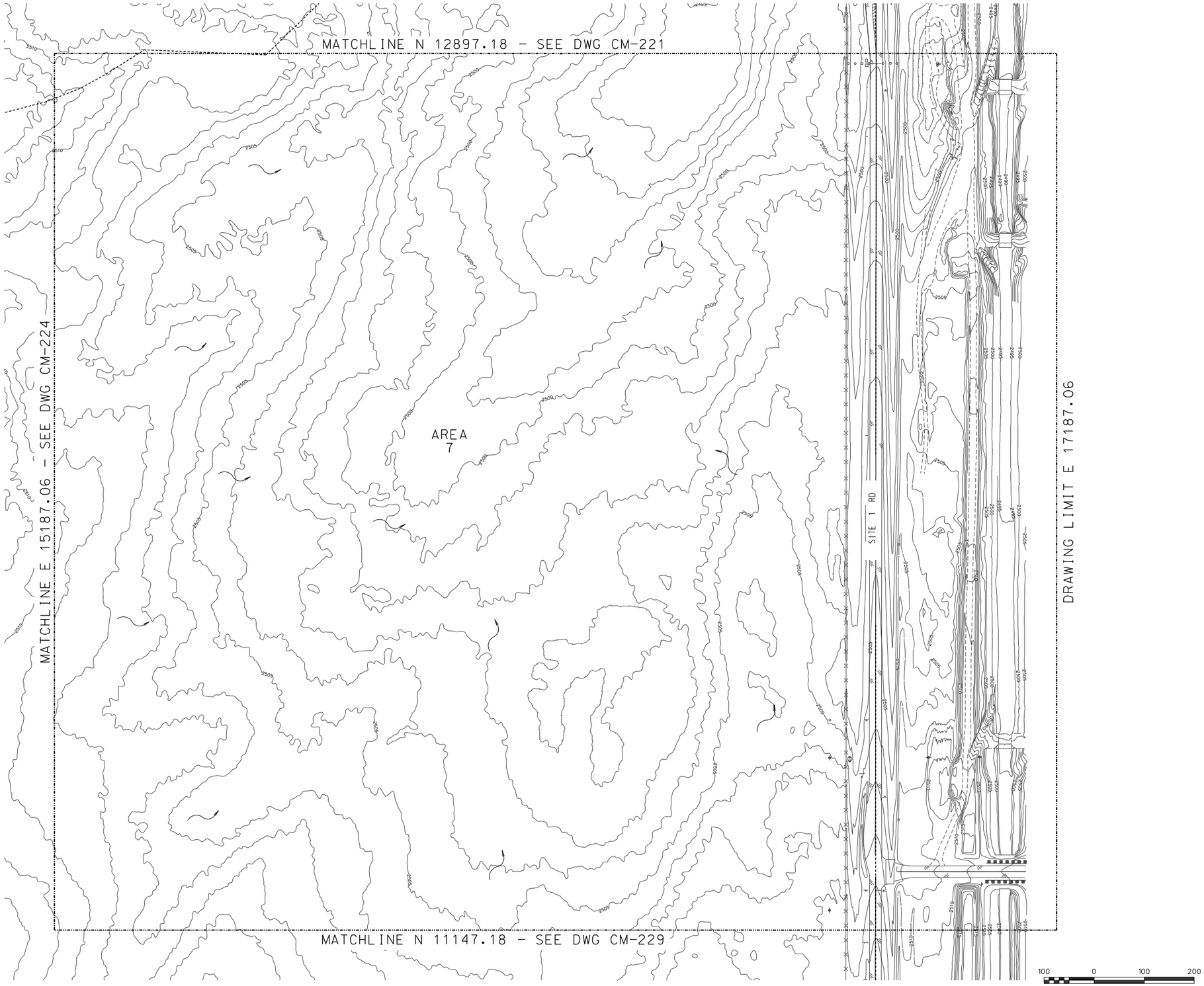
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-224



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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PALMDALE COMBINED CYCLE
POWER PROJECT

Kiewit

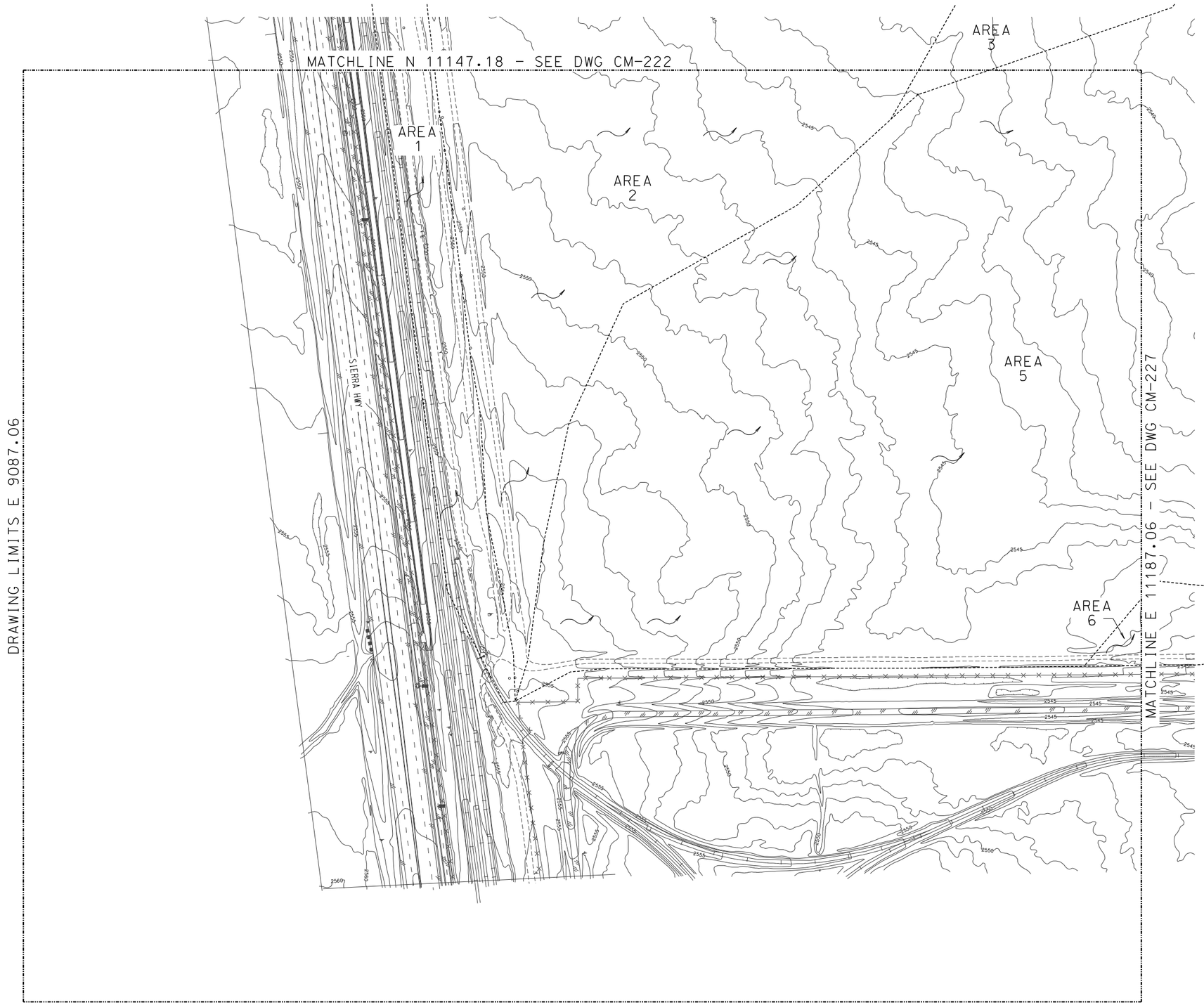
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-225

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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PALMDALE COMBINED CYCLE POWER PROJECT

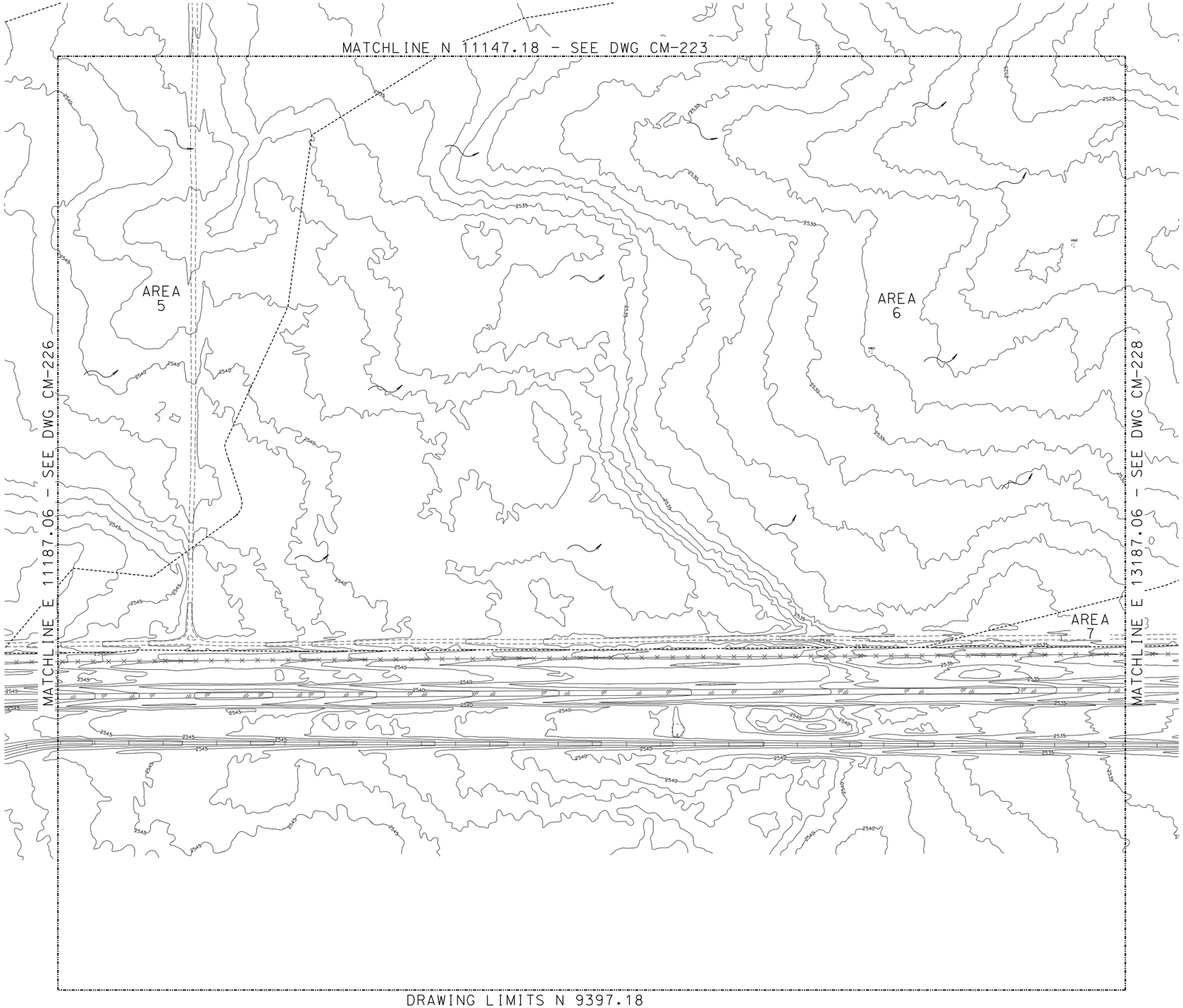
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-226



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

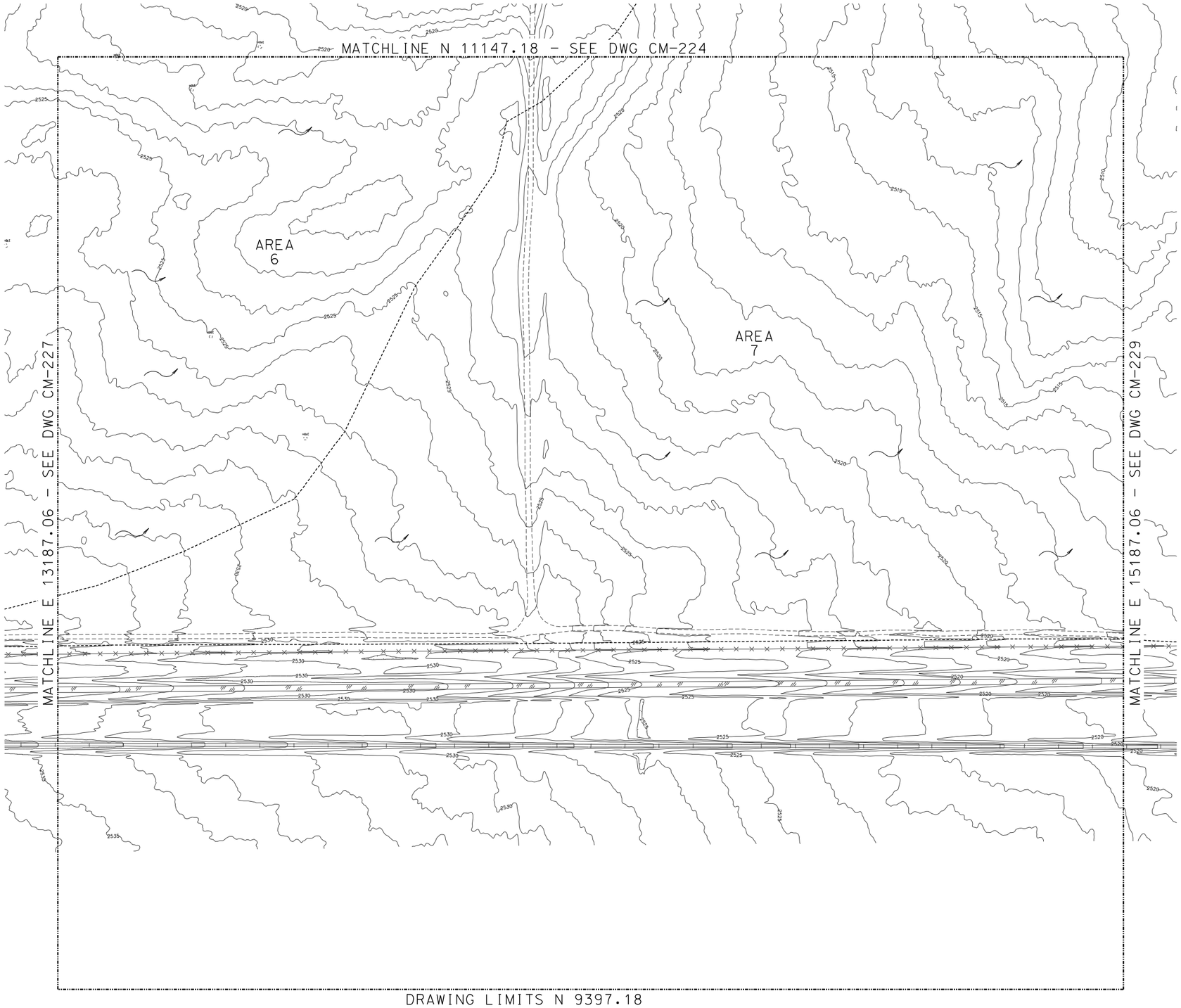
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-227



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

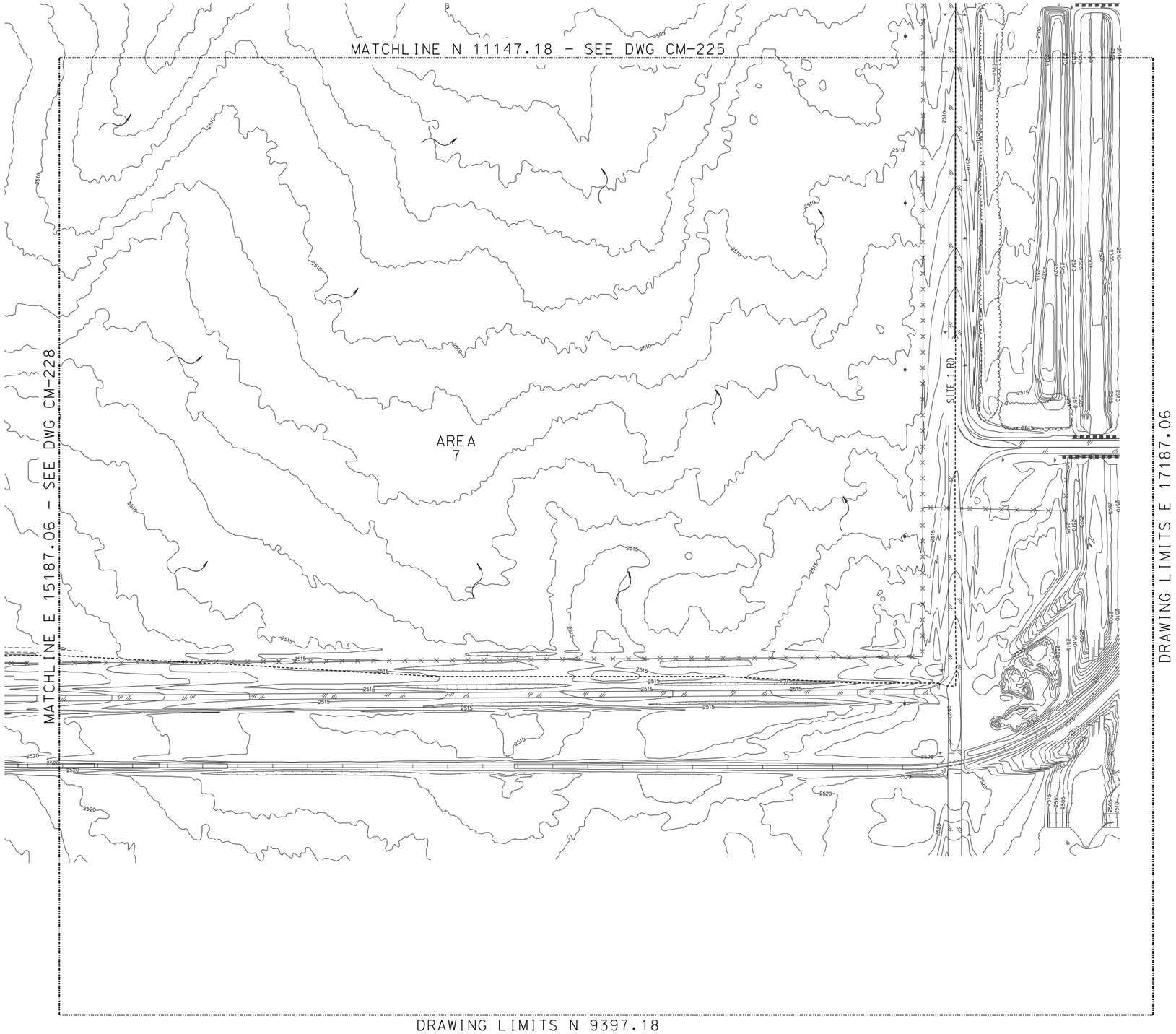
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER

2007-021-CM-228



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

Kiewit

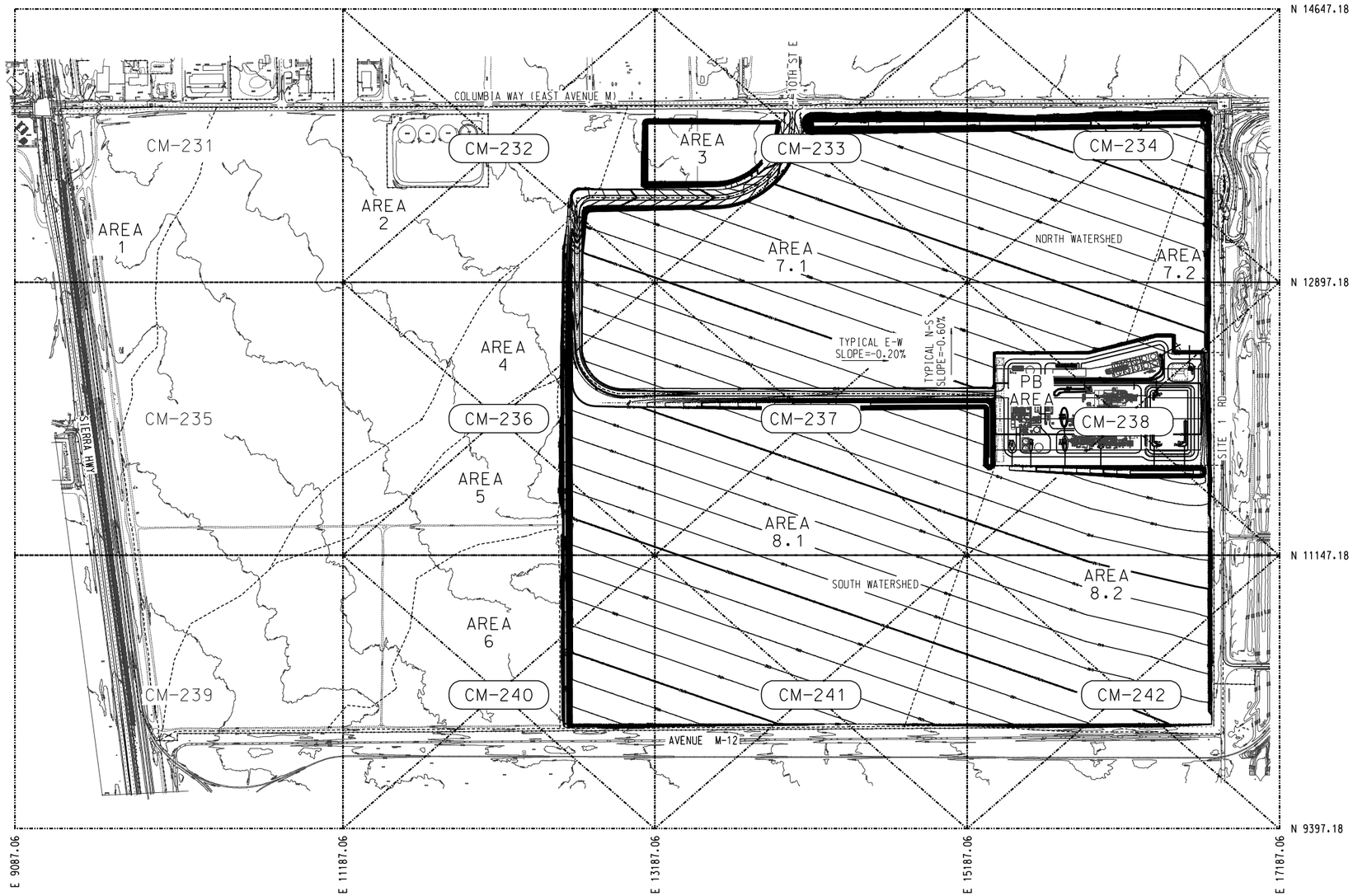
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-229

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04



– PRELIMINARY –
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

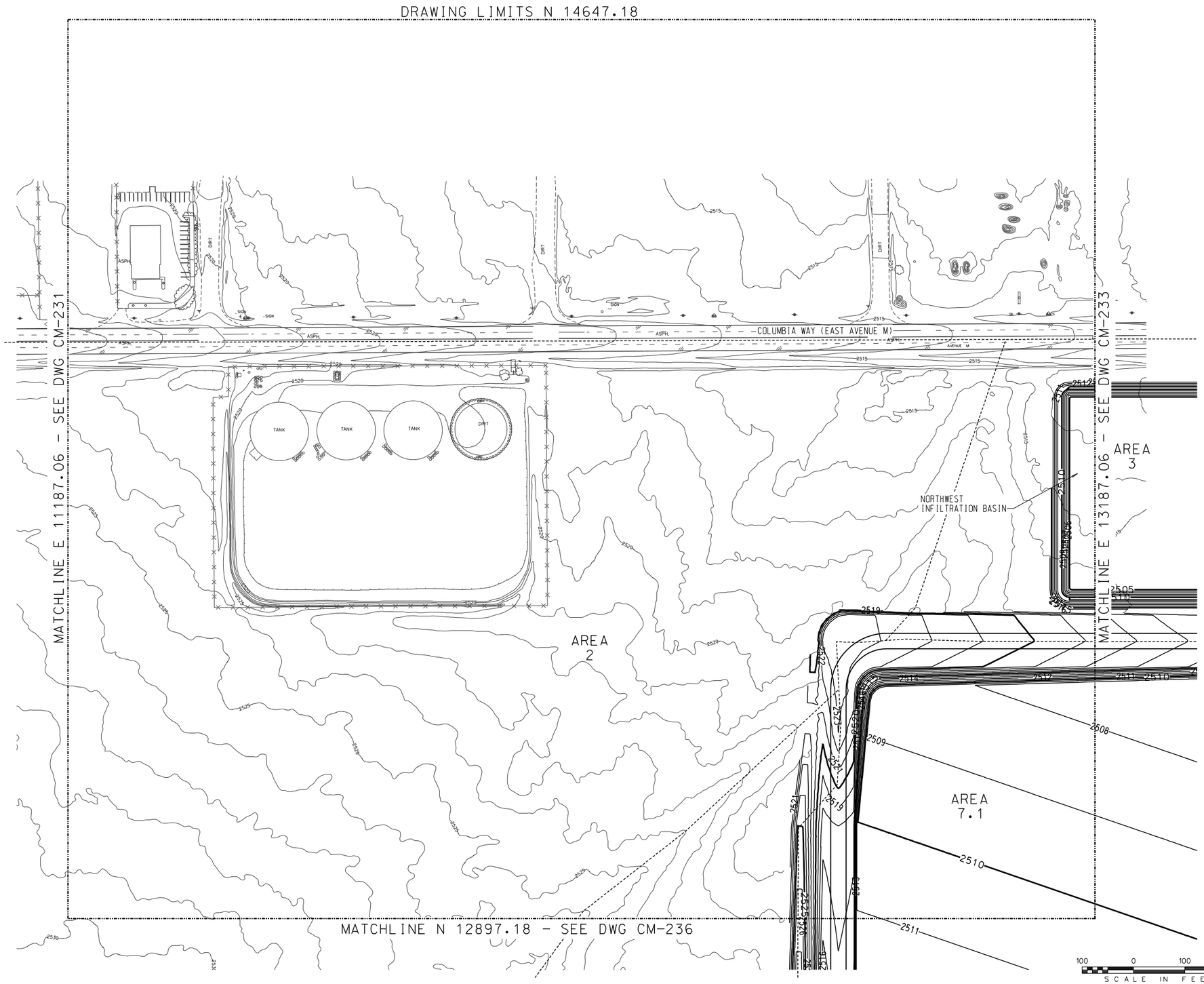
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPEMENT DRAINAGE

	by	date
DESIGNED	SAG	04-21-08
DRAWN	SAG	04-21-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-230

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

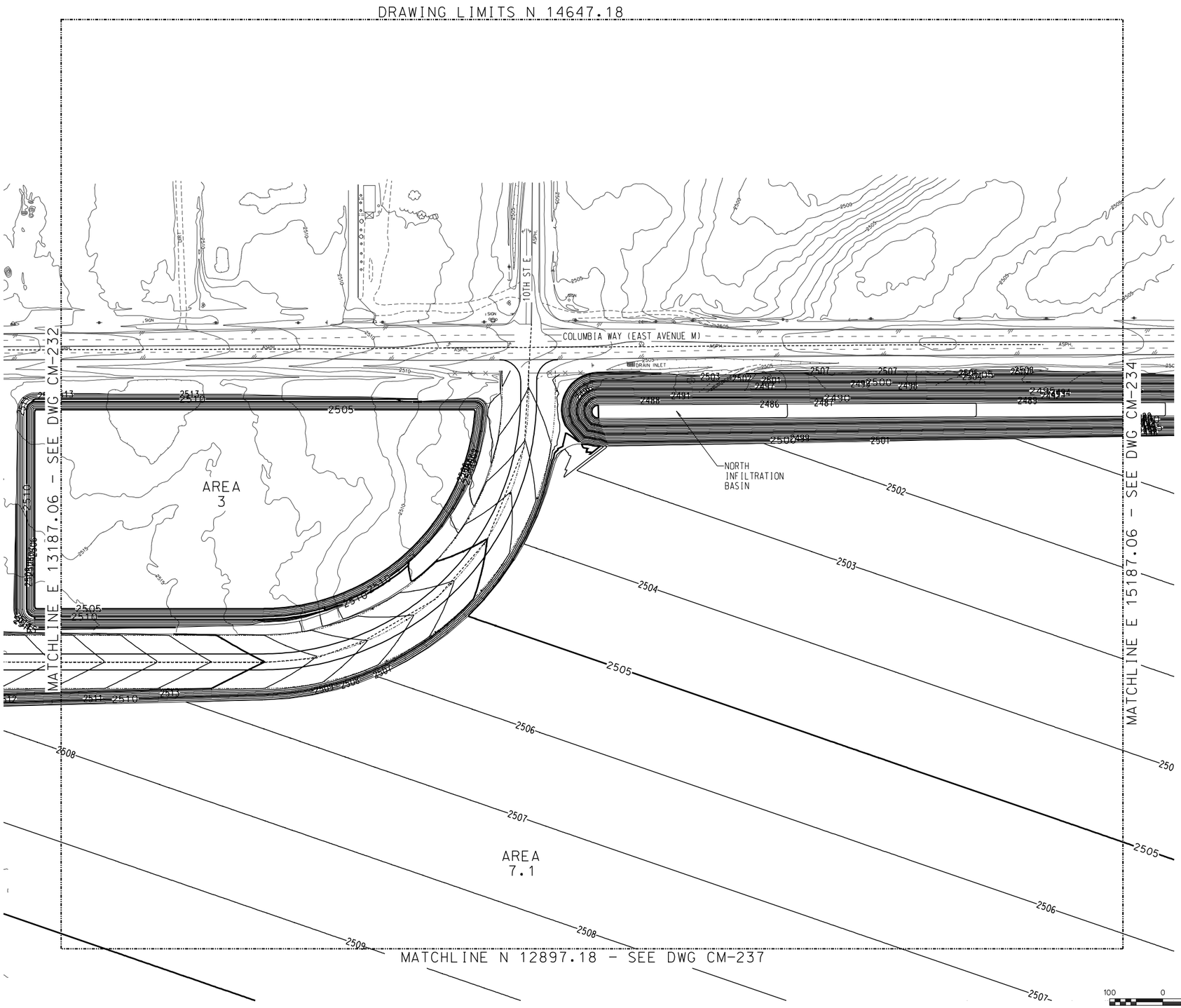
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-232

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04



100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

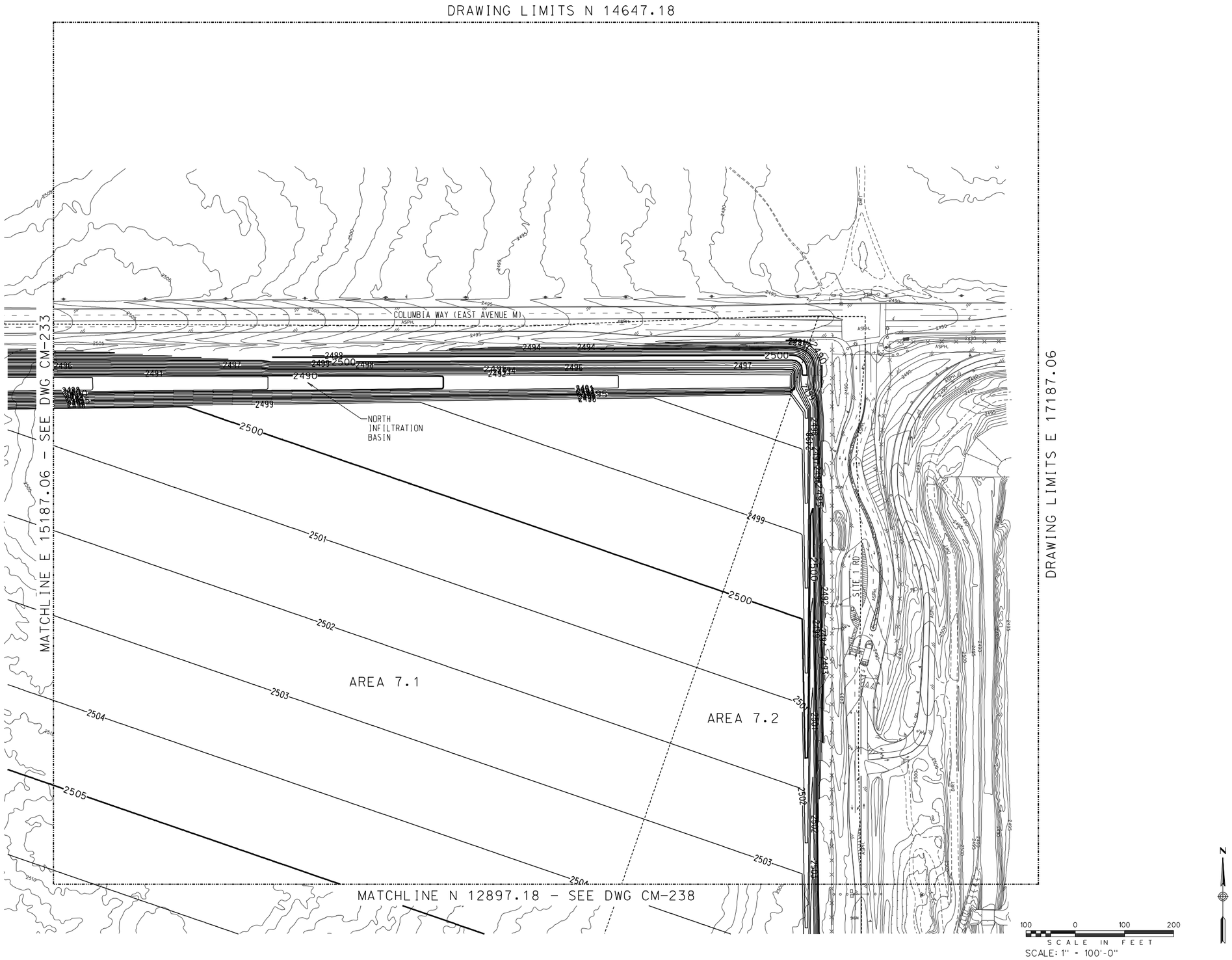
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-233

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

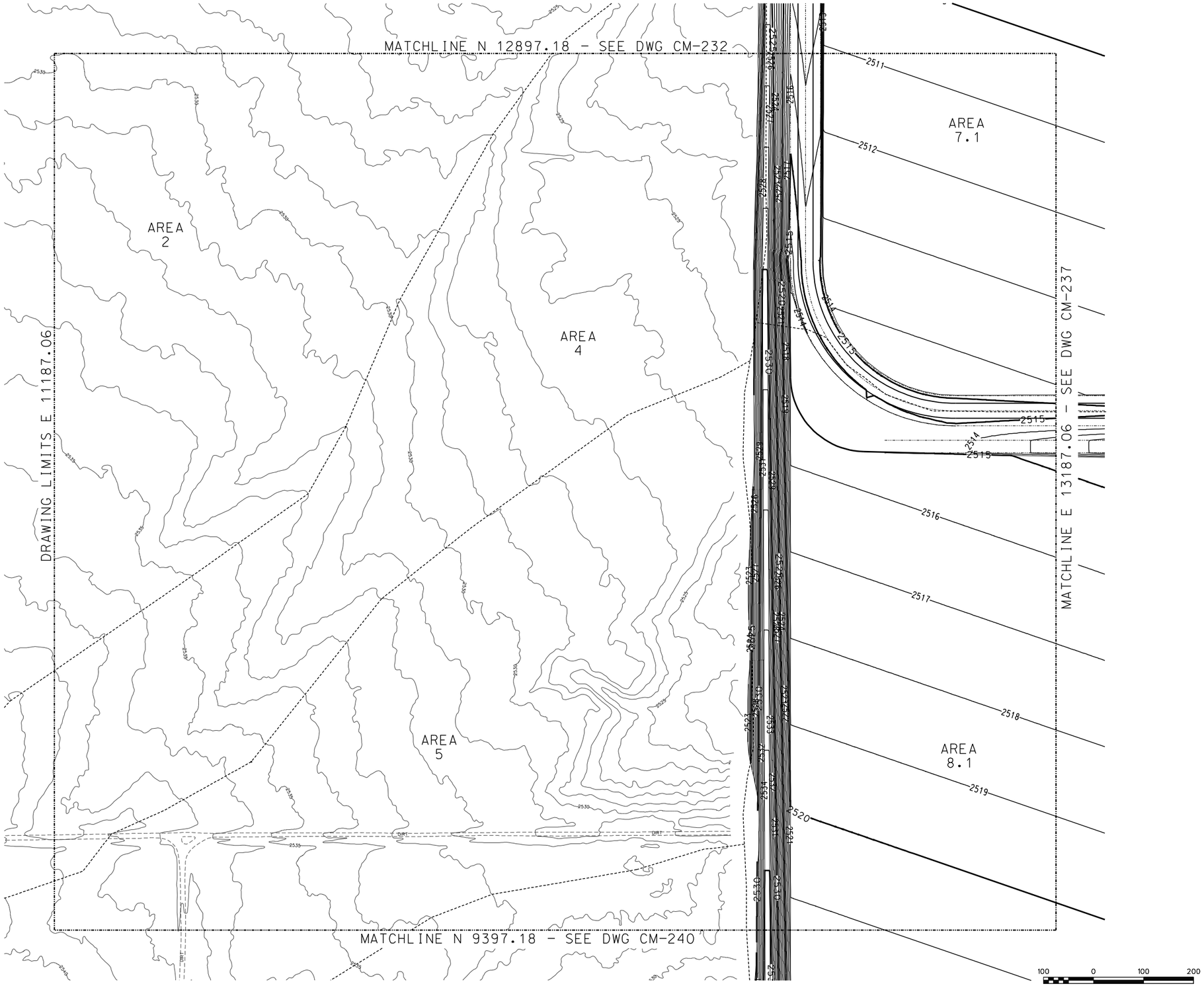
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-234



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

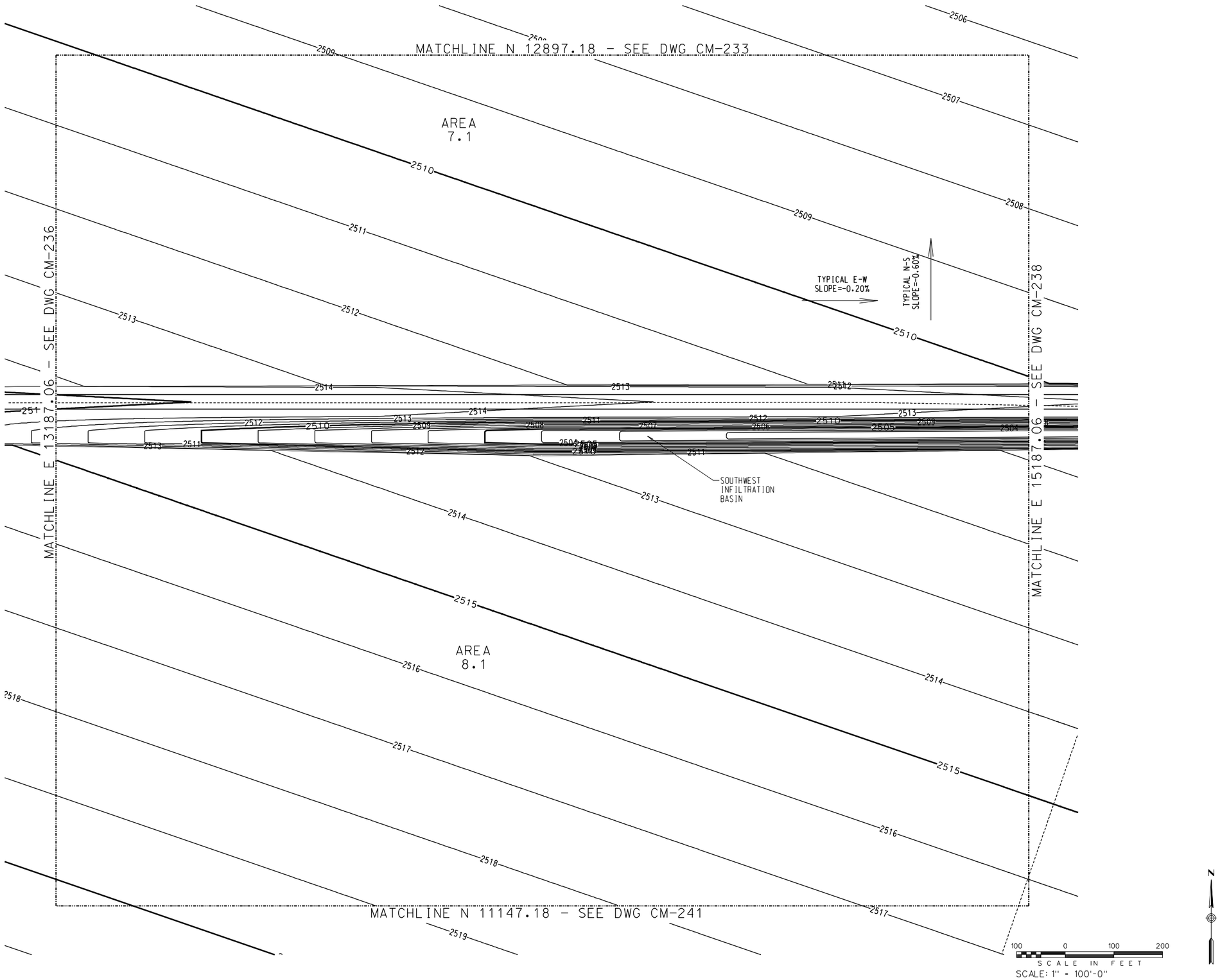
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-236



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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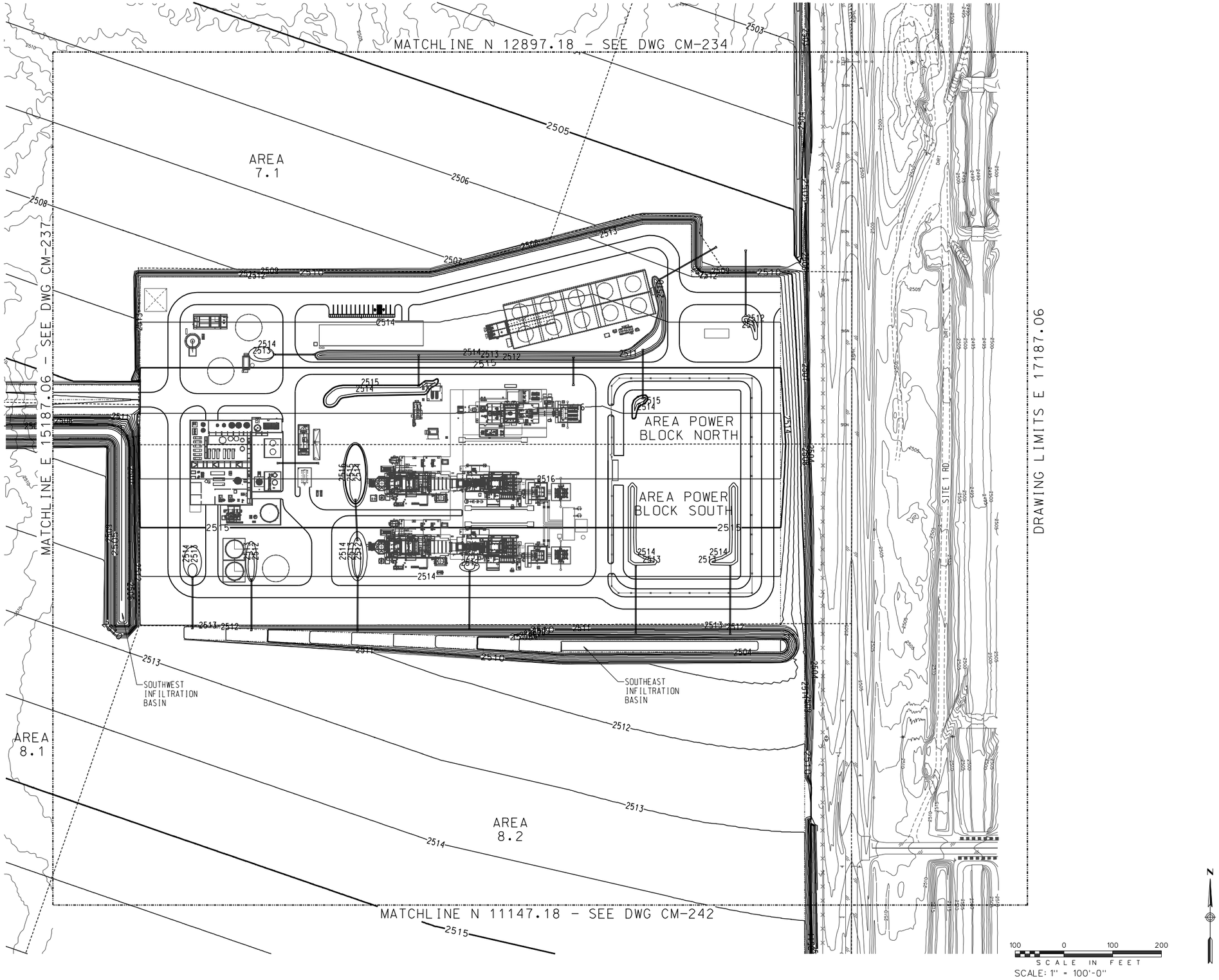
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-237



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-238

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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PALMDALE COMBINED CYCLE
POWER PROJECT

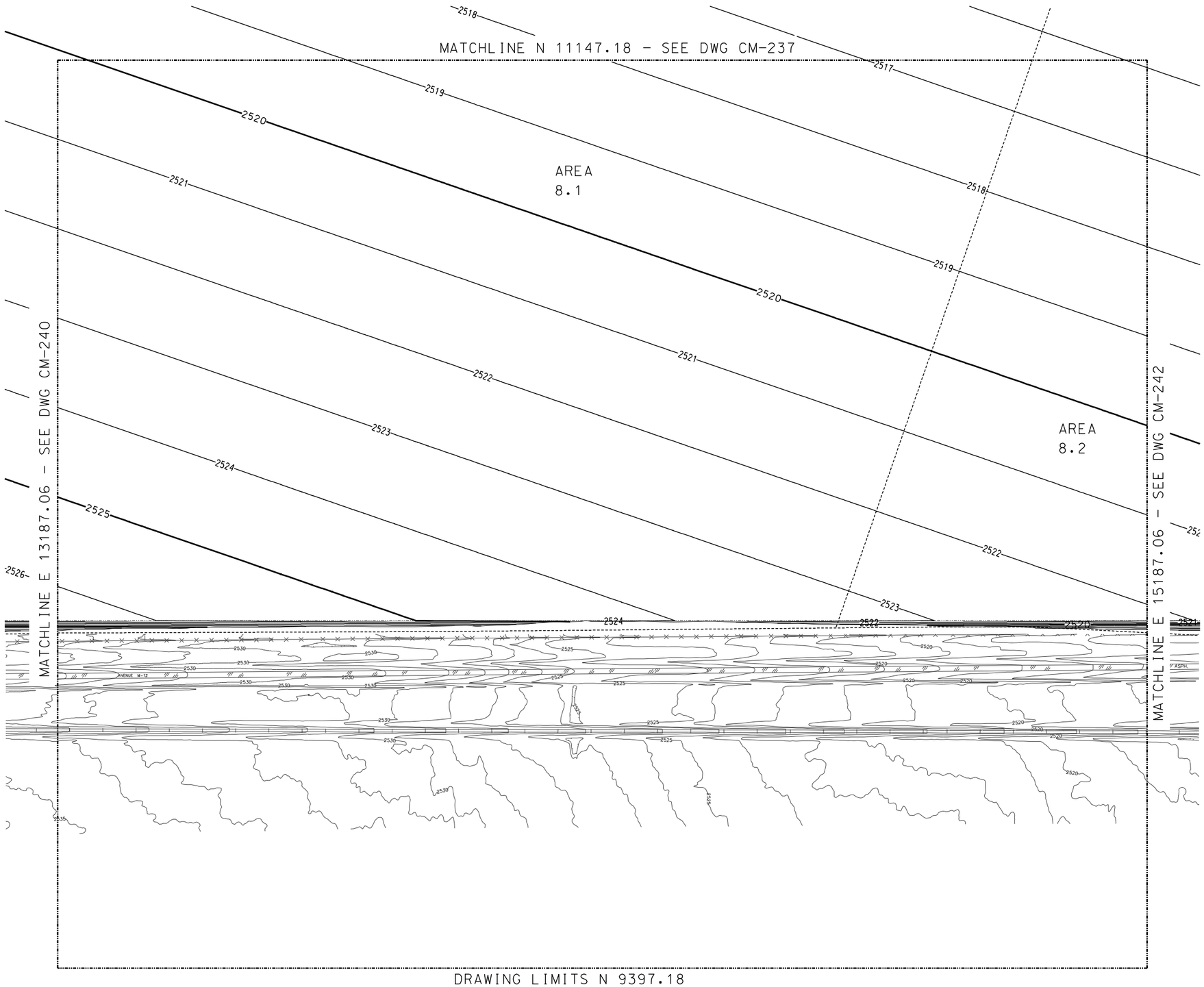
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-240



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV.	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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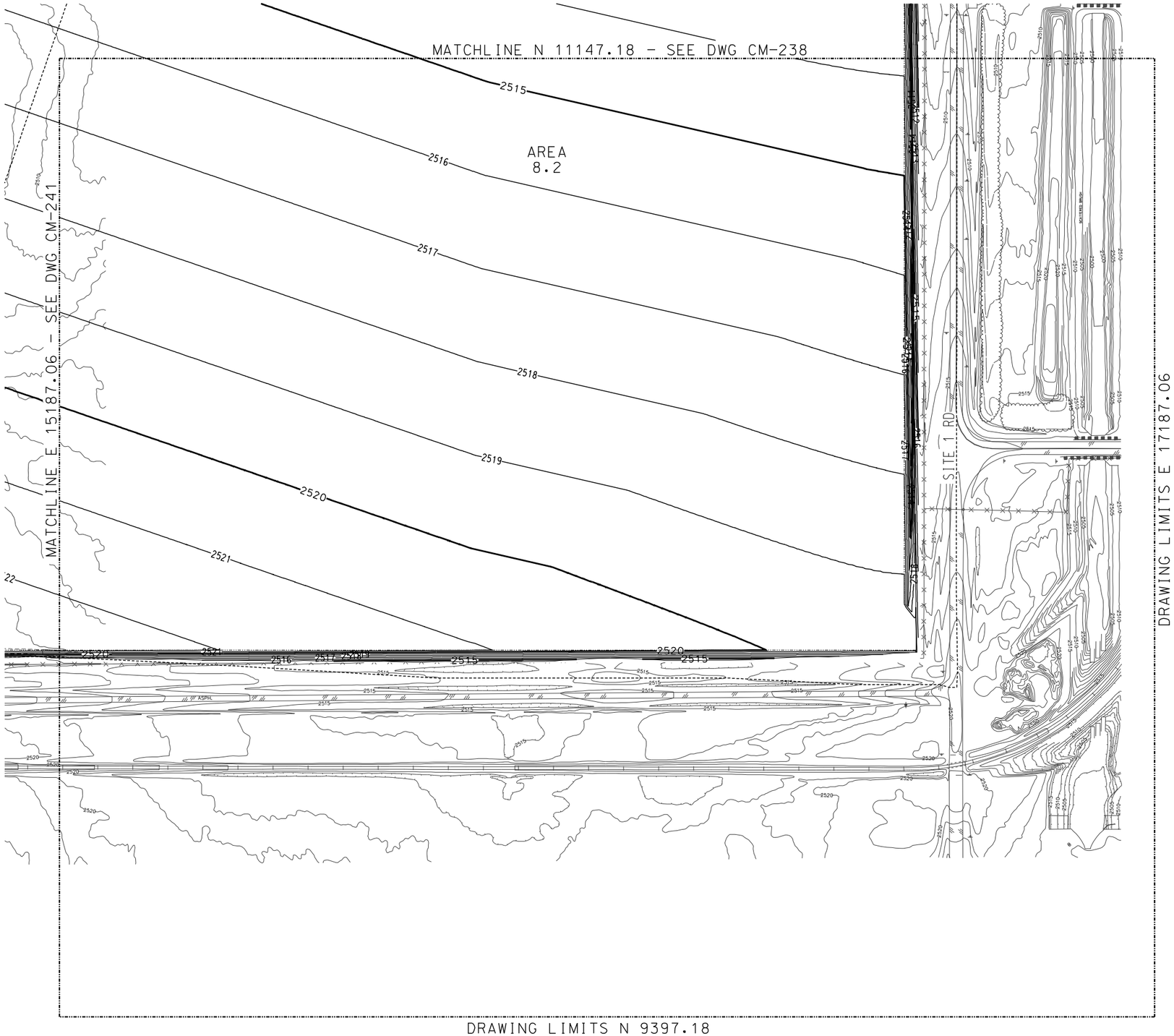
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-241



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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PALMDALE COMBINED CYCLE
POWER PROJECT

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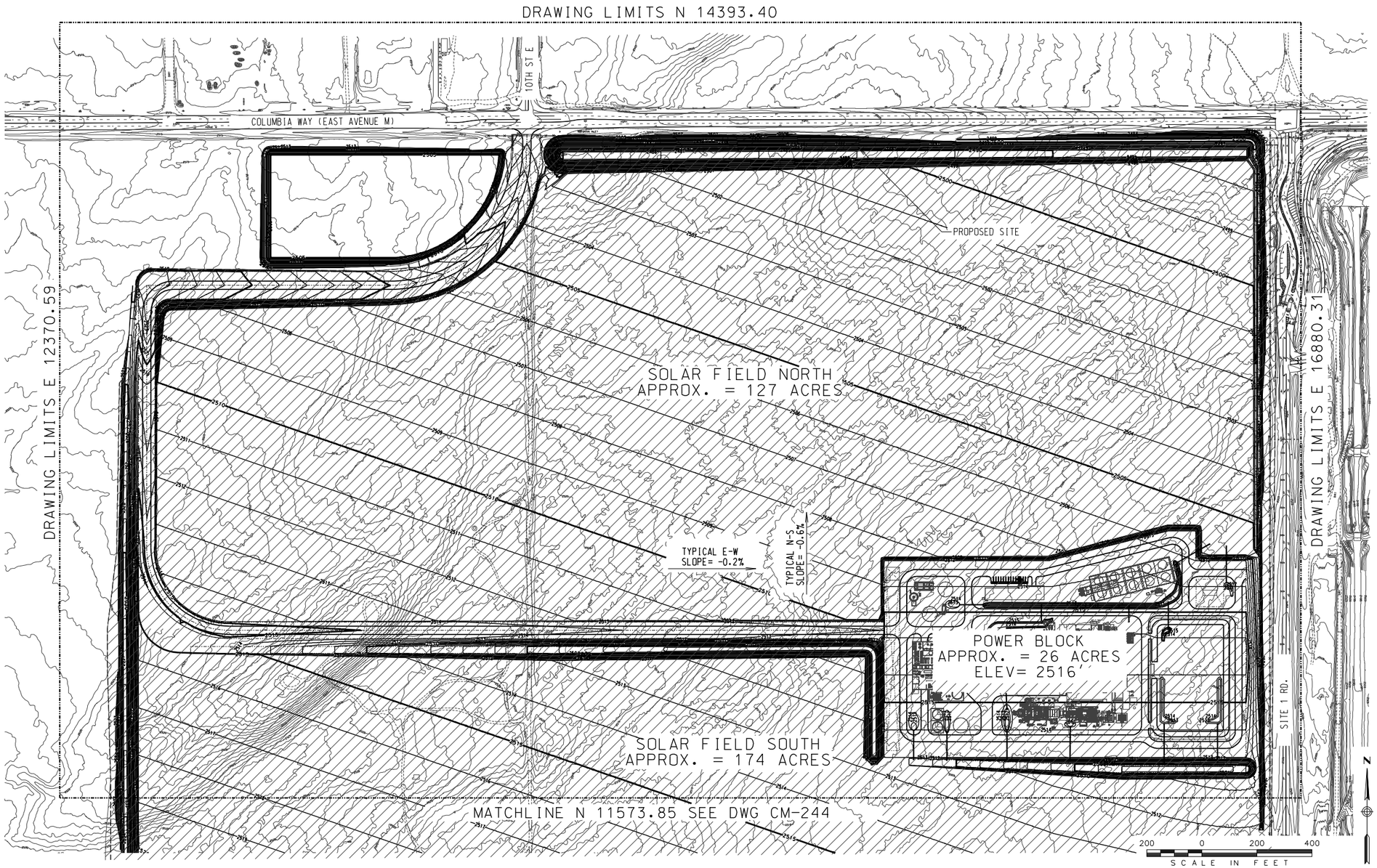
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-242



CLEARING AND GRADING

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	MTW	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

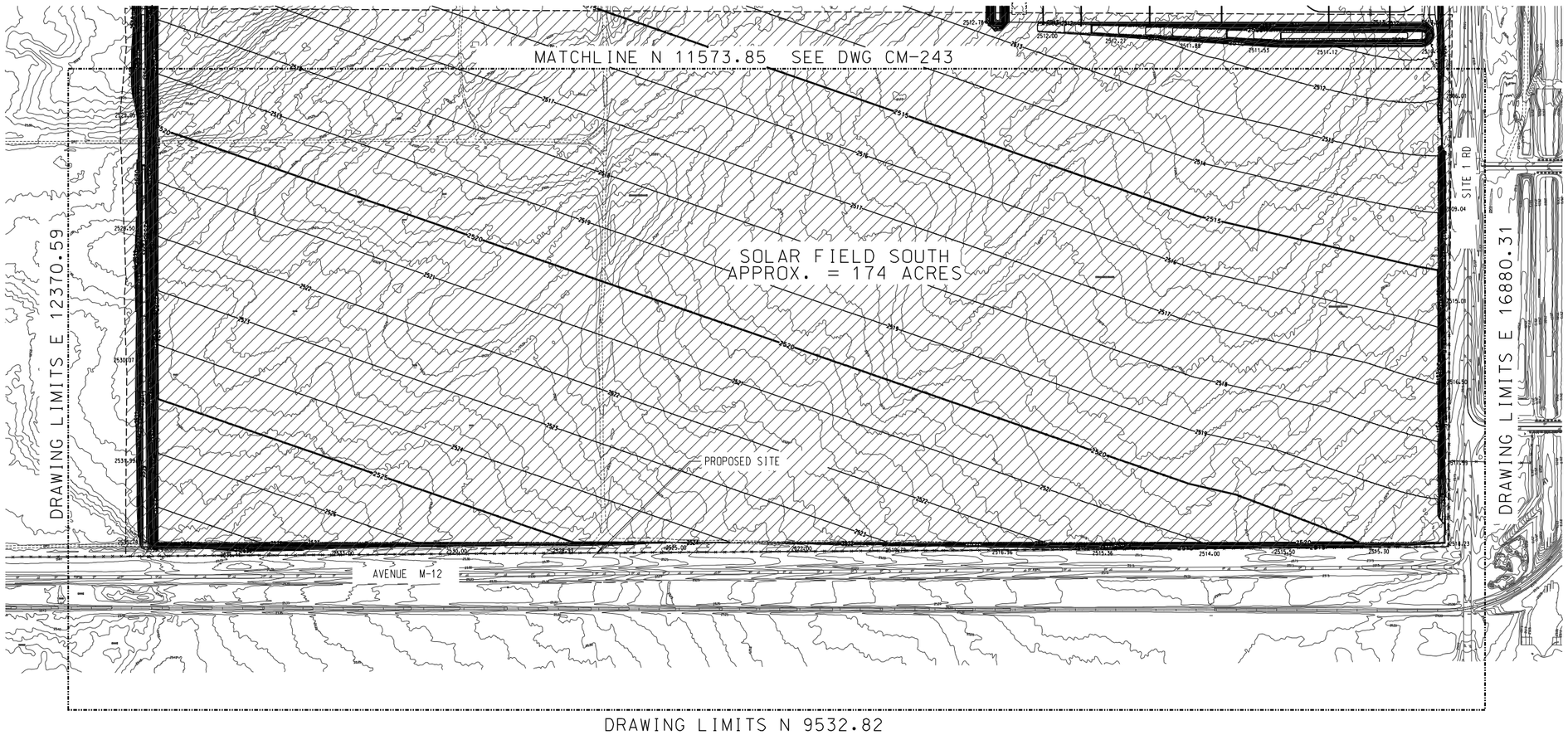
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

CLEARING AND GRADING PLAN

	by	date
DESIGNED	MTW	04-21-08
DRAWN	MTW	04-21-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-243



CLEARING AND GRADING

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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PALMDALE COMBINED CYCLE
POWER PROJECT

Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

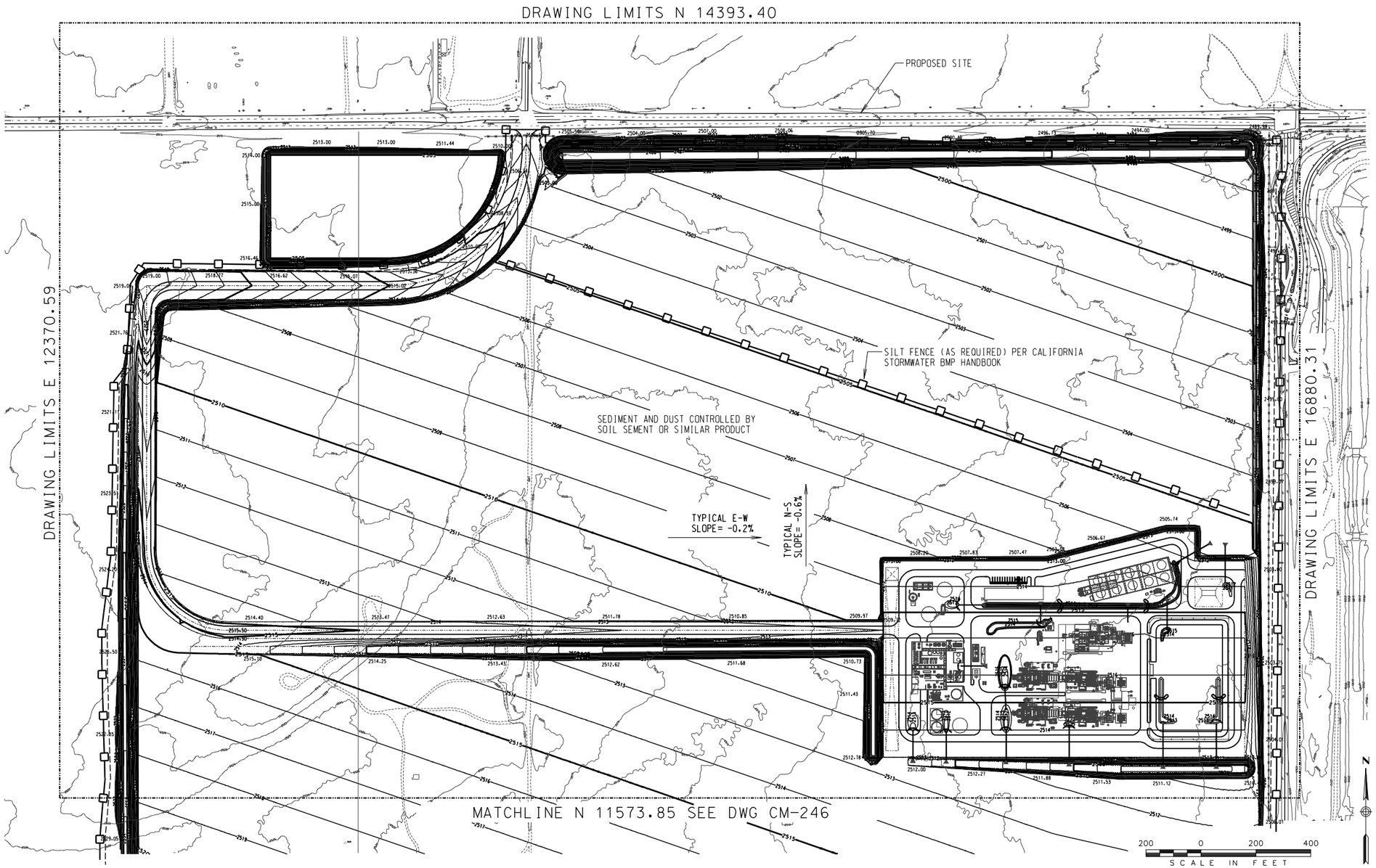
CLEARING AND GRADING PLAN

	by	date
DESIGNED	SAG	06-05-08
DRAWN	SAG	06-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-244

200 0 200 400
SCALE IN FEET
SCALE: 1" = 200'-0"

N



HAY BALES

RIP RAP

SILT FENCE

– PRELIMINARY – NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

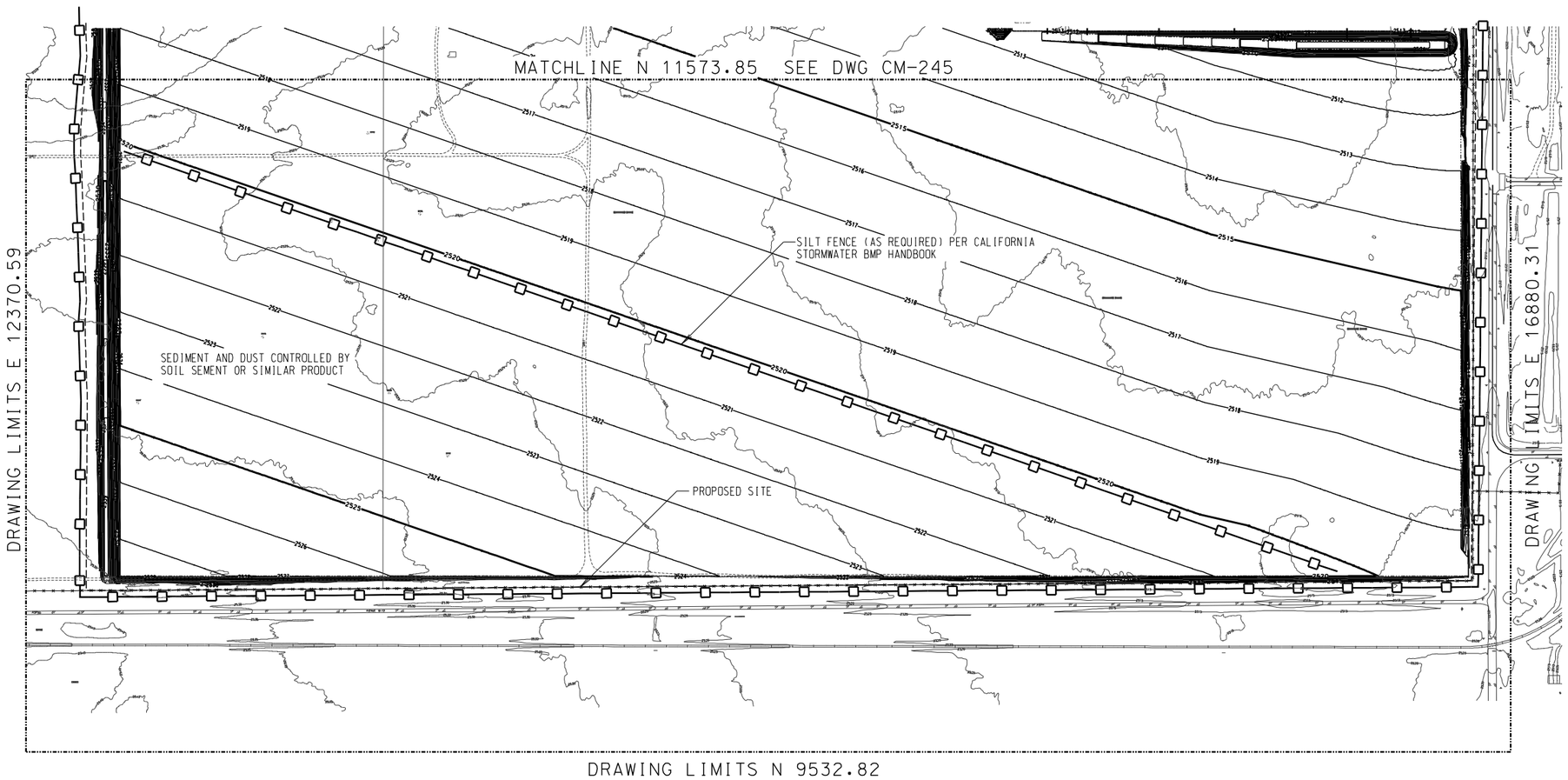
BEST MANAGEMENT PRACTICES

	by	date
DESIGNED	MTW	04-21-08
DRAWN	MTW	04-21-08
CHECKED	MAA	06-20-08
APPROVED	AGH	06-25-08

DRAWING NUMBER

2007-021-CM-245

SILT FENCE



200 0 200 400
SCALE IN FEET
SCALE: 1" = 200'-0"

N

– PRELIMINARY –
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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Kiewit Power
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Lenexa, Kansas 66214

BEST MANAGEMENT PRACTICES

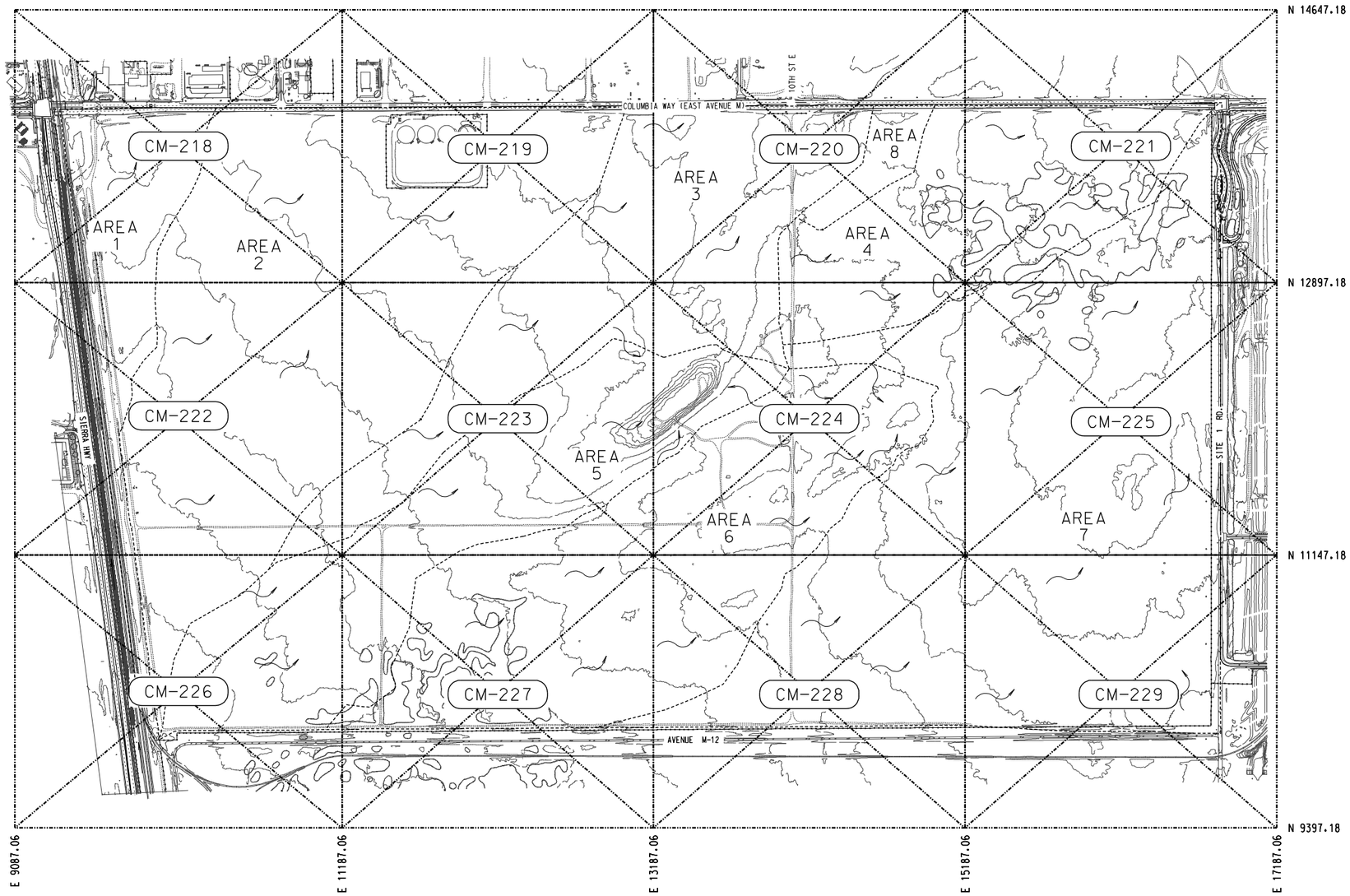
	by	date
DESIGNED	SAG	04-21-08
DRAWN	SAG	04-21-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-246

Appendix A

Pre- and Post-Development Drainage Plans

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



400 0 400 800
SCALE IN FEET
SCALE: 1" = 400'

N

– PRELIMINARY –
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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Kiewit

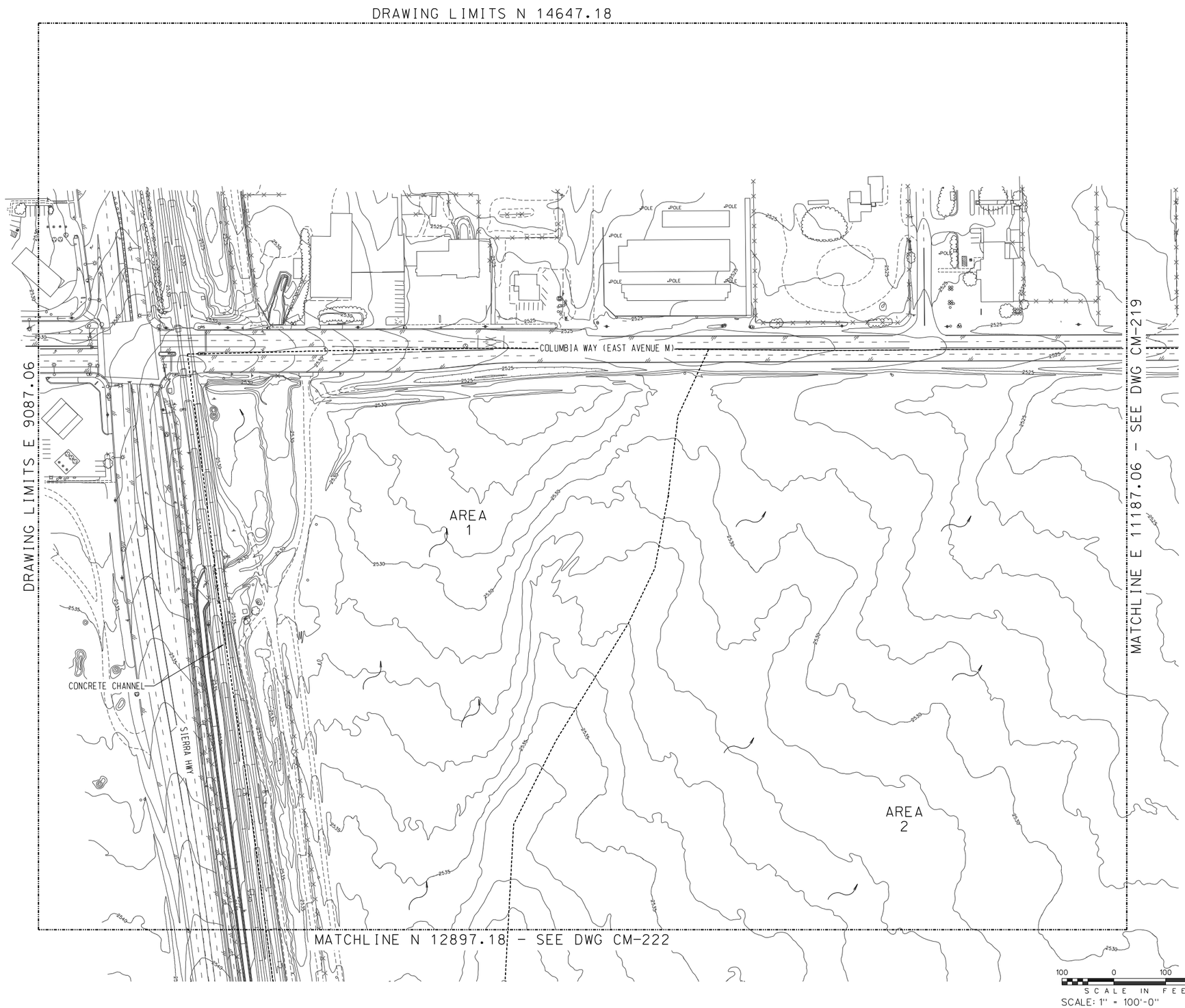
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPEMENT DRAINAGE

	by	date
DESIGNED	SAG	05-21-08
DRAWN	SAG	05-21-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-217

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

Kiewit

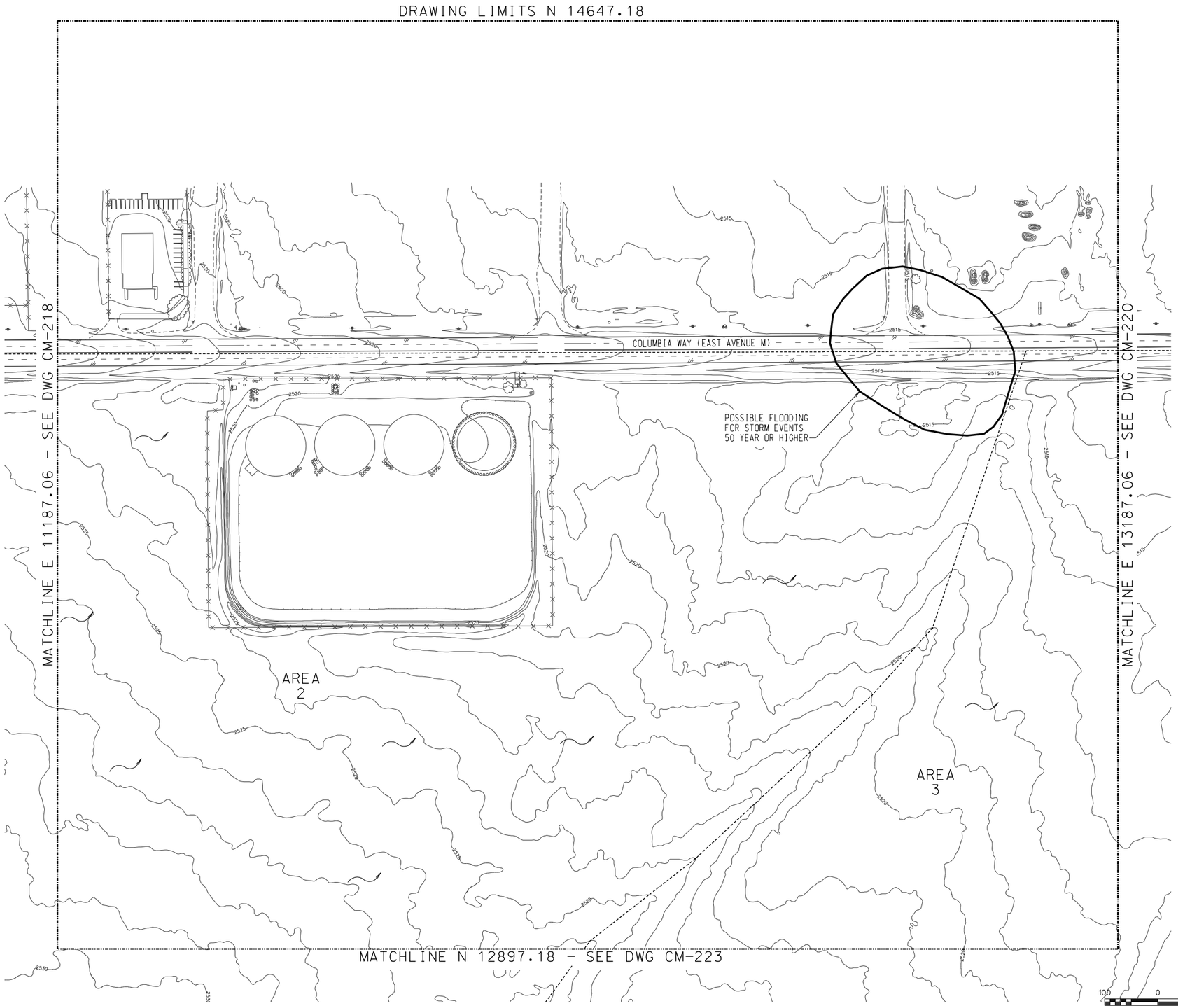
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-218

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

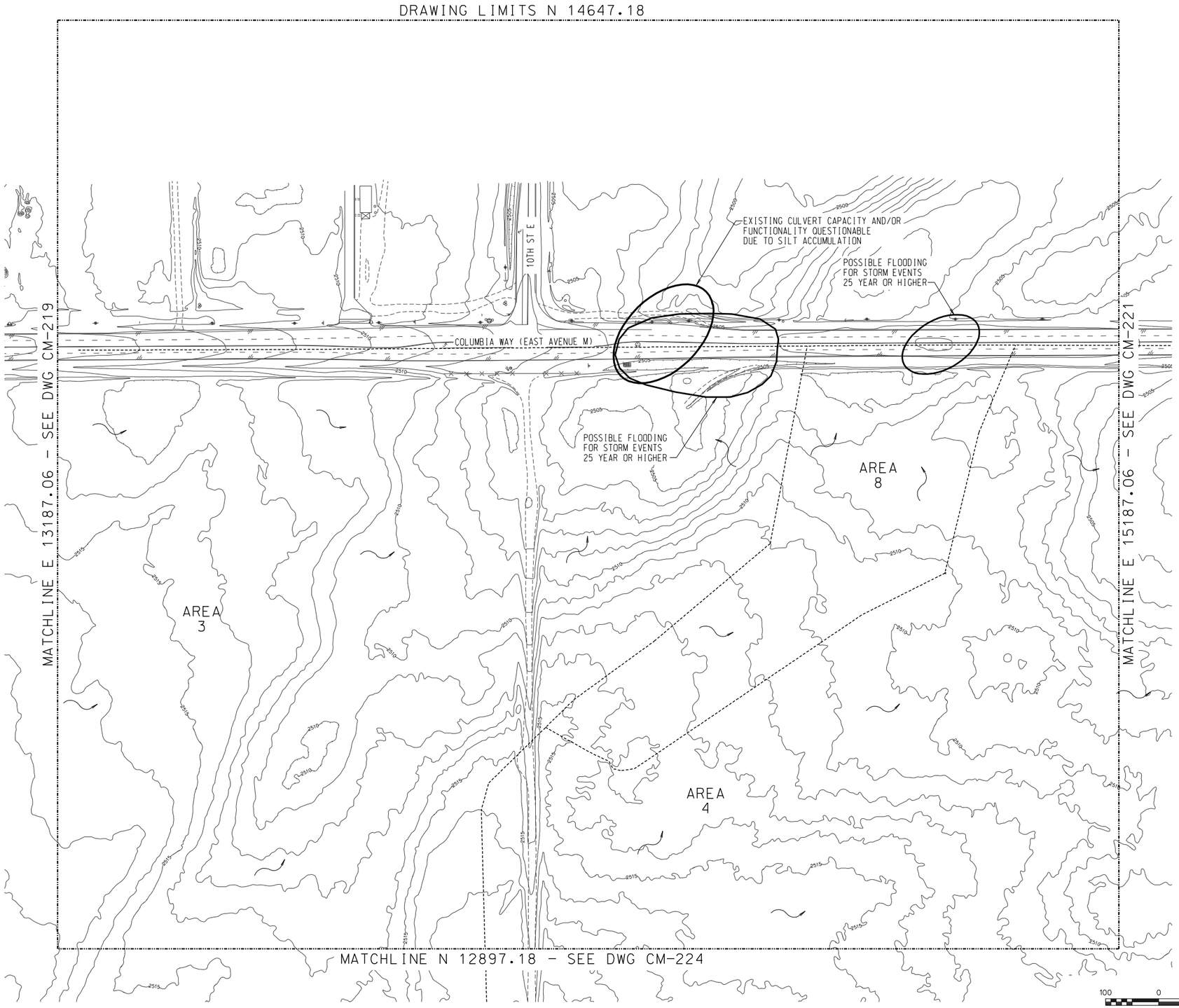
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-219



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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PALMDALE COMBINED CYCLE POWER PROJECT

Kiewit

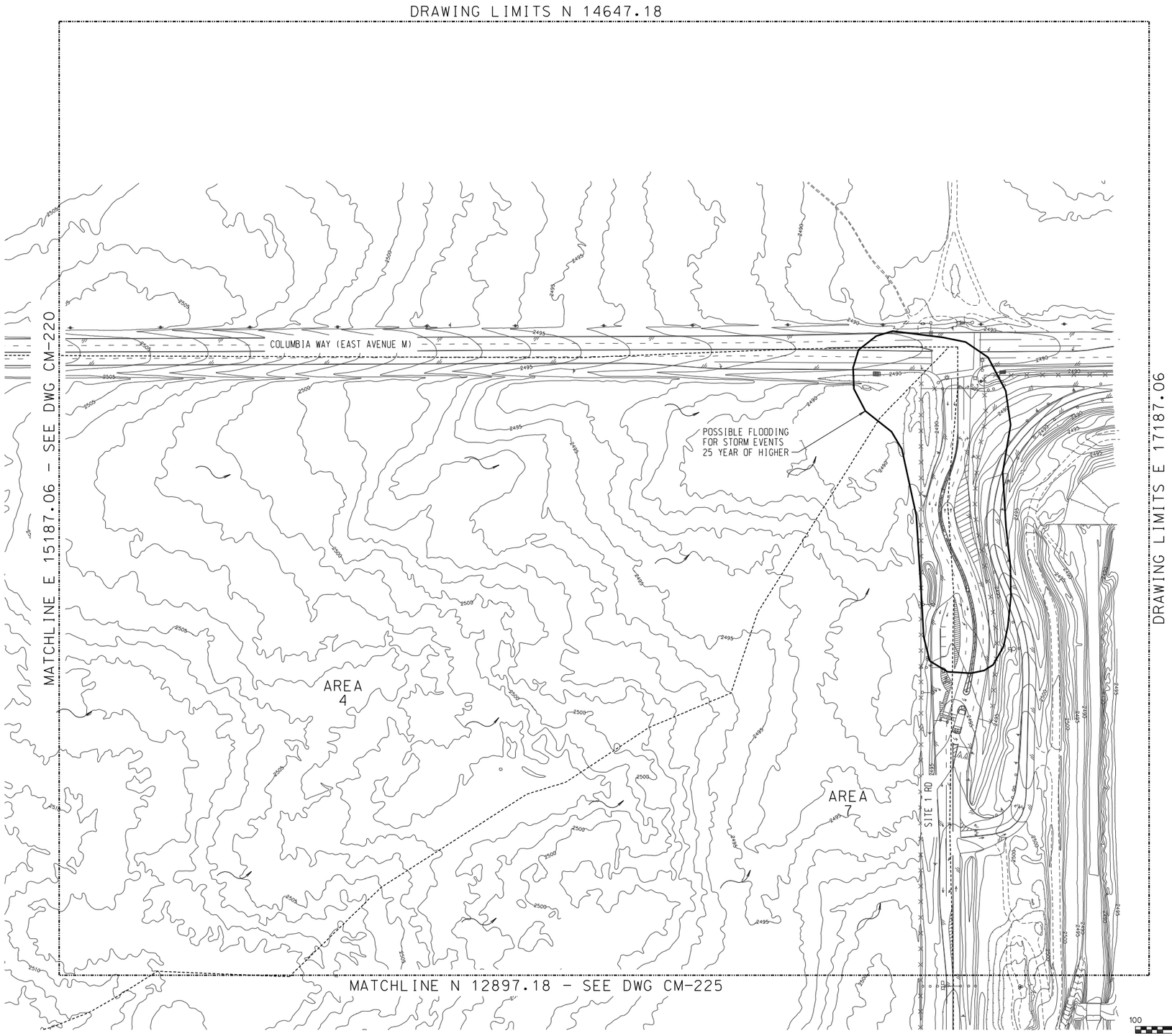
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-220

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

Kiewit

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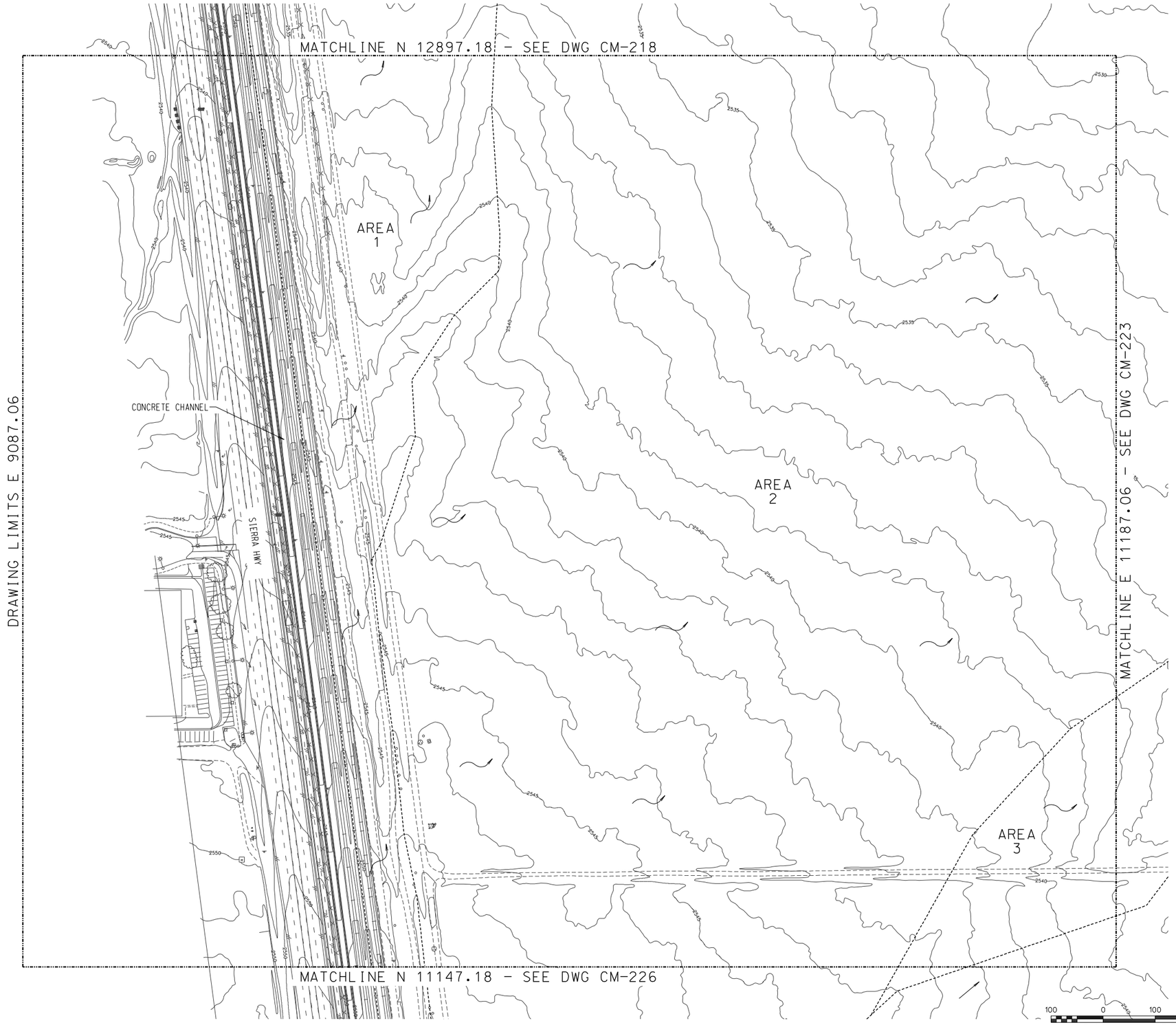
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-221



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

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Kiewit

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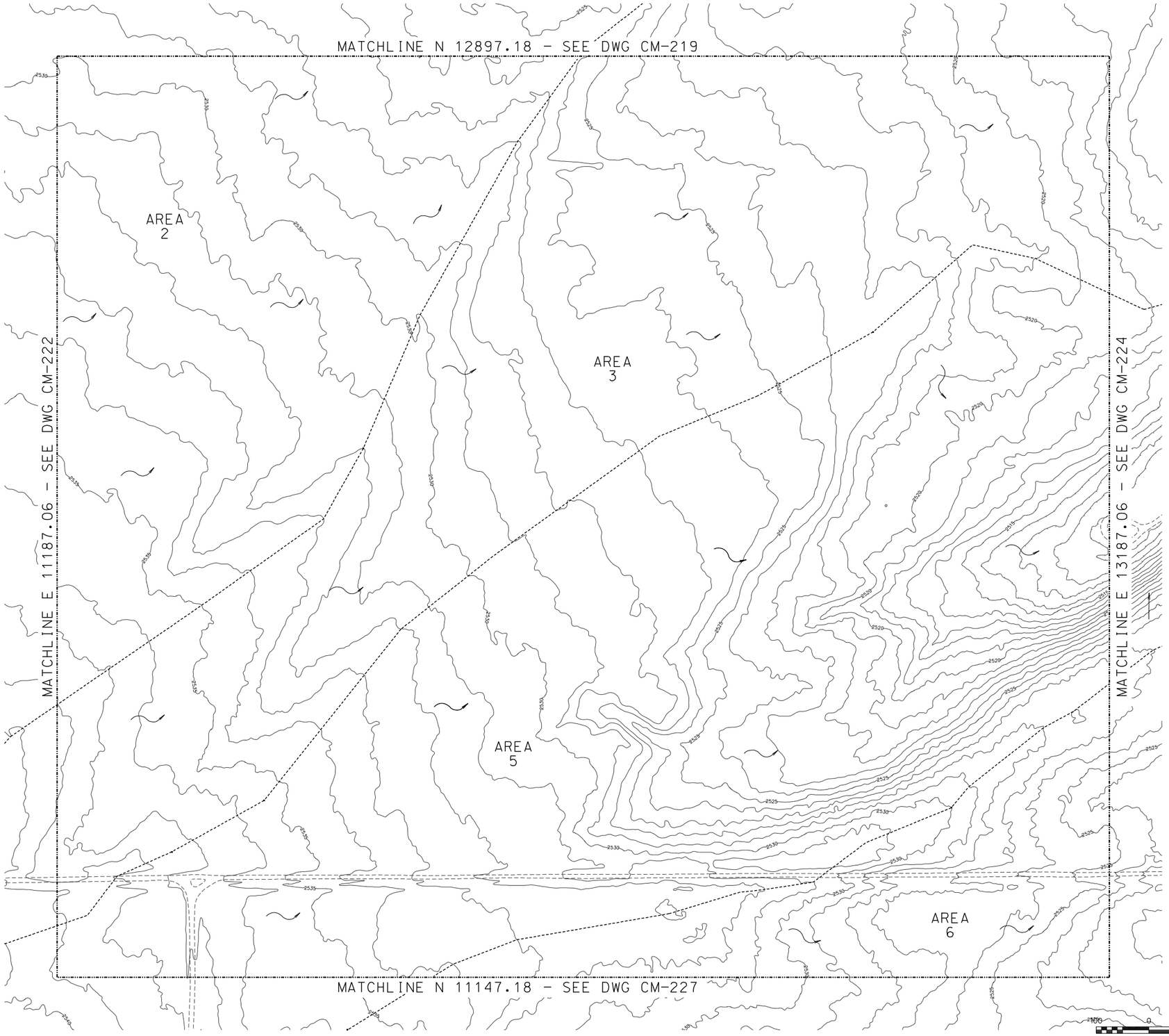
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-222



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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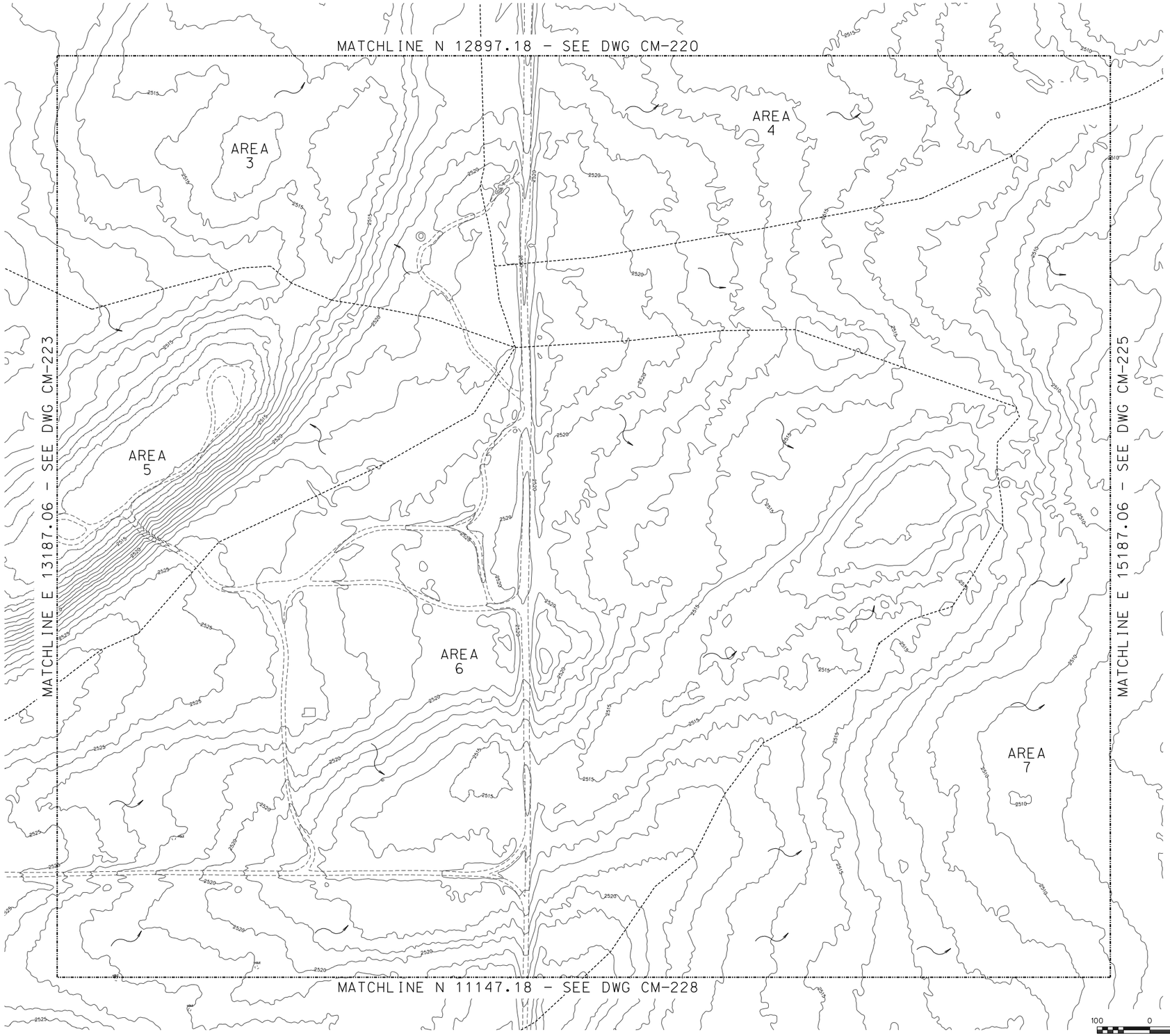
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-223



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

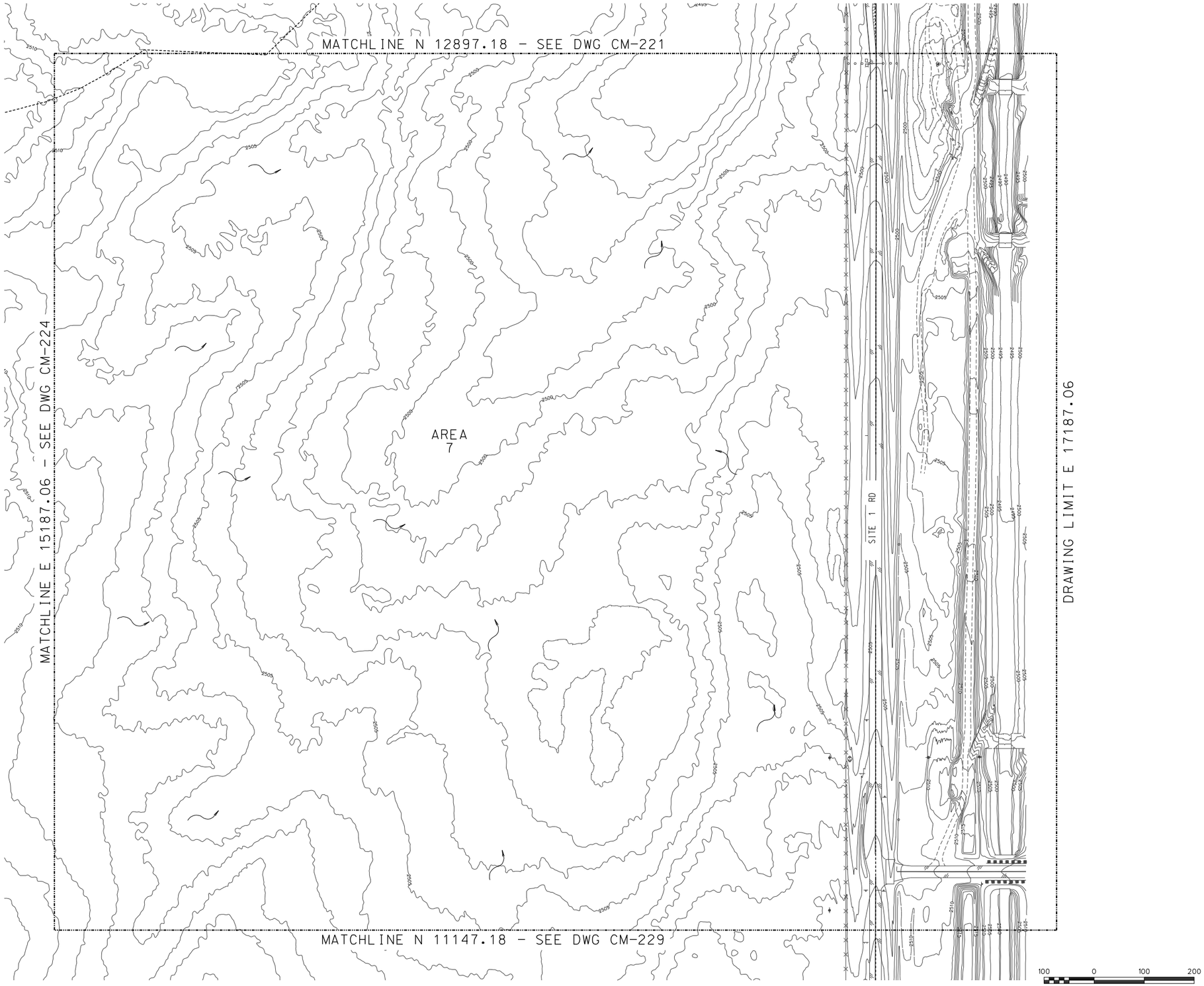
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-224



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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POWER PROJECT

Kiewit

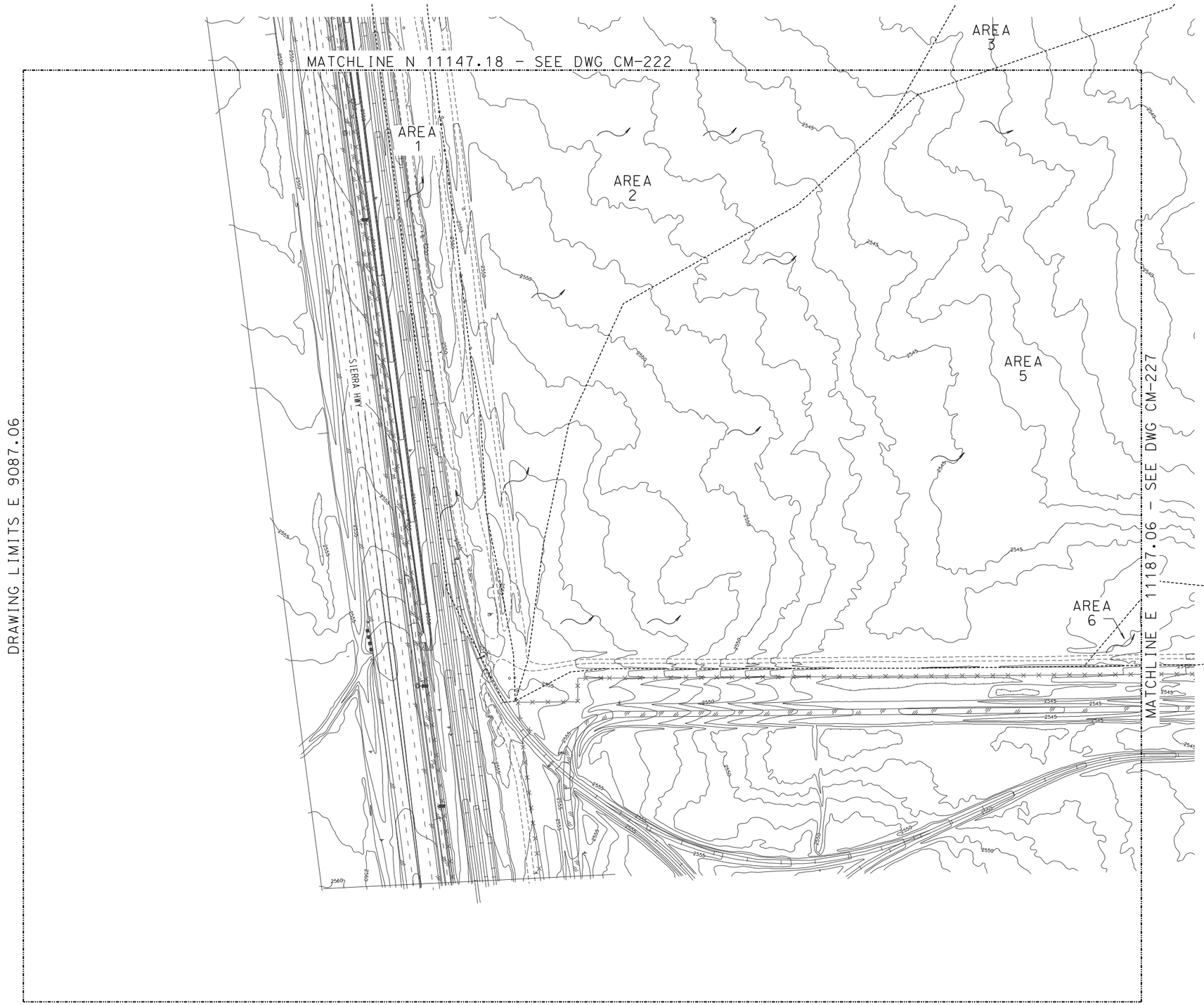
Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-225

PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23



100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE POWER PROJECT

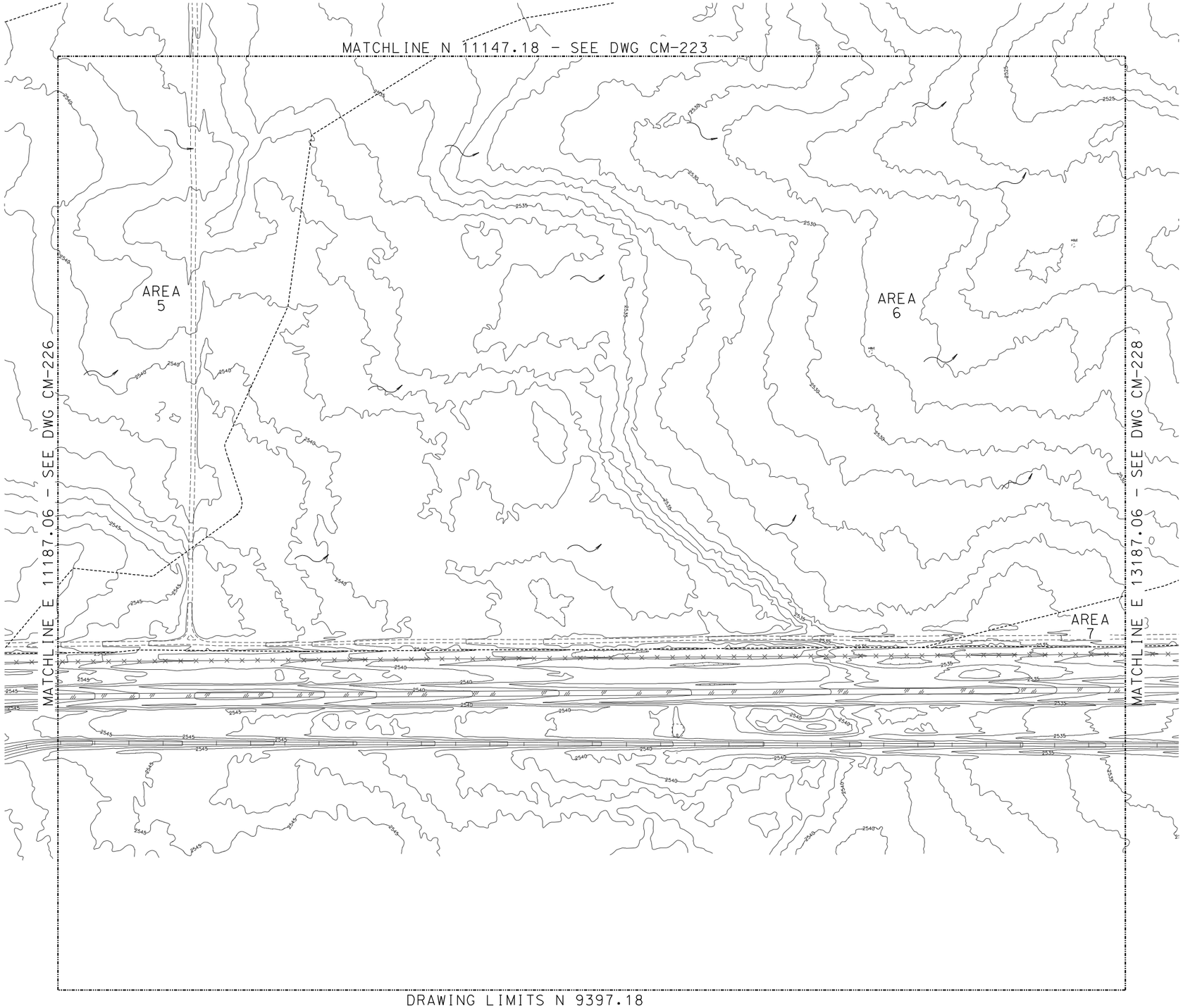
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-226



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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PALMDALE COMBINED CYCLE
POWER PROJECT

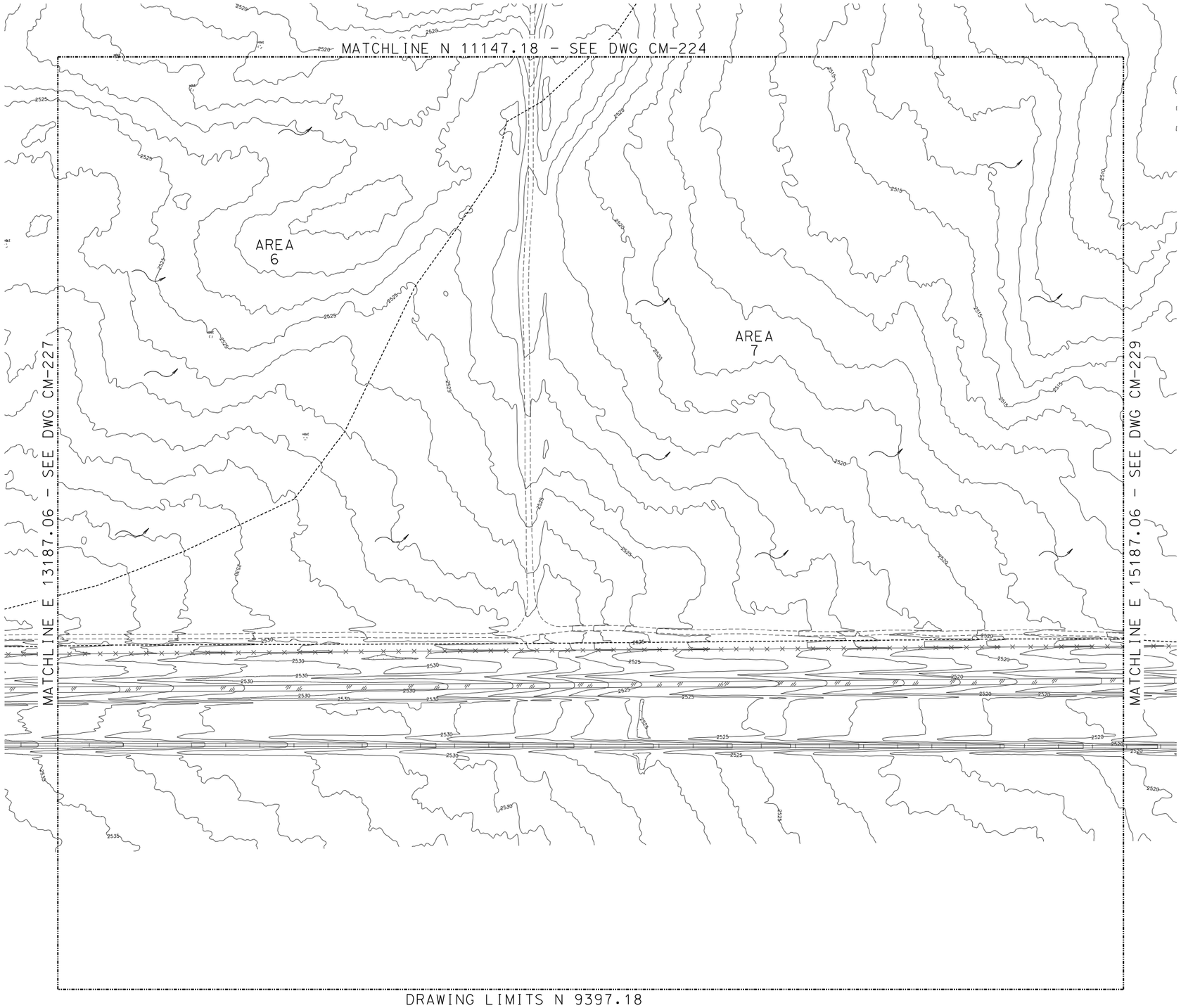
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-227



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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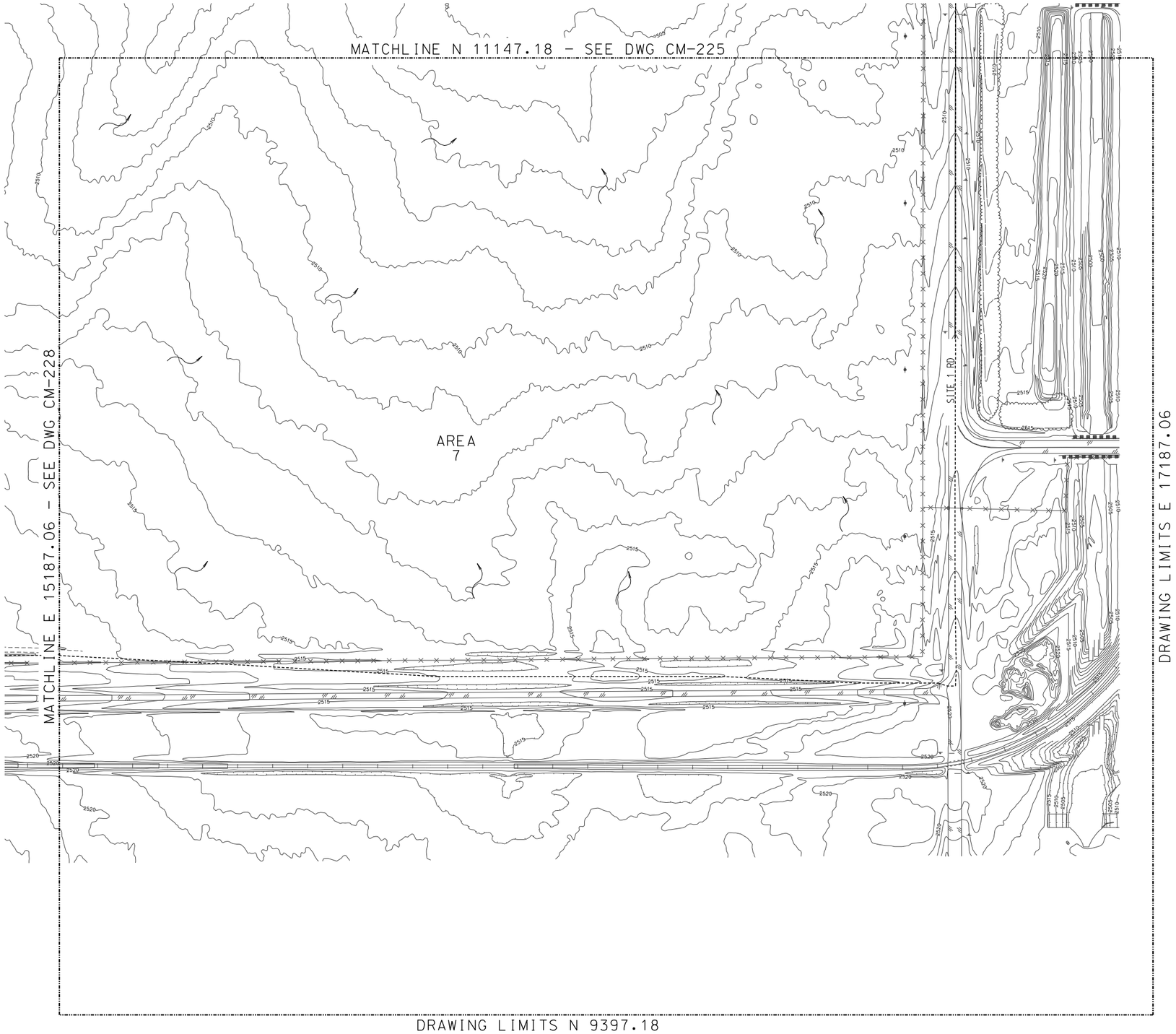
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER

2007-021-CM-228



PRE - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	141.09	63	0.19	19.67
3	76.90	63	0.10	13.29
4	54.78	63	0.07	13.35
5	73.60	63	0.10	14.72
6	96.81	63	0.13	20.57
7	179.17	63	0.24	31.59
8	6.00	63	0.01	1.23

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

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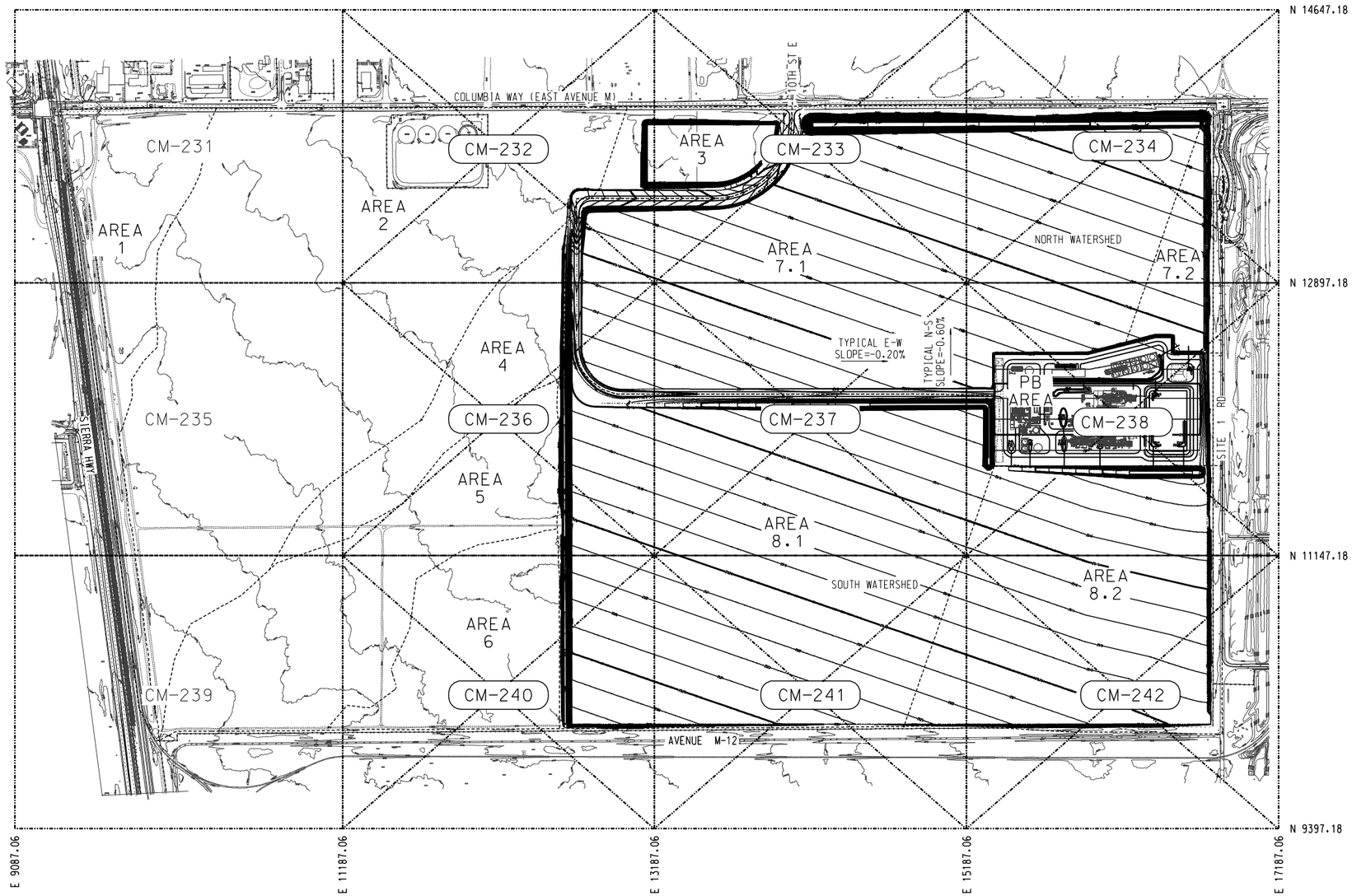
Lenexa, Kansas 66214

PRE DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-229

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04



400 0 400 800
SCALE IN FEET
SCALE: 1" = 400'

N

– PRELIMINARY –
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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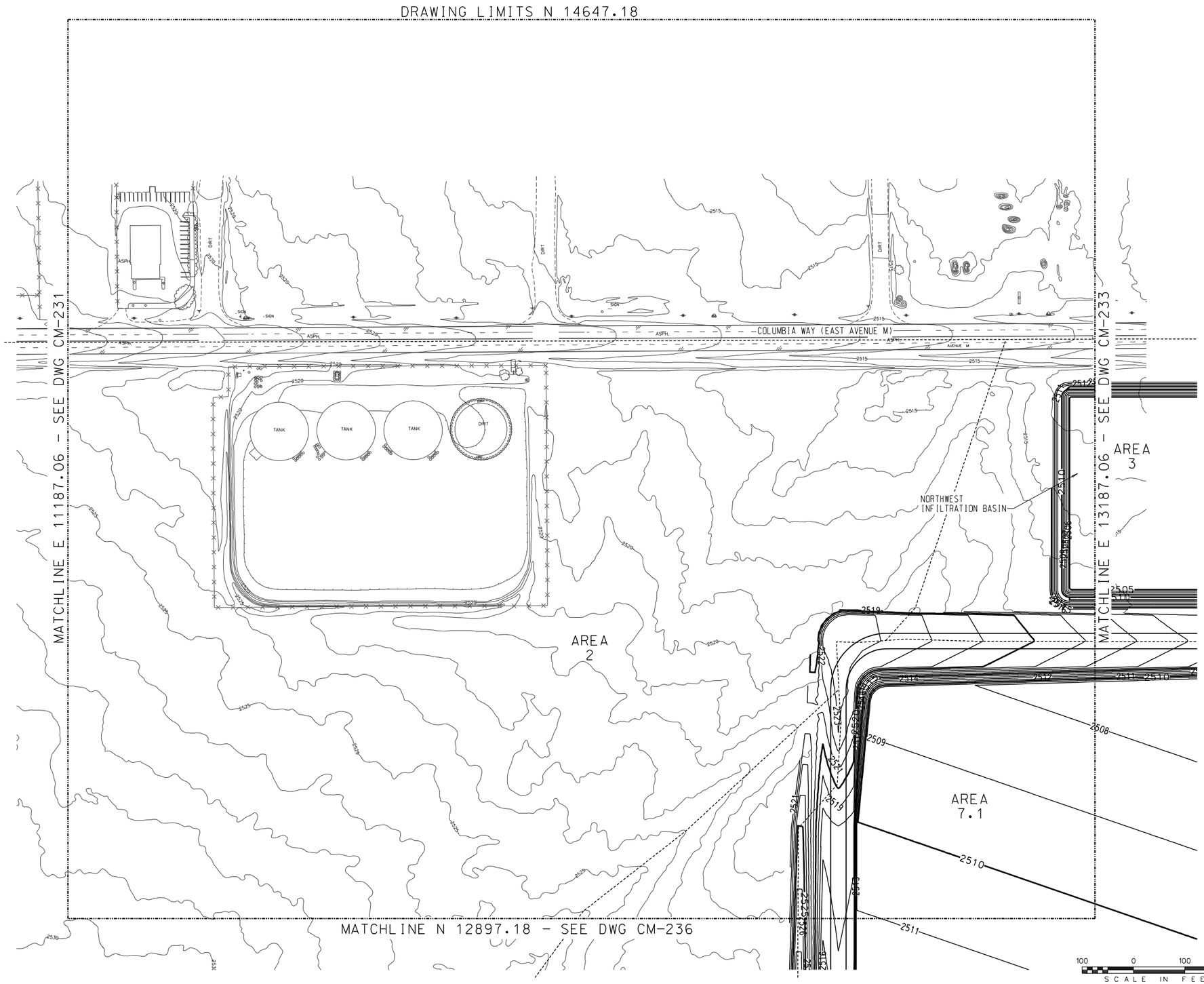
Lenexa, Kansas 66214

POST DEVELOPEMENT DRAINAGE

	by	date
DESIGNED	SAG	04-21-08
DRAWN	SAG	04-21-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-230

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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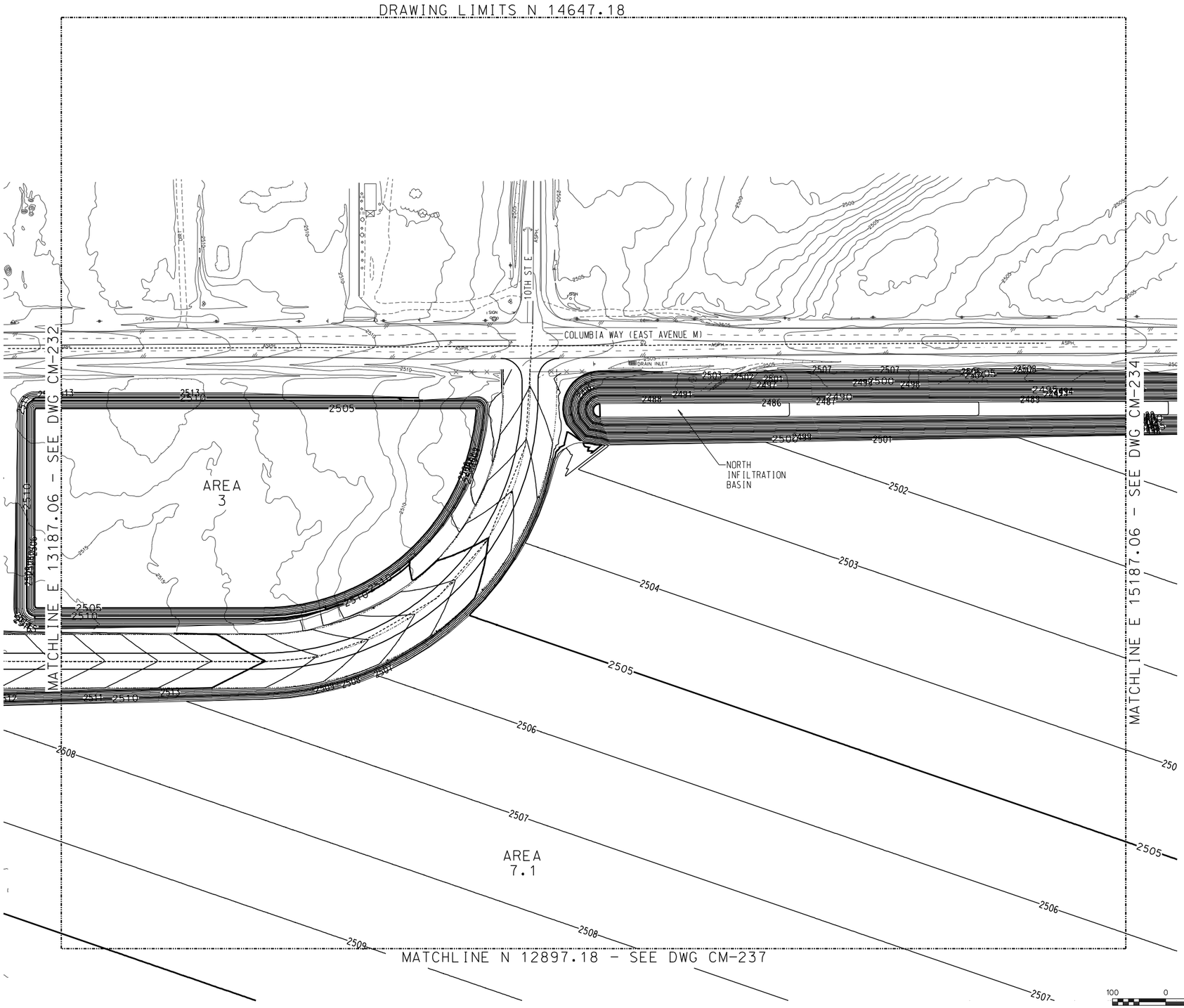
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-232

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04



SCALE: 1" = 100'-0"

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
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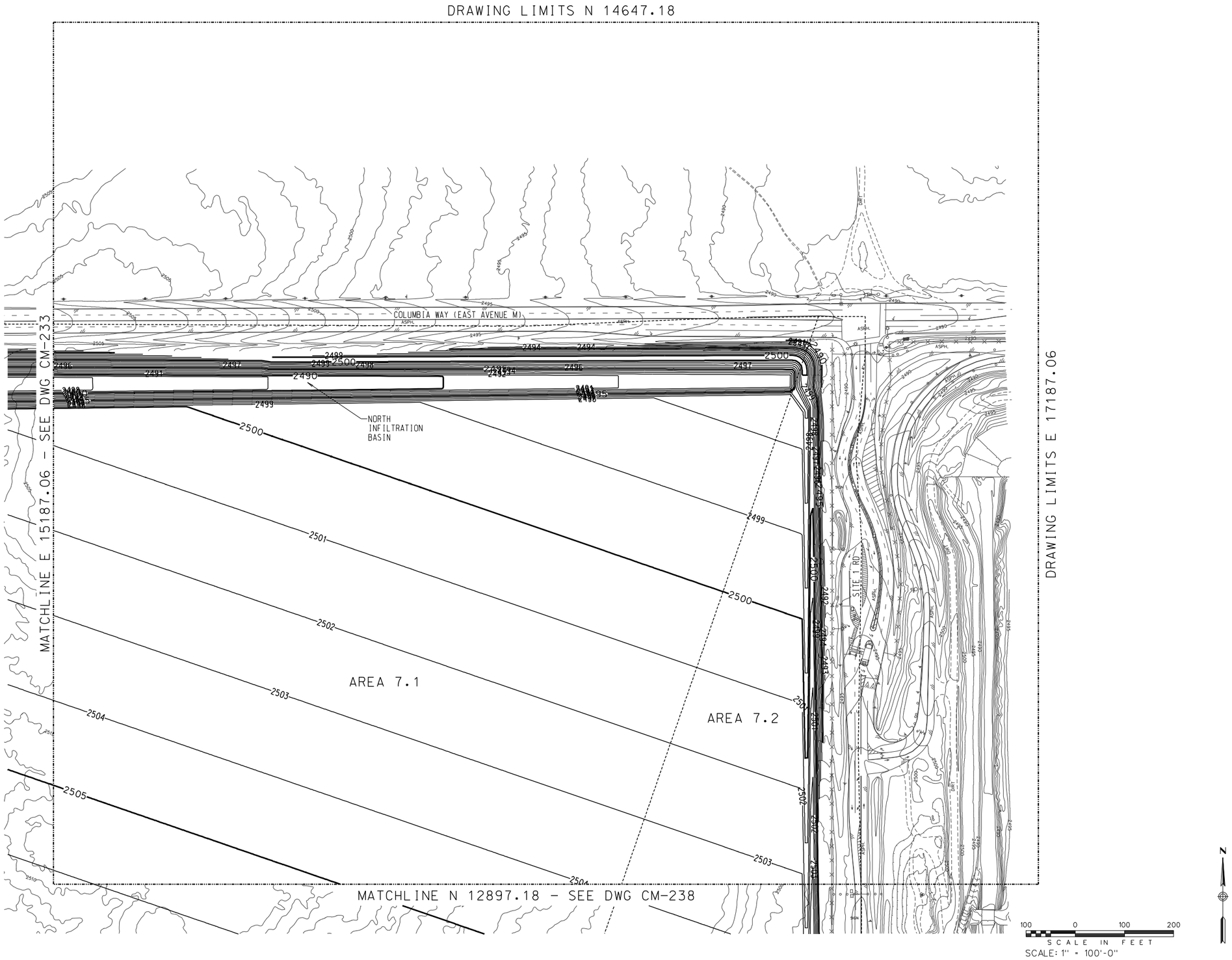
POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-233

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04



- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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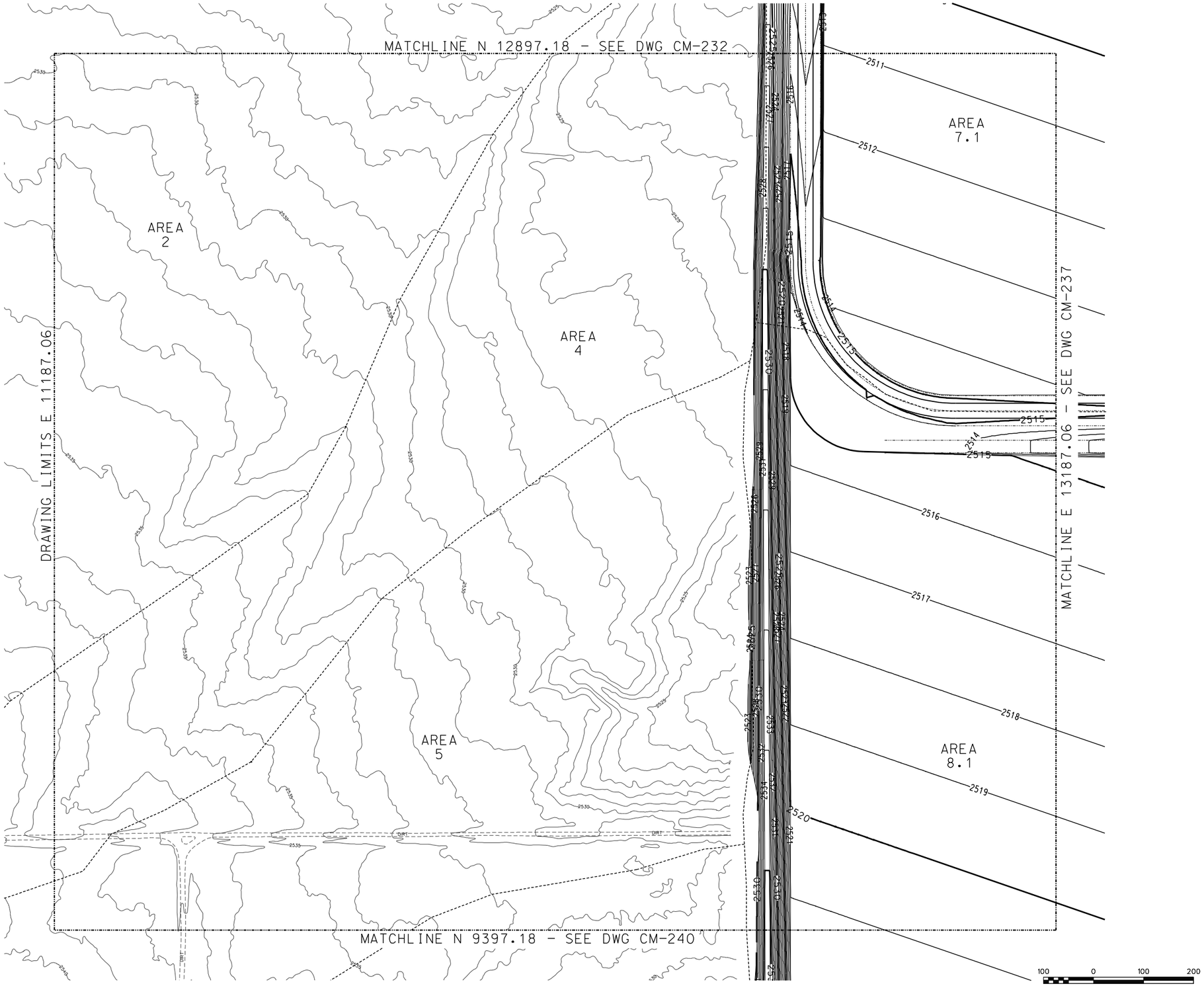
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-234



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

KIEWIT INDUSTRIAL CO.
A Kiewit Company

INLAND ENERGY

PALMDALE COMBINED CYCLE
POWER PROJECT

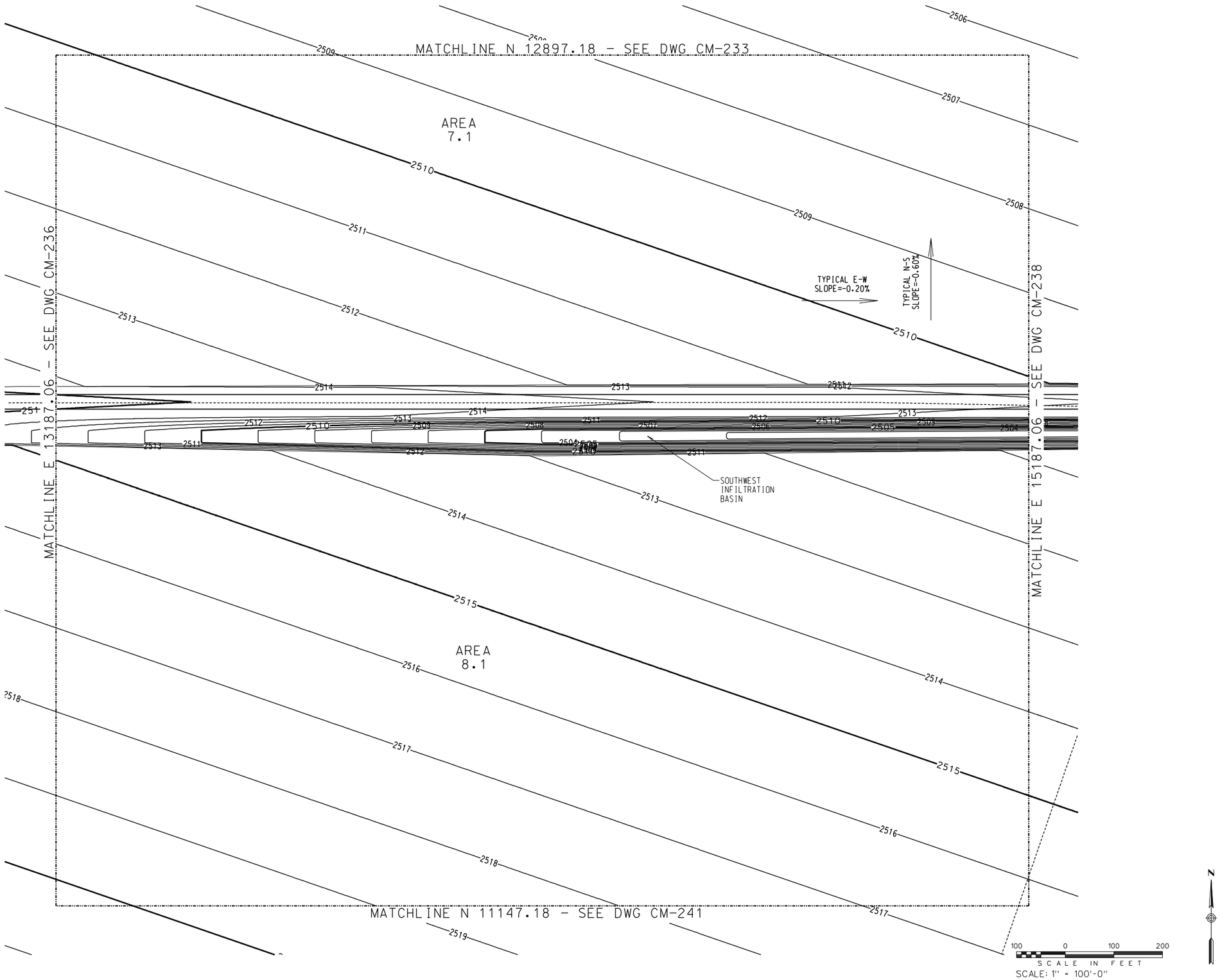
Kiewit

Kiewit Power
8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-236



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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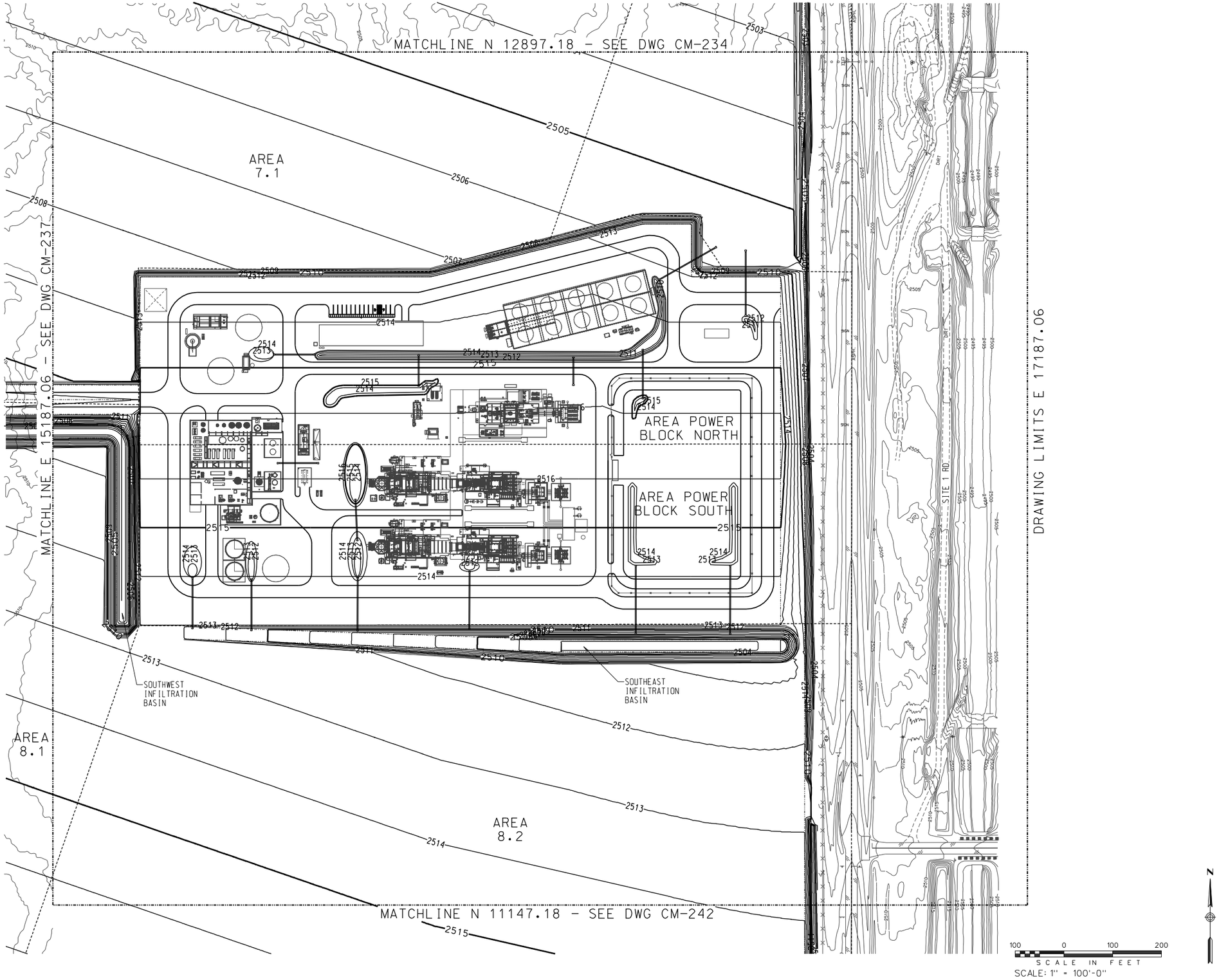
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-237



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-238

POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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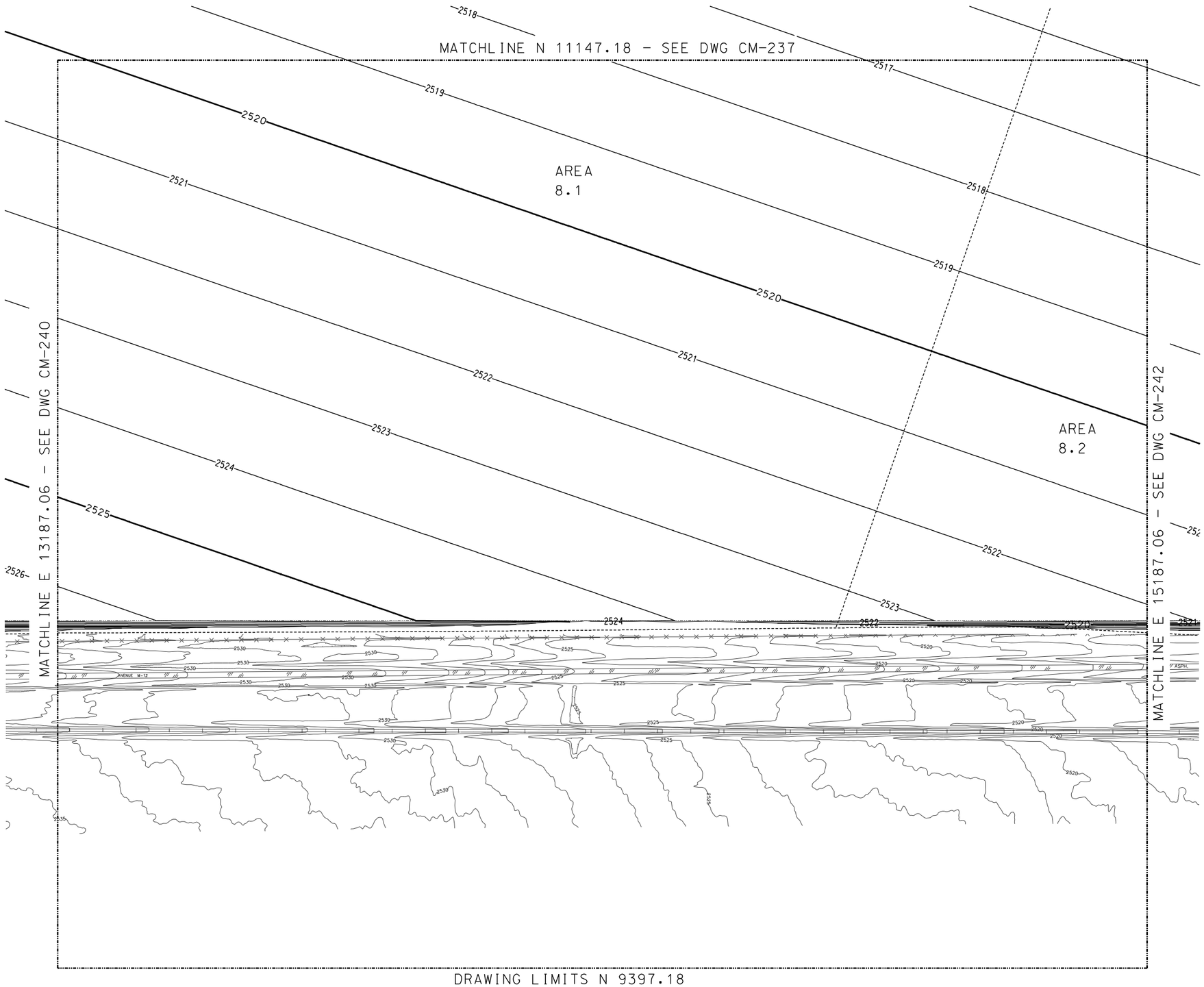
POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-240



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV.	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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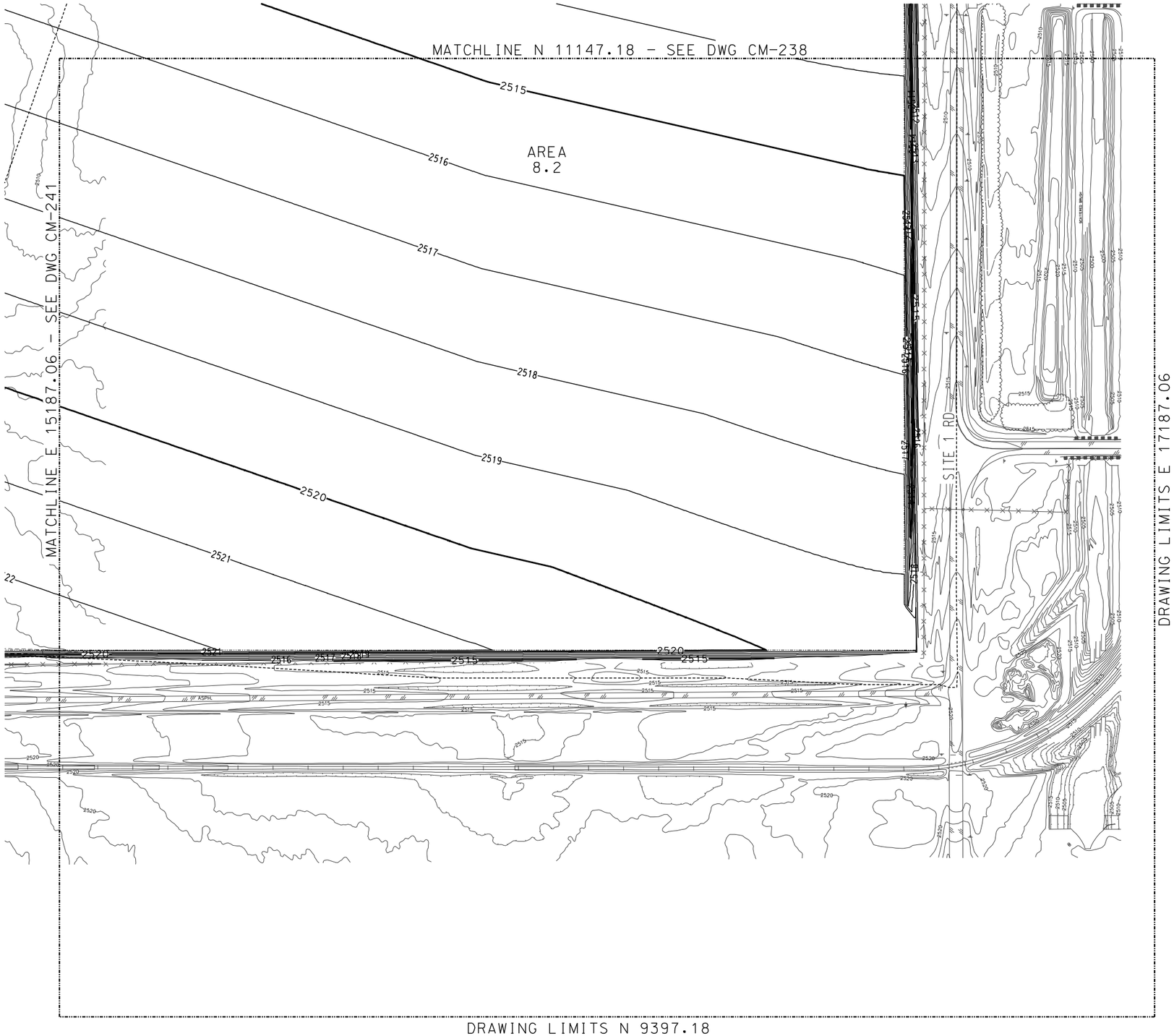
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-241



POST - DEVELOPMENT SITE DRAINAGE MAP				
Area	Acres	CN	Q 2, cfs	Q 100, cfs
1	30.25	63	0.04	5.89
2	140.99	63	0.19	23.38
3	14.35	63	0.02	4.64
4	23.57	63	0.03	5.75
5	51.90	63	0.07	17.62
6	28.00	63	0.04	9.05
7.1	136.95	85	14.72	116.35
7.2	12.57	85	1.91	14.84
8.1	126.47	85	13.59	107.45
8.2	68.22	85	8.06	63.42
Power Block North	13.38	98	10.49	30.14
Power Block South	11.96	98	11.87	34.04

100 0 100 200
SCALE IN FEET
SCALE: 1" = 100'-0"

N

- PRELIMINARY -
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DWN	CHK	APP	DATE
A	ISSUED FOR REVIEW	SAG	MTW	MAA	06-26-08

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POWER PROJECT

Kiewit

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8455 Lenexa Drive
Lenexa, Kansas 66214

POST DEVELOPMENT DRAINAGE

	by	date
DESIGNED	SAG	05-05-08
DRAWN	SAG	05-05-08
CHECKED	MAA	06-20-08
APPROVED	AHG	06-25-08

DRAWING NUMBER
2007-021-CM-242

Appendix B

Pre-Development Drainage Calculations

Hydraflow Table of Contents

Palmdale Pre Dev June2008.gpw

Hydraflow Hydrographs by Intelisolve v9.23

Wednesday, Jun 25, 2008

Hydrograph Return Period Recap 1

2 - Year

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Hydrograph Return Period Recap

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SCS Runoff	-------	0.000	0.041	-------	-------	0.504	1.631	3.392	5.892	Area 1
2	SCS Runoff	-------	0.000	0.191	-------	-------	2.335	6.278	11.95	19.67	Area 2
3	SCS Runoff	-------	0.000	0.104	-------	-------	1.273	3.866	7.806	13.29	Area 3
4	SCS Runoff	-------	0.000	0.074	-------	-------	0.909	3.314	7.498	13.35	Area 4
5	SCS Runoff	-------	0.000	0.099	-------	-------	1.220	4.016	8.421	14.72	Area 5
6	SCS Runoff	-------	0.000	0.132	-------	-------	1.616	5.474	11.67	20.57	Area 6
7	SCS Runoff	-------	0.000	0.241	-------	-------	2.952	9.094	18.48	31.59	Area 7
8	SCS Runoff	-------	0.000	0.008	-------	-------	0.099	0.331	0.702	1.233	Area 8
9	Reservoir	5	0.000	0.000	-------	-------	0.000	0.000	0.000	0.000	Area 5 Ponding
10	Reservoir	6	0.000	0.000	-------	-------	0.000	0.000	0.000	0.000	Area 6 ponding
11	Reservoir	2	0.000	0.000	-------	-------	2.241	5.521	11.57	18.47	Area 2 ponding
12	Combine	3, 11	0.000	0.104	-------	-------	3.432	8.356	16.80	27.89	Area 2 overflow + Area 3
13	Reservoir	12	0.000	0.000	-------	-------	0.000	0.000	0.000	0.000	Area 3 Ponding
14	Reservoir	8	0.000	0.000	-------	-------	0.000	0.000	0.000	0.000	Area 8 ponding
15	Reservoir	1	0.000	0.000	-------	-------	0.000	0.000	0.000	0.000	Area 1 ponding
16	Combine	4, 7,	0.000	0.315	-------	-------	3.860	11.60	24.28	42.09	Area 4 + 7
17	Reservoir	16	0.000	0.000	-------	-------	0.000	0.000	0.000	0.000	Area 4,7 Ponding

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	0.041	1	1363	842	----	------	------	Area 1
2	SCS Runoff	0.191	1	1385	3,915	----	------	------	Area 2
3	SCS Runoff	0.104	1	1369	2,127	----	------	------	Area 3
4	SCS Runoff	0.074	1	1354	1,515	----	------	------	Area 4
5	SCS Runoff	0.099	1	1361	2,036	----	------	------	Area 5
6	SCS Runoff	0.132	1	1359	2,696	----	------	------	Area 6
7	SCS Runoff	0.241	1	1368	4,932	----	------	------	Area 7
8	SCS Runoff	0.008	1	1360	165	----	------	------	Area 8
9	Reservoir	0.000	1	n/a	0	5	2511.03	2,036	Area 5 Ponding
10	Reservoir	0.000	1	n/a	0	6	2511.09	2,696	Area 6 ponding
11	Reservoir	0.000	1	n/a	0	2	2515.16	3,915	Area 2 ponding
12	Combine	0.104	1	1369	2,127	3, 11	------	------	Area 2 overflow + Area 3
13	Reservoir	0.000	1	n/a	0	12	2503.68	2,127	Area 3 Ponding
14	Reservoir	0.000	1	n/a	0	8	2507.01	165	Area 8 ponding
15	Reservoir	0.000	1	n/a	0	1	2527.03	842	Area 1 ponding
16	Combine	0.315	1	1364	6,448	4, 7,	------	------	Area 4 + 7
17	Reservoir	0.000	1	n/a	0	16	2489.43	6,448	Area 4,7 Ponding

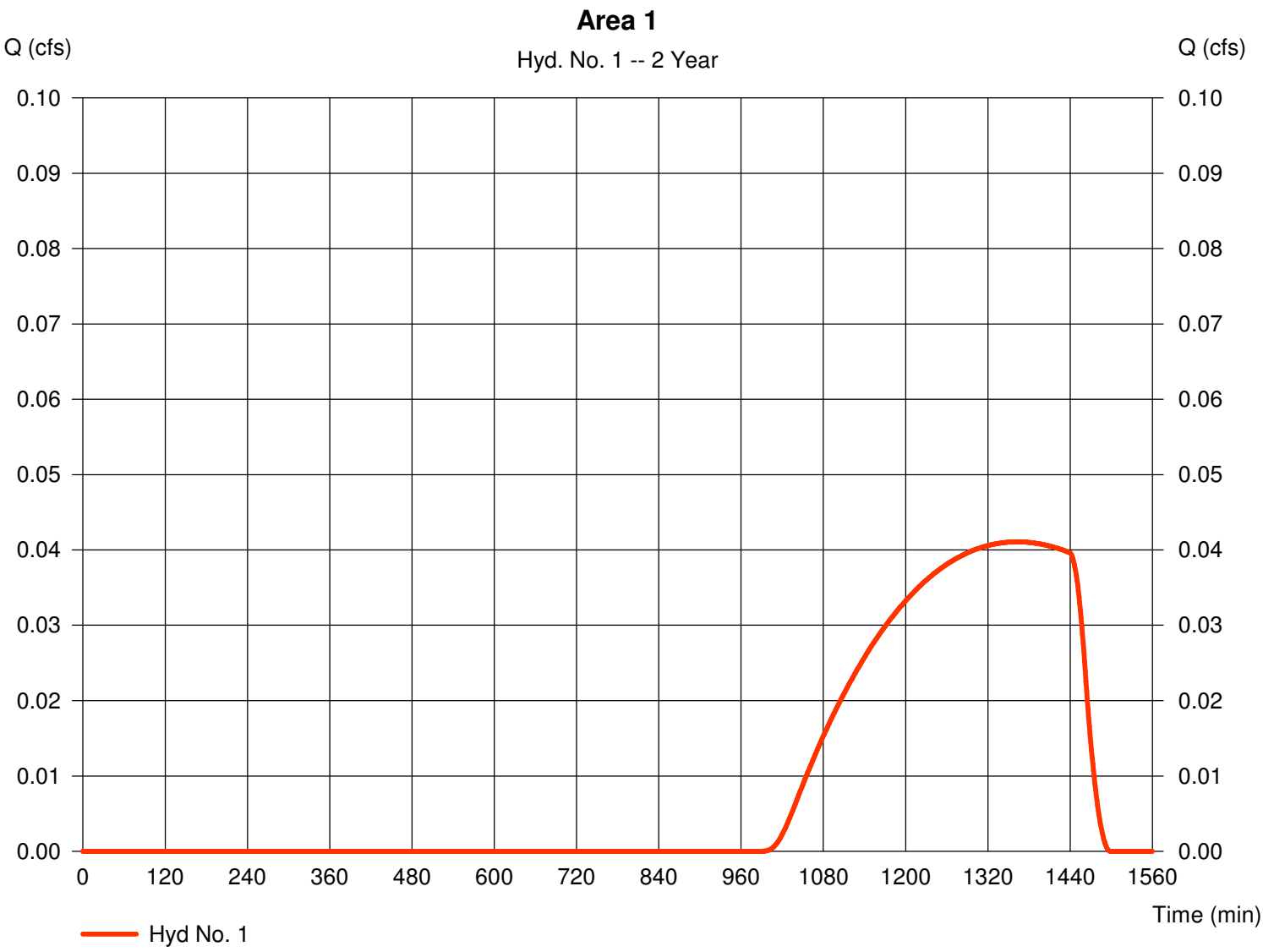
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 1

Area 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.041 cfs
Storm frequency	=	2 yrs	Time to peak	=	1363 min
Time interval	=	1 min	Hyd. volume	=	842 cuft
Drainage area	=	30.250 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	36.70 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 1

Area 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.60		0.00		0.00		
Travel Time (min)	**=**	**5.92**	**+**	**0.00**	**+**	**0.00**	**=**	**5.92**
Shallow Concentrated Flow								
Flow length (ft)	=	1670.00		0.00		0.00		
Watercourse slope (%)	=	0.60		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.25		0.00		0.00		
Travel Time (min)	**=**	**22.27**	**+**	**0.00**	**+**	**0.00**	**=**	**22.27**
Channel Flow								
X sectional flow area (sqft)	=	130.00		10.00		0.00		
Wetted perimeter (ft)	=	130.00		0.00		0.00		
Channel slope (%)	=	0.60		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	4.44		0.00		0.00		
Flow length (ft)	=	2279.0		250.0		0.0		
Travel Time (min)	**=**	**8.56**	**+**	**0.00**	**+**	**0.00**	**=**	**8.56**

Total Travel Time, Tc ..... 36.70 min

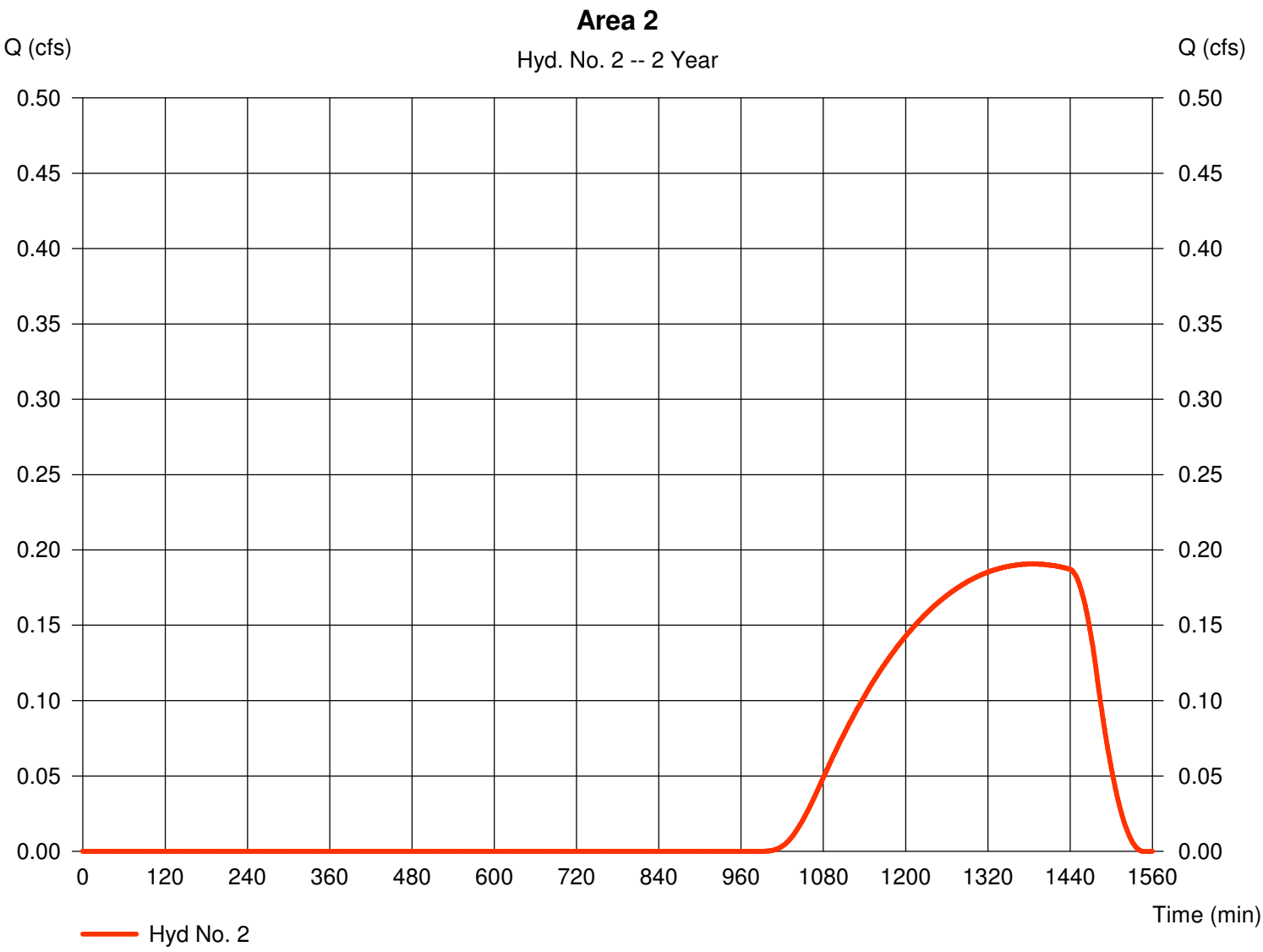
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 2

Area 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.191 cfs
Storm frequency	=	2 yrs	Time to peak	=	1385 min
Time interval	=	1 min	Hyd. volume	=	3,915 cuft
Drainage area	=	141.090 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	67.20 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 2

Area 2

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.90		0.00		0.00		
Travel Time (min)	**=**	**5.04**	**+**	**0.00**	**+**	**0.00**	**=**	**5.04**
Shallow Concentrated Flow								
Flow length (ft)	=	4735.00		0.00		0.00		
Watercourse slope (%)	=	0.90		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.53		0.00		0.00		
Travel Time (min)	**=**	**51.56**	**+**	**0.00**	**+**	**0.00**	**=**	**51.56**
Channel Flow								
X sectional flow area (sqft)	=	130.00		200.00		0.00		
Wetted perimeter (ft)	=	130.00		200.00		0.00		
Channel slope (%)	=	0.90		0.90		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	5.44		5.44		0.00		
Flow length (ft)	=	2000.0		1444.0		0.0		
Travel Time (min)	**=**	**6.13**	**+**	**4.43**	**+**	**0.00**	**=**	**10.56**

Total Travel Time, Tc ..... 67.20 min

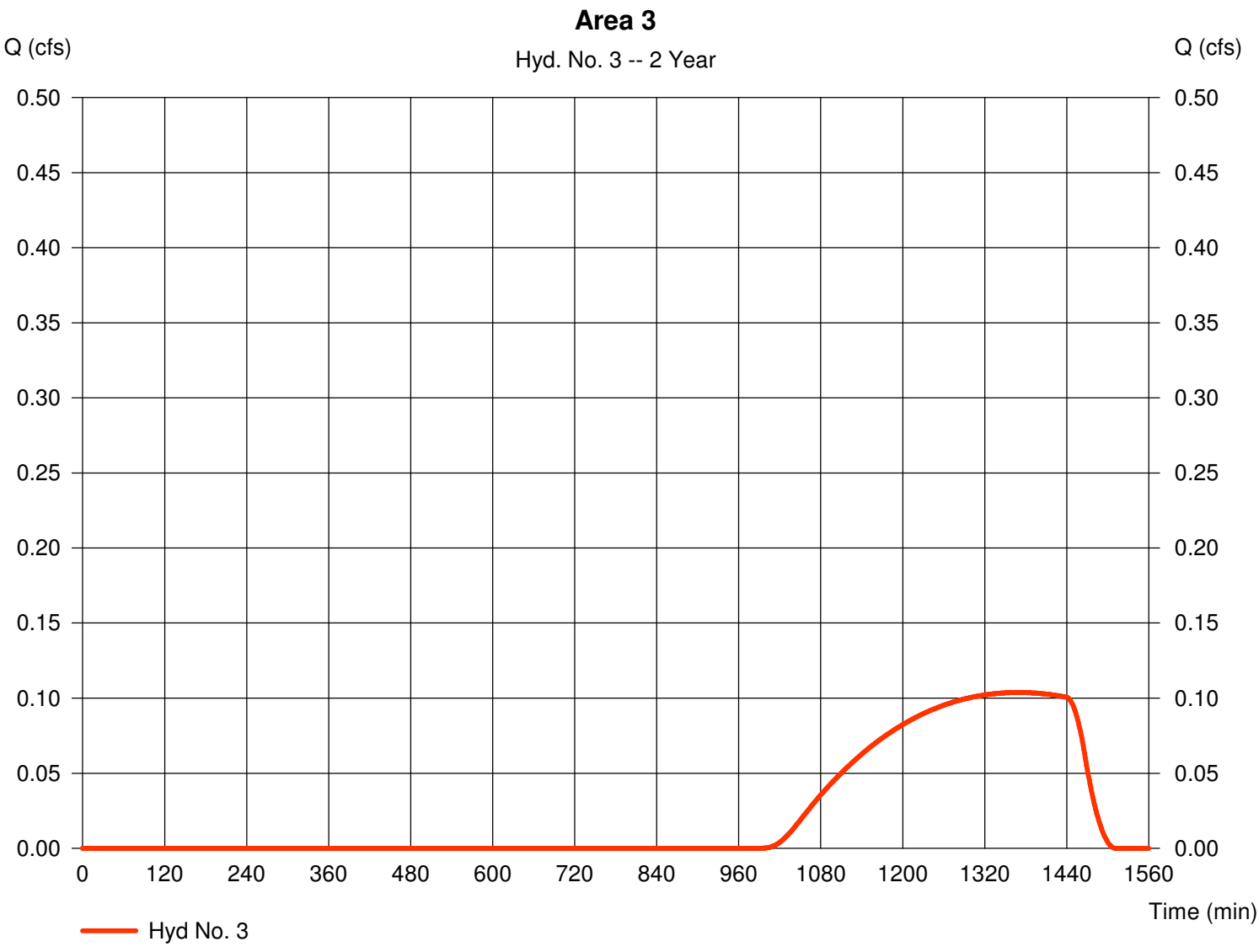
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 3

Area 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.104 cfs
Storm frequency	=	2 yrs	Time to peak	=	1369 min
Time interval	=	1 min	Hyd. volume	=	2,127 cuft
Drainage area	=	76.900 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	44.50 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 3

Area 3

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.80		0.00		0.00		
Travel Time (min)	**=**	**5.28**	**+**	**0.00**	**+**	**0.00**	**=**	**5.28**
Shallow Concentrated Flow								
Flow length (ft)	=	3140.00		0.00		0.00		
Watercourse slope (%)	=	0.80		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.44		0.00		0.00		
Travel Time (min)	**=**	**36.26**	**+**	**0.00**	**+**	**0.00**	**=**	**36.26**
Channel Flow								
X sectional flow area (sqft)	=	130.00		0.00		0.00		
Wetted perimeter (ft)	=	130.00		0.00		0.00		
Channel slope (%)	=	0.80		0.00		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	5.13		0.00		0.00		
Flow length (ft)	=	913.0		0.0		0.0		
Travel Time (min)	**=**	**2.97**	**+**	**0.00**	**+**	**0.00**	**=**	**2.97**

Total Travel Time, Tc ..... 44.50 min

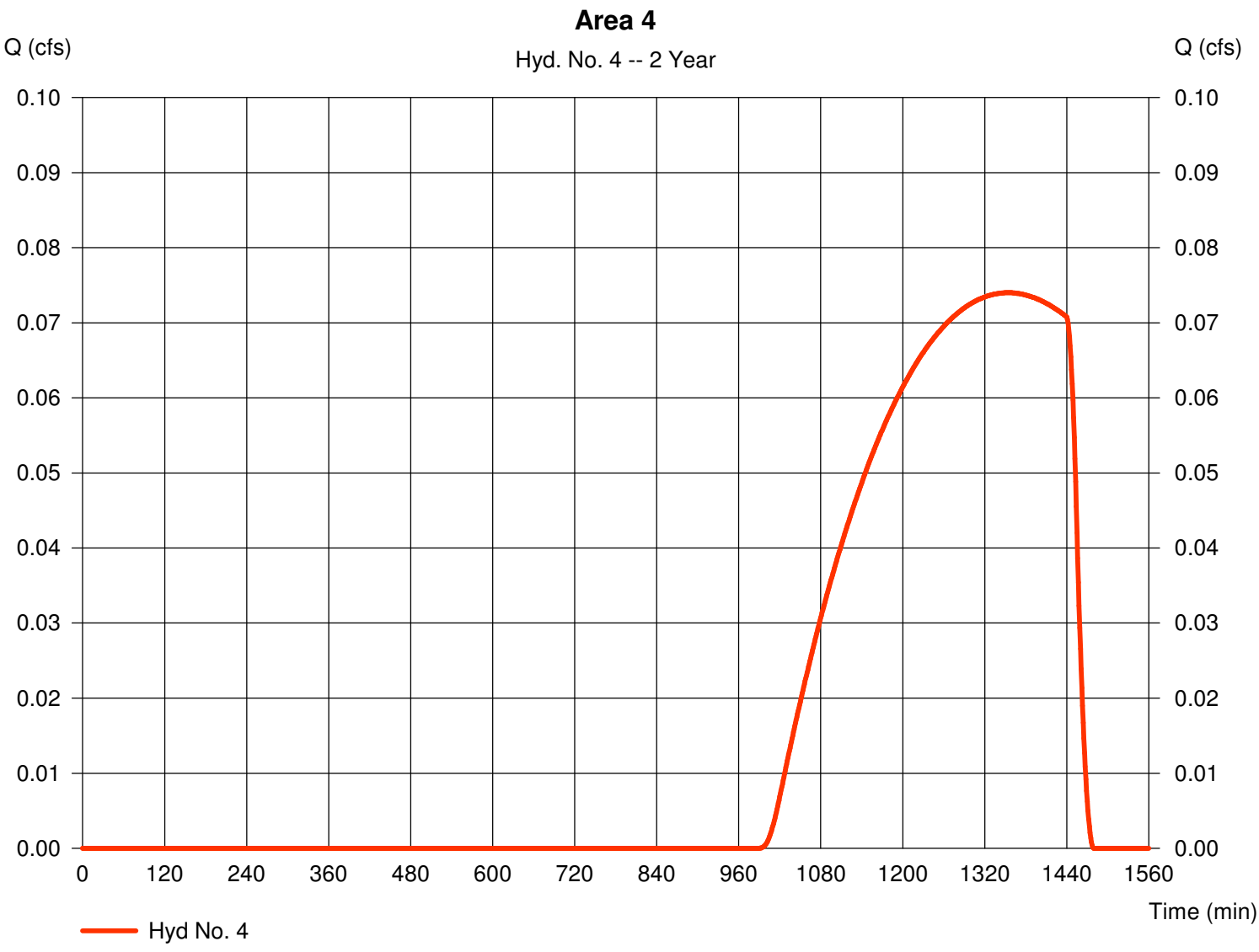
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 4

Area 4

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.074 cfs
Storm frequency	=	2 yrs	Time to peak	=	1354 min
Time interval	=	1 min	Hyd. volume	=	1,515 cuft
Drainage area	=	54.780 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	23.80 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 4

Area 4

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**4.65**	**+**	**0.00**	**+**	**0.00**	**=**	**4.65**
Shallow Concentrated Flow								
Flow length (ft)	=	1601.00		0.00		0.00		
Watercourse slope (%)	=	1.10		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.69		0.00		0.00		
Travel Time (min)	**=**	**15.77**	**+**	**0.00**	**+**	**0.00**	**=**	**15.77**
Channel Flow								
X sectional flow area (sqft)	=	70.00		0.00		0.00		
Wetted perimeter (ft)	=	70.00		0.00		0.00		
Channel slope (%)	=	1.10		0.00		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	6.01		0.00		0.00		
Flow length (ft)	=	1220.0		0.0		0.0		
Travel Time (min)	**=**	**3.38**	**+**	**0.00**	**+**	**0.00**	**=**	**3.38**

Total Travel Time, Tc ..... 23.80 min

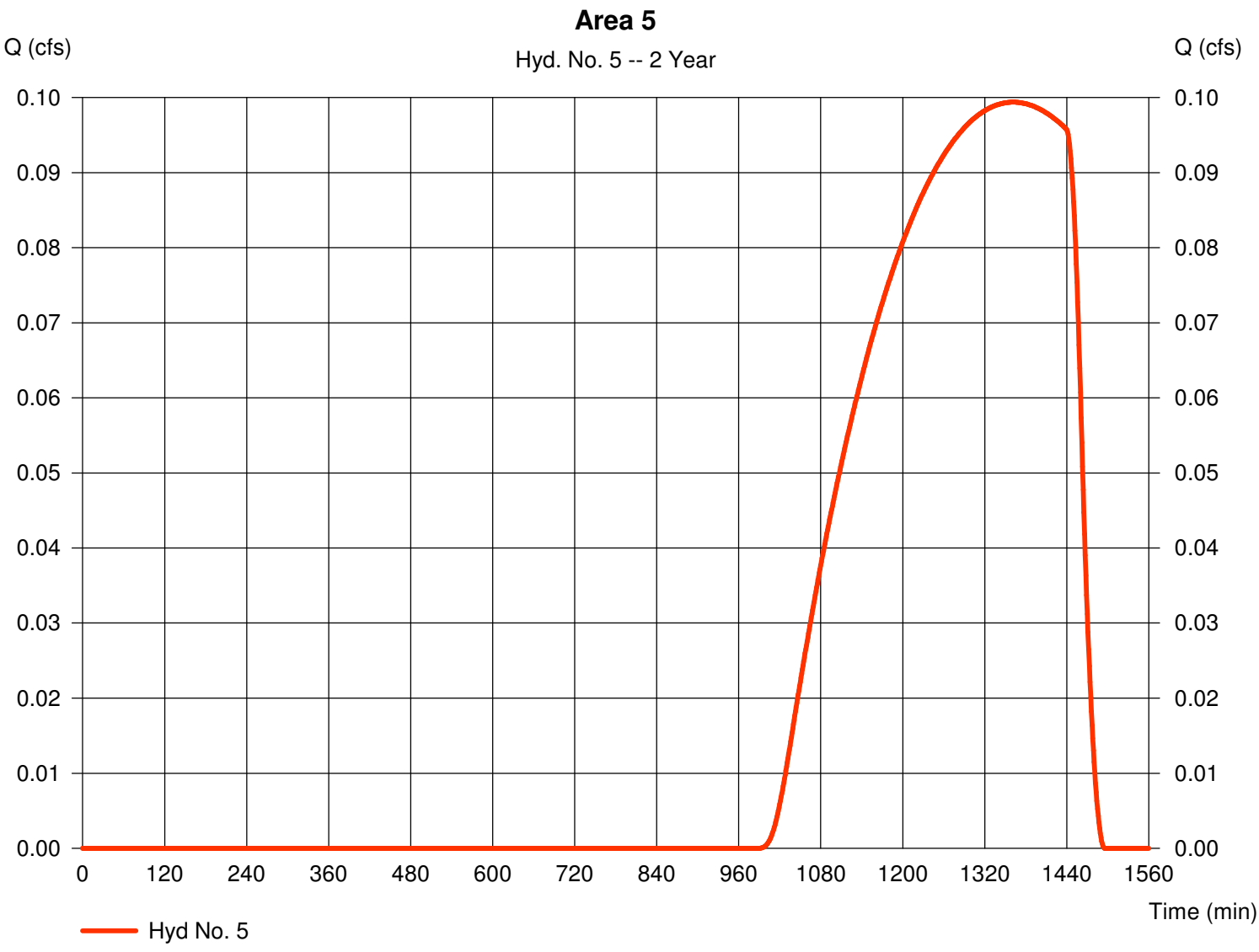
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 5

Area 5

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.099 cfs
Storm frequency	=	2 yrs	Time to peak	=	1361 min
Time interval	=	1 min	Hyd. volume	=	2,036 cuft
Drainage area	=	73.600 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	34.40 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 5

Area 5

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.90		0.00		0.00		
Travel Time (min)	**=**	**5.04**	**+**	**0.00**	**+**	**0.00**	**=**	**5.04**
Shallow Concentrated Flow								
Flow length (ft)	=	2404.00		0.00		0.00		
Watercourse slope (%)	=	0.90		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.53		0.00		0.00		
Travel Time (min)	**=**	**26.18**	**+**	**0.00**	**+**	**0.00**	**=**	**26.18**
Channel Flow								
X sectional flow area (sqft)	=	25.00		0.00		0.00		
Wetted perimeter (ft)	=	25.00		0.00		0.00		
Channel slope (%)	=	1.70		0.00		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	7.47		0.00		0.00		
Flow length (ft)	=	1413.0		0.0		0.0		
Travel Time (min)	**=**	**3.15**	**+**	**0.00**	**+**	**0.00**	**=**	**3.15**

Total Travel Time, Tc ..... 34.40 min

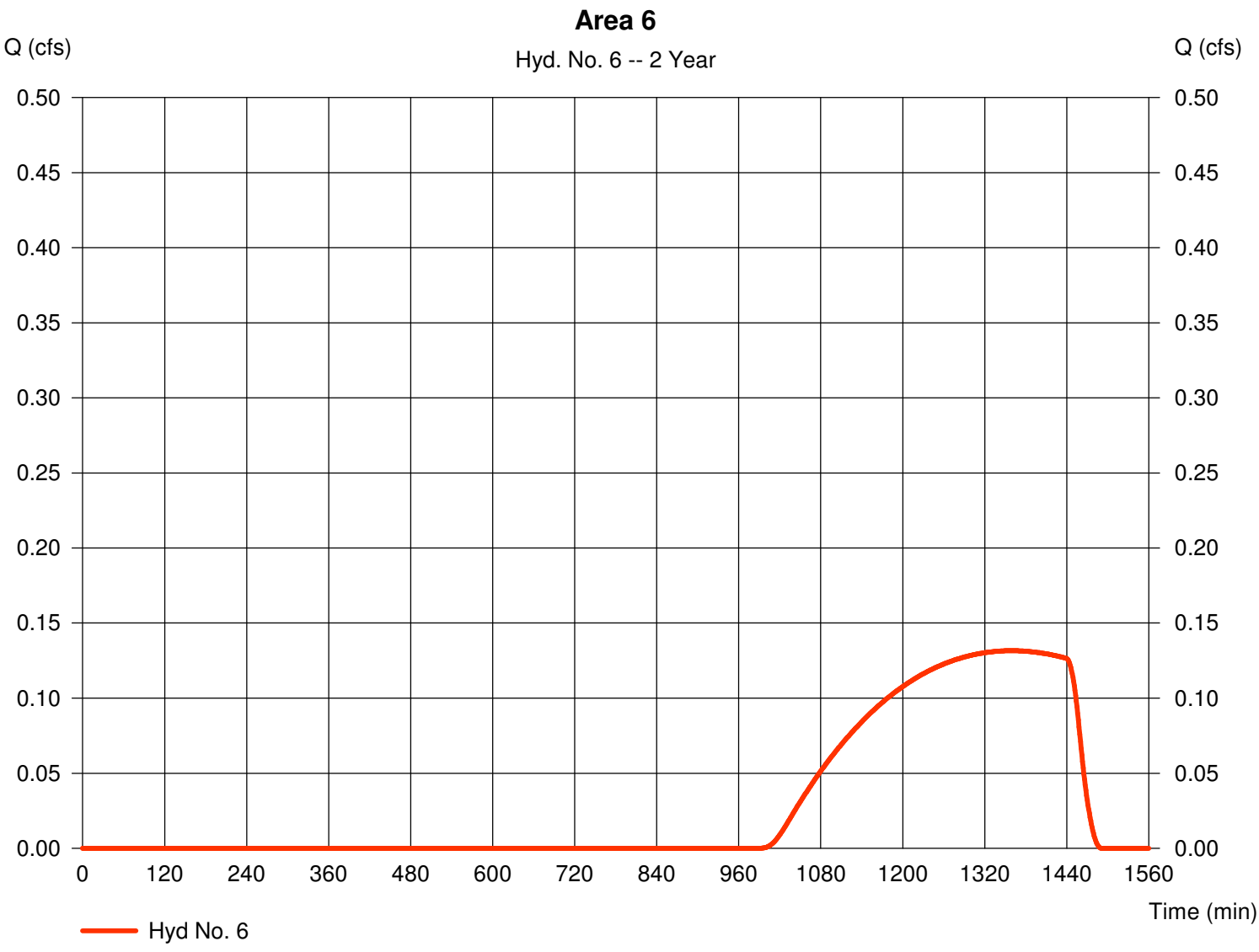
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 6

Area 6

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.132 cfs
Storm frequency	=	2 yrs	Time to peak	=	1359 min
Time interval	=	1 min	Hyd. volume	=	2,696 cuft
Drainage area	=	96.810 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	25.71 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 6

Area 6

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.70		0.00		0.00		
Travel Time (min)	**=**	**5.57**	**+**	**0.00**	**+**	**0.00**	**=**	**5.57**
Shallow Concentrated Flow								
Flow length (ft)	=	1210.00		0.00		0.00		
Watercourse slope (%)	=	0.70		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.35		0.00		0.00		
Travel Time (min)	**=**	**14.94**	**+**	**0.00**	**+**	**0.00**	**=**	**14.94**
Channel Flow								
X sectional flow area (sqft)	=	70.00		0.00		0.00		
Wetted perimeter (ft)	=	70.00		0.00		0.00		
Channel slope (%)	=	0.70		0.00		0.00		
Manning's n-value	=	0.013		0.026		0.015		
Velocity (ft/s)	=	9.59		0.00		0.00		
Flow length (ft)	=	2996.0		0.0		0.0		
Travel Time (min)	**=**	**5.21**	**+**	**0.00**	**+**	**0.00**	**=**	**5.21**

Total Travel Time, Tc ..... 25.71 min

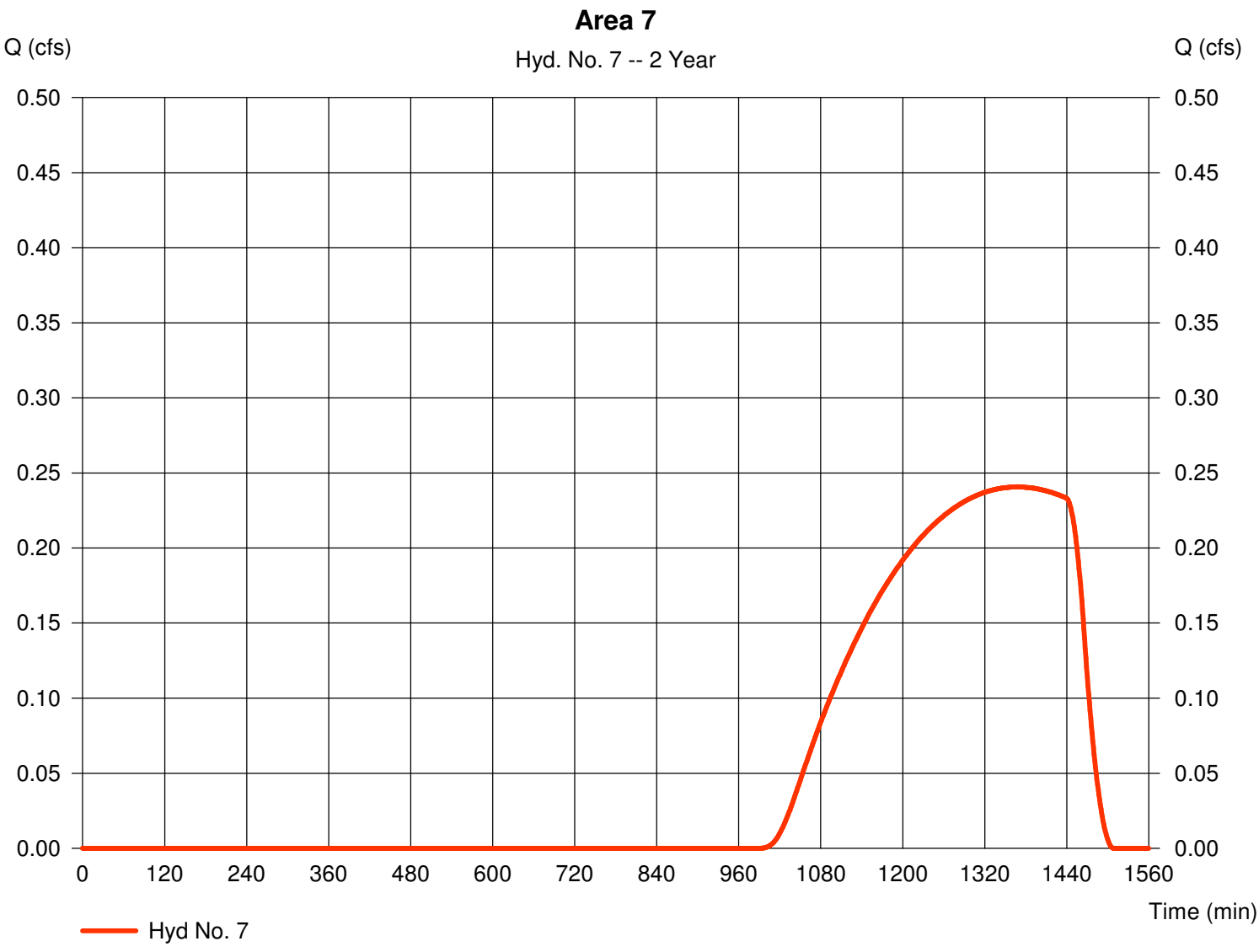
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 7

Area 7

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.241 cfs
Storm frequency	=	2 yrs	Time to peak	=	1368 min
Time interval	=	1 min	Hyd. volume	=	4,932 cuft
Drainage area	=	179.170 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	43.00 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 7

Area 7

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**6.37**	**+**	**0.00**	**+**	**0.00**	**=**	**6.37**
Shallow Concentrated Flow								
Flow length (ft)	=	1727.00		0.00		0.00		
Watercourse slope (%)	=	0.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.14		0.00		0.00		
Travel Time (min)	**=**	**25.23**	**+**	**0.00**	**+**	**0.00**	**=**	**25.23**
Channel Flow								
X sectional flow area (sqft)	=	60.00		0.00		0.00		
Wetted perimeter (ft)	=	65.00		0.00		0.00		
Channel slope (%)	=	1.10		0.00		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	5.70		0.00		0.00		
Flow length (ft)	=	3883.0		0.0		0.0		
Travel Time (min)	**=**	**11.36**	**+**	**0.00**	**+**	**0.00**	**=**	**11.36**

Total Travel Time, Tc ..... 43.00 min

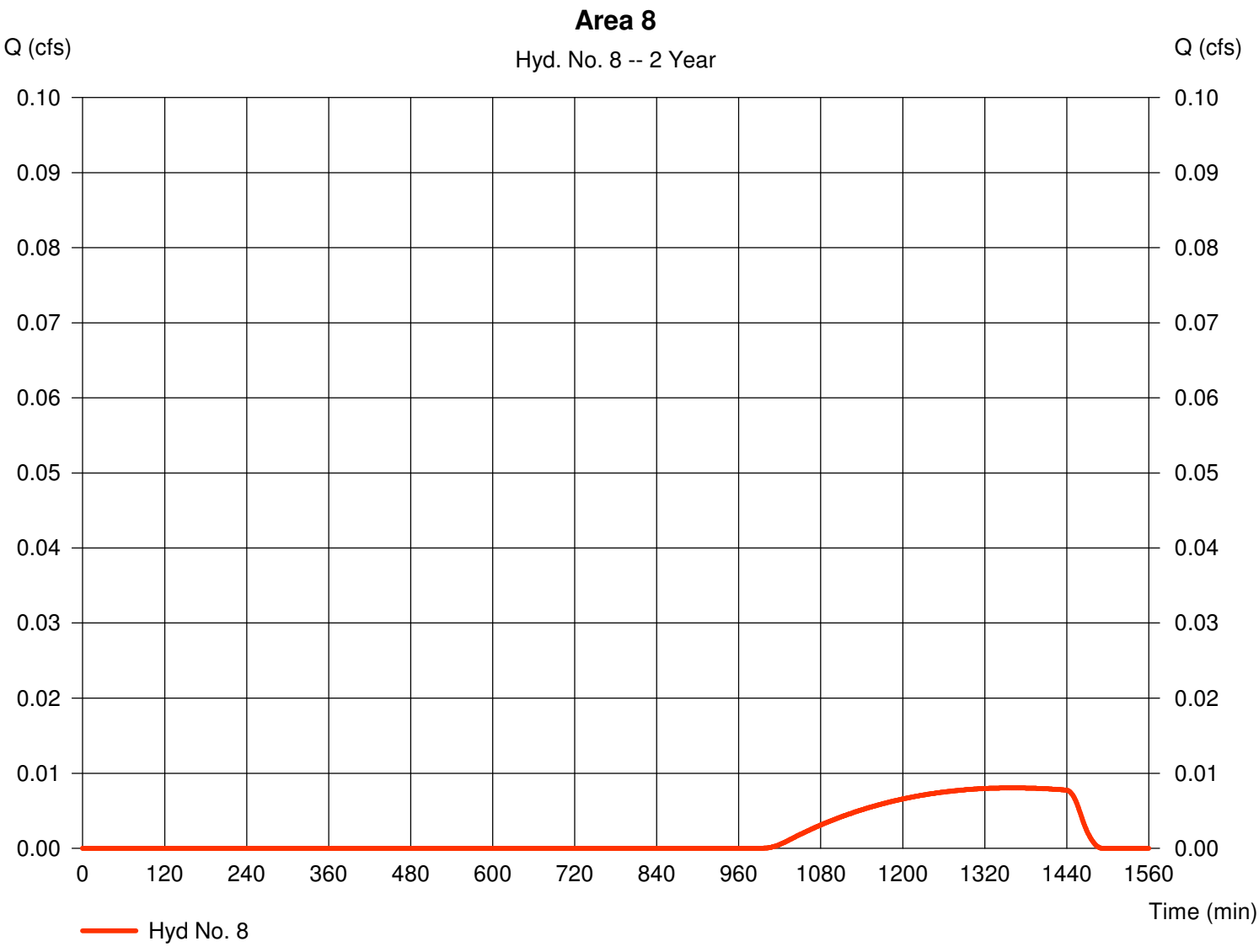
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 8

Area 8

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.008 cfs
Storm frequency	=	2 yrs	Time to peak	=	1360 min
Time interval	=	1 min	Hyd. volume	=	165 cuft
Drainage area	=	6.000 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	33.70 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 8

Area 8

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.70		0.00		0.00		
Travel Time (min)	**=**	**5.57**	**+**	**0.00**	**+**	**0.00**	**=**	**5.57**
Shallow Concentrated Flow								
Flow length (ft)	=	2221.00		0.00		0.00		
Watercourse slope (%)	=	0.70		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.35		0.00		0.00		
Travel Time (min)	**=**	**27.42**	**+**	**0.00**	**+**	**0.00**	**=**	**27.42**
Channel Flow								
X sectional flow area (sqft)	=	70.00		0.00		0.00		
Wetted perimeter (ft)	=	70.00		0.00		0.00		
Channel slope (%)	=	0.70		0.00		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	4.79		0.00		0.00		
Flow length (ft)	=	200.0		0.0		0.0		
Travel Time (min)	**=**	**0.70**	**+**	**0.00**	**+**	**0.00**	**=**	**0.70**

Total Travel Time, Tc ..... 33.70 min

Hydrograph Report

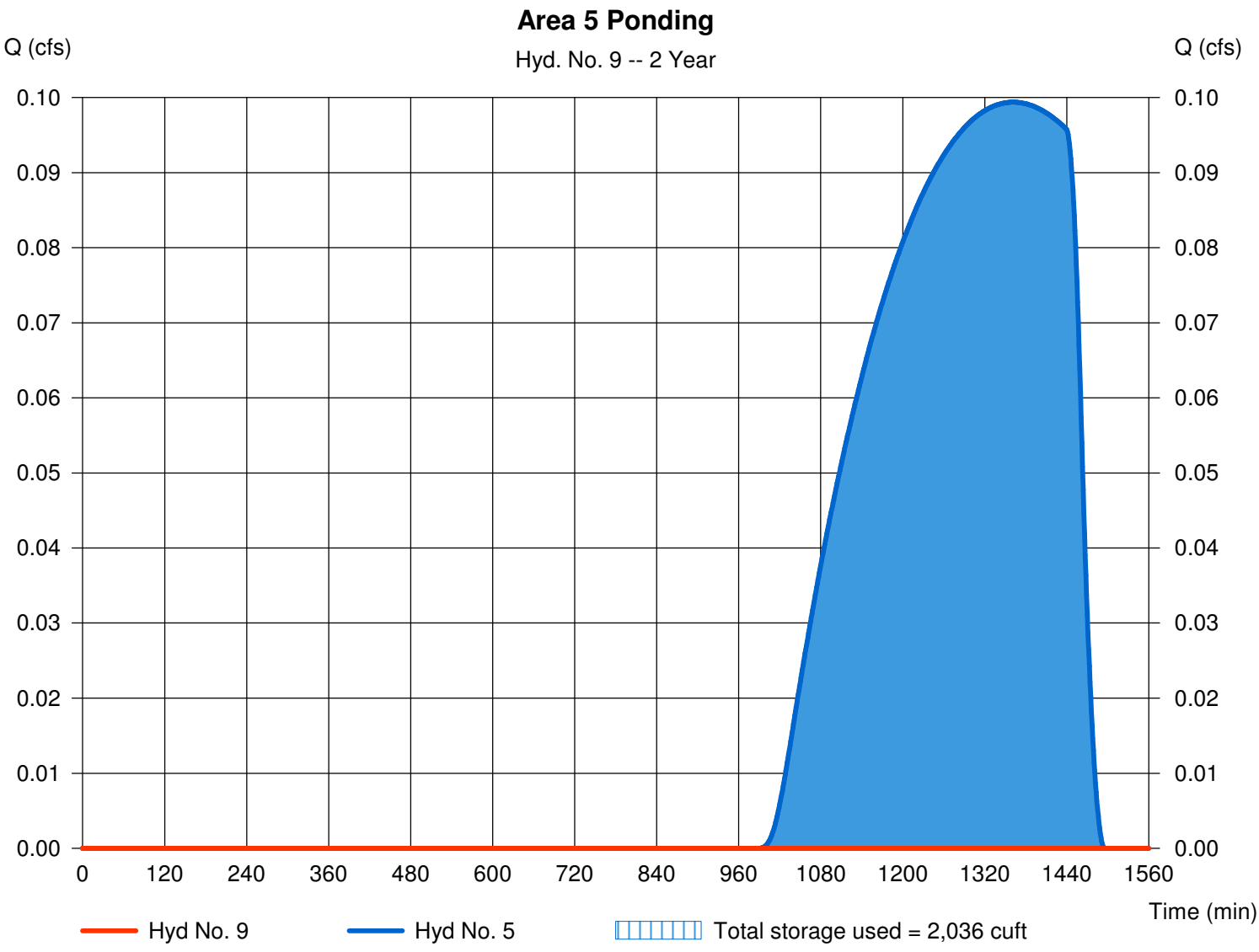
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 9

Area 5 Ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	5 - Area 5	Max. Elevation	=	2511.03 ft
Reservoir name	=	Area 5 pond	Max. Storage	=	2,036 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 — Wednesday, Jun 25, 2008

Pond No. 1 - Area 5 pond

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2511.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2511.00	50,638	0	0
1.00	2512.00	79,526	64,535	64,535
2.00	2513.00	106,871	92,853	157,388
3.00	2514.00	138,606	122,383	279,771

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2511.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	6,453	2511.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	12,907	2511.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	19,360	2511.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	25,814	2511.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	32,267	2511.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	38,721	2511.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	45,174	2511.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	51,628	2511.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	58,081	2511.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	64,535	2512.00	---	---	---	---	---	---	---	---	---	---	0.000
1.10	73,820	2512.10	---	---	---	---	---	---	---	---	---	---	0.000
1.20	83,105	2512.20	---	---	---	---	---	---	---	---	---	---	0.000
1.30	92,390	2512.30	---	---	---	---	---	---	---	---	---	---	0.000
1.40	101,676	2512.40	---	---	---	---	---	---	---	---	---	---	0.000
1.50	110,961	2512.50	---	---	---	---	---	---	---	---	---	---	0.000
1.60	120,246	2512.60	---	---	---	---	---	---	---	---	---	---	0.000
1.70	129,532	2512.70	---	---	---	---	---	---	---	---	---	---	0.000
1.80	138,817	2512.80	---	---	---	---	---	---	---	---	---	---	0.000
1.90	148,102	2512.90	---	---	---	---	---	---	---	---	---	---	0.000
2.00	157,388	2513.00	---	---	---	---	---	---	---	---	---	---	0.000
2.10	169,626	2513.10	---	---	---	---	---	---	---	---	---	---	0.000
2.20	181,864	2513.20	---	---	---	---	---	---	---	---	---	---	0.000
2.30	194,103	2513.30	---	---	---	---	---	---	---	---	---	---	0.000
2.40	206,341	2513.40	---	---	---	---	---	---	---	---	---	---	0.000
2.50	218,579	2513.50	---	---	---	---	---	---	---	---	---	---	0.000
2.60	230,817	2513.60	---	---	---	---	---	---	---	---	---	---	0.000
2.70	243,056	2513.70	---	---	---	---	---	---	---	---	---	---	0.000
2.80	255,294	2513.80	---	---	---	---	---	---	---	---	---	---	0.000
2.90	267,532	2513.90	---	---	---	---	---	---	---	---	---	---	0.000
3.00	279,771	2514.00	---	---	---	---	---	---	---	---	---	---	0.000

Hydrograph Report

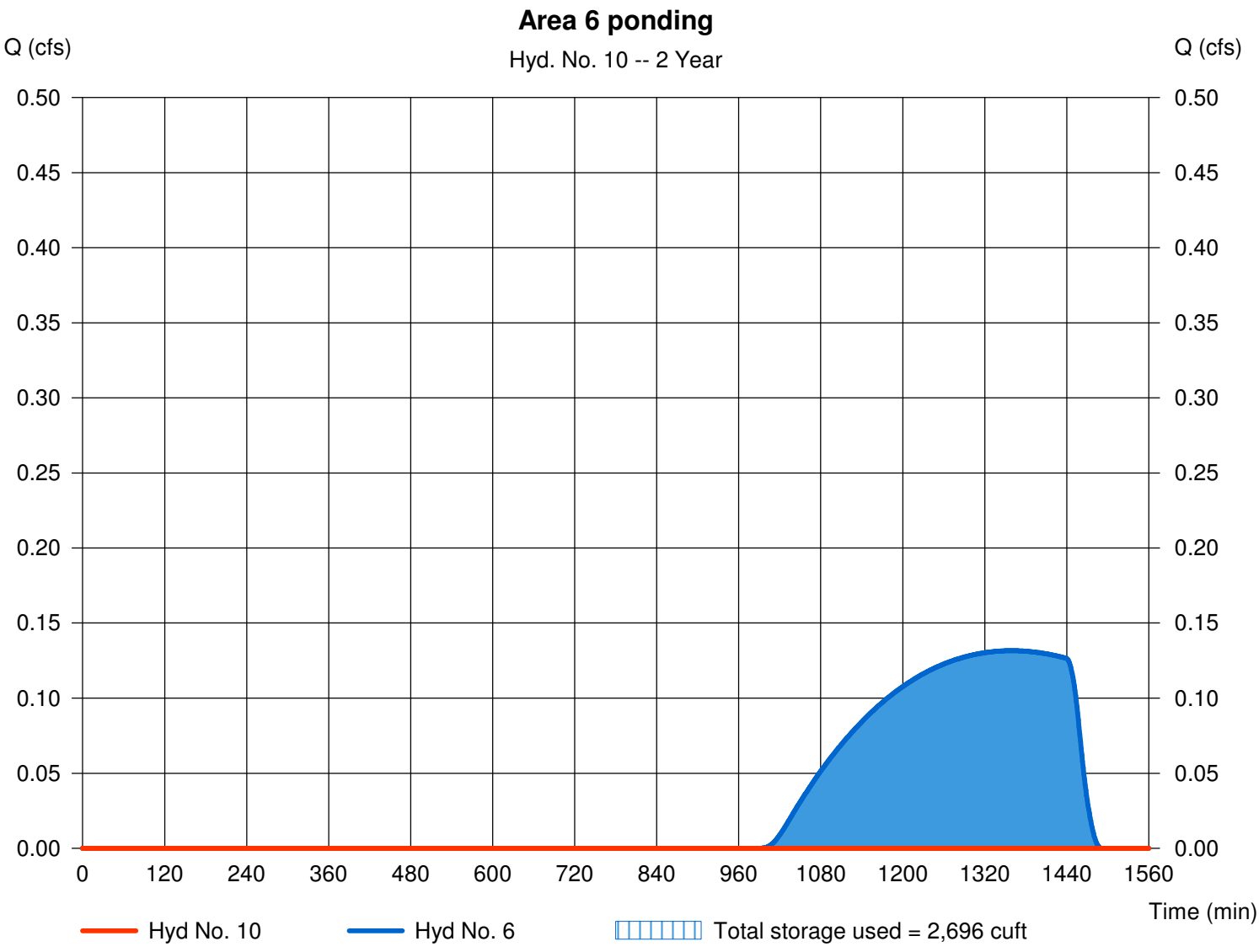
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 10

Area 6 ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	6 - Area 6	Max. Elevation	=	2511.09 ft
Reservoir name	=	Area 6	Max. Storage	=	2,696 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 — Wednesday, Jun 25, 2008

Pond No. 2 - Area 6

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2511.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2511.00	18,183	0	0
1.00	2512.00	41,282	28,951	28,951
2.00	2513.00	70,791	55,372	84,323
3.00	2514.00	128,096	98,028	182,351
4.00	2515.00	244,100	182,990	365,341

Culvert / Orifice Structures

		[A]	[B]	[C]	[PrfRsr]
Rise (in)	=	0.00	0.00	0.00	0.00
Span (in)	=	0.00	0.00	0.00	0.00
No. Barrels	=	0	0	0	0
Invert El. (ft)	=	0.00	0.00	0.00	0.00
Length (ft)	=	0.00	0.00	0.00	0.00
Slope (%)	=	0.00	0.00	0.00	n/a
N-Value	=	.000	.000	.000	n/a
Orifice Coeff.	=	0.00	0.00	0.00	0.00
Multi-Stage	=	n/a	No	No	No

Weir Structures

		[A]	[B]	[C]	[D]
Crest Len (ft)	=	0.00	0.00	0.00	0.00
Crest El. (ft)	=	0.00	0.00	0.00	0.00
Weir Coeff.	=	0.00	0.00	0.00	0.00
Weir Type	=	---	---	---	---
Multi-Stage	=	No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2511.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	2,895	2511.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	5,790	2511.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	8,685	2511.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	11,581	2511.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	14,476	2511.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	17,371	2511.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	20,266	2511.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	23,161	2511.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	26,056	2511.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	28,951	2512.00	---	---	---	---	---	---	---	---	---	---	0.000
1.10	34,489	2512.10	---	---	---	---	---	---	---	---	---	---	0.000
1.20	40,026	2512.20	---	---	---	---	---	---	---	---	---	---	0.000
1.30	45,563	2512.30	---	---	---	---	---	---	---	---	---	---	0.000
1.40	51,100	2512.40	---	---	---	---	---	---	---	---	---	---	0.000
1.50	56,637	2512.50	---	---	---	---	---	---	---	---	---	---	0.000
1.60	62,174	2512.60	---	---	---	---	---	---	---	---	---	---	0.000
1.70	67,712	2512.70	---	---	---	---	---	---	---	---	---	---	0.000
1.80	73,249	2512.80	---	---	---	---	---	---	---	---	---	---	0.000
1.90	78,786	2512.90	---	---	---	---	---	---	---	---	---	---	0.000
2.00	84,323	2513.00	---	---	---	---	---	---	---	---	---	---	0.000
2.10	94,126	2513.10	---	---	---	---	---	---	---	---	---	---	0.000
2.20	103,929	2513.20	---	---	---	---	---	---	---	---	---	---	0.000
2.30	113,732	2513.30	---	---	---	---	---	---	---	---	---	---	0.000
2.40	123,534	2513.40	---	---	---	---	---	---	---	---	---	---	0.000
2.50	133,337	2513.50	---	---	---	---	---	---	---	---	---	---	0.000
2.60	143,140	2513.60	---	---	---	---	---	---	---	---	---	---	0.000
2.70	152,943	2513.70	---	---	---	---	---	---	---	---	---	---	0.000
2.80	162,746	2513.80	---	---	---	---	---	---	---	---	---	---	0.000
2.90	172,548	2513.90	---	---	---	---	---	---	---	---	---	---	0.000
3.00	182,351	2514.00	---	---	---	---	---	---	---	---	---	---	0.000
3.10	200,650	2514.10	---	---	---	---	---	---	---	---	---	---	0.000
3.20	218,949	2514.20	---	---	---	---	---	---	---	---	---	---	0.000
3.30	237,248	2514.30	---	---	---	---	---	---	---	---	---	---	0.000
3.40	255,547	2514.40	---	---	---	---	---	---	---	---	---	---	0.000
3.50	273,846	2514.50	---	---	---	---	---	---	---	---	---	---	0.000
3.60	292,145	2514.60	---	---	---	---	---	---	---	---	---	---	0.000
3.70	310,444	2514.70	---	---	---	---	---	---	---	---	---	---	0.000
3.80	328,743	2514.80	---	---	---	---	---	---	---	---	---	---	0.000

Continues on next page...

Area 6

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.90	347,042	2514.90	---	---	---	---	---	---	---	---	---	---	0.000
4.00	365,341	2515.00	---	---	---	---	---	---	---	---	---	---	0.000

...End

Hydrograph Report

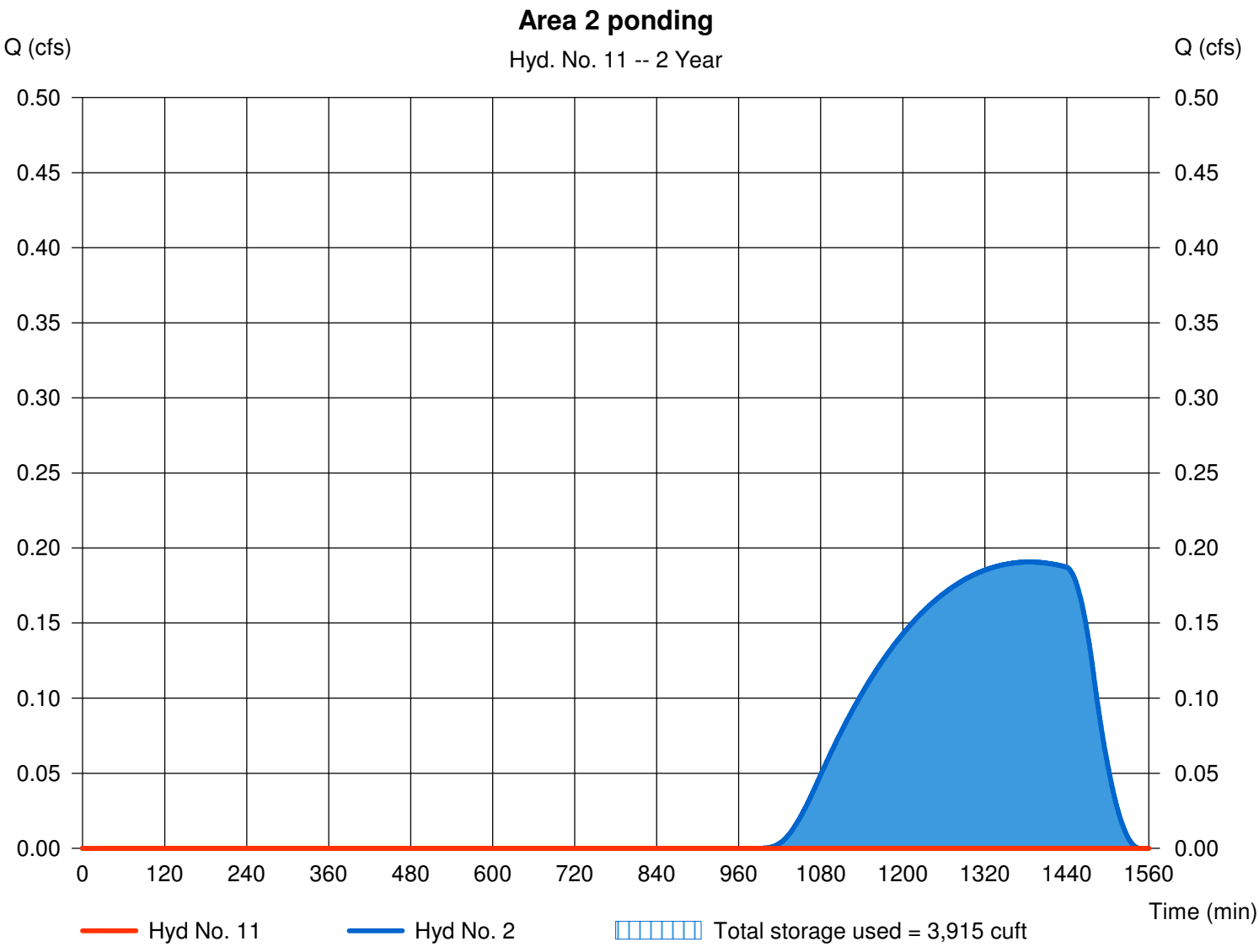
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 11

Area 2 ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	2 - Area 2	Max. Elevation	=	2515.16 ft
Reservoir name	=	Area 2 ponding	Max. Storage	=	3,915 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 — Wednesday, Jun 25, 2008

Pond No. 4 - Area 2 ponding

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2515.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2515.00	8,335	0	0
1.00	2516.00	47,516	25,248	25,248
2.00	2517.00	129,705	85,233	110,482
3.00	2518.00	242,559	183,194	293,676

Culvert / Orifice Structures

		[A]	[B]	[C]	[PrfRsr]
Rise (in)	=	0.00	0.00	0.00	0.00
Span (in)	=	0.00	0.00	0.00	0.00
No. Barrels	=	0	0	0	0
Invert El. (ft)	=	0.00	0.00	0.00	0.00
Length (ft)	=	0.00	0.00	0.00	0.00
Slope (%)	=	0.00	0.00	0.00	n/a
N-Value	=	.013	.013	.013	n/a
Orifice Coeff.	=	0.60	0.60	0.60	0.60
Multi-Stage	=	n/a	No	No	No

Weir Structures

		[A]	[B]	[C]	[D]
Crest Len (ft)	=	35.00	70.00	150.00	0.00
Crest El. (ft)	=	2515.75	2516.75	2517.50	0.00
Weir Coeff.	=	3.33	3.33	3.33	3.33
Weir Type	=	Rect	Rect	Rect	---
Multi-Stage	=	No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2515.00	---	---	---	---	0.00	0.00	0.00	---	---	---	0.000
0.10	2,525	2515.10	---	---	---	---	0.00	0.00	0.00	---	---	---	0.000
0.20	5,050	2515.20	---	---	---	---	0.00	0.00	0.00	---	---	---	0.000
0.30	7,574	2515.30	---	---	---	---	0.00	0.00	0.00	---	---	---	0.000
0.40	10,099	2515.40	---	---	---	---	0.00	0.00	0.00	---	---	---	0.000
0.50	12,624	2515.50	---	---	---	---	0.00	0.00	0.00	---	---	---	0.000
0.60	15,149	2515.60	---	---	---	---	0.00	0.00	0.00	---	---	---	0.000
0.70	17,674	2515.70	---	---	---	---	0.00	0.00	0.00	---	---	---	0.000
0.80	20,198	2515.80	---	---	---	---	1.33	0.00	0.00	---	---	---	1.334
0.90	22,723	2515.90	---	---	---	---	6.83	0.00	0.00	---	---	---	6.831
1.00	25,248	2516.00	---	---	---	---	14.57	0.00	0.00	---	---	---	14.57
1.10	33,771	2516.10	---	---	---	---	24.14	0.00	0.00	---	---	---	24.14
1.20	42,295	2516.20	---	---	---	---	35.21	0.00	0.00	---	---	---	35.21
1.30	50,818	2516.30	---	---	---	---	47.58	0.00	0.00	---	---	---	47.58
1.40	59,342	2516.40	---	---	---	---	61.13	0.00	0.00	---	---	---	61.13
1.50	67,865	2516.50	---	---	---	---	75.78	0.00	0.00	---	---	---	75.78
1.60	76,388	2516.60	---	---	---	---	91.43	0.00	0.00	---	---	---	91.43
1.70	84,912	2516.70	---	---	---	---	108.04	0.00	0.00	---	---	---	108.04
1.80	93,435	2516.80	---	---	---	---	125.54	2.67	0.00	---	---	---	128.21
1.90	101,958	2516.90	---	---	---	---	143.90	13.66	0.00	---	---	---	157.56
2.00	110,482	2517.00	---	---	---	---	162.88	29.14	0.00	---	---	---	192.02
2.10	128,801	2517.10	---	---	---	---	182.84	48.29	0.00	---	---	---	231.12
2.20	147,120	2517.20	---	---	---	---	203.54	70.41	0.00	---	---	---	273.95
2.30	165,440	2517.30	---	---	---	---	224.97	95.16	0.00	---	---	---	320.13
2.40	183,759	2517.40	---	---	---	---	247.11	122.27	0.00	---	---	---	369.38
2.50	202,079	2517.50	---	---	---	---	269.93	151.55	0.01	---	---	---	421.49
2.60	220,398	2517.60	---	---	---	---	293.41	182.86	15.93	---	---	---	492.21
2.70	238,717	2517.70	---	---	---	---	317.54	216.07	44.91	---	---	---	578.51
2.80	257,037	2517.80	---	---	---	---	342.29	251.08	82.40	---	---	---	675.76
2.90	275,356	2517.90	---	---	---	---	367.65	287.80	126.78	---	---	---	782.23
3.00	293,676	2518.00	---	---	---	---	393.36	325.77	176.60	---	---	---	895.72

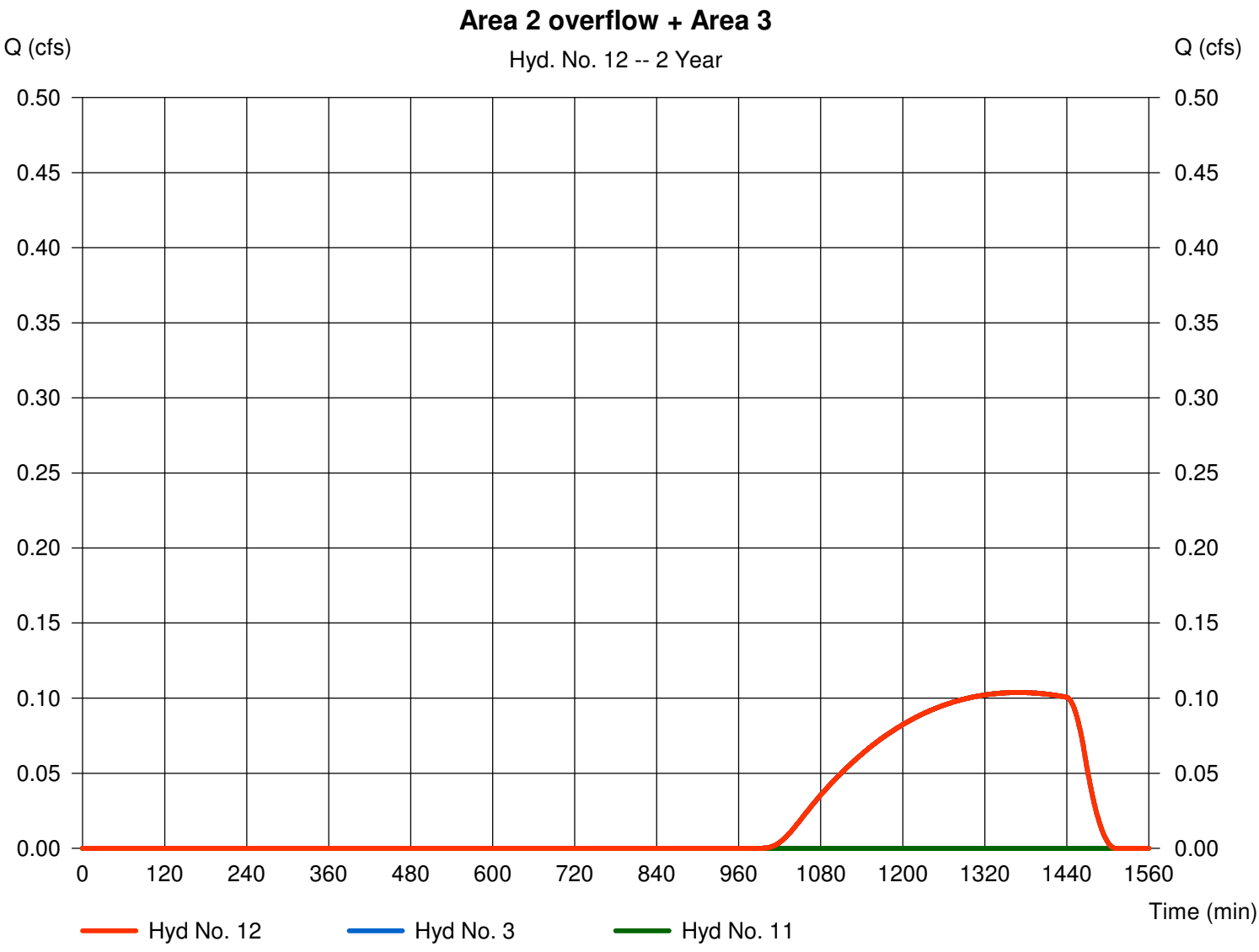
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 12

Area 2 overflow + Area 3

Hydrograph type	= Combine	Peak discharge	= 0.104 cfs
Storm frequency	= 2 yrs	Time to peak	= 1369 min
Time interval	= 1 min	Hyd. volume	= 2,127 cuft
Inflow hyds.	= 3, 11	Contrib. drain. area	= 76.900 ac



Hydrograph Report

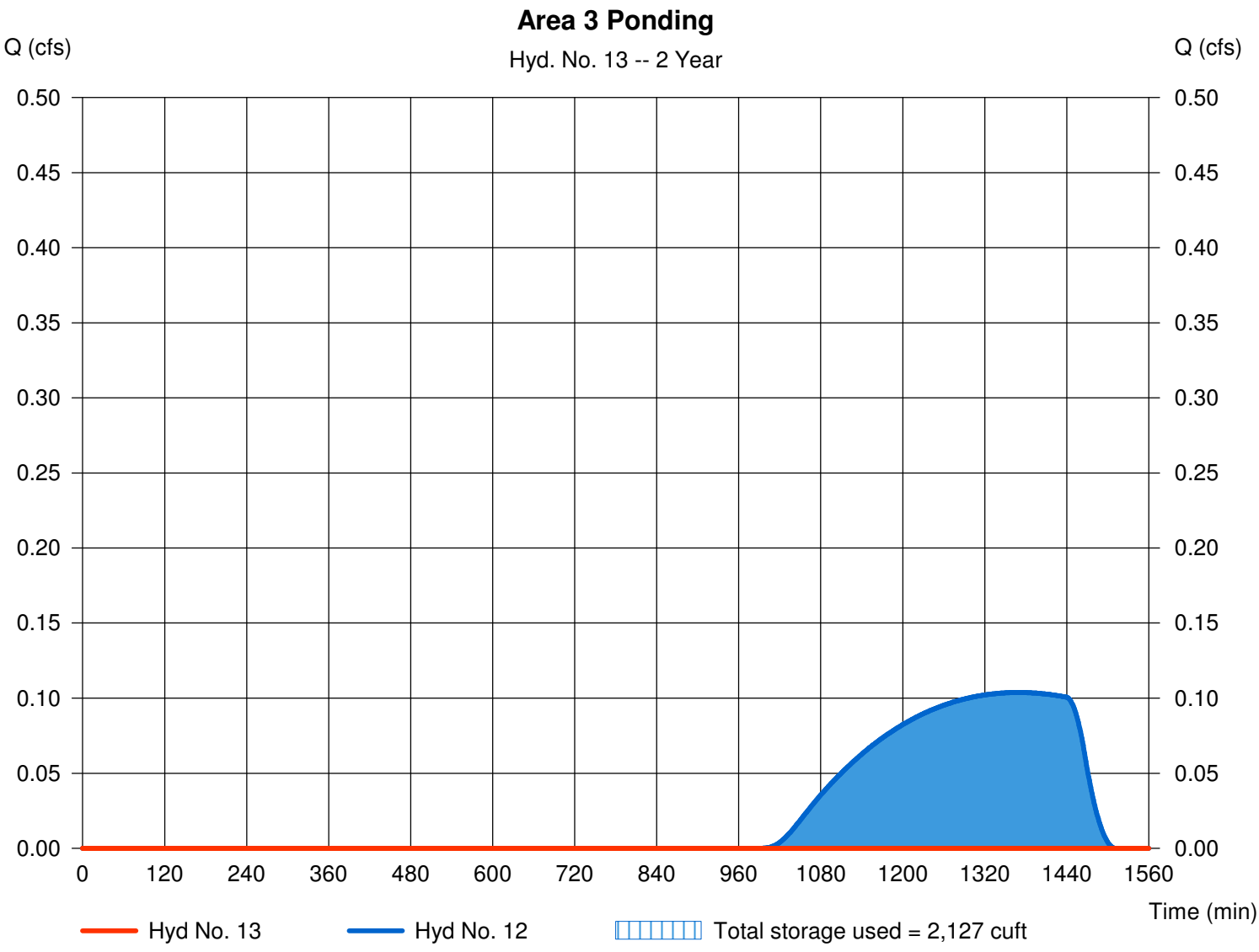
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 13

Area 3 Ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	12 - Area 2 overflow + Area 3	Max. Elevation	=	2503.68 ft
Reservoir name	=	Area 3	Max. Storage	=	2,127 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Pond No. 3 - Area 3

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2503.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2503.00	110	0	0
1.00	2504.00	8,404	3,158	3,158
2.00	2505.00	43,316	23,597	26,756
3.00	2506.00	123,394	79,932	106,687
4.00	2507.00	207,808	163,762	270,449
5.00	2508.00	204,215	205,988	476,437
6.00	2509.00	231,079	217,487	693,924
7.00	2510.00	309,514	269,316	963,240
11.00	2514.00	886,982	2,293,712	3,256,952
12.00	2515.00	1,156,008	1,018,428	4,275,380
13.00	2516.00	1,386,346	1,269,307	5,544,687

Culvert / Orifice Structures

		[A]	[B]	[C]	[PrfRsr]
Rise (in)	=	0.00	0.00	0.00	0.00
Span (in)	=	0.00	0.00	0.00	0.00
No. Barrels	=	0	0	0	0
Invert El. (ft)	=	0.00	0.00	0.00	0.00
Length (ft)	=	0.00	0.00	0.00	0.00
Slope (%)	=	0.00	0.00	0.00	n/a
N-Value	=	.000	.000	.000	n/a
Orifice Coeff.	=	0.00	0.00	0.00	0.00
Multi-Stage	=	n/a	No	No	No

Weir Structures

		[A]	[B]	[C]	[D]
Crest Len (ft)	=	0.00	0.00	0.00	0.00
Crest El. (ft)	=	0.00	0.00	0.00	0.00
Weir Coeff.	=	0.00	0.00	0.00	0.00
Weir Type	=	---	---	---	---
Multi-Stage	=	No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2503.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	316	2503.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	632	2503.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	947	2503.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	1,263	2503.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	1,579	2503.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	1,895	2503.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	2,211	2503.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	2,527	2503.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	2,842	2503.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	3,158	2504.00	---	---	---	---	---	---	---	---	---	---	0.000
1.10	5,518	2504.10	---	---	---	---	---	---	---	---	---	---	0.000
1.20	7,878	2504.20	---	---	---	---	---	---	---	---	---	---	0.000
1.30	10,237	2504.30	---	---	---	---	---	---	---	---	---	---	0.000
1.40	12,597	2504.40	---	---	---	---	---	---	---	---	---	---	0.000
1.50	14,957	2504.50	---	---	---	---	---	---	---	---	---	---	0.000
1.60	17,317	2504.60	---	---	---	---	---	---	---	---	---	---	0.000
1.70	19,676	2504.70	---	---	---	---	---	---	---	---	---	---	0.000
1.80	22,036	2504.80	---	---	---	---	---	---	---	---	---	---	0.000
1.90	24,396	2504.90	---	---	---	---	---	---	---	---	---	---	0.000
2.00	26,756	2505.00	---	---	---	---	---	---	---	---	---	---	0.000
2.10	34,749	2505.10	---	---	---	---	---	---	---	---	---	---	0.000
2.20	42,742	2505.20	---	---	---	---	---	---	---	---	---	---	0.000
2.30	50,735	2505.30	---	---	---	---	---	---	---	---	---	---	0.000
2.40	58,728	2505.40	---	---	---	---	---	---	---	---	---	---	0.000
2.50	66,722	2505.50	---	---	---	---	---	---	---	---	---	---	0.000
2.60	74,715	2505.60	---	---	---	---	---	---	---	---	---	---	0.000
2.70	82,708	2505.70	---	---	---	---	---	---	---	---	---	---	0.000
2.80	90,701	2505.80	---	---	---	---	---	---	---	---	---	---	0.000
2.90	98,694	2505.90	---	---	---	---	---	---	---	---	---	---	0.000
3.00	106,687	2506.00	---	---	---	---	---	---	---	---	---	---	0.000
3.10	123,064	2506.10	---	---	---	---	---	---	---	---	---	---	0.000
3.20	139,440	2506.20	---	---	---	---	---	---	---	---	---	---	0.000

Continues on next page...

Area 3

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.30	155,816	2506.30	---	---	---	---	---	---	---	---	---	---	0.000
3.40	172,192	2506.40	---	---	---	---	---	---	---	---	---	---	0.000
3.50	188,568	2506.50	---	---	---	---	---	---	---	---	---	---	0.000
3.60	204,944	2506.60	---	---	---	---	---	---	---	---	---	---	0.000
3.70	221,321	2506.70	---	---	---	---	---	---	---	---	---	---	0.000
3.80	237,697	2506.80	---	---	---	---	---	---	---	---	---	---	0.000
3.90	254,073	2506.90	---	---	---	---	---	---	---	---	---	---	0.000
4.00	270,449	2507.00	---	---	---	---	---	---	---	---	---	---	0.000
4.10	291,048	2507.10	---	---	---	---	---	---	---	---	---	---	0.000
4.20	311,647	2507.20	---	---	---	---	---	---	---	---	---	---	0.000
4.30	332,245	2507.30	---	---	---	---	---	---	---	---	---	---	0.000
4.40	352,844	2507.40	---	---	---	---	---	---	---	---	---	---	0.000
4.50	373,443	2507.50	---	---	---	---	---	---	---	---	---	---	0.000
4.60	394,042	2507.60	---	---	---	---	---	---	---	---	---	---	0.000
4.70	414,641	2507.70	---	---	---	---	---	---	---	---	---	---	0.000
4.80	435,240	2507.80	---	---	---	---	---	---	---	---	---	---	0.000
4.90	455,838	2507.90	---	---	---	---	---	---	---	---	---	---	0.000
5.00	476,437	2508.00	---	---	---	---	---	---	---	---	---	---	0.000
5.10	498,186	2508.10	---	---	---	---	---	---	---	---	---	---	0.000
5.20	519,935	2508.20	---	---	---	---	---	---	---	---	---	---	0.000
5.30	541,683	2508.30	---	---	---	---	---	---	---	---	---	---	0.000
5.40	563,432	2508.40	---	---	---	---	---	---	---	---	---	---	0.000
5.50	585,181	2508.50	---	---	---	---	---	---	---	---	---	---	0.000
5.60	606,929	2508.60	---	---	---	---	---	---	---	---	---	---	0.000
5.70	628,678	2508.70	---	---	---	---	---	---	---	---	---	---	0.000
5.80	650,427	2508.80	---	---	---	---	---	---	---	---	---	---	0.000
5.90	672,175	2508.90	---	---	---	---	---	---	---	---	---	---	0.000
6.00	693,924	2509.00	---	---	---	---	---	---	---	---	---	---	0.000
6.10	720,856	2509.10	---	---	---	---	---	---	---	---	---	---	0.000
6.20	747,787	2509.20	---	---	---	---	---	---	---	---	---	---	0.000
6.30	774,719	2509.30	---	---	---	---	---	---	---	---	---	---	0.000
6.40	801,651	2509.40	---	---	---	---	---	---	---	---	---	---	0.000
6.50	828,582	2509.50	---	---	---	---	---	---	---	---	---	---	0.000
6.60	855,514	2509.60	---	---	---	---	---	---	---	---	---	---	0.000
6.70	882,446	2509.70	---	---	---	---	---	---	---	---	---	---	0.000
6.80	909,377	2509.80	---	---	---	---	---	---	---	---	---	---	0.000
6.90	936,309	2509.90	---	---	---	---	---	---	---	---	---	---	0.000
7.00	963,240	2510.00	---	---	---	---	---	---	---	---	---	---	0.000
7.40	1,192,612	2510.40	---	---	---	---	---	---	---	---	---	---	0.000
7.80	1,421,983	2510.80	---	---	---	---	---	---	---	---	---	---	0.000
8.20	1,651,354	2511.20	---	---	---	---	---	---	---	---	---	---	0.000
8.60	1,880,725	2511.60	---	---	---	---	---	---	---	---	---	---	0.000
9.00	2,110,096	2512.00	---	---	---	---	---	---	---	---	---	---	0.000
9.40	2,339,467	2512.40	---	---	---	---	---	---	---	---	---	---	0.000
9.80	2,568,838	2512.80	---	---	---	---	---	---	---	---	---	---	0.000
10.20	2,798,209	2513.20	---	---	---	---	---	---	---	---	---	---	0.000
10.60	3,027,580	2513.60	---	---	---	---	---	---	---	---	---	---	0.000
11.00	3,256,952	2514.00	---	---	---	---	---	---	---	---	---	---	0.000
11.10	3,358,794	2514.10	---	---	---	---	---	---	---	---	---	---	0.000
11.20	3,460,637	2514.20	---	---	---	---	---	---	---	---	---	---	0.000
11.30	3,562,480	2514.30	---	---	---	---	---	---	---	---	---	---	0.000
11.40	3,664,323	2514.40	---	---	---	---	---	---	---	---	---	---	0.000
11.50	3,766,165	2514.50	---	---	---	---	---	---	---	---	---	---	0.000
11.60	3,868,008	2514.60	---	---	---	---	---	---	---	---	---	---	0.000
11.70	3,969,851	2514.70	---	---	---	---	---	---	---	---	---	---	0.000
11.80	4,071,694	2514.80	---	---	---	---	---	---	---	---	---	---	0.000
11.90	4,173,536	2514.90	---	---	---	---	---	---	---	---	---	---	0.000
12.00	4,275,380	2515.00	---	---	---	---	---	---	---	---	---	---	0.000
12.10	4,402,310	2515.10	---	---	---	---	---	---	---	---	---	---	0.000
12.20	4,529,241	2515.20	---	---	---	---	---	---	---	---	---	---	0.000
12.30	4,656,172	2515.30	---	---	---	---	---	---	---	---	---	---	0.000
12.40	4,783,103	2515.40	---	---	---	---	---	---	---	---	---	---	0.000
12.50	4,910,034	2515.50	---	---	---	---	---	---	---	---	---	---	0.000
12.60	5,036,965	2515.60	---	---	---	---	---	---	---	---	---	---	0.000
12.70	5,163,896	2515.70	---	---	---	---	---	---	---	---	---	---	0.000
12.80	5,290,827	2515.80	---	---	---	---	---	---	---	---	---	---	0.000
12.90	5,417,758	2515.90	---	---	---	---	---	---	---	---	---	---	0.000
13.00	5,544,687	2516.00	---	---	---	---	---	---	---	---	---	---	0.000

...End

Hydrograph Report

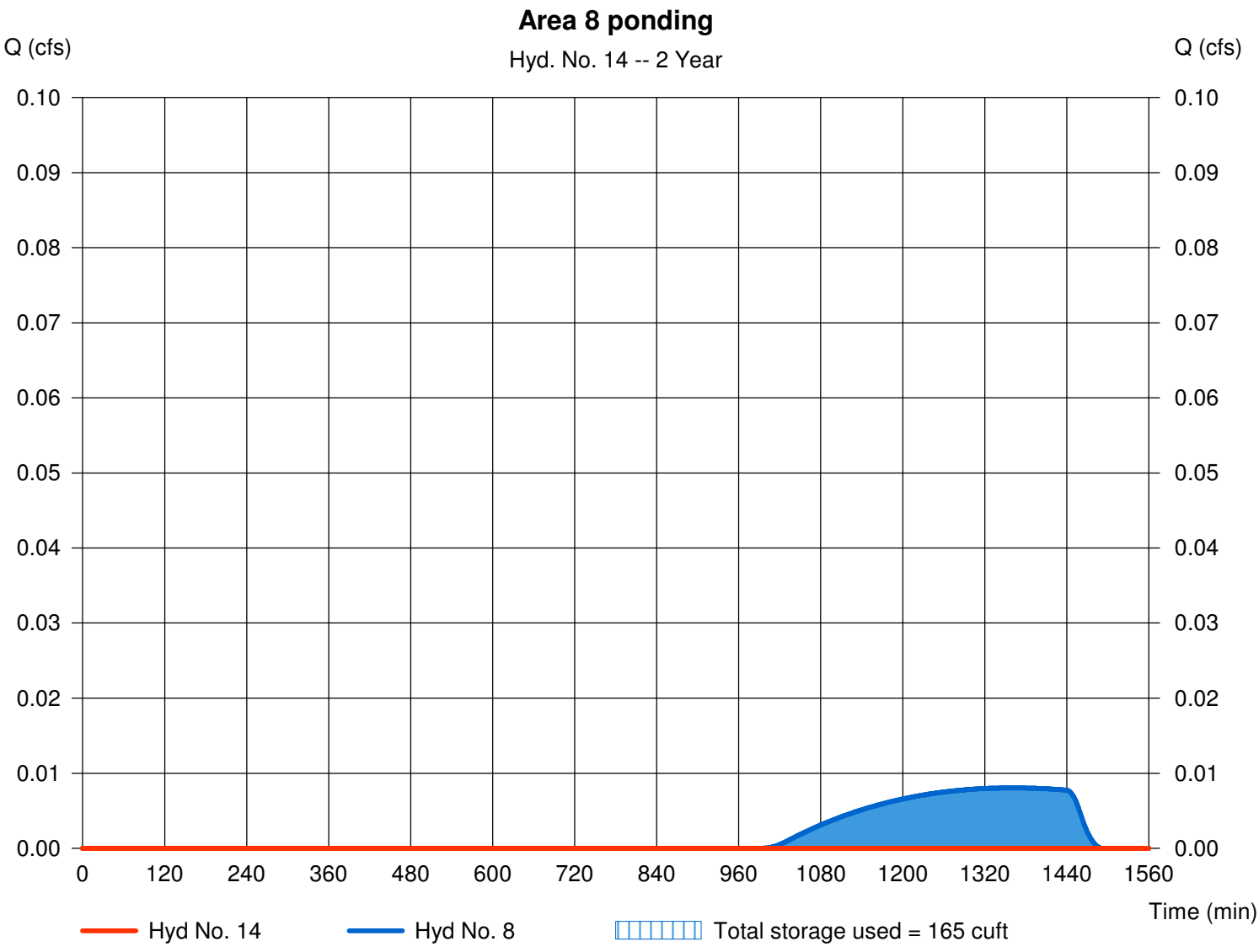
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 14

Area 8 ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	8 - Area 8	Max. Elevation	=	2507.01 ft
Reservoir name	=	Area 8 ponding	Max. Storage	=	165 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Pond No. 5 - Area 8 ponding

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2507.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2507.00	11,012	0	0
1.00	2508.00	30,931	20,131	20,131

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2507.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	2,013	2507.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	4,026	2507.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	6,039	2507.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	8,052	2507.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	10,065	2507.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	12,079	2507.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	14,092	2507.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	16,105	2507.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	18,118	2507.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	20,131	2508.00	---	---	---	---	---	---	---	---	---	---	0.000

Hydrograph Report

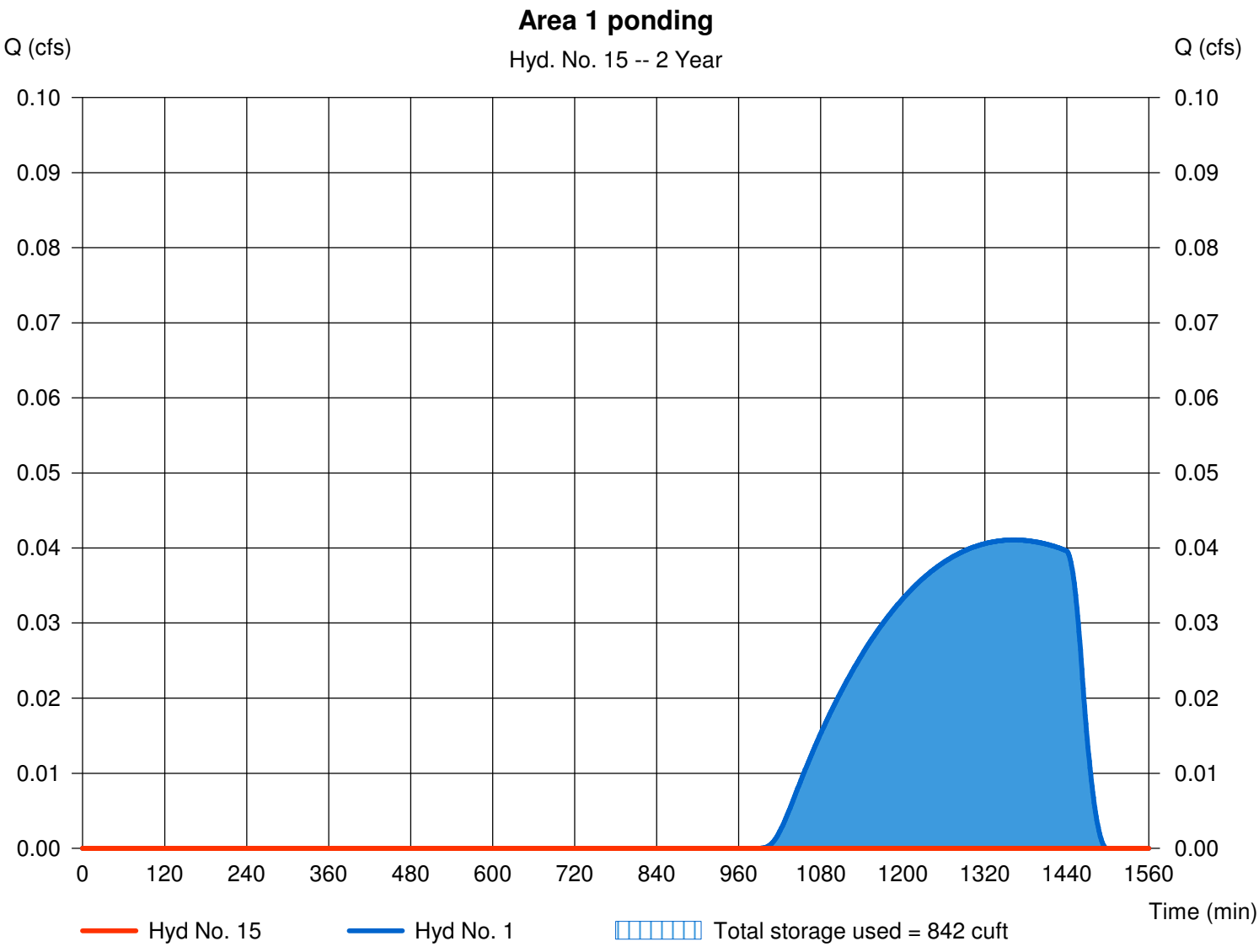
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 15

Area 1 ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	1 - Area 1	Max. Elevation	=	2527.03 ft
Reservoir name	=	Area 1	Max. Storage	=	842 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Pond No. 6 - Area 1

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2527.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2527.00	14,002	0	0
1.00	2528.00	56,338	32,806	32,806
2.00	2529.00	113,588	83,299	116,104

Culvert / Orifice Structures

		[A]	[B]	[C]	[PrfRsr]
Rise (in)	=	0.00	0.00	0.00	0.00
Span (in)	=	0.00	0.00	0.00	0.00
No. Barrels	=	0	0	0	0
Invert El. (ft)	=	0.00	0.00	0.00	0.00
Length (ft)	=	0.00	0.00	0.00	0.00
Slope (%)	=	0.00	0.00	0.00	n/a
N-Value	=	.000	.000	.000	n/a
Orifice Coeff.	=	0.00	0.00	0.00	0.00
Multi-Stage	=	n/a	No	No	No

Weir Structures

		[A]	[B]	[C]	[D]
Crest Len (ft)	=	0.00	0.00	0.00	0.00
Crest El. (ft)	=	0.00	0.00	0.00	0.00
Weir Coeff.	=	0.00	0.00	0.00	0.00
Weir Type	=	---	---	---	---
Multi-Stage	=	No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2527.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	3,281	2527.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	6,561	2527.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	9,842	2527.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	13,122	2527.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	16,403	2527.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	19,683	2527.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	22,964	2527.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	26,244	2527.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	29,525	2527.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	32,806	2528.00	---	---	---	---	---	---	---	---	---	---	0.000
1.10	41,135	2528.10	---	---	---	---	---	---	---	---	---	---	0.000
1.20	49,465	2528.20	---	---	---	---	---	---	---	---	---	---	0.000
1.30	57,795	2528.30	---	---	---	---	---	---	---	---	---	---	0.000
1.40	66,125	2528.40	---	---	---	---	---	---	---	---	---	---	0.000
1.50	74,455	2528.50	---	---	---	---	---	---	---	---	---	---	0.000
1.60	82,785	2528.60	---	---	---	---	---	---	---	---	---	---	0.000
1.70	91,115	2528.70	---	---	---	---	---	---	---	---	---	---	0.000
1.80	99,445	2528.80	---	---	---	---	---	---	---	---	---	---	0.000
1.90	107,775	2528.90	---	---	---	---	---	---	---	---	---	---	0.000
2.00	116,104	2529.00	---	---	---	---	---	---	---	---	---	---	0.000

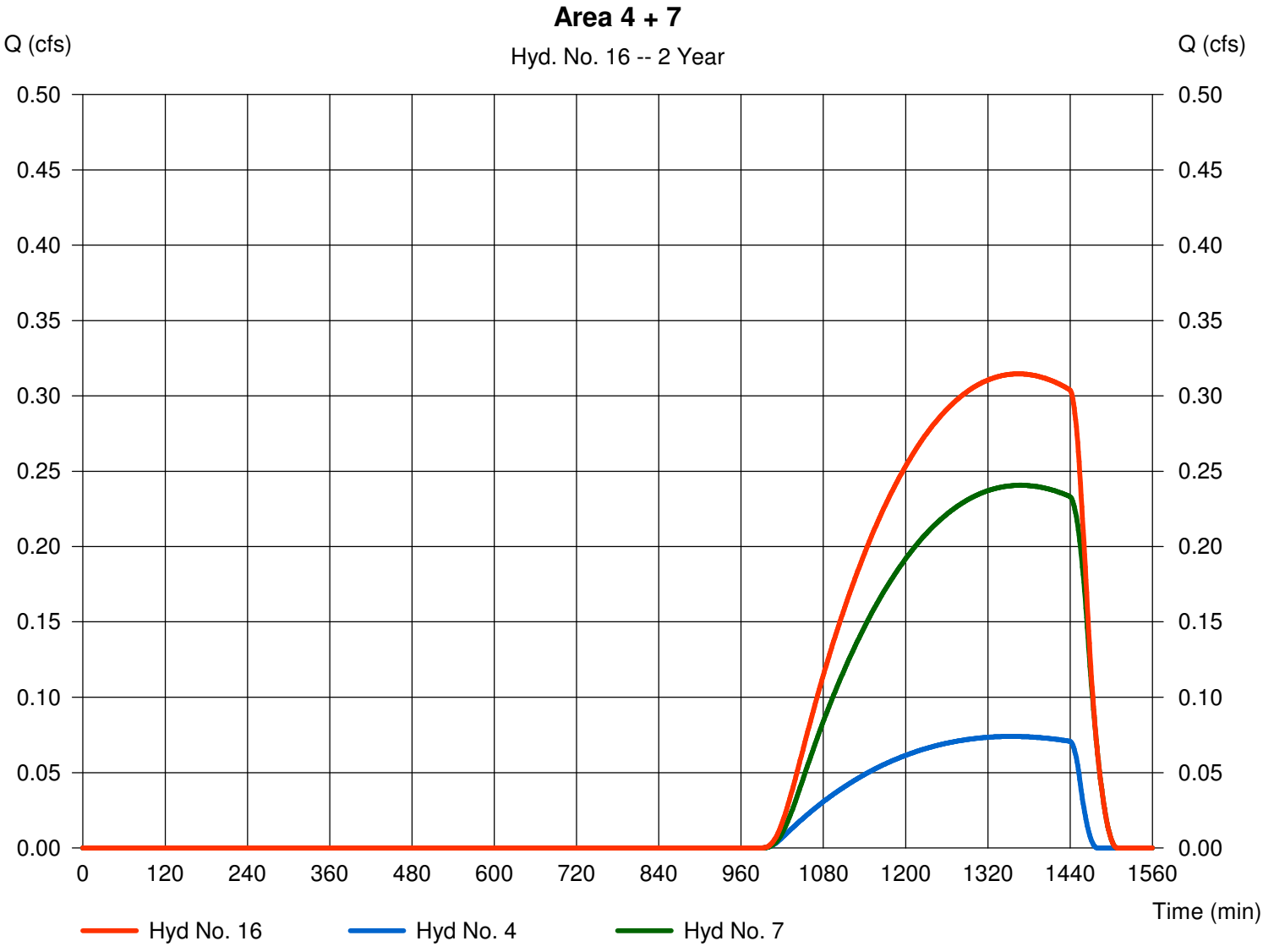
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 16

Area 4 + 7

Hydrograph type	=	Combine	Peak discharge	=	0.315 cfs
Storm frequency	=	2 yrs	Time to peak	=	1364 min
Time interval	=	1 min	Hyd. volume	=	6,448 cuft
Inflow hyds.	=	4, 7	Contrib. drain. area	=	233.950 ac



Hydrograph Report

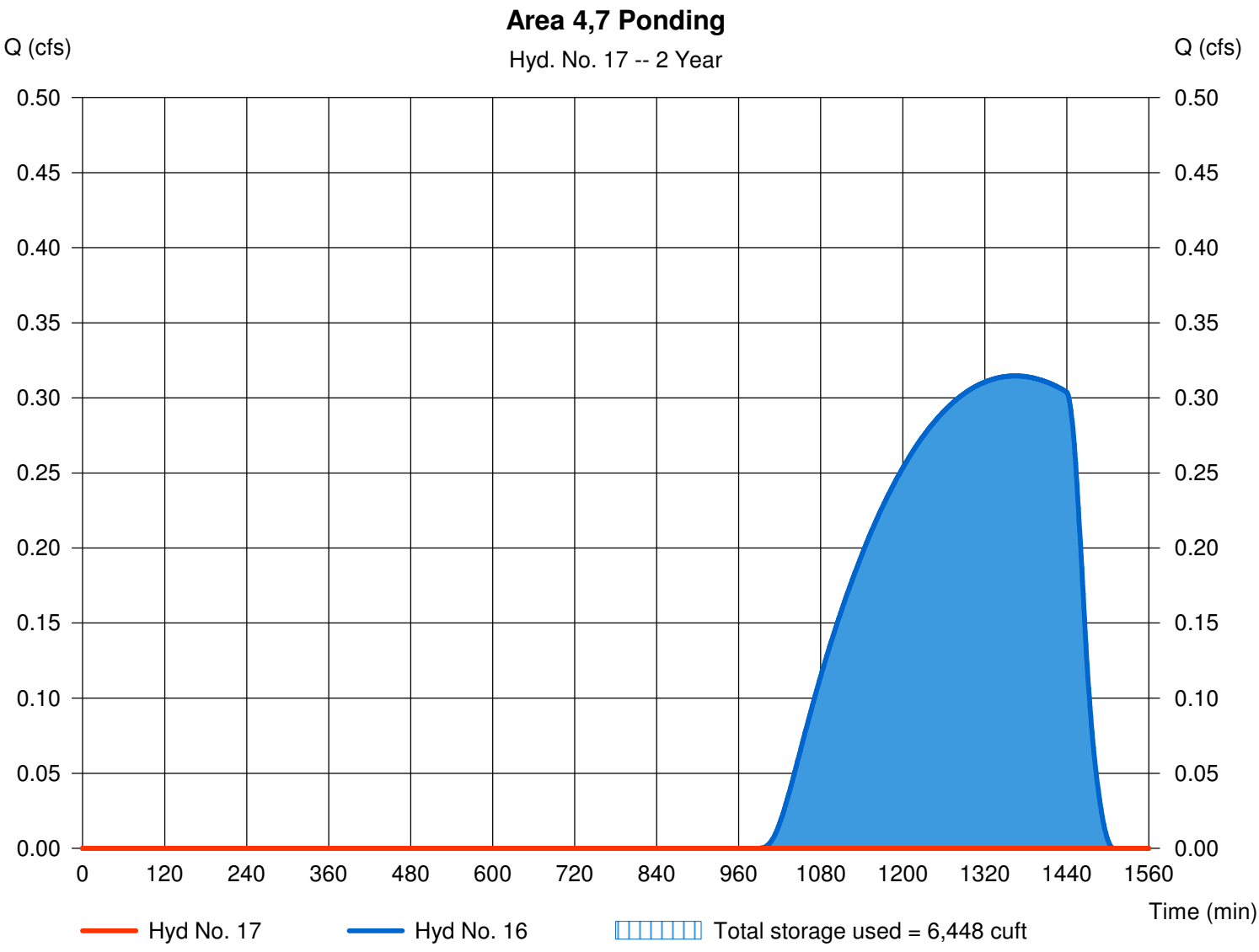
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 17

Area 4,7 Ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	16 - Area 4 + 7	Max. Elevation	=	2489.43 ft
Reservoir name	=	Area 4 & 7 ponding	Max. Storage	=	6,448 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 — Wednesday, Jun 25, 2008

Pond No. 7 - Area 4 & 7 ponding

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2489.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2489.00	562	0	0
1.00	2490.00	39,397	14,887	14,887
2.00	2491.00	101,687	68,119	83,006
3.00	2492.00	162,461	130,880	213,886
4.00	2493.00	288,676	222,544	436,430
5.00	2494.00	331,686	309,901	746,331

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2489.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	1,489	2489.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	2,977	2489.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	4,466	2489.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	5,955	2489.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	7,443	2489.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	8,932	2489.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	10,421	2489.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	11,909	2489.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	13,398	2489.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	14,887	2490.00	---	---	---	---	---	---	---	---	---	---	0.000
1.10	21,699	2490.10	---	---	---	---	---	---	---	---	---	---	0.000
1.20	28,511	2490.20	---	---	---	---	---	---	---	---	---	---	0.000
1.30	35,322	2490.30	---	---	---	---	---	---	---	---	---	---	0.000
1.40	42,134	2490.40	---	---	---	---	---	---	---	---	---	---	0.000
1.50	48,946	2490.50	---	---	---	---	---	---	---	---	---	---	0.000
1.60	55,758	2490.60	---	---	---	---	---	---	---	---	---	---	0.000
1.70	62,570	2490.70	---	---	---	---	---	---	---	---	---	---	0.000
1.80	69,382	2490.80	---	---	---	---	---	---	---	---	---	---	0.000
1.90	76,194	2490.90	---	---	---	---	---	---	---	---	---	---	0.000
2.00	83,006	2491.00	---	---	---	---	---	---	---	---	---	---	0.000
2.10	96,094	2491.10	---	---	---	---	---	---	---	---	---	---	0.000
2.20	109,182	2491.20	---	---	---	---	---	---	---	---	---	---	0.000
2.30	122,270	2491.30	---	---	---	---	---	---	---	---	---	---	0.000
2.40	135,358	2491.40	---	---	---	---	---	---	---	---	---	---	0.000
2.50	148,446	2491.50	---	---	---	---	---	---	---	---	---	---	0.000
2.60	161,534	2491.60	---	---	---	---	---	---	---	---	---	---	0.000
2.70	174,622	2491.70	---	---	---	---	---	---	---	---	---	---	0.000
2.80	187,710	2491.80	---	---	---	---	---	---	---	---	---	---	0.000
2.90	200,798	2491.90	---	---	---	---	---	---	---	---	---	---	0.000
3.00	213,886	2492.00	---	---	---	---	---	---	---	---	---	---	0.000
3.10	236,140	2492.10	---	---	---	---	---	---	---	---	---	---	0.000
3.20	258,395	2492.20	---	---	---	---	---	---	---	---	---	---	0.000
3.30	280,649	2492.30	---	---	---	---	---	---	---	---	---	---	0.000
3.40	302,903	2492.40	---	---	---	---	---	---	---	---	---	---	0.000
3.50	325,158	2492.50	---	---	---	---	---	---	---	---	---	---	0.000
3.60	347,412	2492.60	---	---	---	---	---	---	---	---	---	---	0.000
3.70	369,666	2492.70	---	---	---	---	---	---	---	---	---	---	0.000

Continues on next page...

Area 4 & 7 ponding

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.80	391,921	2492.80	---	---	---	---	---	---	---	---	---	---	0.000
3.90	414,175	2492.90	---	---	---	---	---	---	---	---	---	---	0.000
4.00	436,430	2493.00	---	---	---	---	---	---	---	---	---	---	0.000
4.10	467,420	2493.10	---	---	---	---	---	---	---	---	---	---	0.000
4.20	498,410	2493.20	---	---	---	---	---	---	---	---	---	---	0.000
4.30	529,400	2493.30	---	---	---	---	---	---	---	---	---	---	0.000
4.40	560,390	2493.40	---	---	---	---	---	---	---	---	---	---	0.000
4.50	591,380	2493.50	---	---	---	---	---	---	---	---	---	---	0.000
4.60	622,370	2493.60	---	---	---	---	---	---	---	---	---	---	0.000
4.70	653,360	2493.70	---	---	---	---	---	---	---	---	---	---	0.000
4.80	684,350	2493.80	---	---	---	---	---	---	---	---	---	---	0.000
4.90	715,341	2493.90	---	---	---	---	---	---	---	---	---	---	0.000
5.00	746,331	2494.00	---	---	---	---	---	---	---	---	---	---	0.000

...End

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	5.892	1	621	86,697	----	------	------	Area 1
2	SCS Runoff	19.67	1	651	403,339	----	------	------	Area 2
3	SCS Runoff	13.29	1	629	219,153	----	------	------	Area 3
4	SCS Runoff	13.35	1	611	156,114	----	------	------	Area 4
5	SCS Runoff	14.72	1	619	209,748	----	------	------	Area 5
6	SCS Runoff	20.57	1	617	277,708	----	------	------	Area 6
7	SCS Runoff	31.59	1	627	508,150	----	------	------	Area 7
8	SCS Runoff	1.233	1	618	16,992	----	------	------	Area 8
9	Reservoir	0.000	1	n/a	0	5	2513.43	209,748	Area 5 Ponding
10	Reservoir	0.000	1	n/a	0	6	2514.52	277,708	Area 6 ponding
11	Reservoir	18.47	1	668	385,664	2	2516.04	28,721	Area 2 ponding
12	Combine	27.89	1	650	604,816	3, 11	------	------	Area 2 overflow + Area 3
13	Reservoir	0.000	1	n/a	0	12	2508.59	604,816	Area 3 Ponding
14	Reservoir	0.000	1	n/a	0	8	2507.85	16,992	Area 8 ponding
15	Reservoir	0.000	1	n/a	0	1	2528.65	86,697	Area 1 ponding
16	Combine	42.09	1	622	664,264	4, 7,	------	------	Area 4 + 7
17	Reservoir	0.000	1	n/a	0	16	2493.74	664,264	Area 4,7 Ponding

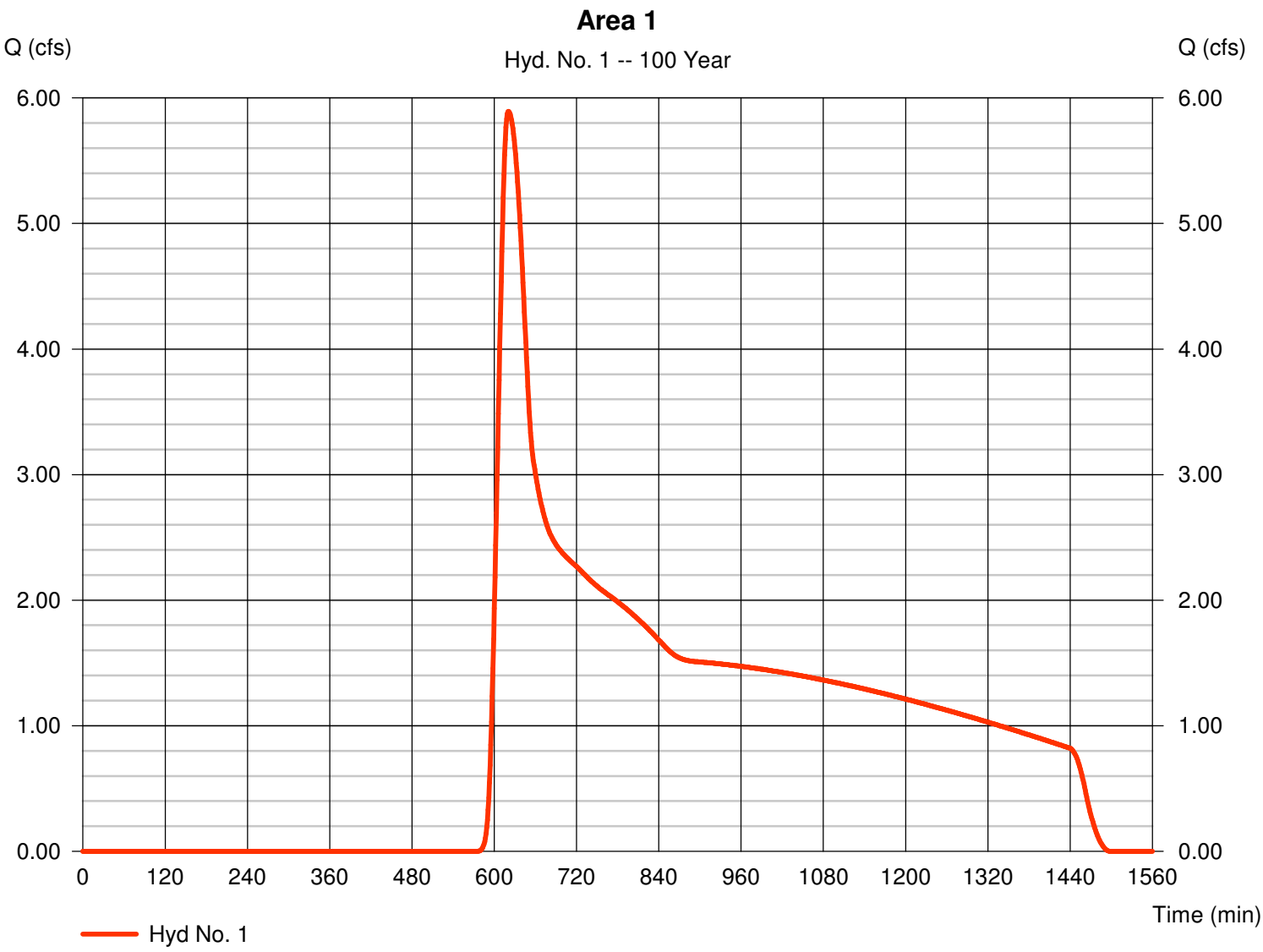
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 1

Area 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.892 cfs
Storm frequency	=	100 yrs	Time to peak	=	621 min
Time interval	=	1 min	Hyd. volume	=	86,697 cuft
Drainage area	=	30.250 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	36.70 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



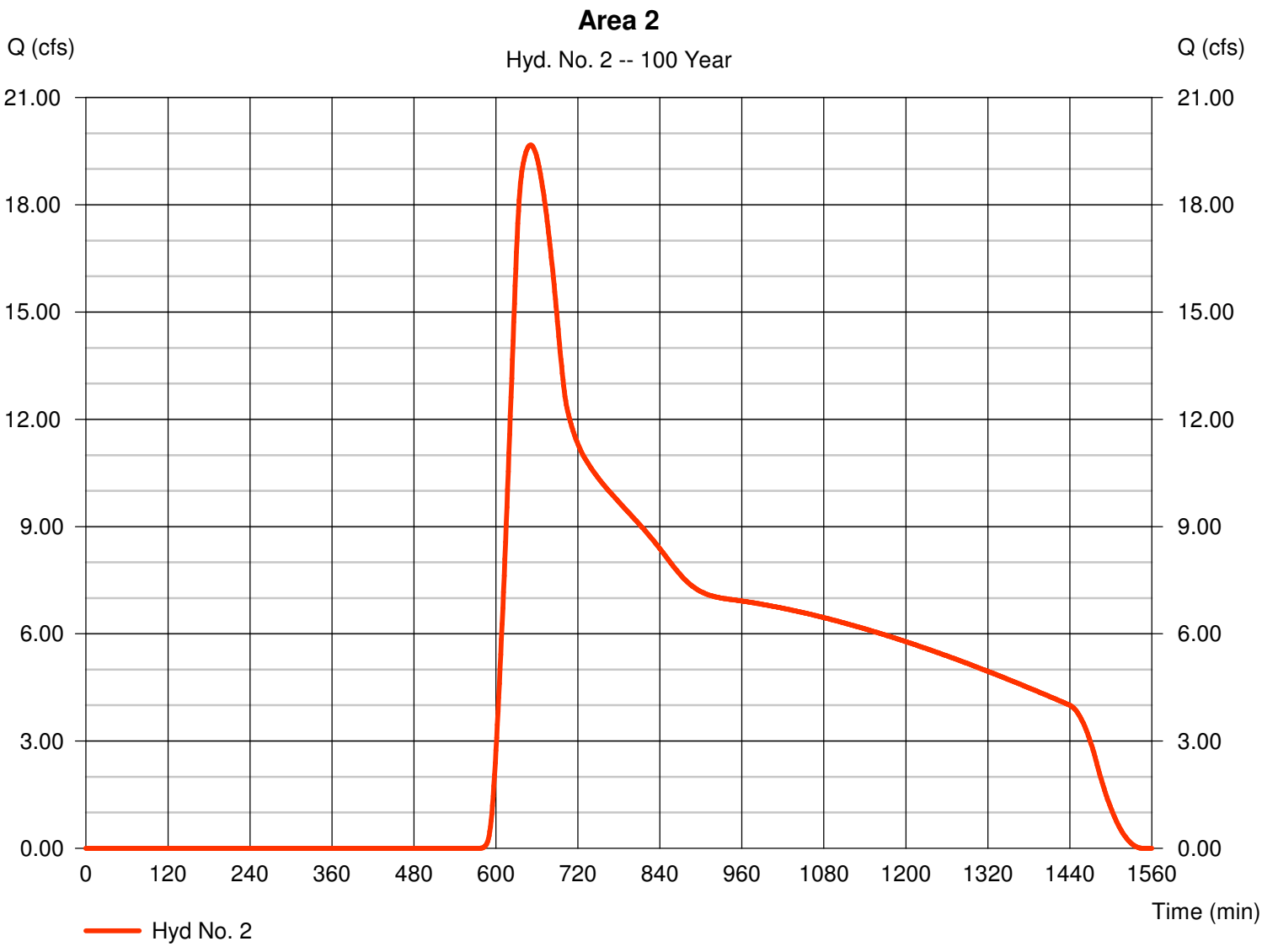
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 2

Area 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	19.67 cfs
Storm frequency	=	100 yrs	Time to peak	=	651 min
Time interval	=	1 min	Hyd. volume	=	403,339 cuft
Drainage area	=	141.090 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	67.20 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



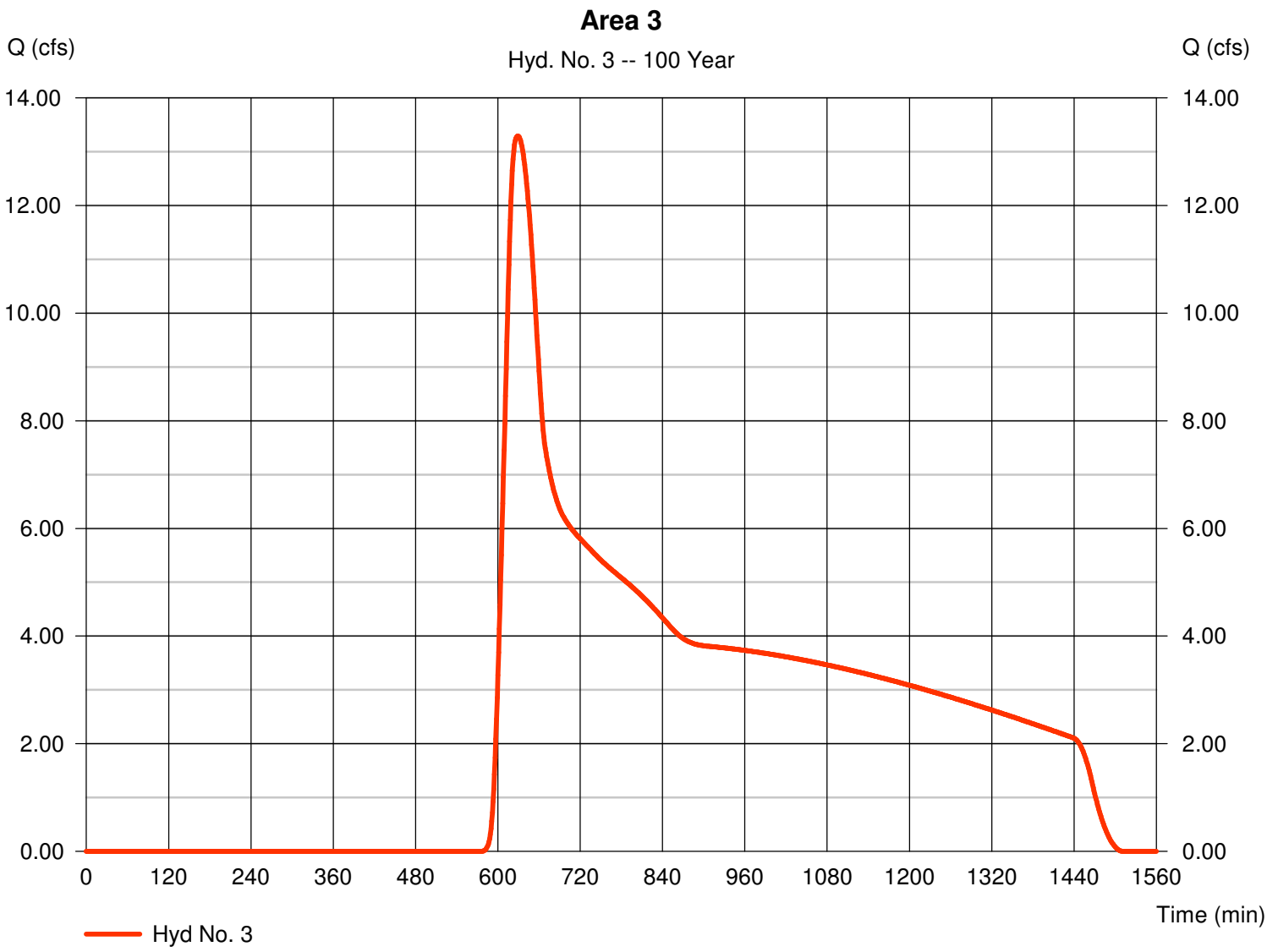
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 3

Area 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.29 cfs
Storm frequency	=	100 yrs	Time to peak	=	629 min
Time interval	=	1 min	Hyd. volume	=	219,153 cuft
Drainage area	=	76.900 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	44.50 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



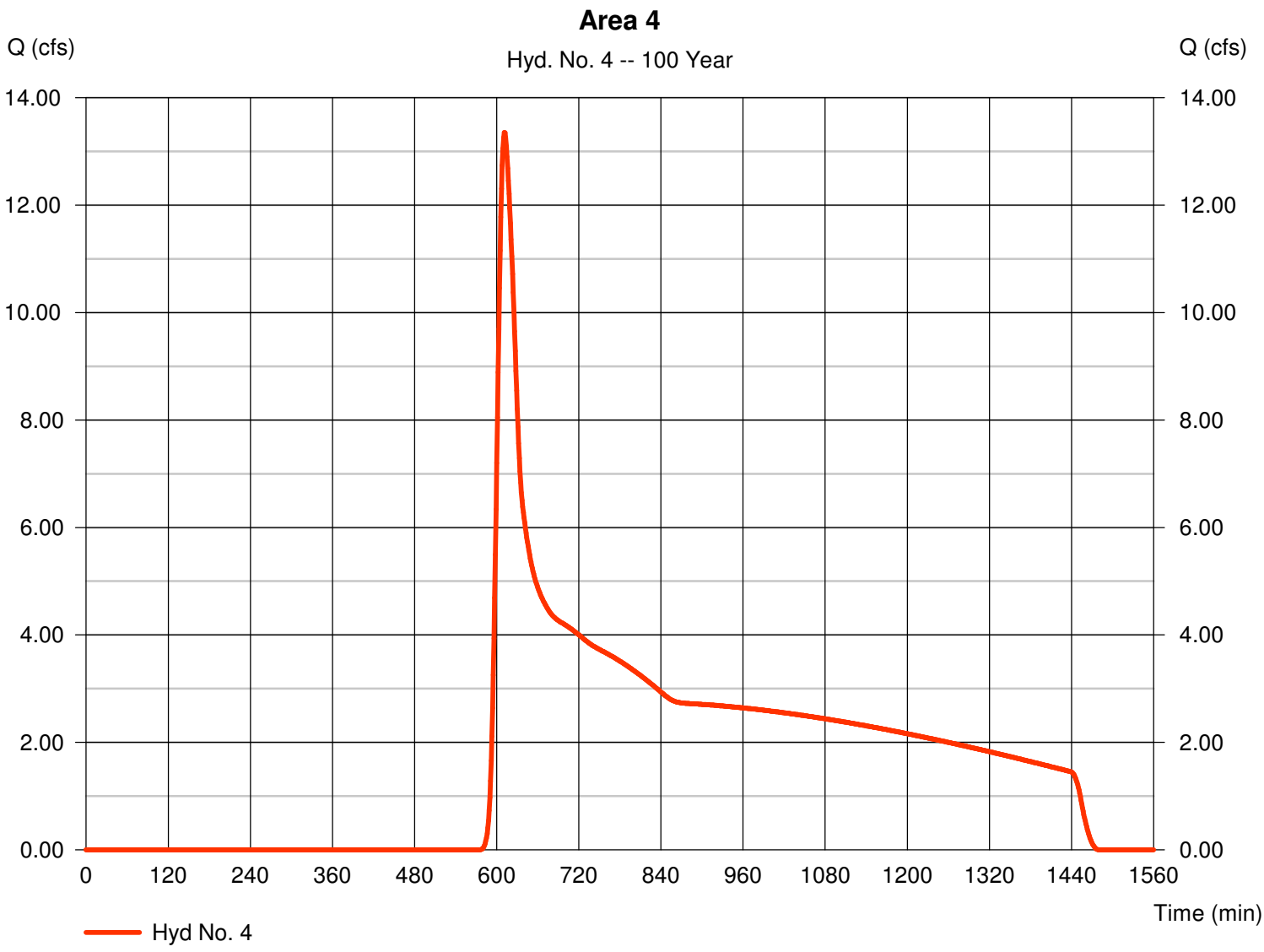
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 4

Area 4

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.35 cfs
Storm frequency	=	100 yrs	Time to peak	=	611 min
Time interval	=	1 min	Hyd. volume	=	156,114 cuft
Drainage area	=	54.780 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	23.80 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



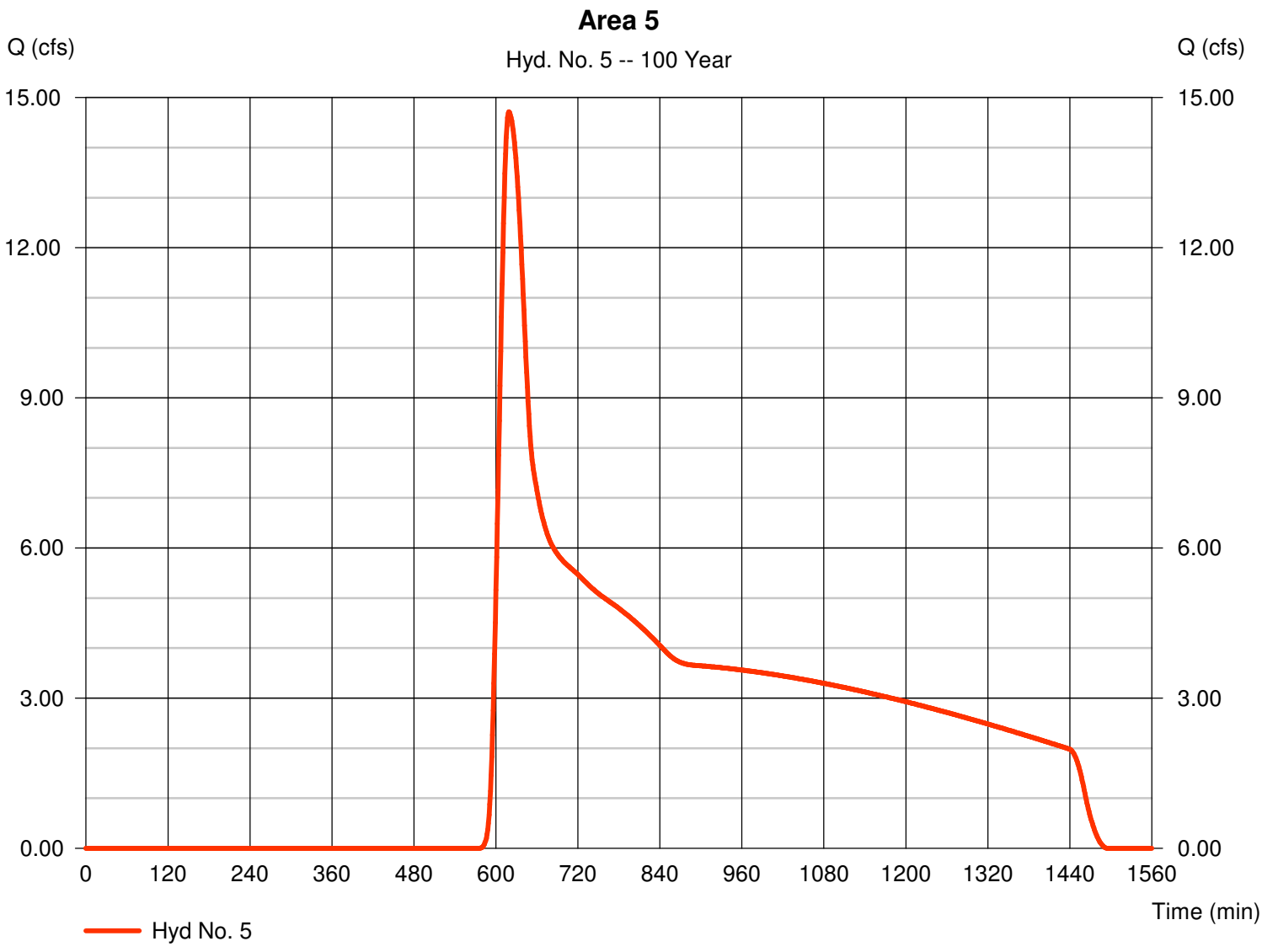
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 5

Area 5

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.72 cfs
Storm frequency	=	100 yrs	Time to peak	=	619 min
Time interval	=	1 min	Hyd. volume	=	209,748 cuft
Drainage area	=	73.600 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	34.40 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



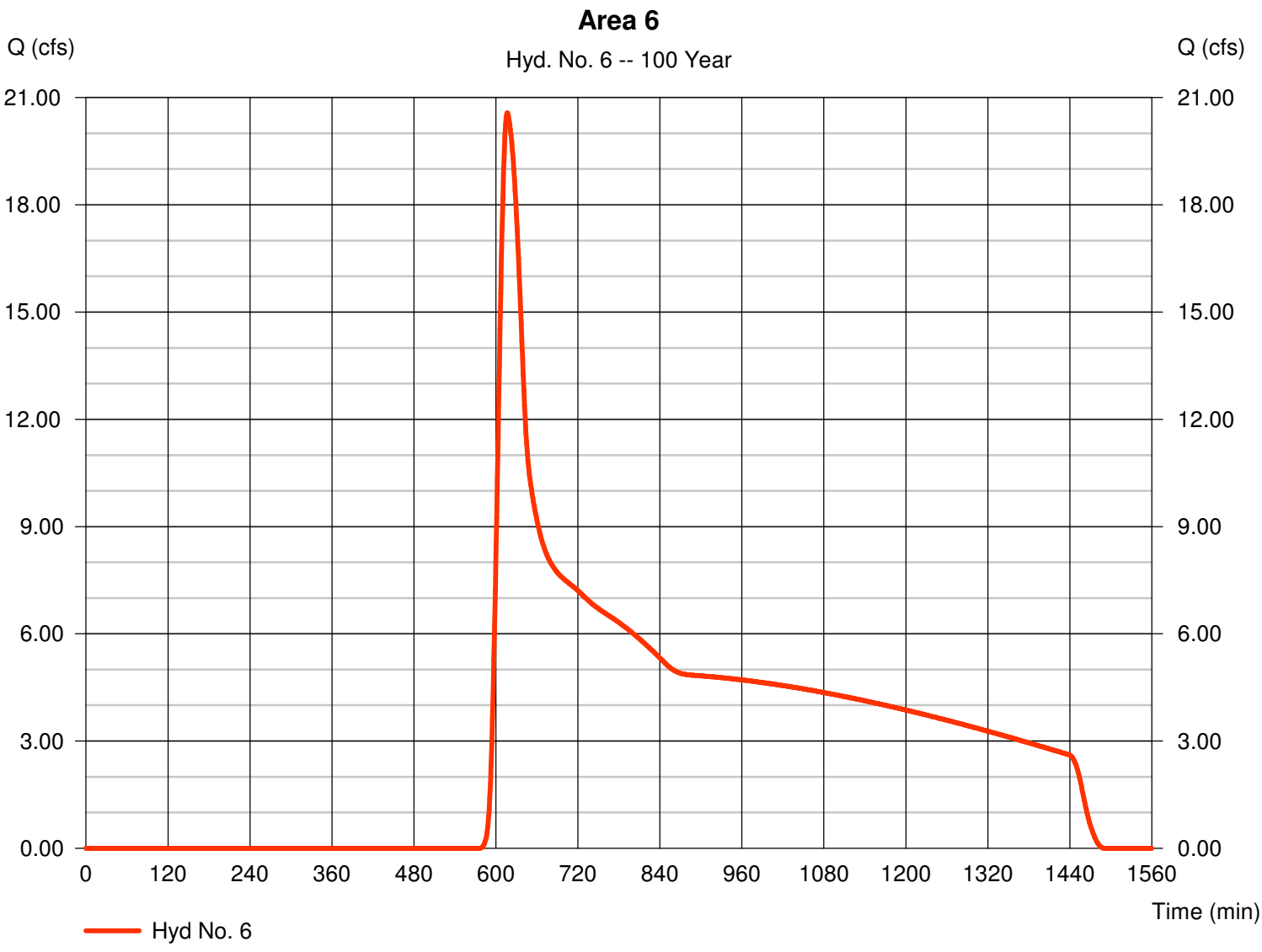
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 6

Area 6

Hydrograph type	=	SCS Runoff	Peak discharge	=	20.57 cfs
Storm frequency	=	100 yrs	Time to peak	=	617 min
Time interval	=	1 min	Hyd. volume	=	277,708 cuft
Drainage area	=	96.810 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	25.71 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



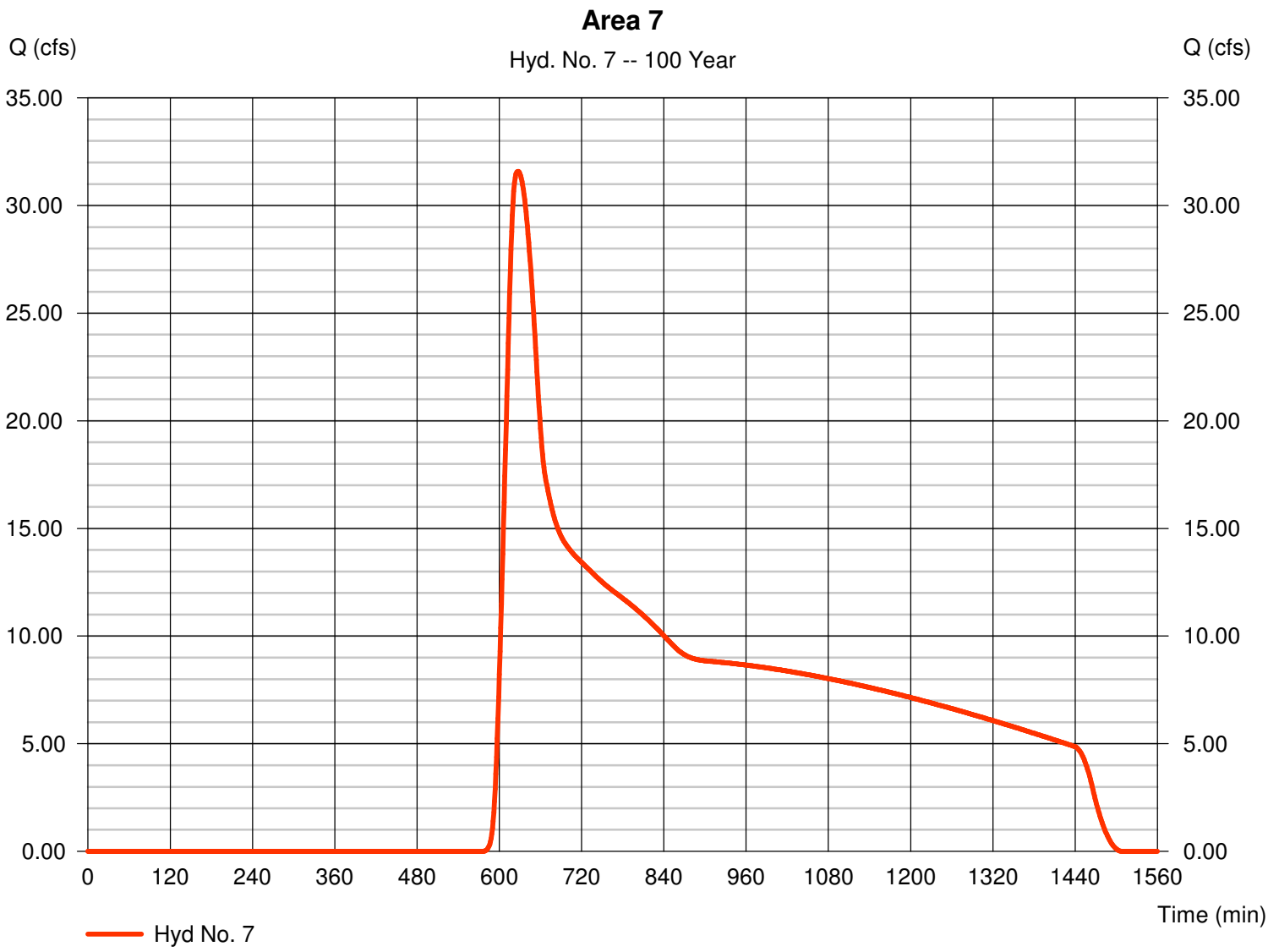
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 7

Area 7

Hydrograph type	=	SCS Runoff	Peak discharge	=	31.59 cfs
Storm frequency	=	100 yrs	Time to peak	=	627 min
Time interval	=	1 min	Hyd. volume	=	508,150 cuft
Drainage area	=	179.170 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	43.00 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



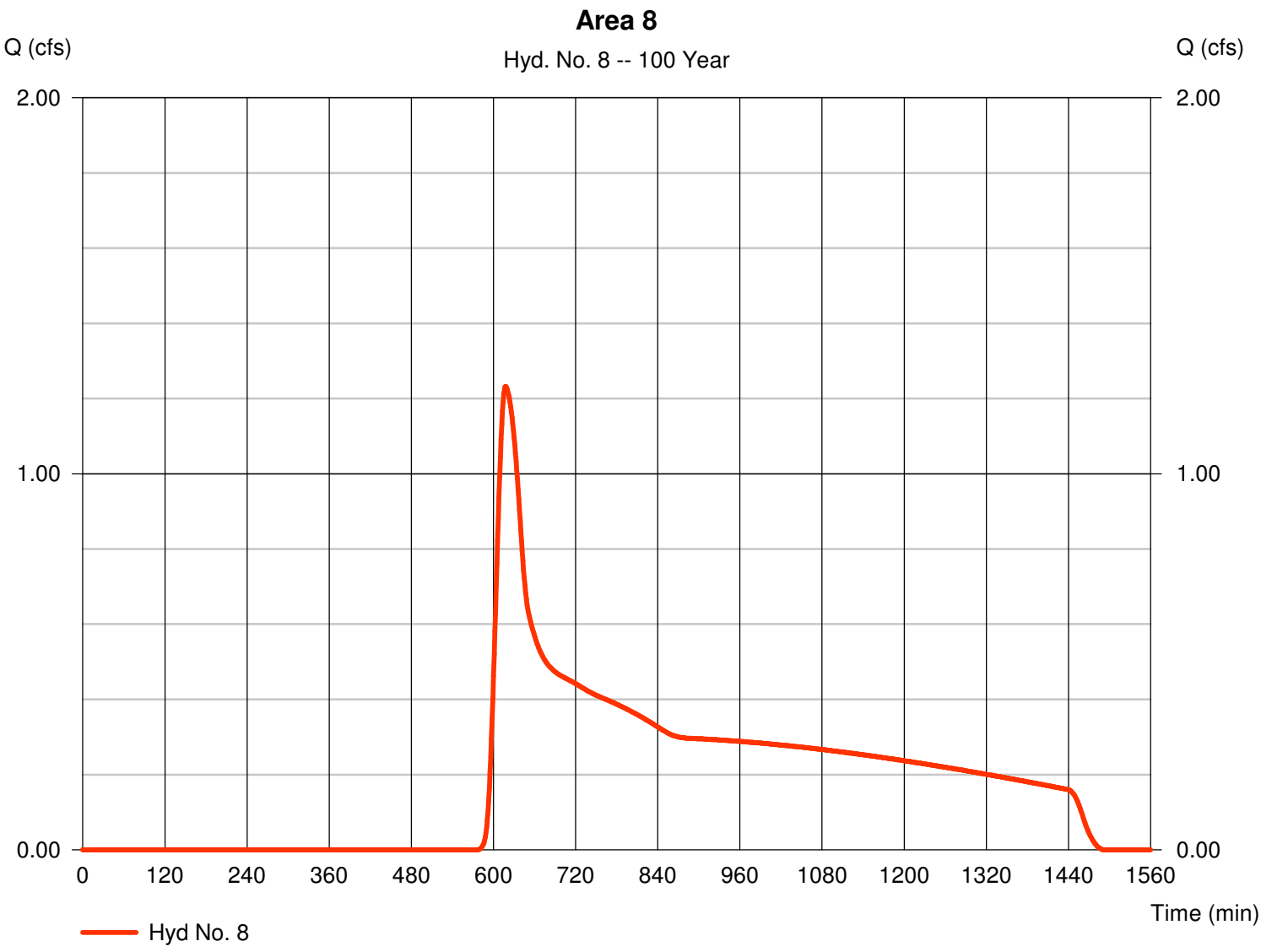
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 8

Area 8

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.233 cfs
Storm frequency	=	100 yrs	Time to peak	=	618 min
Time interval	=	1 min	Hyd. volume	=	16,992 cuft
Drainage area	=	6.000 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	33.70 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

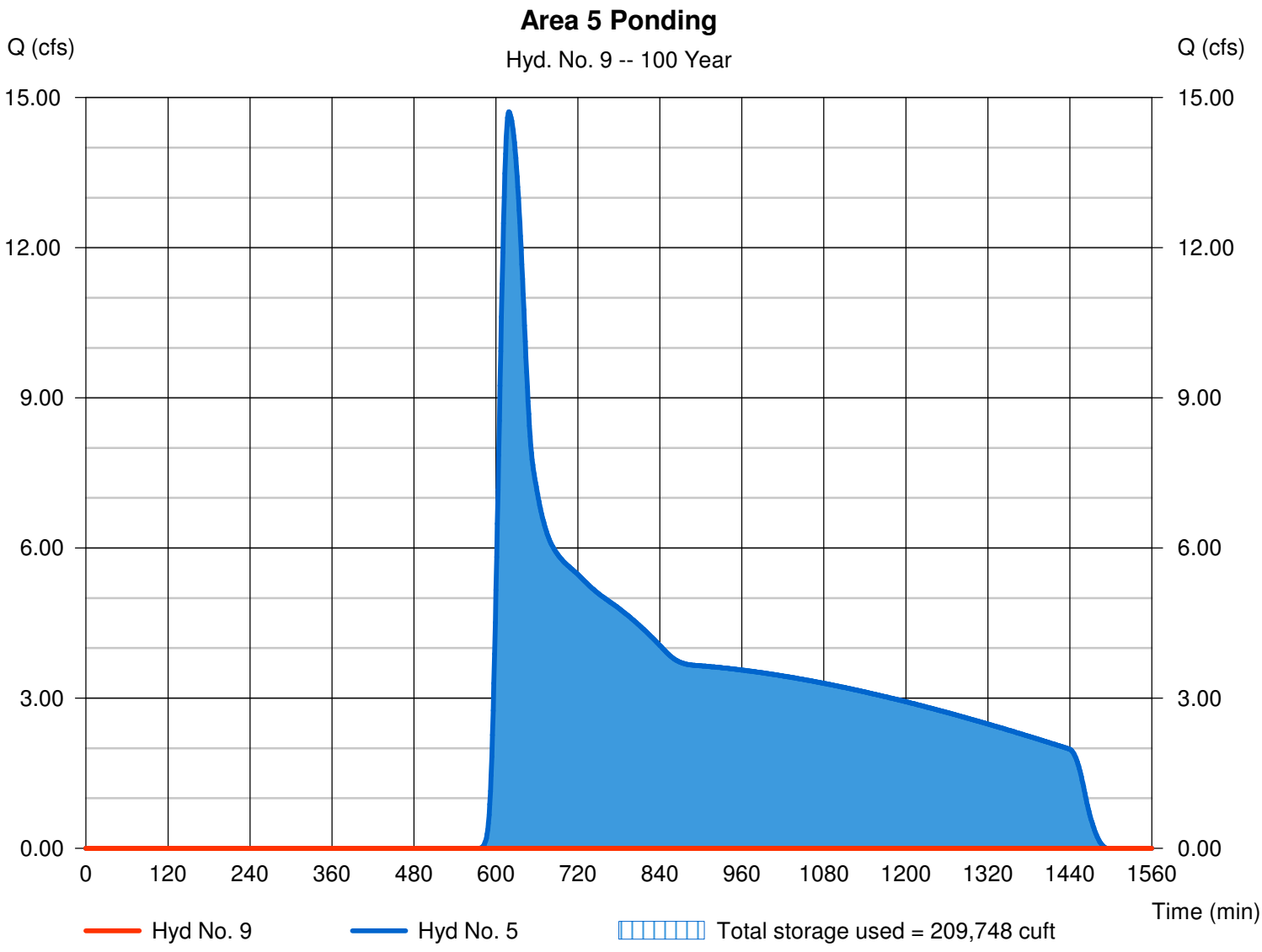
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 9

Area 5 Ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	5 - Area 5	Max. Elevation	=	2513.43 ft
Reservoir name	=	Area 5 pond	Max. Storage	=	209,748 cuft

Storage Indication method used.



Hydrograph Report

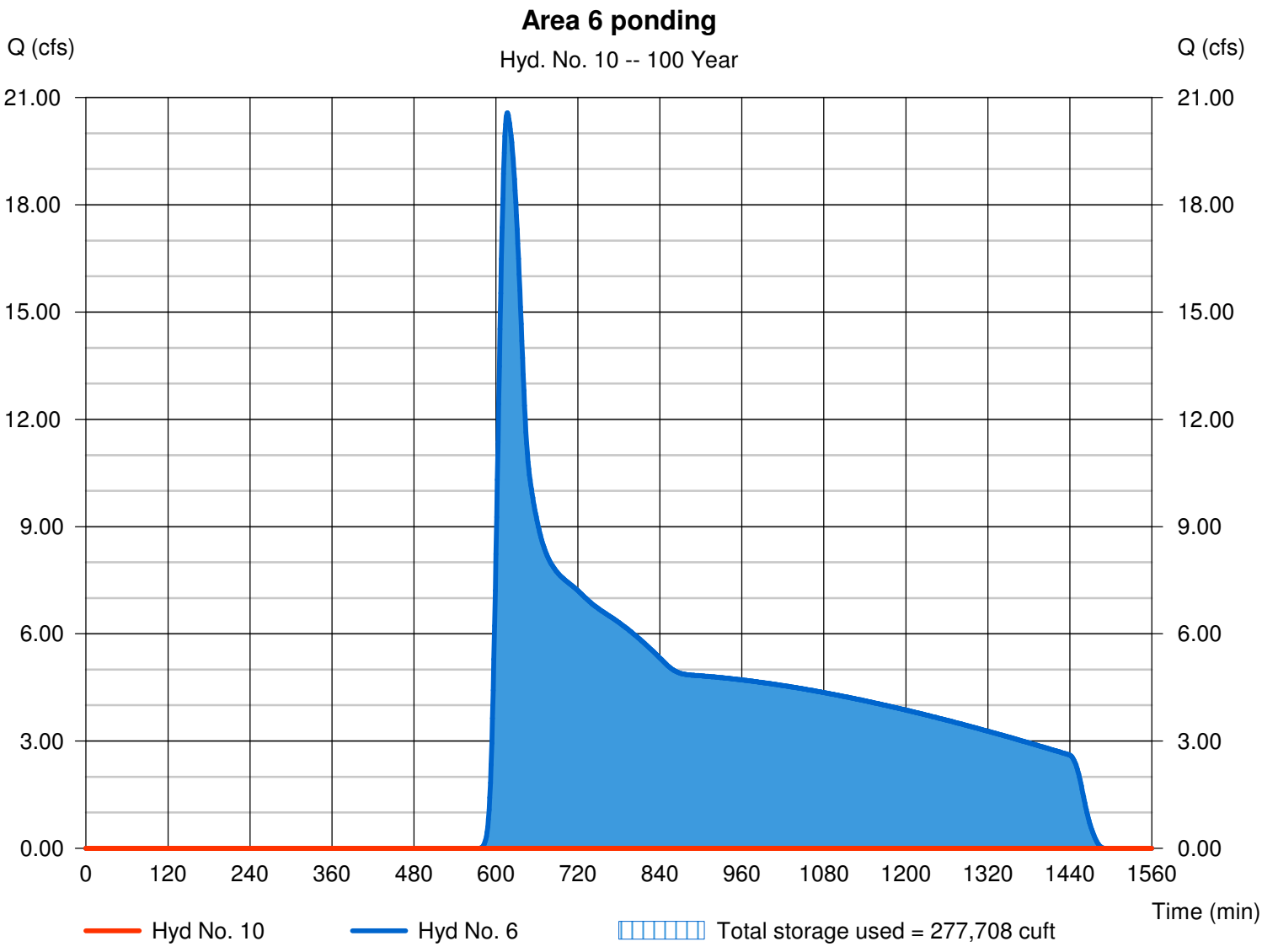
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 10

Area 6 ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	6 - Area 6	Max. Elevation	=	2514.52 ft
Reservoir name	=	Area 6	Max. Storage	=	277,708 cuft

Storage Indication method used.



Hydrograph Report

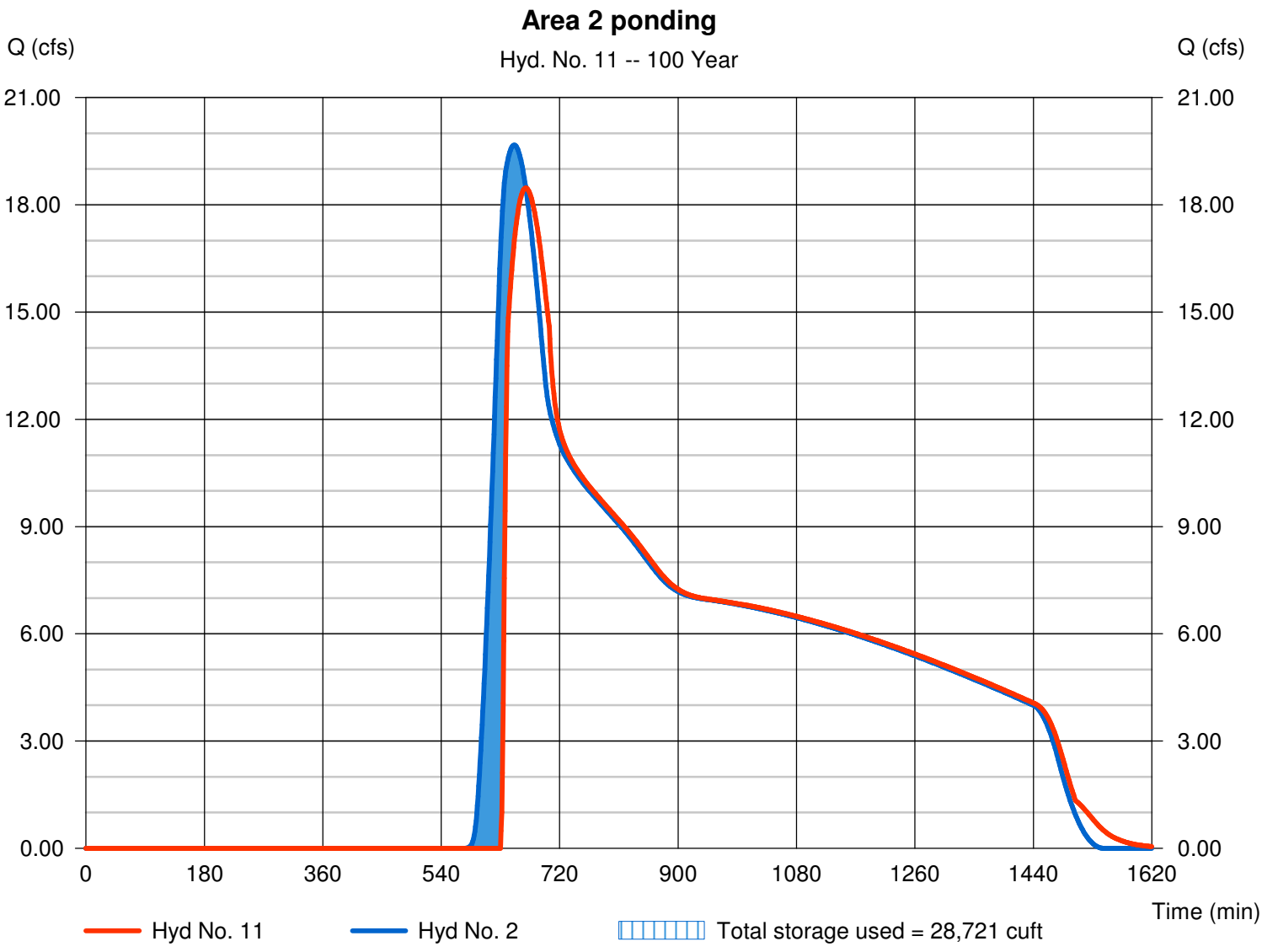
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 11

Area 2 ponding

Hydrograph type	=	Reservoir	Peak discharge	=	18.47 cfs
Storm frequency	=	100 yrs	Time to peak	=	668 min
Time interval	=	1 min	Hyd. volume	=	385,664 cuft
Inflow hyd. No.	=	2 - Area 2	Max. Elevation	=	2516.04 ft
Reservoir name	=	Area 2 ponding	Max. Storage	=	28,721 cuft

Storage Indication method used.



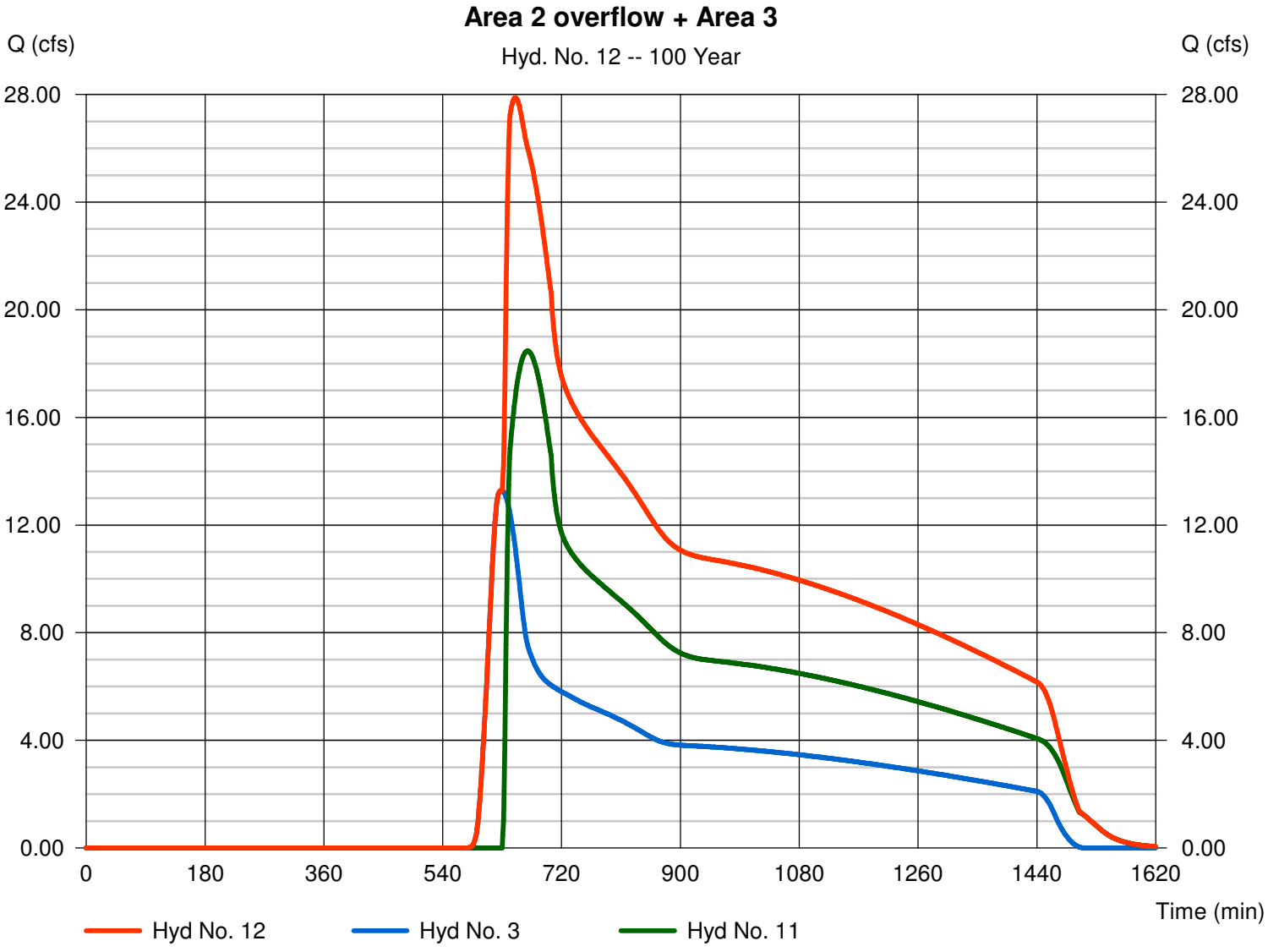
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 12

Area 2 overflow + Area 3

Hydrograph type	= Combine	Peak discharge	= 27.89 cfs
Storm frequency	= 100 yrs	Time to peak	= 650 min
Time interval	= 1 min	Hyd. volume	= 604,816 cuft
Inflow hyds.	= 3, 11	Contrib. drain. area	= 76.900 ac



Hydrograph Report

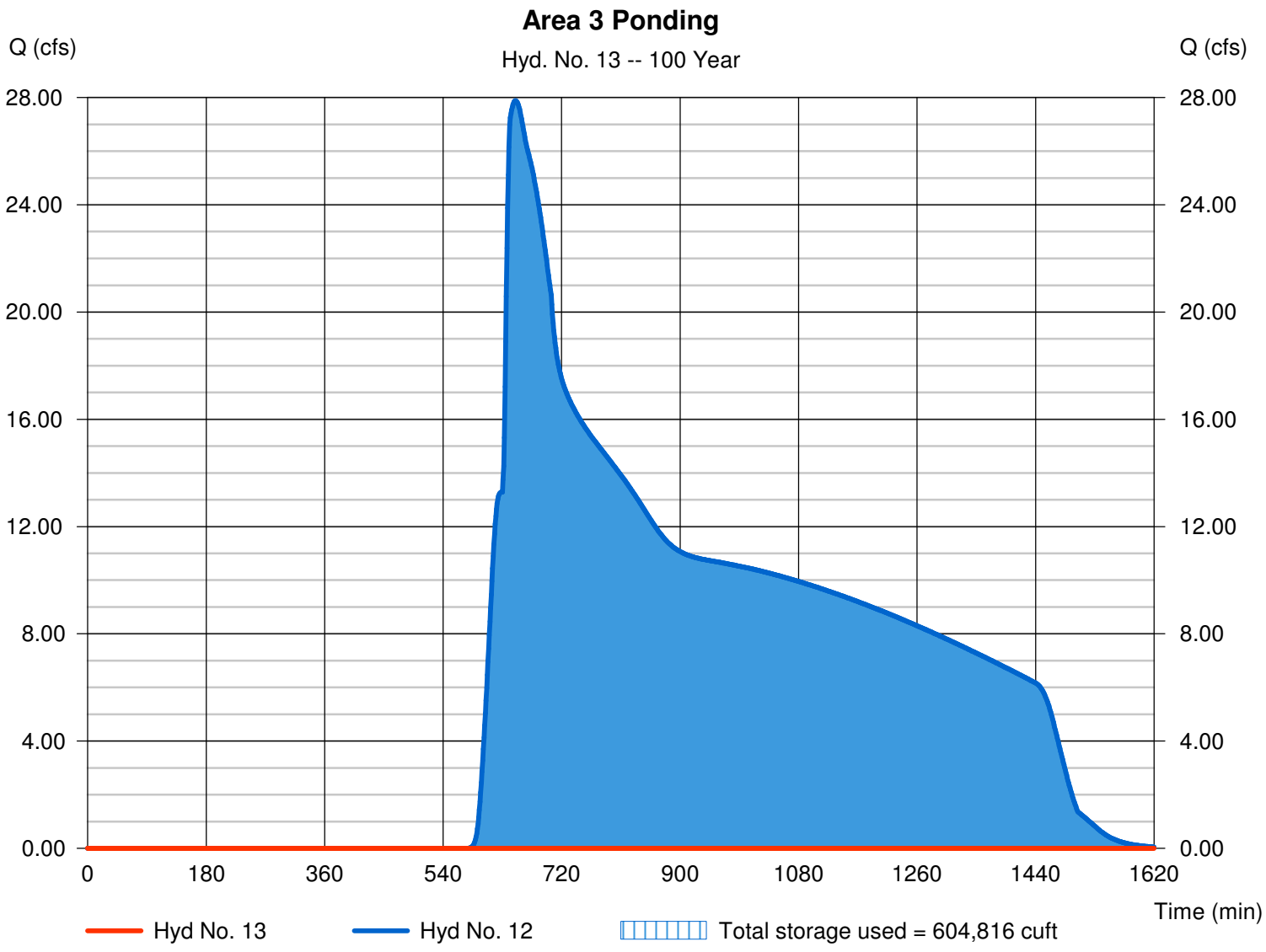
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 13

Area 3 Ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	12 - Area 2 overflow + Area 3	Max. Elevation	=	2508.59 ft
Reservoir name	=	Area 3	Max. Storage	=	604,816 cuft

Storage Indication method used.



Hydrograph Report

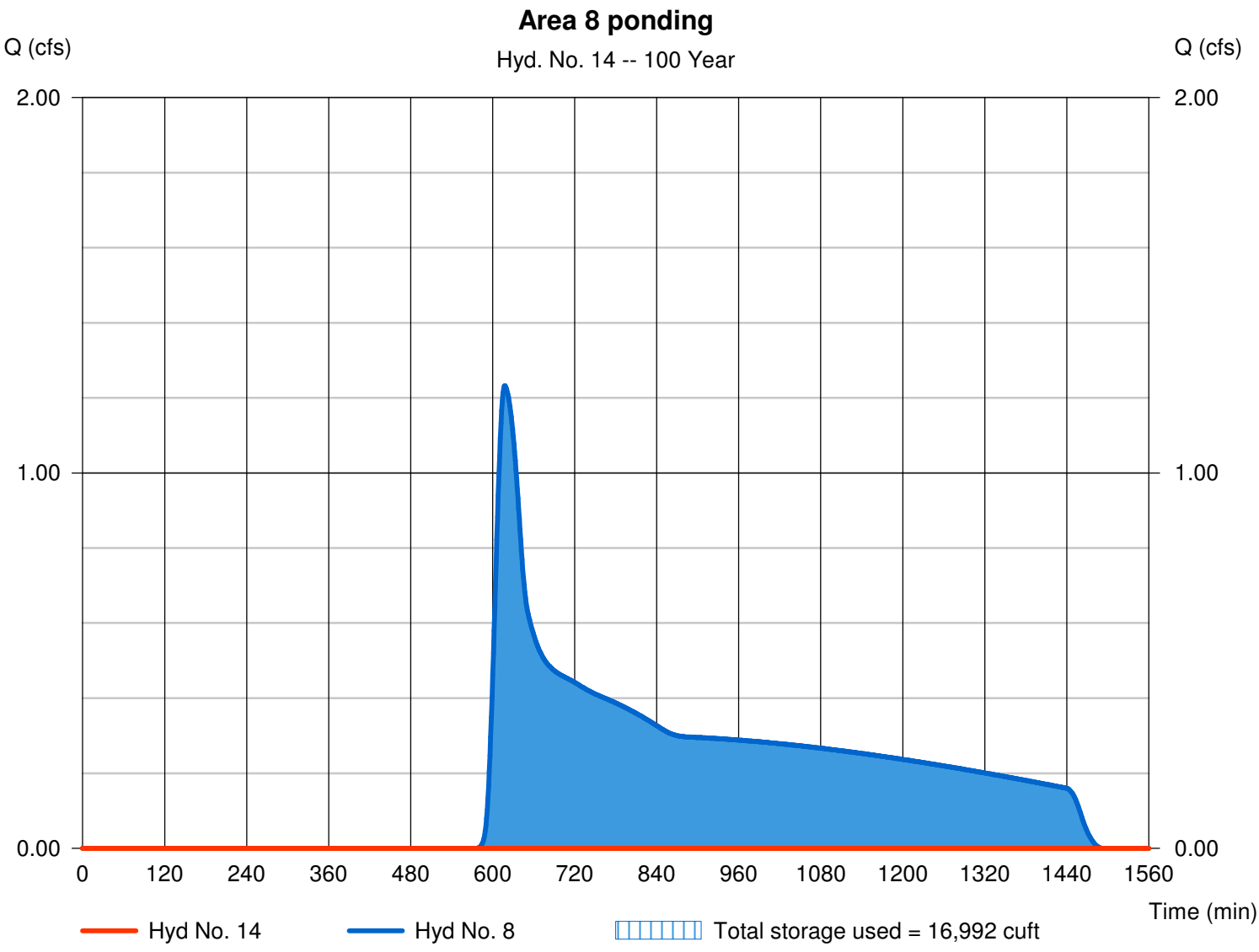
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 14

Area 8 ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	8 - Area 8	Max. Elevation	=	2507.85 ft
Reservoir name	=	Area 8 ponding	Max. Storage	=	16,992 cuft

Storage Indication method used.



Hydrograph Report

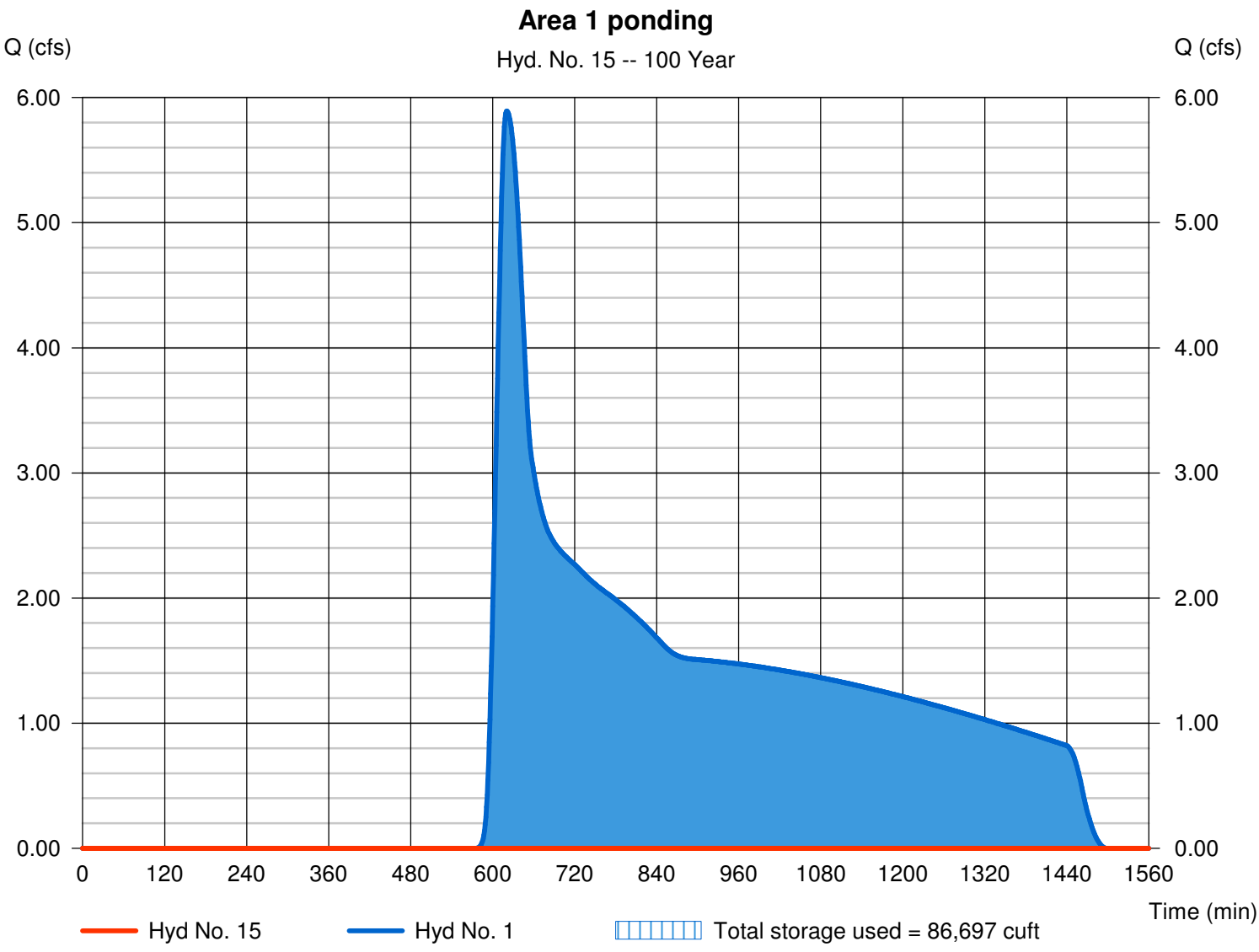
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 15

Area 1 ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	1 - Area 1	Max. Elevation	=	2528.65 ft
Reservoir name	=	Area 1	Max. Storage	=	86,697 cuft

Storage Indication method used.



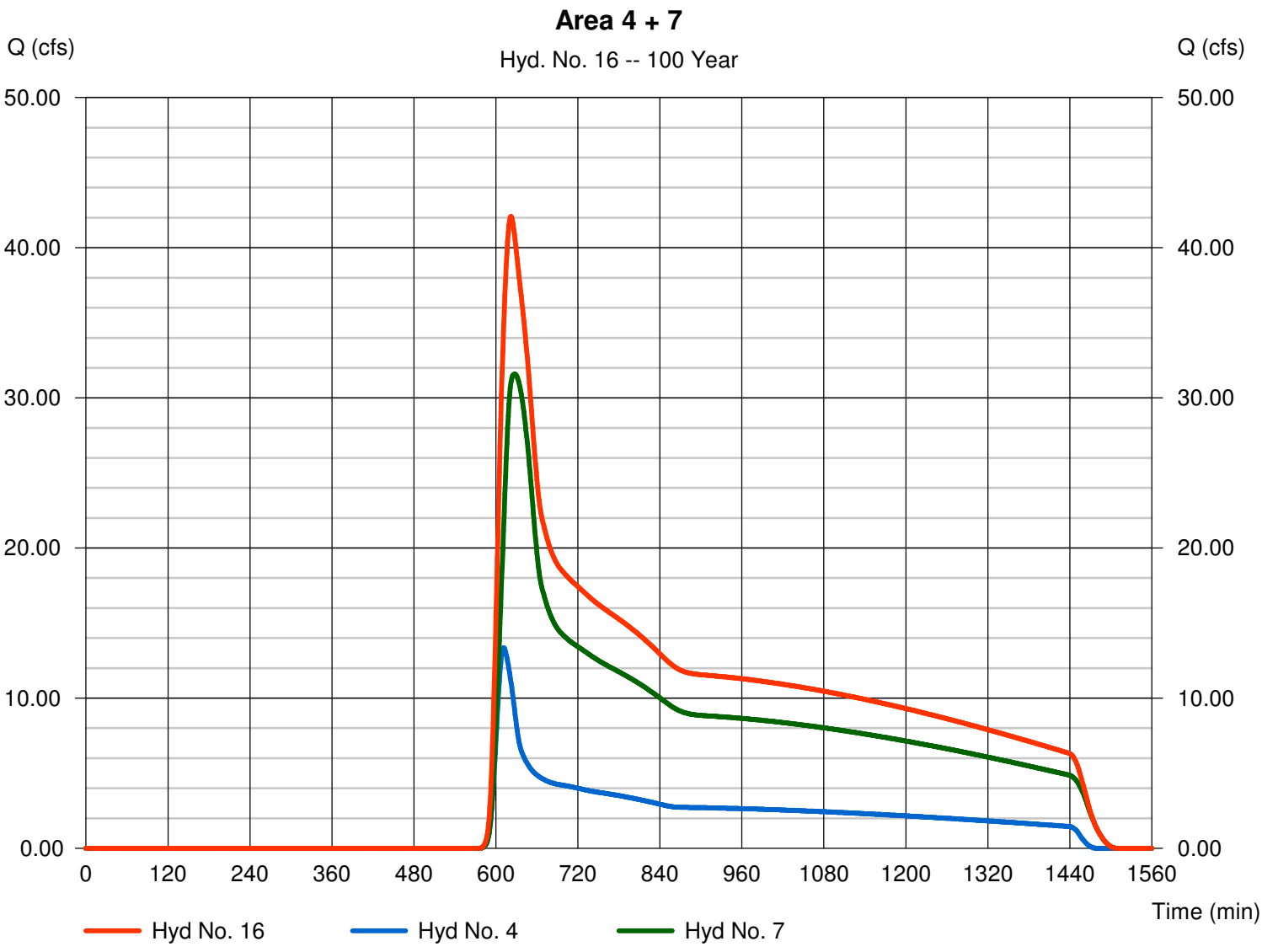
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 16

Area 4 + 7

Hydrograph type	=	Combine	Peak discharge	=	42.09 cfs
Storm frequency	=	100 yrs	Time to peak	=	622 min
Time interval	=	1 min	Hyd. volume	=	664,264 cuft
Inflow hyds.	=	4, 7	Contrib. drain. area	=	233.950 ac



Hydrograph Report

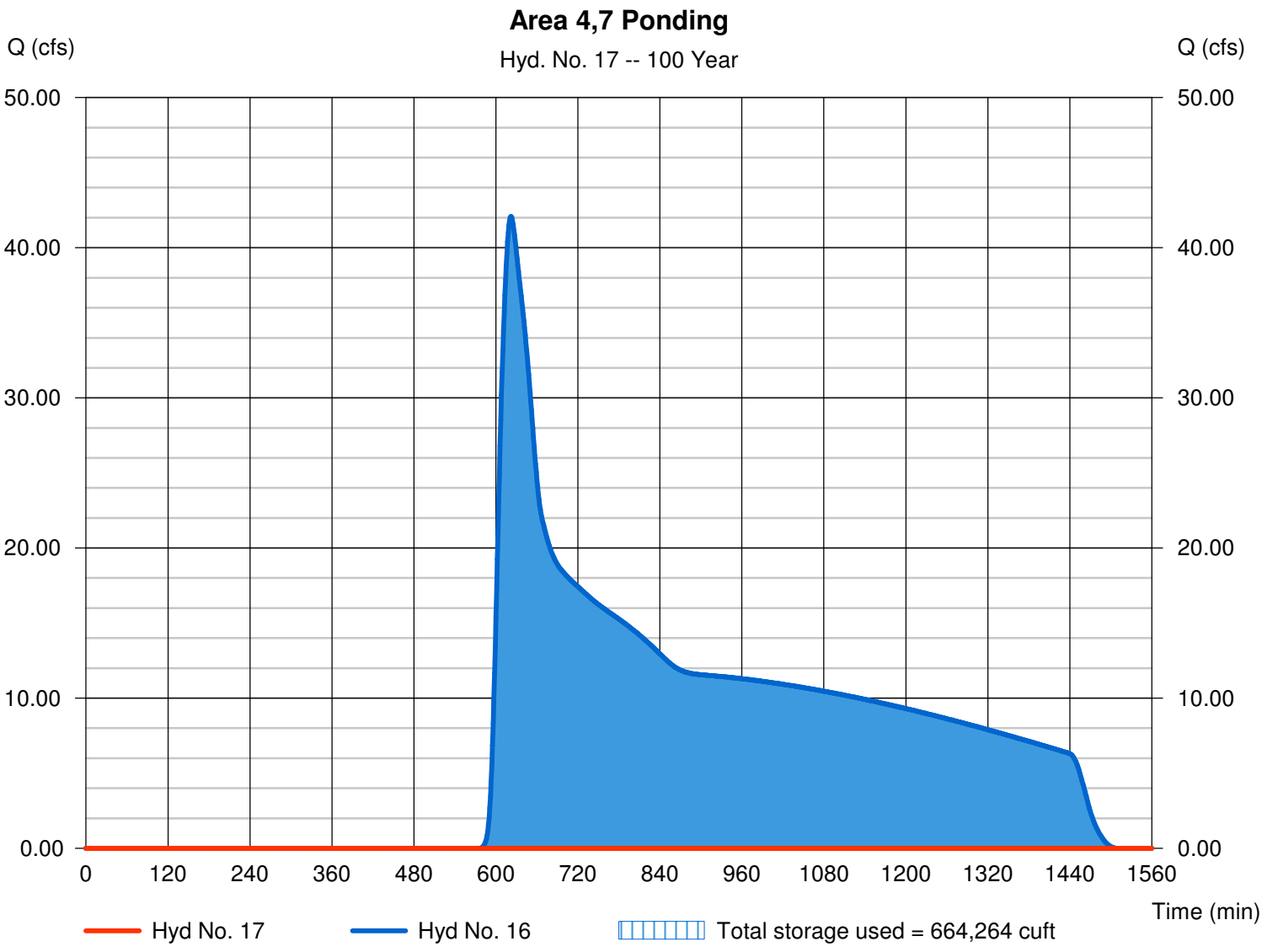
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 17

Area 4,7 Ponding

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	16 - Area 4 + 7	Max. Elevation	=	2493.74 ft
Reservoir name	=	Area 4 & 7 ponding	Max. Storage	=	664,264 cuft

Storage Indication method used.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	24.0939	10.7000	0.8283	--------
3	0.0000	0.0000	0.0000	--------
5	39.1252	10.7000	0.8283	--------
10	50.5834	10.7000	0.8283	--------
25	63.5202	10.7000	0.8283	--------
50	74.6089	10.7000	0.8283	--------
100	84.4654	10.7000	0.8283	--------

File name: palmdale.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	2.46	1.96	1.64	1.41	1.25	1.12	1.02	0.93	0.86	0.80	0.75	0.71
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	4.00	3.18	2.66	2.29	2.02	1.82	1.65	1.51	1.40	1.30	1.22	1.15
10	5.17	4.11	3.44	2.97	2.62	2.35	2.13	1.96	1.81	1.69	1.58	1.49
25	6.49	5.16	4.32	3.72	3.29	2.95	2.68	2.46	2.27	2.12	1.98	1.87
50	7.62	6.06	5.07	4.37	3.86	3.46	3.15	2.89	2.67	2.49	2.33	2.19
100	8.63	6.86	5.74	4.95	4.37	3.92	3.56	3.27	3.02	2.82	2.64	2.48

Tc = time in minutes. Values may exceed 60.

Precip. file name: Palmdale Rainfall.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.05	1.39	0.00	1.93	2.34	2.88	3.31	3.75
SCS 6-Hr	0.76	0.98	0.00	1.32	1.59	1.97	2.27	2.59
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix C

Post-Development Drainage Calculations

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Palmdale Post Dev June2008.gpw

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Hydrograph Return Period Recap

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SCS Runoff	-------	-------	0.041	-------	0.237	0.504	1.631	3.392	5.892	Area 1
2	SCS Runoff	-------	-------	0.189	-------	1.093	2.323	6.908	13.81	23.38	Area 2
3	SCS Runoff	-------	-------	0.019	-------	0.112	0.238	1.076	2.623	4.637	Area 3
4	SCS Runoff	-------	-------	0.032	-------	0.184	0.391	1.426	3.226	5.746	Area 4
5	SCS Runoff	-------	-------	0.069	-------	0.398	0.849	4.109	10.03	17.62	Area 5
6	SCS Runoff	-------	-------	0.038	-------	0.218	0.465	2.099	5.118	9.048	Area 6
7	SCS Runoff	-------	-------	14.72	-------	34.12	51.03	75.07	95.19	116.35	Area 7.1
8	SCS Runoff	-------	-------	1.905	-------	4.383	6.533	9.591	12.15	14.84	Area 7.2
9	SCS Runoff	-------	-------	13.59	-------	31.51	47.13	69.32	87.90	107.45	Area 8.1
10	SCS Runoff	-------	-------	8.057	-------	18.65	27.86	40.97	51.91	63.42	Area 8.2
11	SCS Runoff	-------	-------	10.49	-------	15.05	18.47	22.96	26.51	30.14	Power Block North
12	SCS Runoff	-------	-------	11.87	-------	17.01	20.87	25.93	29.95	34.04	Power Block South
13	Combine	2, 3, 4, 5, 6,	-------	0.347	-------	2.003	4.259	11.76	24.27	43.96	To Area 3 pond
14	Combine	7, 8,	-------	16.06	-------	37.19	55.58	81.75	103.63	126.64	Area 7
15	Combine	9, 10,	-------	21.48	-------	49.76	74.40	109.42	138.70	169.56	Area 8
16	Combine	11, 14,	-------	19.17	-------	41.10	60.48	87.93	110.86	134.95	To North Pond
17	Combine	10, 12,	-------	14.43	-------	24.91	33.62	46.06	57.82	70.16	To SE Pond
18	Reservoir	13	-------	0.000	-------	0.000	0.000	0.000	0.000	0.000	Area 3 pond
19	Reservoir	17	-------	0.000	-------	0.000	0.000	0.000	0.000	3.652	SE Pond
20	Combine	9, 19	-------	13.59	-------	31.51	47.13	69.32	87.90	107.45	To SW Pond
21	Reservoir	20	-------	0.000	-------	0.000	0.000	0.000	0.000	0.000	SW Pond
22	Reservoir	16	-------	0.000	-------	0.000	0.000	0.000	0.000	0.000	North Pond

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	0.041	1	1363	842	----	------	------	Area 1
2	SCS Runoff	0.189	1	1371	3,883	----	------	------	Area 2
3	SCS Runoff	0.019	1	1347	397	----	------	------	Area 3
4	SCS Runoff	0.032	1	1354	652	----	------	------	Area 4
5	SCS Runoff	0.069	1	1346	1,413	----	------	------	Area 5
6	SCS Runoff	0.038	1	1347	775	----	------	------	Area 6
7	SCS Runoff	14.72	1	624	190,829	----	------	------	Area 7.1
8	SCS Runoff	1.905	1	610	17,515	----	------	------	Area 7.2
9	SCS Runoff	13.59	1	624	176,225	----	------	------	Area 8.1
10	SCS Runoff	8.057	1	619	94,542	----	------	------	Area 8.2
11	SCS Runoff	10.49	1	601	56,919	----	------	------	Power Block North
12	SCS Runoff	11.87	1	596	52,468	----	------	------	Power Block South
13	Combine	0.347	1	1361	7,120	2, 3, 4, 5, 6,	------	------	To Area 3 pond
14	Combine	16.06	1	623	208,344	7, 8,	------	------	Area 7
15	Combine	21.48	1	623	270,768	9, 10,	------	------	Area 8
16	Combine	19.17	1	606	265,263	11, 14,	------	------	To North Pond
17	Combine	14.43	1	597	147,011	10, 12,	------	------	To SE Pond
18	Reservoir	0.000	1	n/a	0	13	2505.03	7,120	Area 3 pond
19	Reservoir	0.000	1	n/a	0	17	2508.47	147,011	SE Pond
20	Combine	13.59	1	624	176,225	9, 19	------	------	To SW Pond
21	Reservoir	0.000	1	n/a	0	20	2506.35	176,226	SW Pond
22	Reservoir	0.000	1	n/a	0	16	2491.23	265,264	North Pond

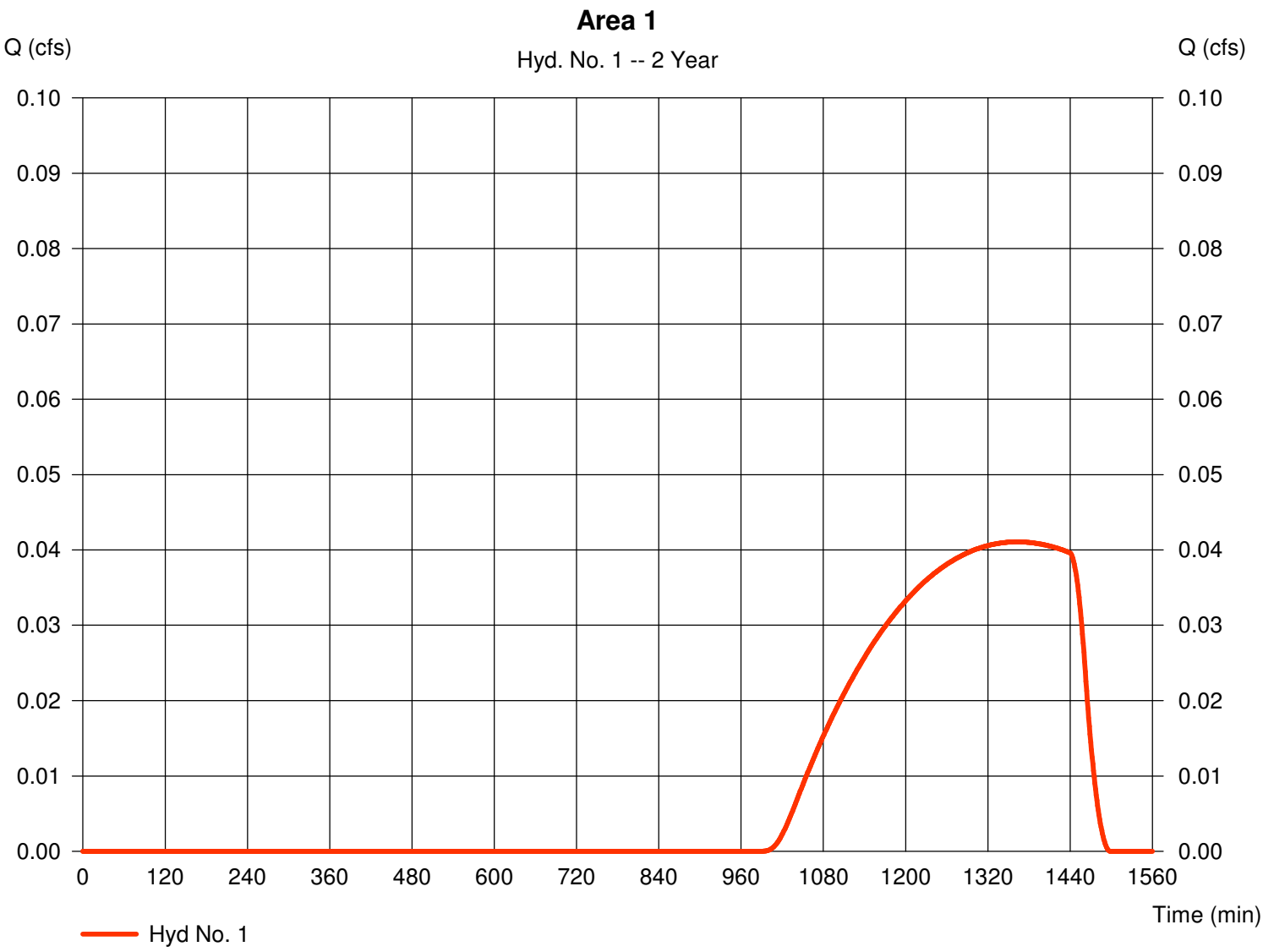
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 1

Area 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.041 cfs
Storm frequency	=	2 yrs	Time to peak	=	1363 min
Time interval	=	1 min	Hyd. volume	=	842 cuft
Drainage area	=	30.250 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	36.75 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 1

Area 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.60		0.00		0.00		
Travel Time (min)	**=**	**5.92**	**+**	**0.00**	**+**	**0.00**	**=**	**5.92**
Shallow Concentrated Flow								
Flow length (ft)	=	1670.00		0.00		0.00		
Watercourse slope (%)	=	0.60		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.25		0.00		0.00		
Travel Time (min)	**=**	**22.27**	**+**	**0.00**	**+**	**0.00**	**=**	**22.27**
Channel Flow								
X sectional flow area (sqft)	=	130.00		10.00		0.00		
Wetted perimeter (ft)	=	130.00		0.00		0.00		
Channel slope (%)	=	0.60		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	4.44		0.00		0.00		
Flow length (ft)	=	2279.0		250.0		0.0		
Travel Time (min)	**=**	**8.56**	**+**	**0.00**	**+**	**0.00**	**=**	**8.56**

Total Travel Time, Tc ..... 36.75 min

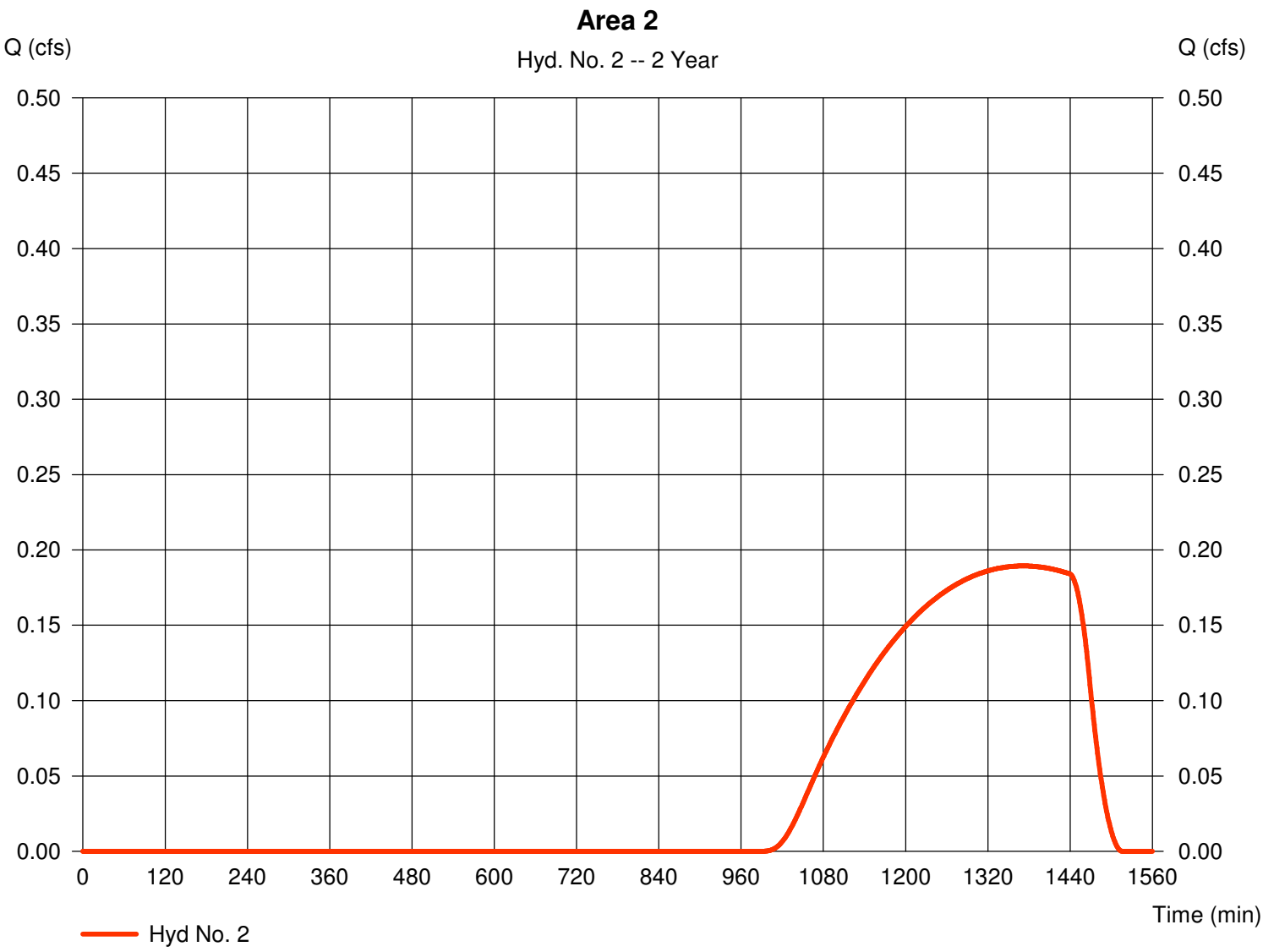
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 2

Area 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.189 cfs
Storm frequency	=	2 yrs	Time to peak	=	1371 min
Time interval	=	1 min	Hyd. volume	=	3,883 cuft
Drainage area	=	140.990 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	47.60 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 2

Area 2

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.90		0.00		0.00		
Travel Time (min)	**=**	**5.04**	**+**	**0.00**	**+**	**0.00**	**=**	**5.04**
Shallow Concentrated Flow								
Flow length (ft)	=	3626.00		0.00		0.00		
Watercourse slope (%)	=	0.90		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.53		0.00		0.00		
Travel Time (min)	**=**	**39.48**	**+**	**0.00**	**+**	**0.00**	**=**	**39.48**
Channel Flow								
X sectional flow area (sqft)	=	75.00		10.00		0.00		
Wetted perimeter (ft)	=	75.00		0.00		0.00		
Channel slope (%)	=	0.90		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	5.44		0.00		0.00		
Flow length (ft)	=	1000.0		0.0		0.0		
Travel Time (min)	**=**	**3.07**	**+**	**0.00**	**+**	**0.00**	**=**	**3.07**

Total Travel Time, Tc ..... 47.60 min

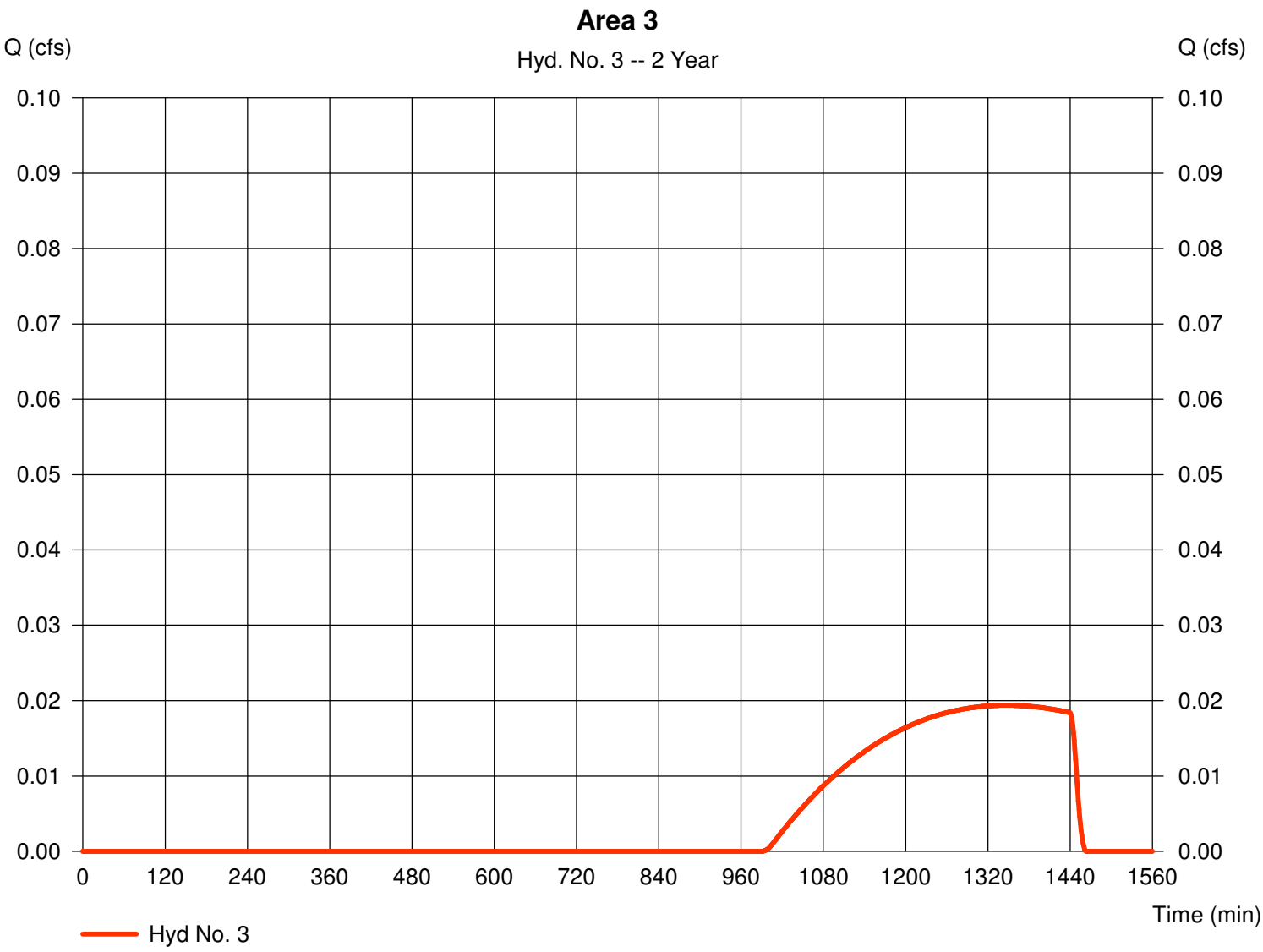
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 3

Area 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.019 cfs
Storm frequency	=	2 yrs	Time to peak	=	1347 min
Time interval	=	1 min	Hyd. volume	=	397 cuft
Drainage area	=	14.350 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.40 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 3

Area 3

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**6.37**	**+**	**0.00**	**+**	**0.00**	**=**	**6.37**
Shallow Concentrated Flow								
Flow length (ft)	=	553.00		0.00		0.00		
Watercourse slope (%)	=	0.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.14		0.00		0.00		
Travel Time (min)	**=**	**8.08**	**+**	**0.00**	**+**	**0.00**	**=**	**8.08**
Channel Flow								
X sectional flow area (sqft)	=	0.00		10.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.50		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	1000.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 14.40 min

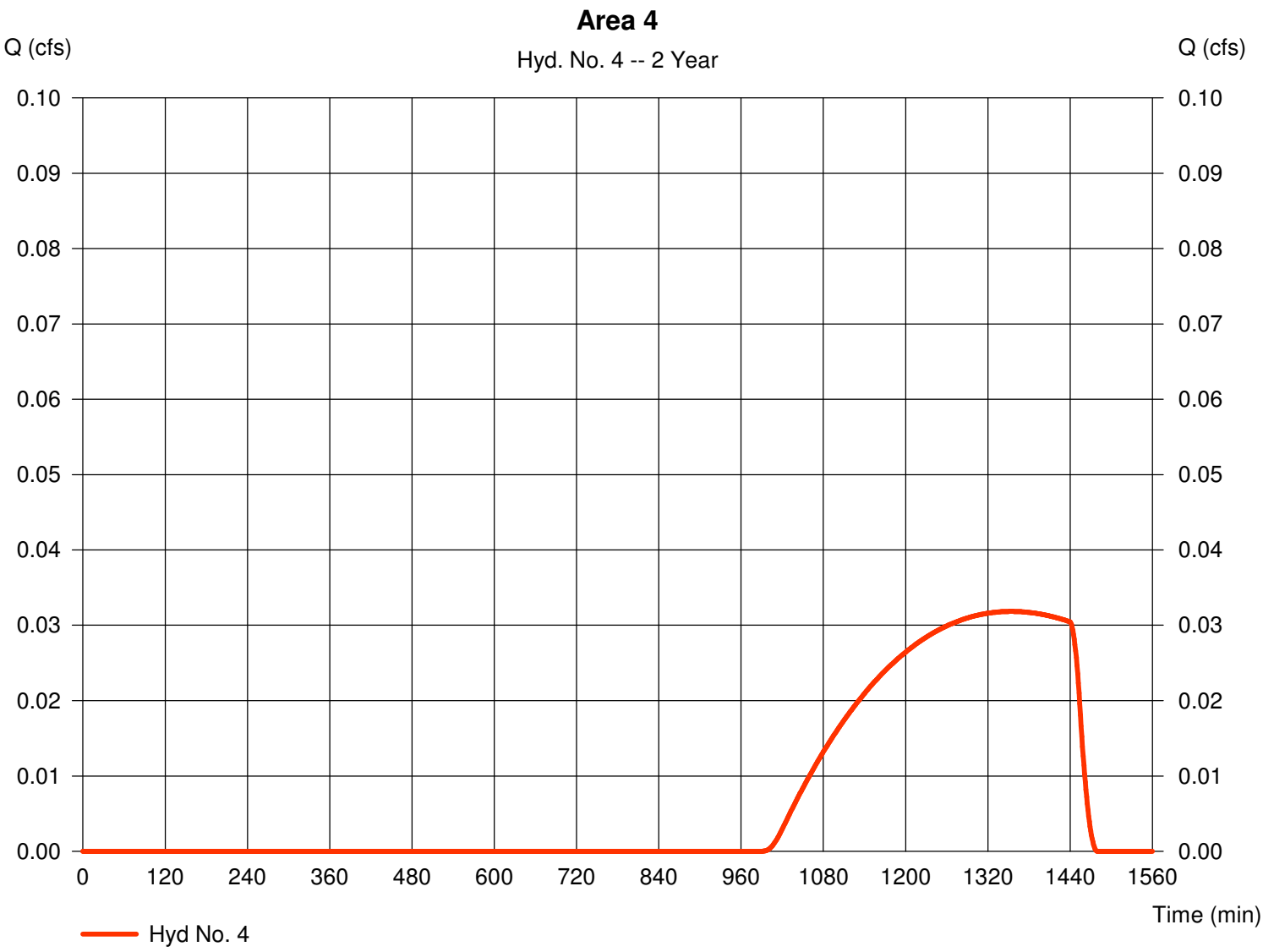
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 4

Area 4

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.032 cfs
Storm frequency	=	2 yrs	Time to peak	=	1354 min
Time interval	=	1 min	Hyd. volume	=	652 cuft
Drainage area	=	23.570 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	24.70 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 4

Area 4

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**4.65**	**+**	**0.00**	**+**	**0.00**	**=**	**4.65**
Shallow Concentrated Flow								
Flow length (ft)	=	1719.00		0.00		0.00		
Watercourse slope (%)	=	1.10		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.69		0.00		0.00		
Travel Time (min)	**=**	**16.93**	**+**	**0.00**	**+**	**0.00**	**=**	**16.93**
Channel Flow								
X sectional flow area (sqft)	=	10.00		10.00		0.00		
Wetted perimeter (ft)	=	10.00		0.00		0.00		
Channel slope (%)	=	0.80		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	5.13		0.00		0.00		
Flow length (ft)	=	945.0		0.0		0.0		
Travel Time (min)	**=**	**3.07**	**+**	**0.00**	**+**	**0.00**	**=**	**3.07**

Total Travel Time, Tc ..... 24.70 min

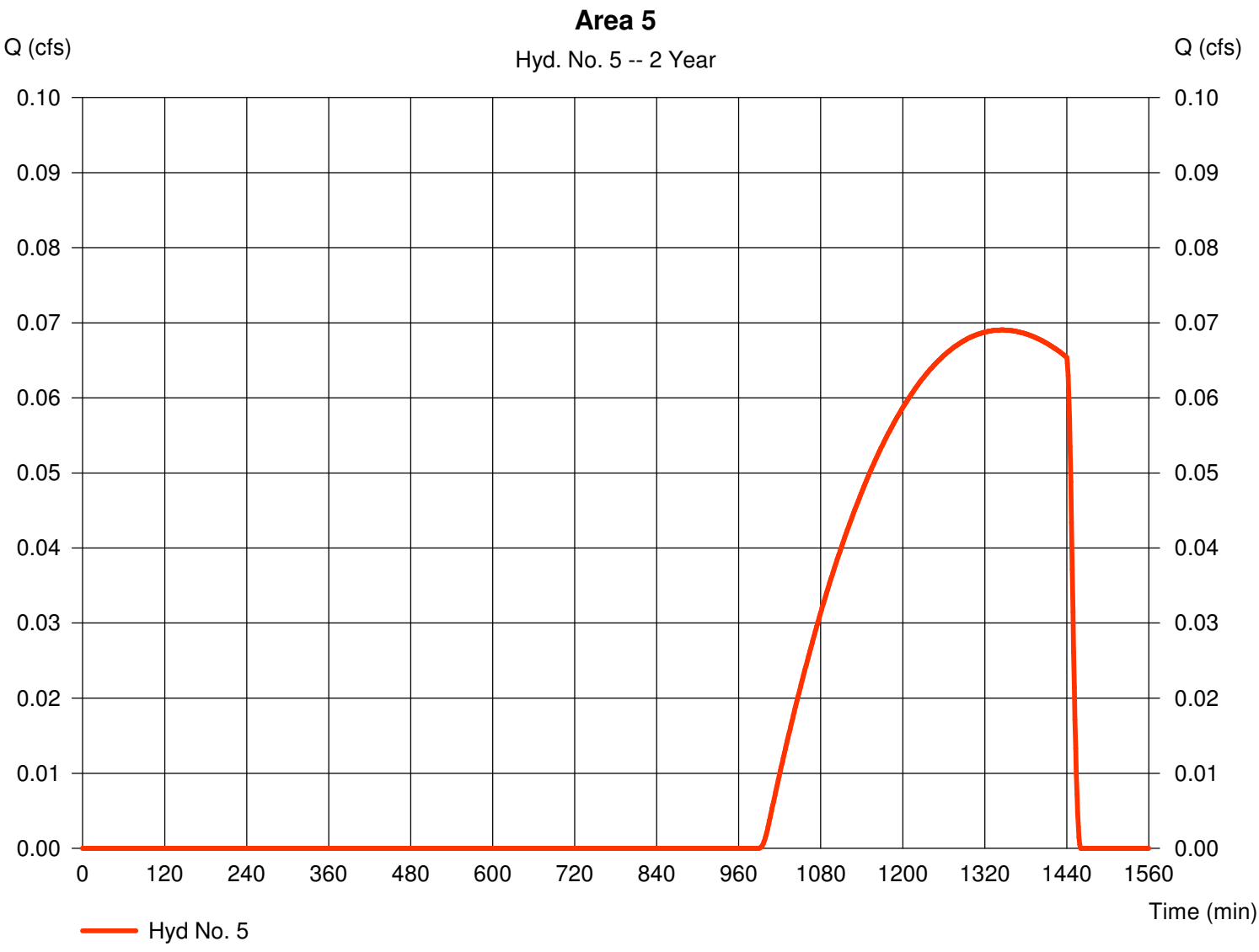
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 5

Area 5

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.069 cfs
Storm frequency	=	2 yrs	Time to peak	=	1346 min
Time interval	=	1 min	Hyd. volume	=	1,413 cuft
Drainage area	=	51.900 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.40 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 5

Area 5

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.90		0.00		0.00		
Travel Time (min)	**=**	**5.04**	**+**	**0.00**	**+**	**0.00**	**=**	**5.04**
Shallow Concentrated Flow								
Flow length (ft)	=	655.00		0.00		0.00		
Watercourse slope (%)	=	0.90		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.53		0.00		0.00		
Travel Time (min)	**=**	**7.13**	**+**	**0.00**	**+**	**0.00**	**=**	**7.13**
Channel Flow								
X sectional flow area (sqft)	=	10.00		10.00		0.00		
Wetted perimeter (ft)	=	10.00		0.00		0.00		
Channel slope (%)	=	0.80		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	5.13		0.00		0.00		
Flow length (ft)	=	370.0		0.0		0.0		
Travel Time (min)	**=**	**1.20**	**+**	**0.00**	**+**	**0.00**	**=**	**1.20**

Total Travel Time, Tc ..... 13.40 min

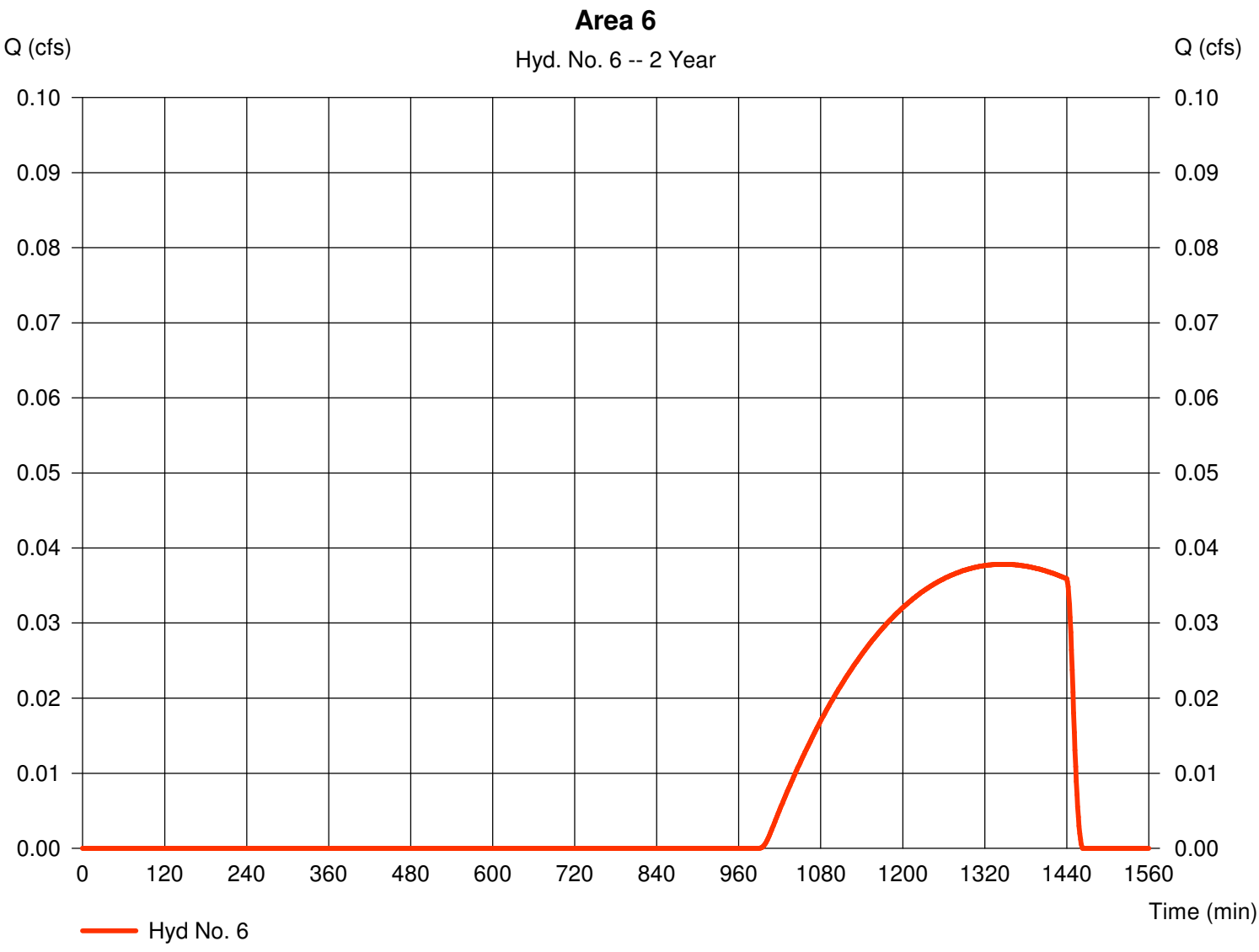
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 6

Area 6

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.038 cfs
Storm frequency	=	2 yrs	Time to peak	=	1347 min
Time interval	=	1 min	Hyd. volume	=	775 cuft
Drainage area	=	28.000 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.40 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 6

Area 6

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.70		0.00		0.00		
Travel Time (min)	**=**	**5.57**	**+**	**0.00**	**+**	**0.00**	**=**	**5.57**
Shallow Concentrated Flow								
Flow length (ft)	=	716.00		0.00		0.00		
Watercourse slope (%)	=	0.70		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.35		0.00		0.00		
Travel Time (min)	**=**	**8.84**	**+**	**0.00**	**+**	**0.00**	**=**	**8.84**
Channel Flow								
X sectional flow area (sqft)	=	10.00		10.00		0.00		
Wetted perimeter (ft)	=	10.00		0.00		0.00		
Channel slope (%)	=	0.70		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	4.79		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 14.40 min

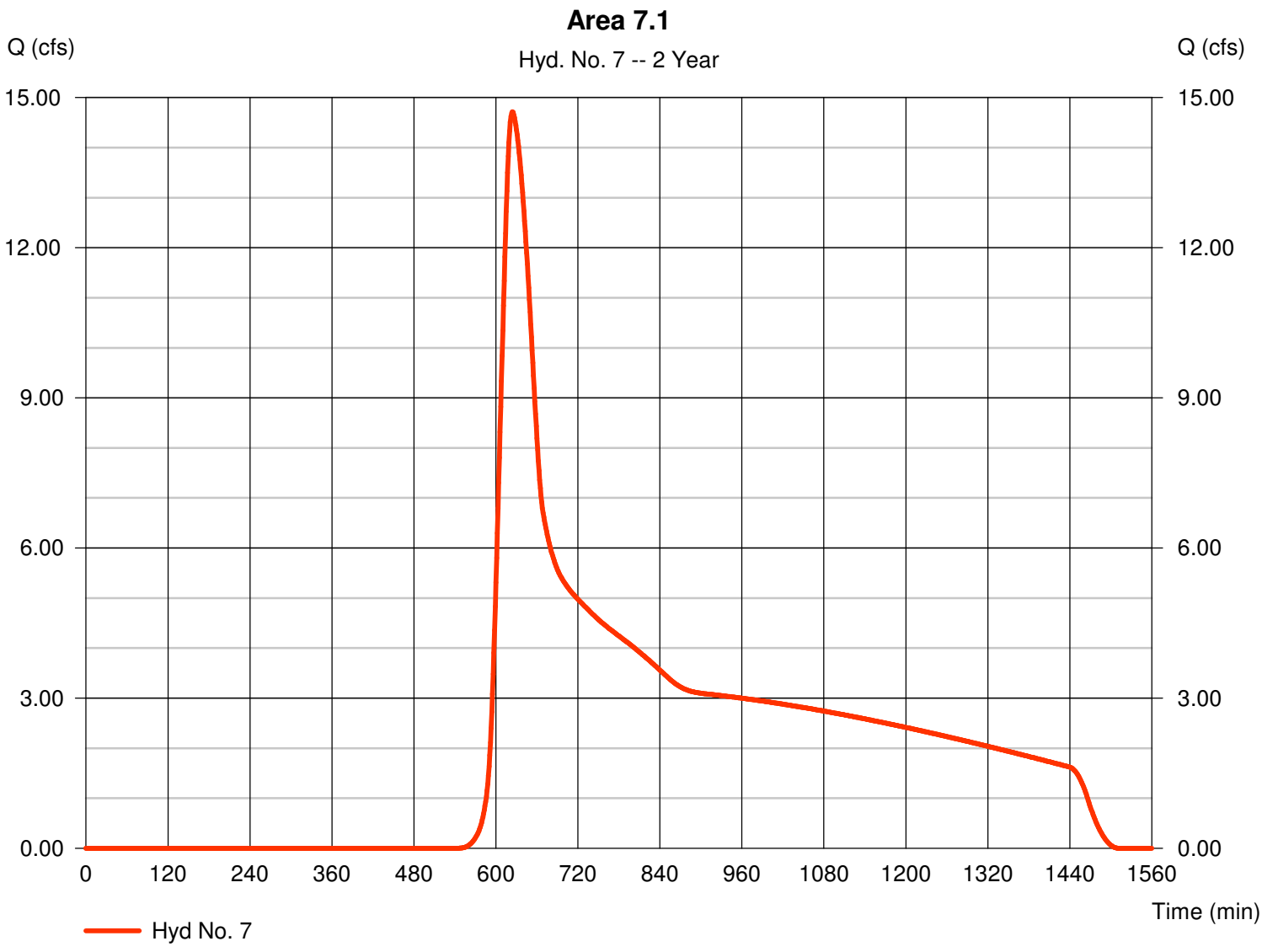
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 7

Area 7.1

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.72 cfs
Storm frequency	=	2 yrs	Time to peak	=	624 min
Time interval	=	1 min	Hyd. volume	=	190,829 cuft
Drainage area	=	136.950 ac	Curve number	=	85
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	45.30 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 7

Area 7.1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.030		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**7.14**	**+**	**0.00**	**+**	**0.00**	**=**	**7.14**
Shallow Concentrated Flow								
Flow length (ft)	=	2152.00		0.00		0.00		
Watercourse slope (%)	=	0.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.14		0.00		0.00		
Travel Time (min)	**=**	**31.44**	**+**	**0.00**	**+**	**0.00**	**=**	**31.44**
Channel Flow								
X sectional flow area (sqft)	=	100.00		10.00		0.00		
Wetted perimeter (ft)	=	100.00		0.00		0.00		
Channel slope (%)	=	0.70		0.60		0.00		
Manning's n-value	=	0.030		0.026		0.015		
Velocity (ft/s)	=	4.16		0.00		0.00		
Flow length (ft)	=	1664.0		0.0		0.0		
Travel Time (min)	**=**	**6.67**	**+**	**0.00**	**+**	**0.00**	**=**	**6.67**

Total Travel Time, Tc ..... 45.30 min

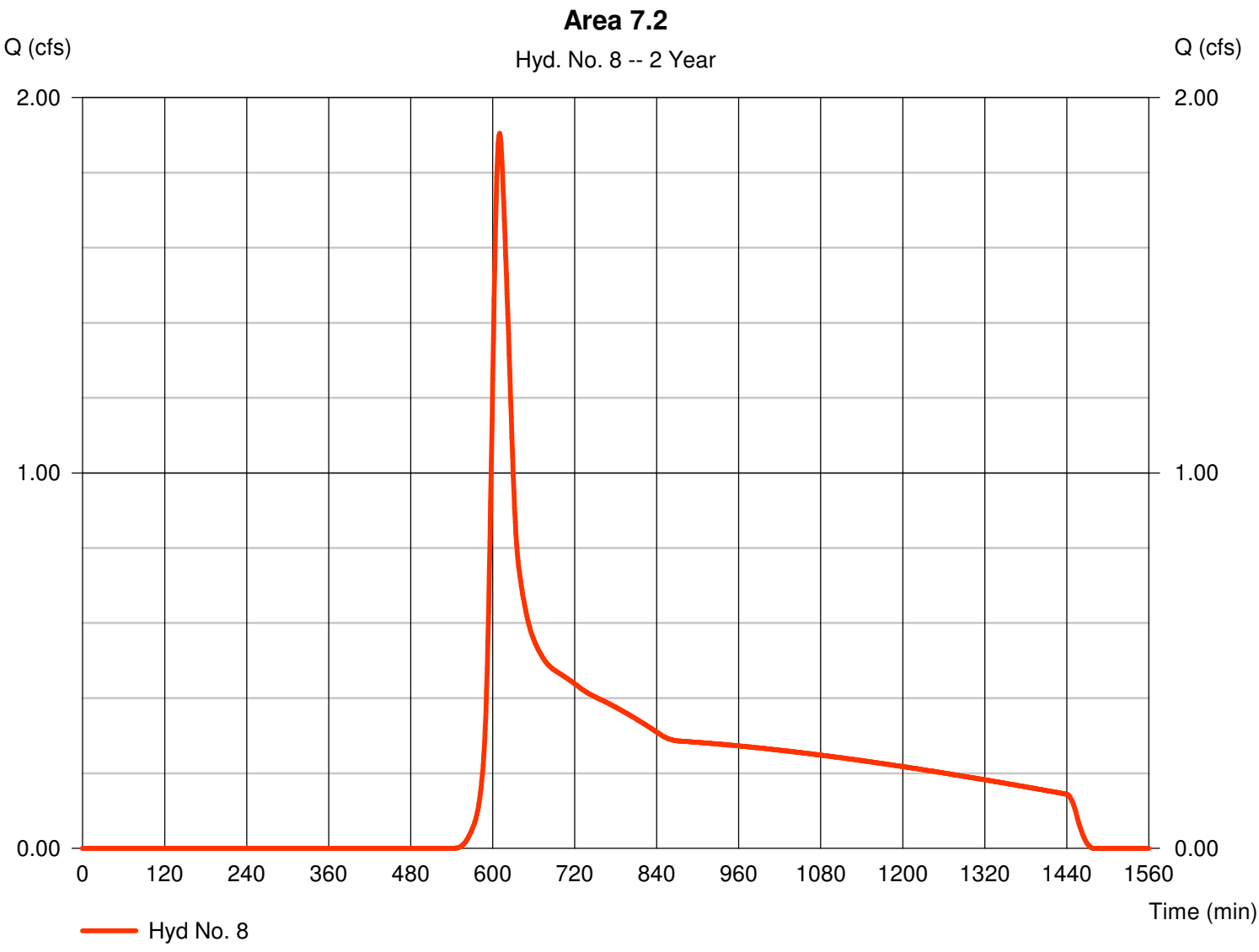
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 8

Area 7.2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.905 cfs
Storm frequency	=	2 yrs	Time to peak	=	610 min
Time interval	=	1 min	Hyd. volume	=	17,515 cuft
Drainage area	=	12.570 ac	Curve number	=	85
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	25.00 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 8

Area 7.2

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**6.37**	**+**	**0.00**	**+**	**0.00**	**=**	**6.37**
Shallow Concentrated Flow								
Flow length (ft)	=	1277.00		0.00		0.00		
Watercourse slope (%)	=	0.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.14		0.00		0.00		
Travel Time (min)	**=**	**18.66**	**+**	**0.00**	**+**	**0.00**	**=**	**18.66**
Channel Flow								
X sectional flow area (sqft)	=	100.00		10.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.50		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	1664.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 25.00 min

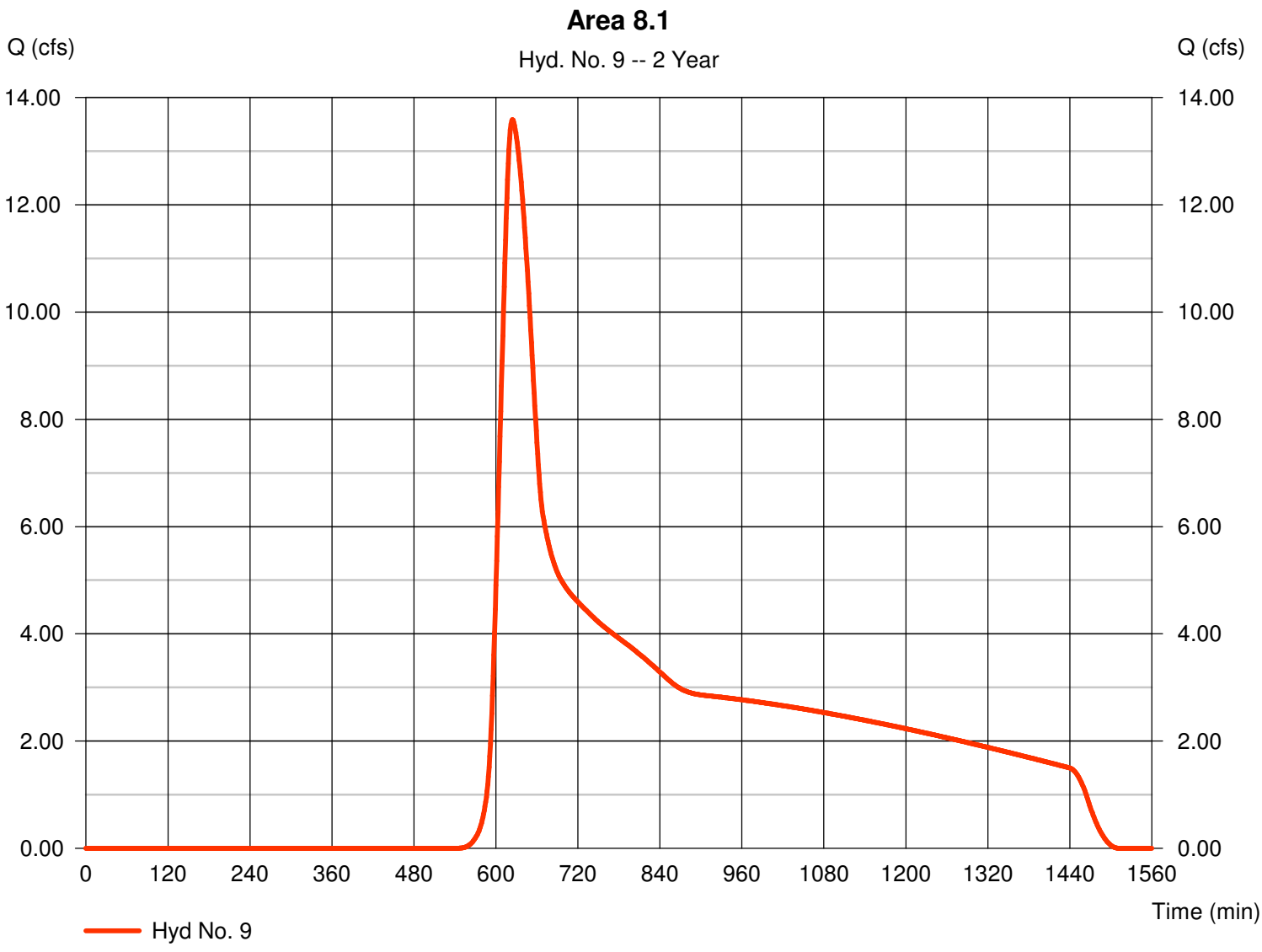
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 9

Area 8.1

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.59 cfs
Storm frequency	=	2 yrs	Time to peak	=	624 min
Time interval	=	1 min	Hyd. volume	=	176,225 cuft
Drainage area	=	126.470 ac	Curve number	=	85
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	44.70 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 9

Area 8.1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**6.37**	**+**	**0.00**	**+**	**0.00**	**=**	**6.37**
Shallow Concentrated Flow								
Flow length (ft)	=	2240.00		0.00		0.00		
Watercourse slope (%)	=	0.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.14		0.00		0.00		
Travel Time (min)	**=**	**32.72**	**+**	**0.00**	**+**	**0.00**	**=**	**32.72**
Channel Flow								
X sectional flow area (sqft)	=	15.00		10.00		0.00		
Wetted perimeter (ft)	=	15.00		0.00		0.00		
Channel slope (%)	=	0.50		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	4.05		0.00		0.00		
Flow length (ft)	=	1354.0		0.0		0.0		
Travel Time (min)	**=**	**5.57**	**+**	**0.00**	**+**	**0.00**	**=**	**5.57**

Total Travel Time, Tc ..... 44.70 min

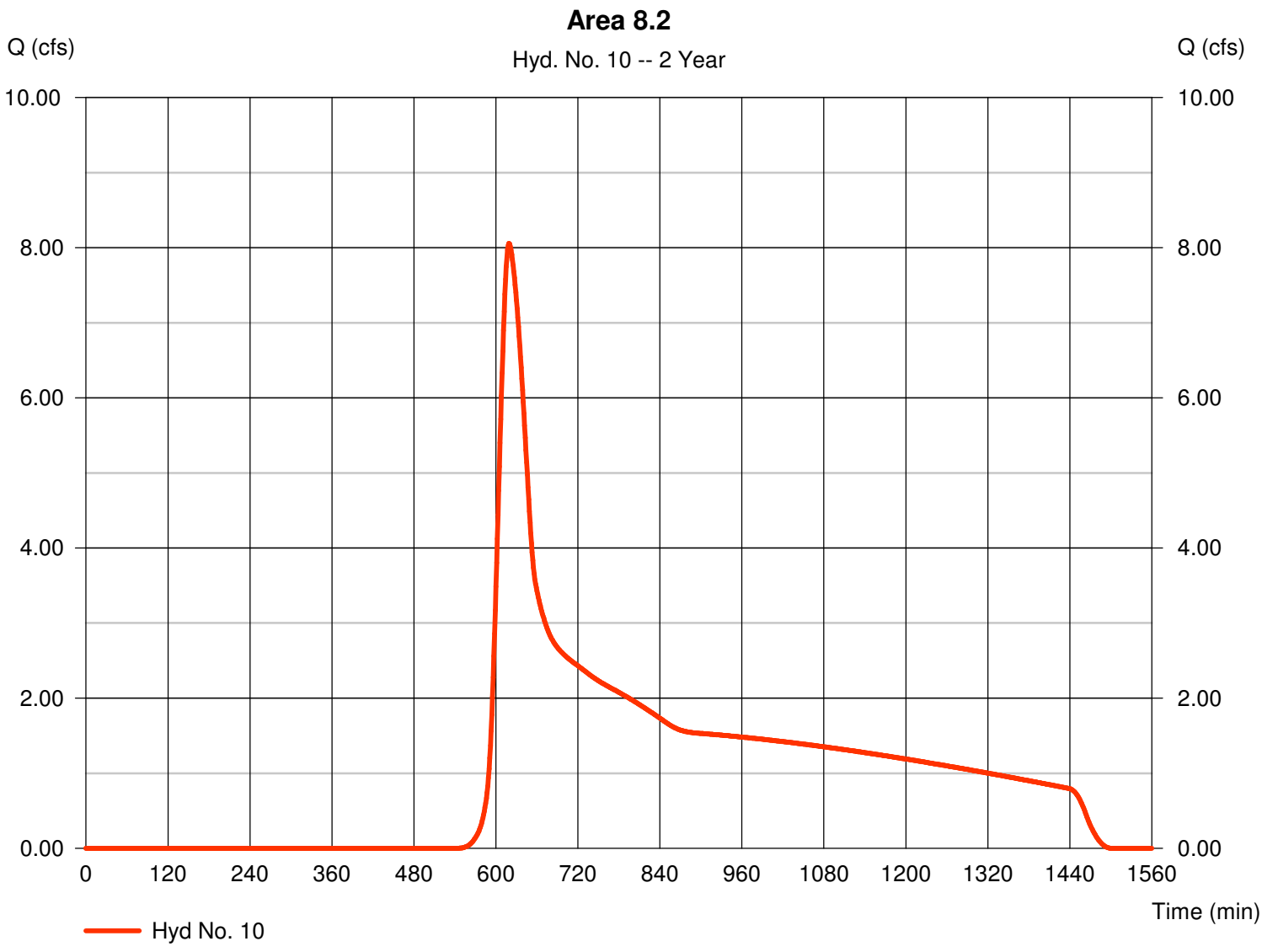
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 10

Area 8.2

Hydrograph type	=	SCS Runoff	Peak discharge	=	8.057 cfs
Storm frequency	=	2 yrs	Time to peak	=	619 min
Time interval	=	1 min	Hyd. volume	=	94,542 cuft
Drainage area	=	68.220 ac	Curve number	=	85
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	37.60 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No. 10

Area 8.2

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.026		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		1.39		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**6.37**	**+**	**0.00**	**+**	**0.00**	**=**	**6.37**
Shallow Concentrated Flow								
Flow length (ft)	=	1926.00		0.00		0.00		
Watercourse slope (%)	=	0.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.14		0.00		0.00		
Travel Time (min)	**=**	**28.14**	**+**	**0.00**	**+**	**0.00**	**=**	**28.14**
Channel Flow								
X sectional flow area (sqft)	=	10.00		10.00		0.00		
Wetted perimeter (ft)	=	10.00		0.00		0.00		
Channel slope (%)	=	0.50		0.60		0.00		
Manning's n-value	=	0.026		0.026		0.015		
Velocity (ft/s)	=	4.05		0.00		0.00		
Flow length (ft)	=	763.0		0.0		0.0		
Travel Time (min)	**=**	**3.14**	**+**	**0.00**	**+**	**0.00**	**=**	**3.14**

Total Travel Time, Tc ..... 37.60 min

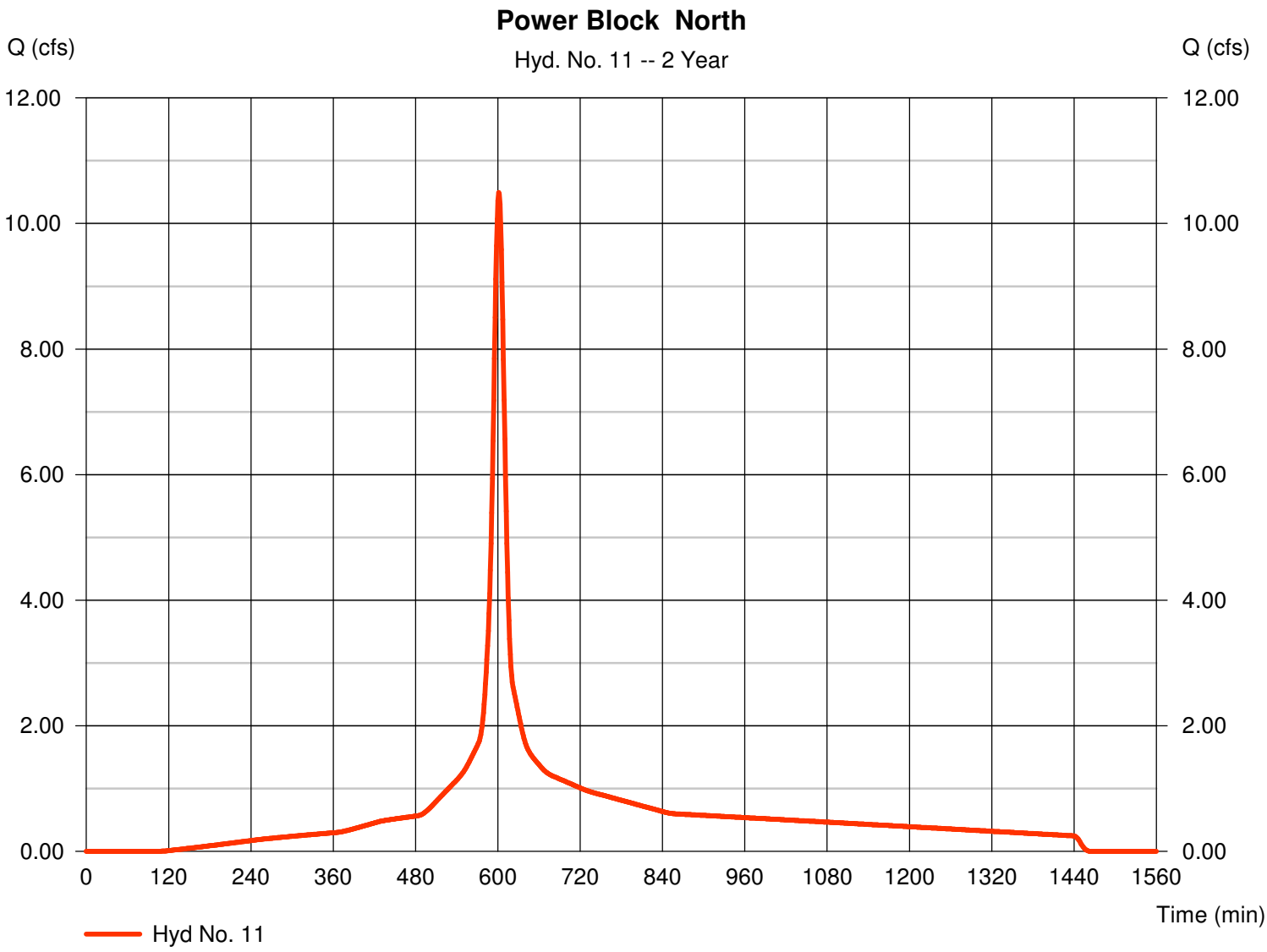
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 11

Power Block North

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.49 cfs
Storm frequency	=	2 yrs	Time to peak	=	601 min
Time interval	=	1 min	Hyd. volume	=	56,919 cuft
Drainage area	=	13.380 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.60 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 11

Power Block North

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.025		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		0.00		0.00		
Land slope (%)	=	1.00		0.00		0.00		
Travel Time (min)	**=**	**4.68**	**+**	**0.00**	**+**	**0.00**	**=**	**4.68**
Shallow Concentrated Flow								
Flow length (ft)	=	1090.00		0.00		0.00		
Watercourse slope (%)	=	1.00		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=	2.03		0.00		0.00		
Travel Time (min)	**=**	**8.94**	**+**	**0.00**	**+**	**0.00**	**=**	**8.94**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 13.60 min

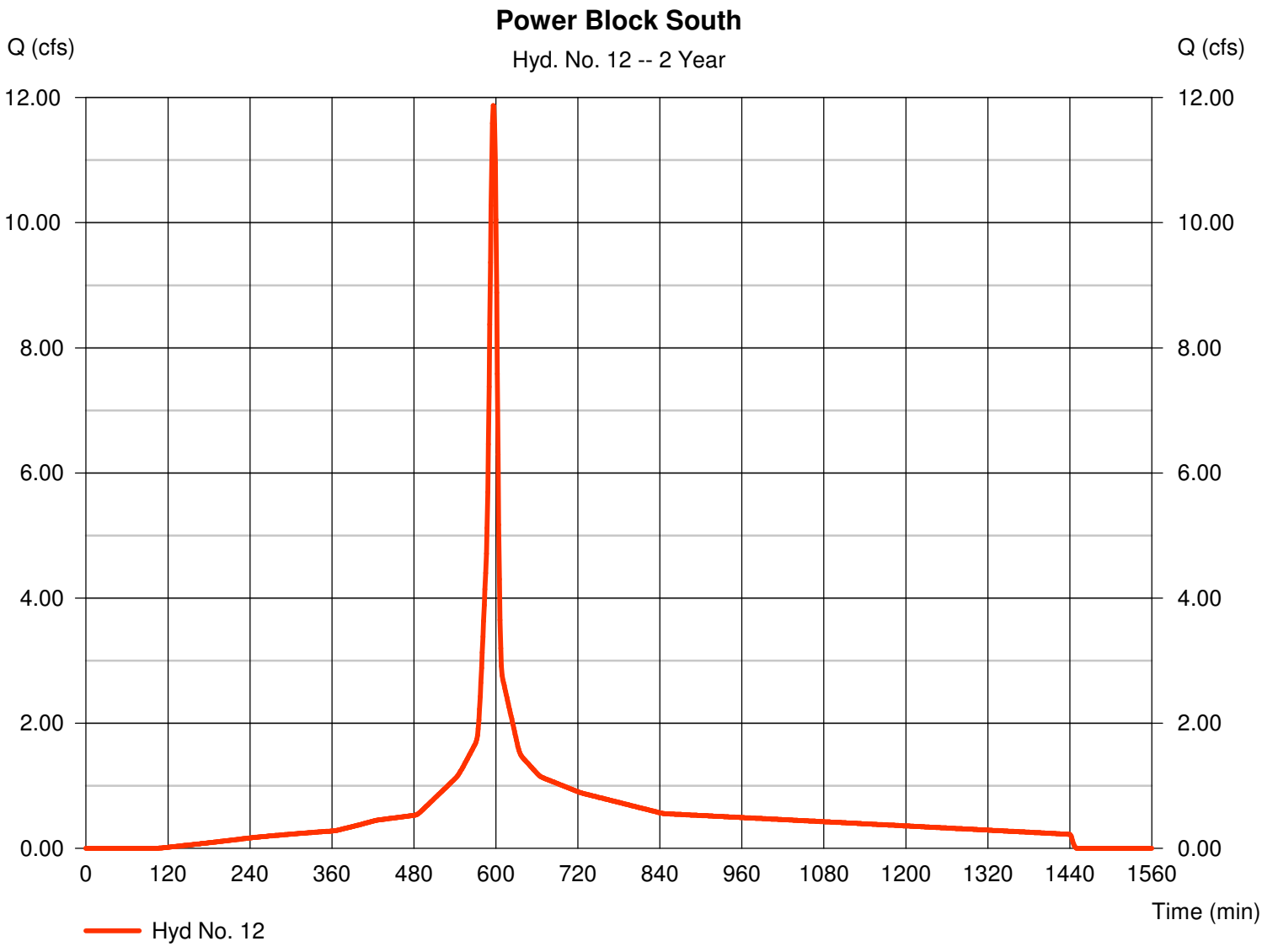
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 12

Power Block South

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.87 cfs
Storm frequency	=	2 yrs	Time to peak	=	596 min
Time interval	=	1 min	Hyd. volume	=	52,468 cuft
Drainage area	=	11.960 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	1.39 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 12

Power Block South

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.025		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	1.39		0.00		0.00		
Land slope (%)	=	1.00		0.00		0.00		
Travel Time (min)	**=**	**4.68**	**+**	**0.00**	**+**	**0.00**	**=**	**4.68**
Shallow Concentrated Flow								
Flow length (ft)	=	240.00		0.00		0.00		
Watercourse slope (%)	=	1.00		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=	2.03		0.00		0.00		
Travel Time (min)	**=**	**1.97**	**+**	**0.00**	**+**	**0.00**	**=**	**1.97**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)	=	0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 6.60 min

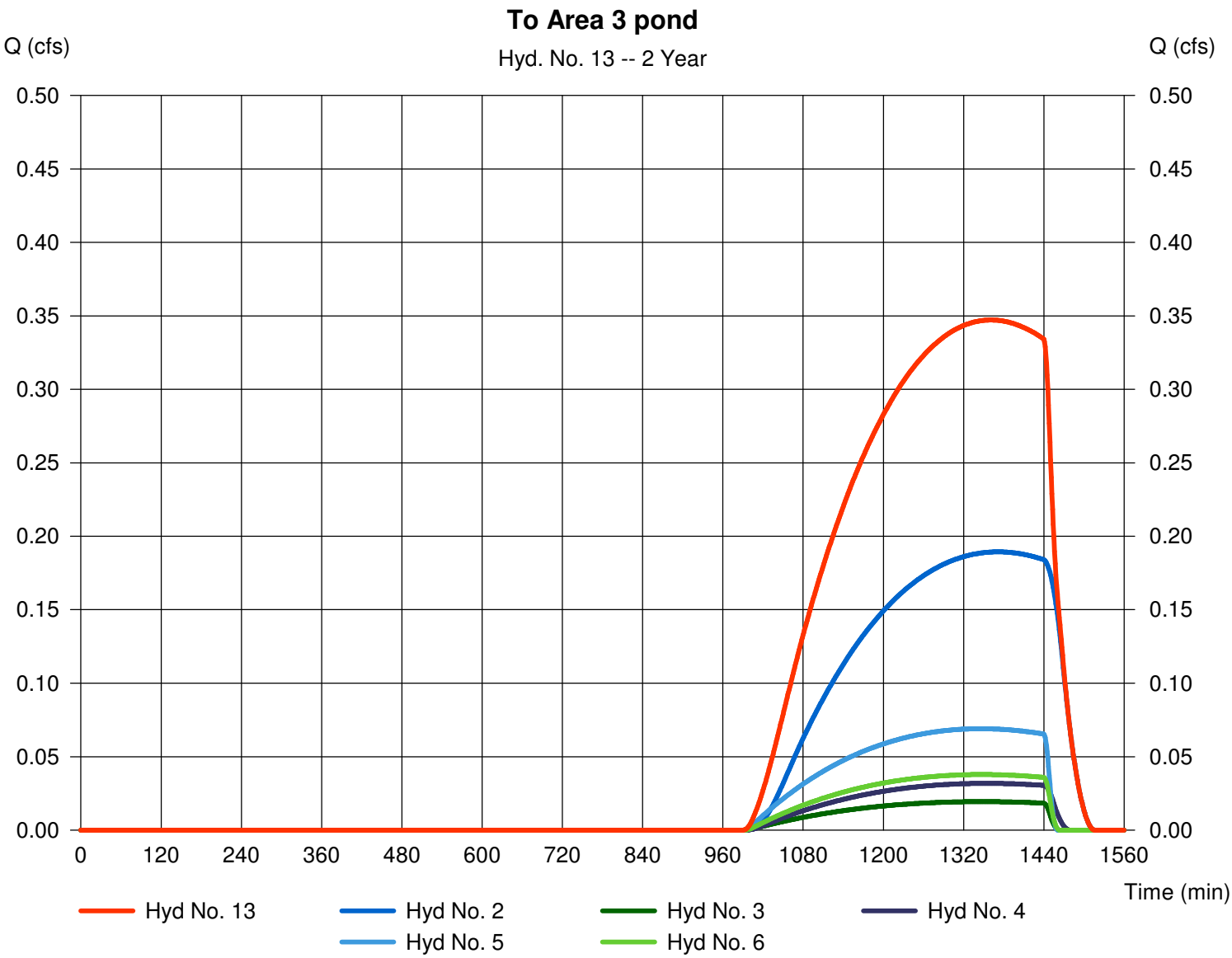
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 13

To Area 3 pond

Hydrograph type	= Combine	Peak discharge	= 0.347 cfs
Storm frequency	= 2 yrs	Time to peak	= 1361 min
Time interval	= 1 min	Hyd. volume	= 7,120 cuft
Inflow hyds.	= 2, 3, 4, 5, 6	Contrib. drain. area	= 258.810 ac



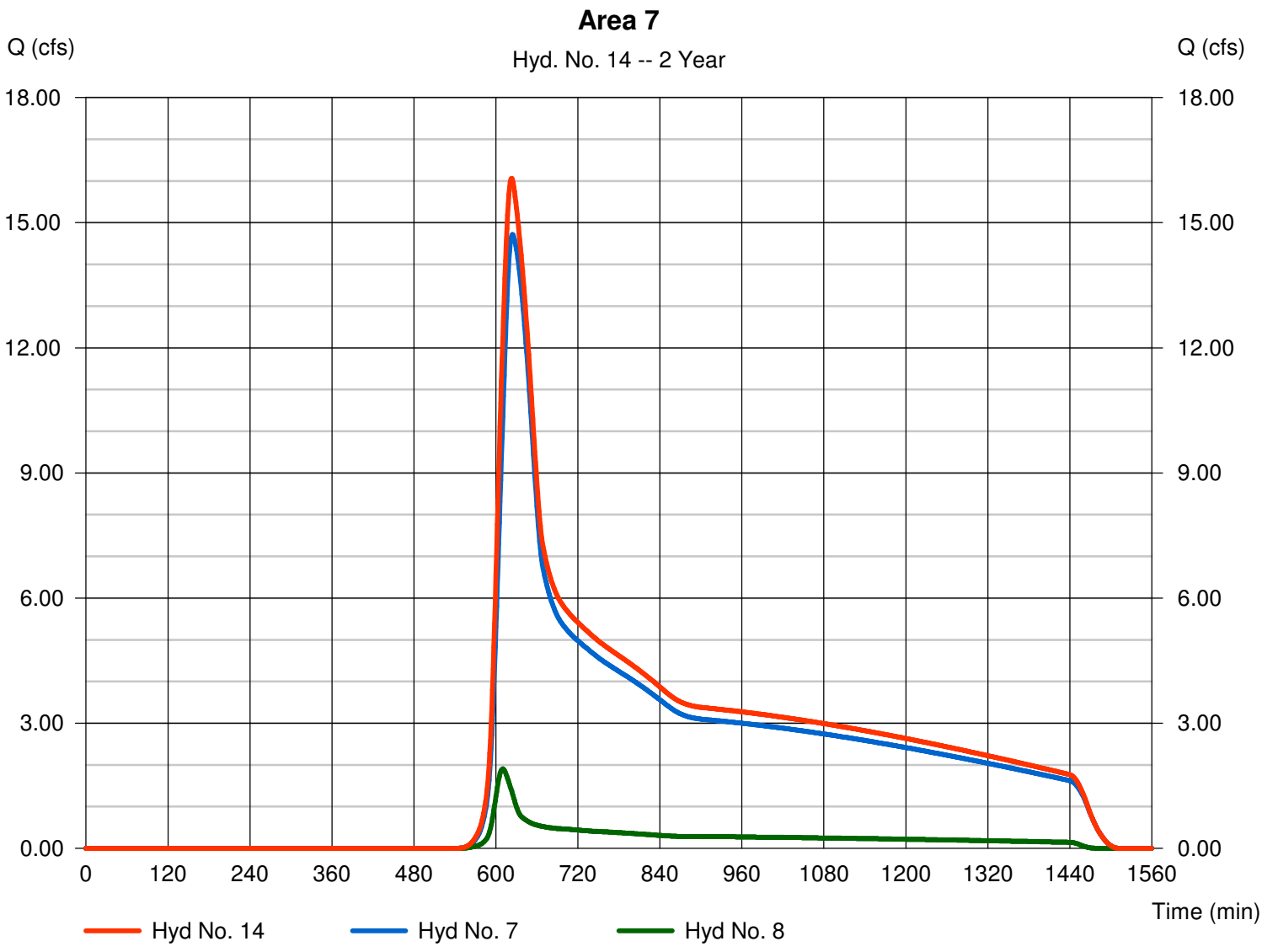
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 14

Area 7

Hydrograph type	=	Combine	Peak discharge	=	16.06 cfs
Storm frequency	=	2 yrs	Time to peak	=	623 min
Time interval	=	1 min	Hyd. volume	=	208,344 cuft
Inflow hyds.	=	7, 8	Contrib. drain. area	=	149.520 ac



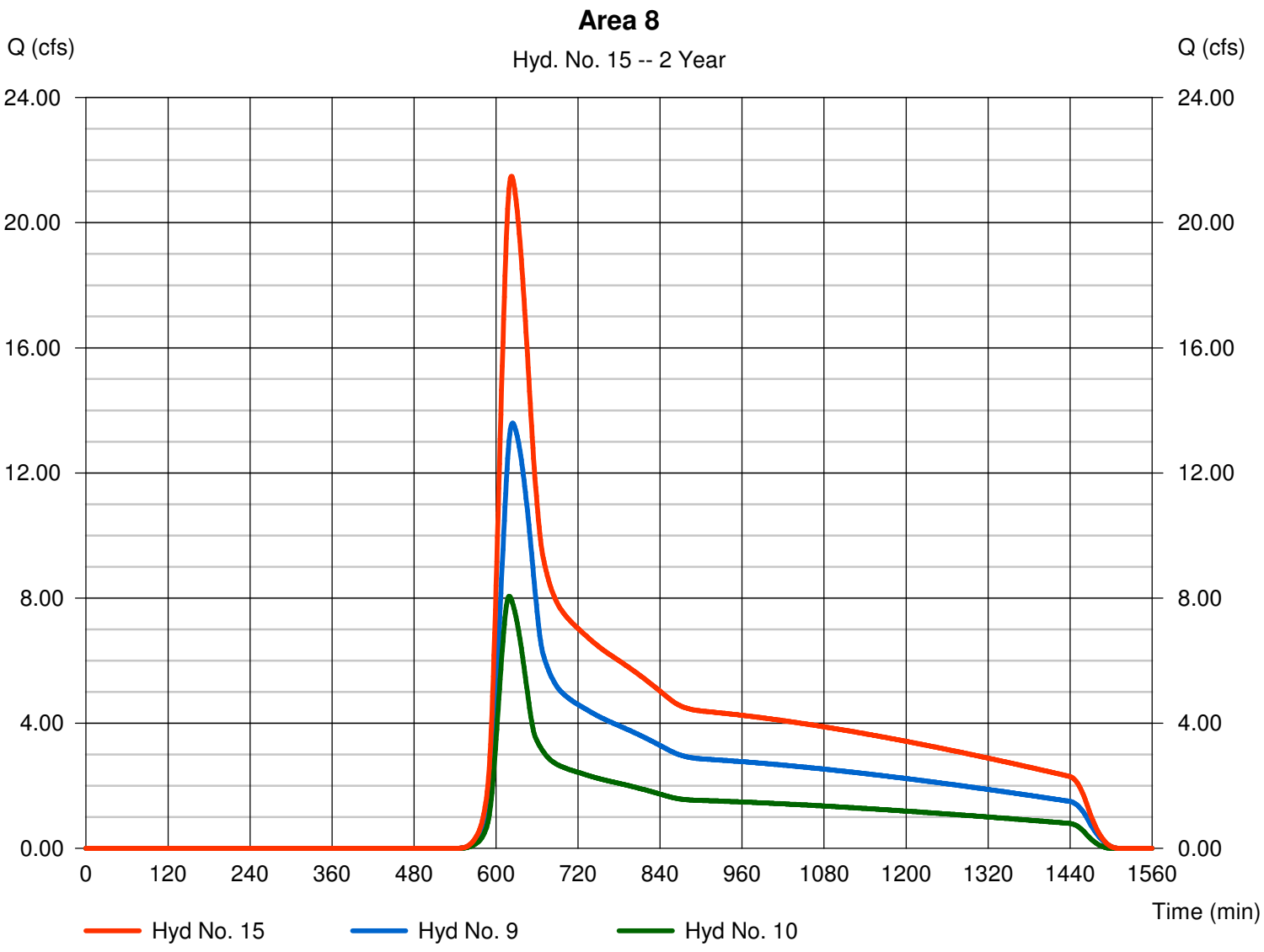
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 15

Area 8

Hydrograph type	=	Combine	Peak discharge	=	21.48 cfs
Storm frequency	=	2 yrs	Time to peak	=	623 min
Time interval	=	1 min	Hyd. volume	=	270,768 cuft
Inflow hyds.	=	9, 10	Contrib. drain. area	=	194.690 ac



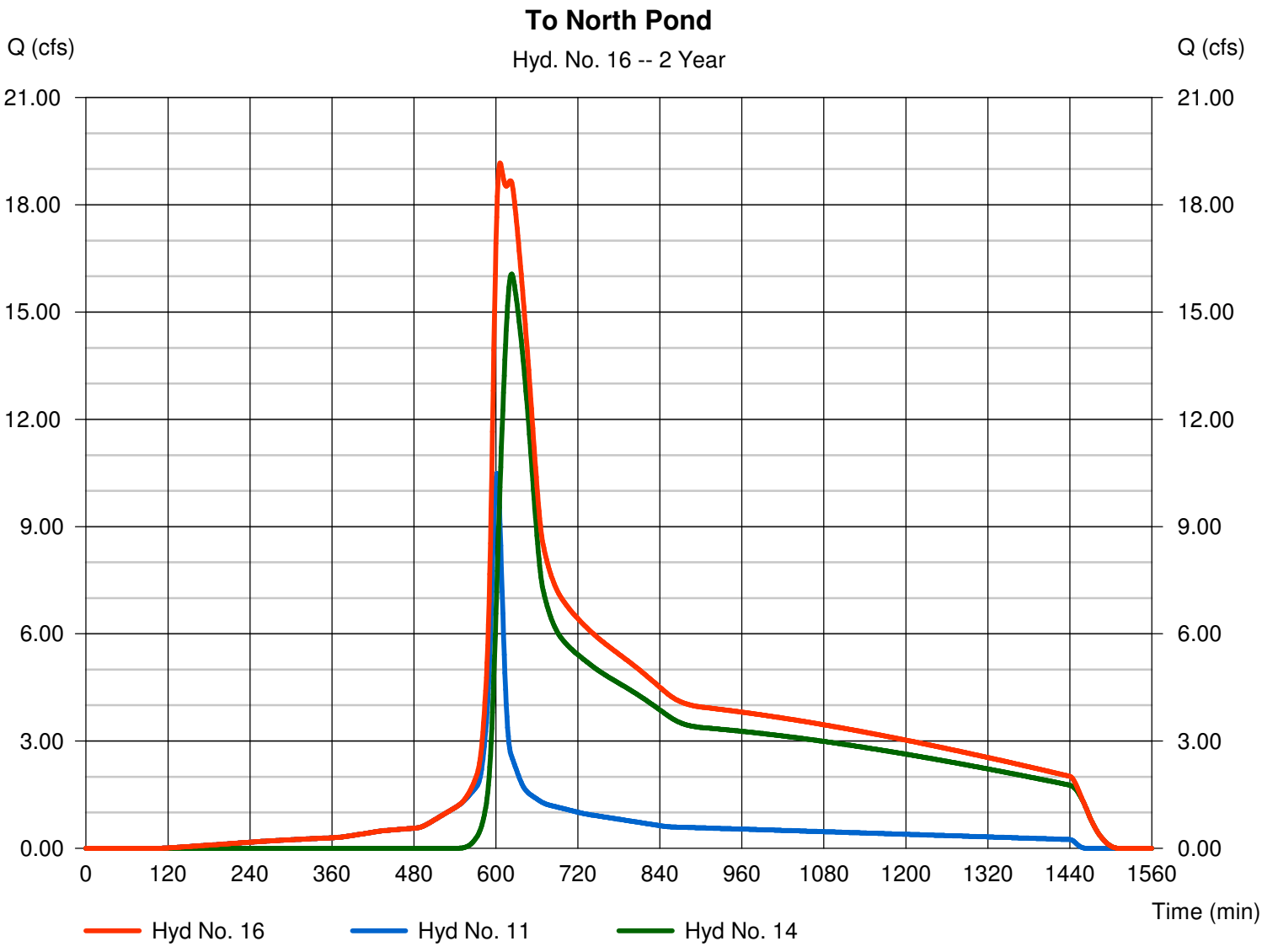
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 16

To North Pond

Hydrograph type	=	Combine	Peak discharge	=	19.17 cfs
Storm frequency	=	2 yrs	Time to peak	=	606 min
Time interval	=	1 min	Hyd. volume	=	265,263 cuft
Inflow hyds.	=	11, 14	Contrib. drain. area	=	13.380 ac



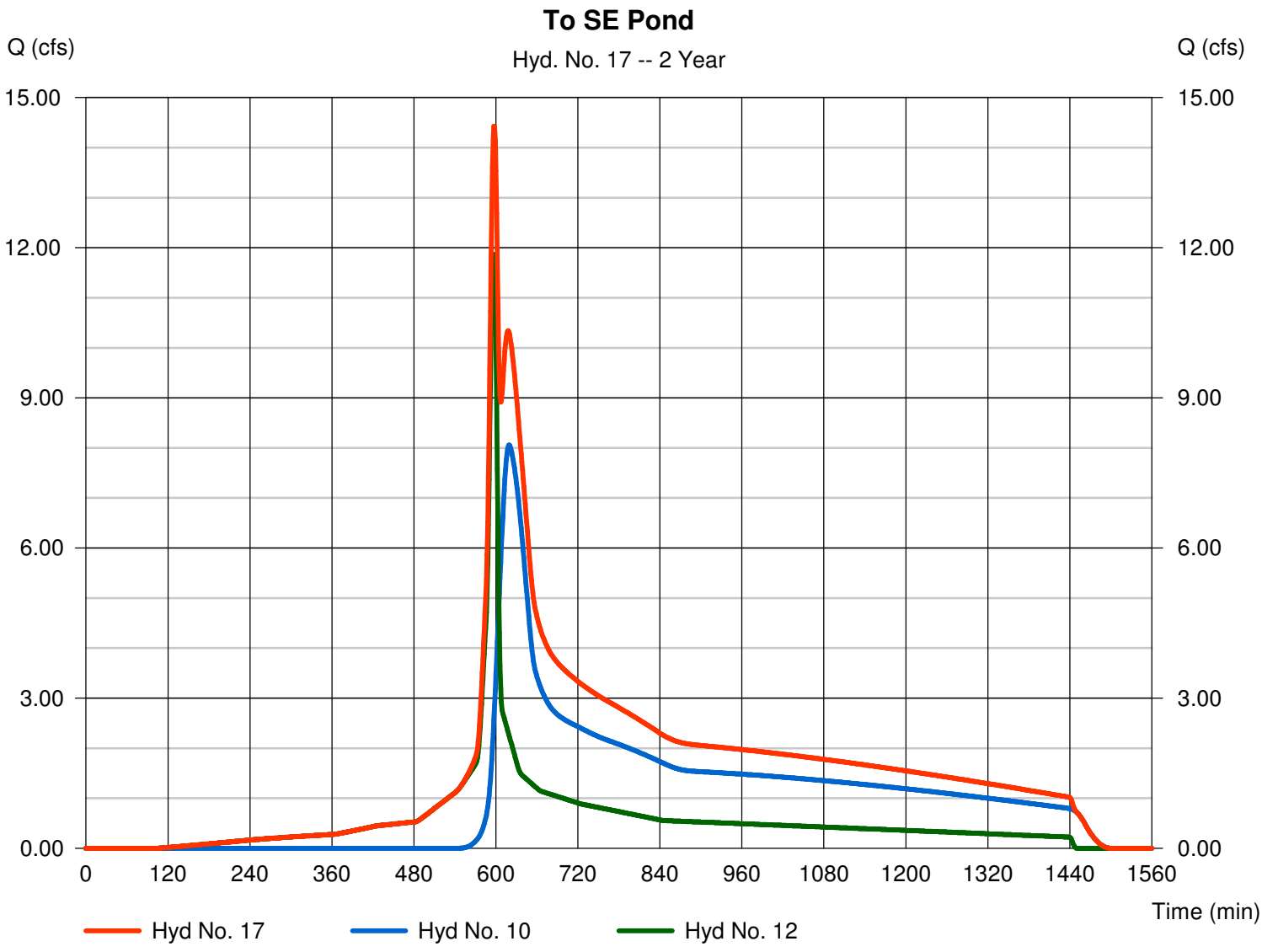
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 17

To SE Pond

Hydrograph type	=	Combine	Peak discharge	=	14.43 cfs
Storm frequency	=	2 yrs	Time to peak	=	597 min
Time interval	=	1 min	Hyd. volume	=	147,011 cuft
Inflow hyds.	=	10, 12	Contrib. drain. area	=	80.180 ac



Hydrograph Report

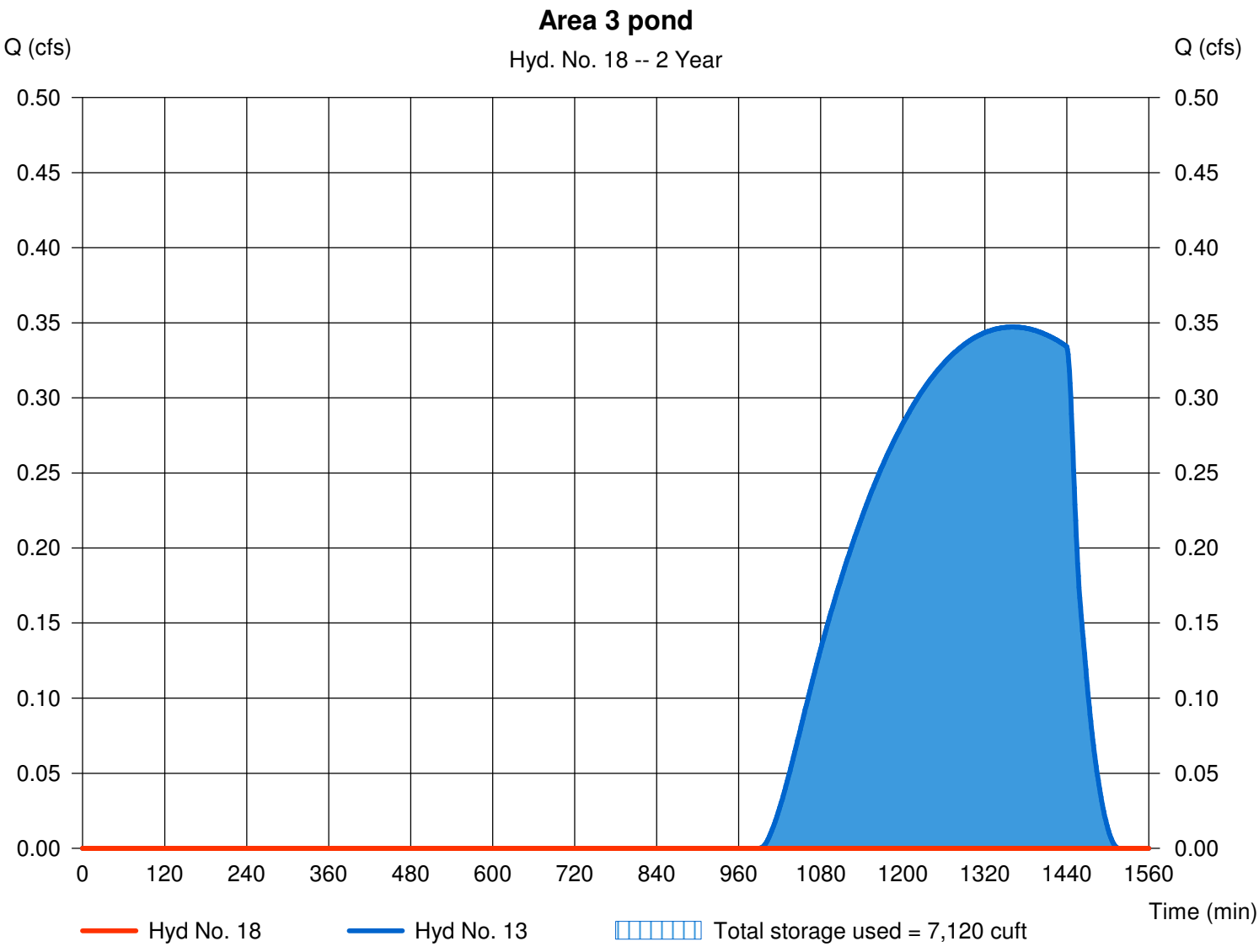
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 18

Area 3 pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	13 - To Area 3 pond	Max. Elevation	=	2505.03 ft
Reservoir name	=	Area 3 ponding	Max. Storage	=	7,120 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 — Wednesday, Jun 25, 2008

Pond No. 1 - Area 3 ponding

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2505.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2505.00	276,612	0	0
1.00	2506.00	283,334	279,938	279,938
2.00	2507.00	290,117	286,690	566,628
3.00	2508.00	296,961	293,503	860,131
4.00	2509.00	303,867	300,378	1,160,509
5.00	2510.00	310,833	307,313	1,467,822

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2505.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	27,994	2505.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	55,988	2505.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	83,981	2505.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	111,975	2505.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	139,969	2505.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	167,963	2505.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	195,957	2505.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	223,951	2505.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	251,945	2505.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	279,938	2506.00	---	---	---	---	---	---	---	---	---	---	0.000
1.10	308,607	2506.10	---	---	---	---	---	---	---	---	---	---	0.000
1.20	337,276	2506.20	---	---	---	---	---	---	---	---	---	---	0.000
1.30	365,945	2506.30	---	---	---	---	---	---	---	---	---	---	0.000
1.40	394,614	2506.40	---	---	---	---	---	---	---	---	---	---	0.000
1.50	423,283	2506.50	---	---	---	---	---	---	---	---	---	---	0.000
1.60	451,952	2506.60	---	---	---	---	---	---	---	---	---	---	0.000
1.70	480,621	2506.70	---	---	---	---	---	---	---	---	---	---	0.000
1.80	509,290	2506.80	---	---	---	---	---	---	---	---	---	---	0.000
1.90	537,959	2506.90	---	---	---	---	---	---	---	---	---	---	0.000
2.00	566,628	2507.00	---	---	---	---	---	---	---	---	---	---	0.000
2.10	595,979	2507.10	---	---	---	---	---	---	---	---	---	---	0.000
2.20	625,329	2507.20	---	---	---	---	---	---	---	---	---	---	0.000
2.30	654,679	2507.30	---	---	---	---	---	---	---	---	---	---	0.000
2.40	684,030	2507.40	---	---	---	---	---	---	---	---	---	---	0.000
2.50	713,380	2507.50	---	---	---	---	---	---	---	---	---	---	0.000
2.60	742,730	2507.60	---	---	---	---	---	---	---	---	---	---	0.000
2.70	772,081	2507.70	---	---	---	---	---	---	---	---	---	---	0.000
2.80	801,431	2507.80	---	---	---	---	---	---	---	---	---	---	0.000
2.90	830,781	2507.90	---	---	---	---	---	---	---	---	---	---	0.000
3.00	860,131	2508.00	---	---	---	---	---	---	---	---	---	---	0.000
3.10	890,169	2508.10	---	---	---	---	---	---	---	---	---	---	0.000
3.20	920,207	2508.20	---	---	---	---	---	---	---	---	---	---	0.000
3.30	950,245	2508.30	---	---	---	---	---	---	---	---	---	---	0.000
3.40	980,282	2508.40	---	---	---	---	---	---	---	---	---	---	0.000
3.50	1,010,320	2508.50	---	---	---	---	---	---	---	---	---	---	0.000
3.60	1,040,358	2508.60	---	---	---	---	---	---	---	---	---	---	0.000
3.70	1,070,396	2508.70	---	---	---	---	---	---	---	---	---	---	0.000

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Area 3 ponding

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.80	1,100,433	2508.80	---	---	---	---	---	---	---	---	---	---	0.000
3.90	1,130,471	2508.90	---	---	---	---	---	---	---	---	---	---	0.000
4.00	1,160,509	2509.00	---	---	---	---	---	---	---	---	---	---	0.000
4.10	1,191,240	2509.10	---	---	---	---	---	---	---	---	---	---	0.000
4.20	1,221,971	2509.20	---	---	---	---	---	---	---	---	---	---	0.000
4.30	1,252,703	2509.30	---	---	---	---	---	---	---	---	---	---	0.000
4.40	1,283,434	2509.40	---	---	---	---	---	---	---	---	---	---	0.000
4.50	1,314,165	2509.50	---	---	---	---	---	---	---	---	---	---	0.000
4.60	1,344,896	2509.60	---	---	---	---	---	---	---	---	---	---	0.000
4.70	1,375,628	2509.70	---	---	---	---	---	---	---	---	---	---	0.000
4.80	1,406,359	2509.80	---	---	---	---	---	---	---	---	---	---	0.000
4.90	1,437,090	2509.90	---	---	---	---	---	---	---	---	---	---	0.000
5.00	1,467,822	2510.00	---	---	---	---	---	---	---	---	---	---	0.000

...End

Hydrograph Report

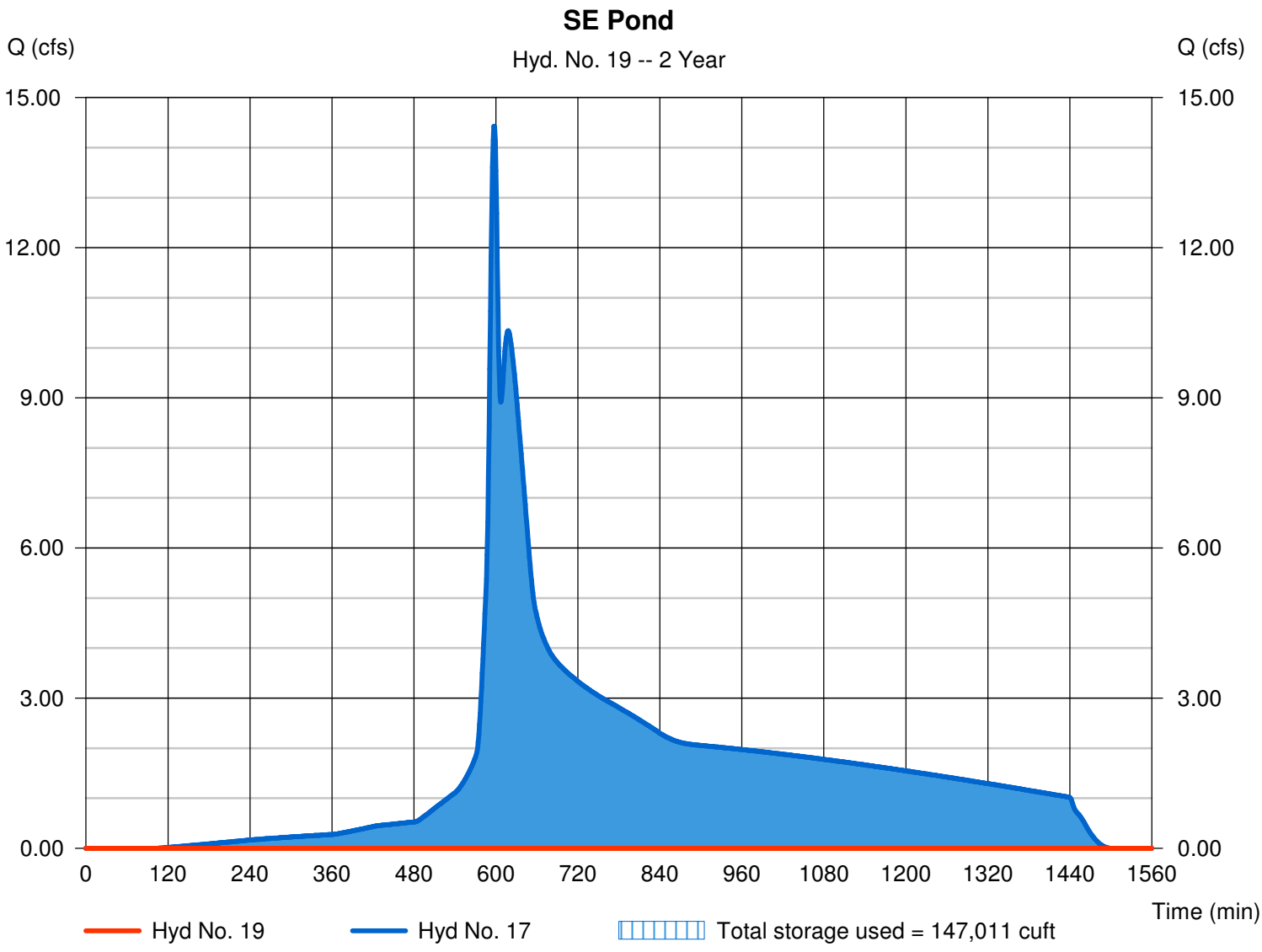
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 19

SE Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	17 - To SE Pond	Max. Elevation	=	2508.47 ft
Reservoir name	=	South East Pond 8.2	Max. Storage	=	147,011 cuft

Storage Indication method used.



Pond No. 2 - South East Pond 8.2

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2503.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2503.00	14,862	0	0
1.00	2504.00	14,862	14,861	14,861
2.00	2505.00	20,867	17,778	32,639
3.00	2506.00	27,323	24,020	56,659
4.00	2507.00	34,353	30,768	87,427
5.00	2508.00	41,953	38,086	125,513
6.00	2509.00	50,141	45,982	171,494
7.00	2510.00	58,638	54,329	225,823
8.00	2511.00	75,525	66,897	292,720
9.00	2512.00	167,798	118,621	411,340
10.00	2513.00	368,631	261,686	673,027

Culvert / Orifice Structures

		[A]	[B]	[C]	[PrfRsr]
Rise (in)	=	0.00	0.00	0.00	0.00
Span (in)	=	0.00	0.00	0.00	0.00
No. Barrels	=	0	0	0	0
Invert El. (ft)	=	0.00	0.00	0.00	0.00
Length (ft)	=	0.00	0.00	0.00	0.00
Slope (%)	=	0.00	0.00	0.00	n/a
N-Value	=	.013	.013	.013	n/a
Orifice Coeff.	=	0.60	0.60	0.60	0.60
Multi-Stage	=	n/a	No	No	No

Weir Structures

		[A]	[B]	[C]	[D]
Crest Len (ft)	=	12.00	0.00	0.00	0.00
Crest El. (ft)	=	2512.75	0.00	0.00	0.00
Weir Coeff.	=	3.33	3.33	3.33	3.33
Weir Type	=	Rect	---	---	---
Multi-Stage	=	No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2503.00	---	---	---	---	0.00	---	---	---	---	---	0.000
0.10	1,486	2503.10	---	---	---	---	0.00	---	---	---	---	---	0.000
0.20	2,972	2503.20	---	---	---	---	0.00	---	---	---	---	---	0.000
0.30	4,458	2503.30	---	---	---	---	0.00	---	---	---	---	---	0.000
0.40	5,944	2503.40	---	---	---	---	0.00	---	---	---	---	---	0.000
0.50	7,430	2503.50	---	---	---	---	0.00	---	---	---	---	---	0.000
0.60	8,916	2503.60	---	---	---	---	0.00	---	---	---	---	---	0.000
0.70	10,402	2503.70	---	---	---	---	0.00	---	---	---	---	---	0.000
0.80	11,888	2503.80	---	---	---	---	0.00	---	---	---	---	---	0.000
0.90	13,374	2503.90	---	---	---	---	0.00	---	---	---	---	---	0.000
1.00	14,861	2504.00	---	---	---	---	0.00	---	---	---	---	---	0.000
1.10	16,638	2504.10	---	---	---	---	0.00	---	---	---	---	---	0.000
1.20	18,416	2504.20	---	---	---	---	0.00	---	---	---	---	---	0.000
1.30	20,194	2504.30	---	---	---	---	0.00	---	---	---	---	---	0.000
1.40	21,972	2504.40	---	---	---	---	0.00	---	---	---	---	---	0.000
1.50	23,750	2504.50	---	---	---	---	0.00	---	---	---	---	---	0.000
1.60	25,527	2504.60	---	---	---	---	0.00	---	---	---	---	---	0.000
1.70	27,305	2504.70	---	---	---	---	0.00	---	---	---	---	---	0.000
1.80	29,083	2504.80	---	---	---	---	0.00	---	---	---	---	---	0.000
1.90	30,861	2504.90	---	---	---	---	0.00	---	---	---	---	---	0.000
2.00	32,639	2505.00	---	---	---	---	0.00	---	---	---	---	---	0.000
2.10	35,041	2505.10	---	---	---	---	0.00	---	---	---	---	---	0.000
2.20	37,443	2505.20	---	---	---	---	0.00	---	---	---	---	---	0.000
2.30	39,845	2505.30	---	---	---	---	0.00	---	---	---	---	---	0.000
2.40	42,247	2505.40	---	---	---	---	0.00	---	---	---	---	---	0.000
2.50	44,649	2505.50	---	---	---	---	0.00	---	---	---	---	---	0.000
2.60	47,051	2505.60	---	---	---	---	0.00	---	---	---	---	---	0.000
2.70	49,453	2505.70	---	---	---	---	0.00	---	---	---	---	---	0.000
2.80	51,855	2505.80	---	---	---	---	0.00	---	---	---	---	---	0.000
2.90	54,257	2505.90	---	---	---	---	0.00	---	---	---	---	---	0.000
3.00	56,659	2506.00	---	---	---	---	0.00	---	---	---	---	---	0.000
3.10	59,736	2506.10	---	---	---	---	0.00	---	---	---	---	---	0.000
3.20	62,812	2506.20	---	---	---	---	0.00	---	---	---	---	---	0.000

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South East Pond 8.2

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.30	65,889	2506.30	---	---	---	---	0.00	---	---	---	---	---	0.000
3.40	68,966	2506.40	---	---	---	---	0.00	---	---	---	---	---	0.000
3.50	72,043	2506.50	---	---	---	---	0.00	---	---	---	---	---	0.000
3.60	75,120	2506.60	---	---	---	---	0.00	---	---	---	---	---	0.000
3.70	78,196	2506.70	---	---	---	---	0.00	---	---	---	---	---	0.000
3.80	81,273	2506.80	---	---	---	---	0.00	---	---	---	---	---	0.000
3.90	84,350	2506.90	---	---	---	---	0.00	---	---	---	---	---	0.000
4.00	87,427	2507.00	---	---	---	---	0.00	---	---	---	---	---	0.000
4.10	91,235	2507.10	---	---	---	---	0.00	---	---	---	---	---	0.000
4.20	95,044	2507.20	---	---	---	---	0.00	---	---	---	---	---	0.000
4.30	98,852	2507.30	---	---	---	---	0.00	---	---	---	---	---	0.000
4.40	102,661	2507.40	---	---	---	---	0.00	---	---	---	---	---	0.000
4.50	106,470	2507.50	---	---	---	---	0.00	---	---	---	---	---	0.000
4.60	110,278	2507.60	---	---	---	---	0.00	---	---	---	---	---	0.000
4.70	114,087	2507.70	---	---	---	---	0.00	---	---	---	---	---	0.000
4.80	117,895	2507.80	---	---	---	---	0.00	---	---	---	---	---	0.000
4.90	121,704	2507.90	---	---	---	---	0.00	---	---	---	---	---	0.000
5.00	125,513	2508.00	---	---	---	---	0.00	---	---	---	---	---	0.000
5.10	130,111	2508.10	---	---	---	---	0.00	---	---	---	---	---	0.000
5.20	134,709	2508.20	---	---	---	---	0.00	---	---	---	---	---	0.000
5.30	139,307	2508.30	---	---	---	---	0.00	---	---	---	---	---	0.000
5.40	143,905	2508.40	---	---	---	---	0.00	---	---	---	---	---	0.000
5.50	148,503	2508.50	---	---	---	---	0.00	---	---	---	---	---	0.000
5.60	153,102	2508.60	---	---	---	---	0.00	---	---	---	---	---	0.000
5.70	157,700	2508.70	---	---	---	---	0.00	---	---	---	---	---	0.000
5.80	162,298	2508.80	---	---	---	---	0.00	---	---	---	---	---	0.000
5.90	166,896	2508.90	---	---	---	---	0.00	---	---	---	---	---	0.000
6.00	171,494	2509.00	---	---	---	---	0.00	---	---	---	---	---	0.000
6.10	176,927	2509.10	---	---	---	---	0.00	---	---	---	---	---	0.000
6.20	182,360	2509.20	---	---	---	---	0.00	---	---	---	---	---	0.000
6.30	187,793	2509.30	---	---	---	---	0.00	---	---	---	---	---	0.000
6.40	193,226	2509.40	---	---	---	---	0.00	---	---	---	---	---	0.000
6.50	198,659	2509.50	---	---	---	---	0.00	---	---	---	---	---	0.000
6.60	204,092	2509.60	---	---	---	---	0.00	---	---	---	---	---	0.000
6.70	209,524	2509.70	---	---	---	---	0.00	---	---	---	---	---	0.000
6.80	214,957	2509.80	---	---	---	---	0.00	---	---	---	---	---	0.000
6.90	220,390	2509.90	---	---	---	---	0.00	---	---	---	---	---	0.000
7.00	225,823	2510.00	---	---	---	---	0.00	---	---	---	---	---	0.000
7.10	232,513	2510.10	---	---	---	---	0.00	---	---	---	---	---	0.000
7.20	239,202	2510.20	---	---	---	---	0.00	---	---	---	---	---	0.000
7.30	245,892	2510.30	---	---	---	---	0.00	---	---	---	---	---	0.000
7.40	252,582	2510.40	---	---	---	---	0.00	---	---	---	---	---	0.000
7.50	259,271	2510.50	---	---	---	---	0.00	---	---	---	---	---	0.000
7.60	265,961	2510.60	---	---	---	---	0.00	---	---	---	---	---	0.000
7.70	272,651	2510.70	---	---	---	---	0.00	---	---	---	---	---	0.000
7.80	279,341	2510.80	---	---	---	---	0.00	---	---	---	---	---	0.000
7.90	286,030	2510.90	---	---	---	---	0.00	---	---	---	---	---	0.000
8.00	292,720	2511.00	---	---	---	---	0.00	---	---	---	---	---	0.000
8.10	304,582	2511.10	---	---	---	---	0.00	---	---	---	---	---	0.000
8.20	316,444	2511.20	---	---	---	---	0.00	---	---	---	---	---	0.000
8.30	328,306	2511.30	---	---	---	---	0.00	---	---	---	---	---	0.000
8.40	340,168	2511.40	---	---	---	---	0.00	---	---	---	---	---	0.000
8.50	352,030	2511.50	---	---	---	---	0.00	---	---	---	---	---	0.000
8.60	363,892	2511.60	---	---	---	---	0.00	---	---	---	---	---	0.000
8.70	375,754	2511.70	---	---	---	---	0.00	---	---	---	---	---	0.000
8.80	387,616	2511.80	---	---	---	---	0.00	---	---	---	---	---	0.000
8.90	399,478	2511.90	---	---	---	---	0.00	---	---	---	---	---	0.000
9.00	411,340	2512.00	---	---	---	---	0.00	---	---	---	---	---	0.000
9.10	437,509	2512.10	---	---	---	---	0.00	---	---	---	---	---	0.000
9.20	463,678	2512.20	---	---	---	---	0.00	---	---	---	---	---	0.000
9.30	489,846	2512.30	---	---	---	---	0.00	---	---	---	---	---	0.000
9.40	516,015	2512.40	---	---	---	---	0.00	---	---	---	---	---	0.000
9.50	542,184	2512.50	---	---	---	---	0.00	---	---	---	---	---	0.000
9.60	568,352	2512.60	---	---	---	---	0.00	---	---	---	---	---	0.000
9.70	594,521	2512.70	---	---	---	---	0.00	---	---	---	---	---	0.000
9.80	620,689	2512.80	---	---	---	---	0.46	---	---	---	---	---	0.457
9.90	646,858	2512.90	---	---	---	---	2.34	---	---	---	---	---	2.342
10.00	673,027	2513.00	---	---	---	---	5.00	---	---	---	---	---	4.995

...End

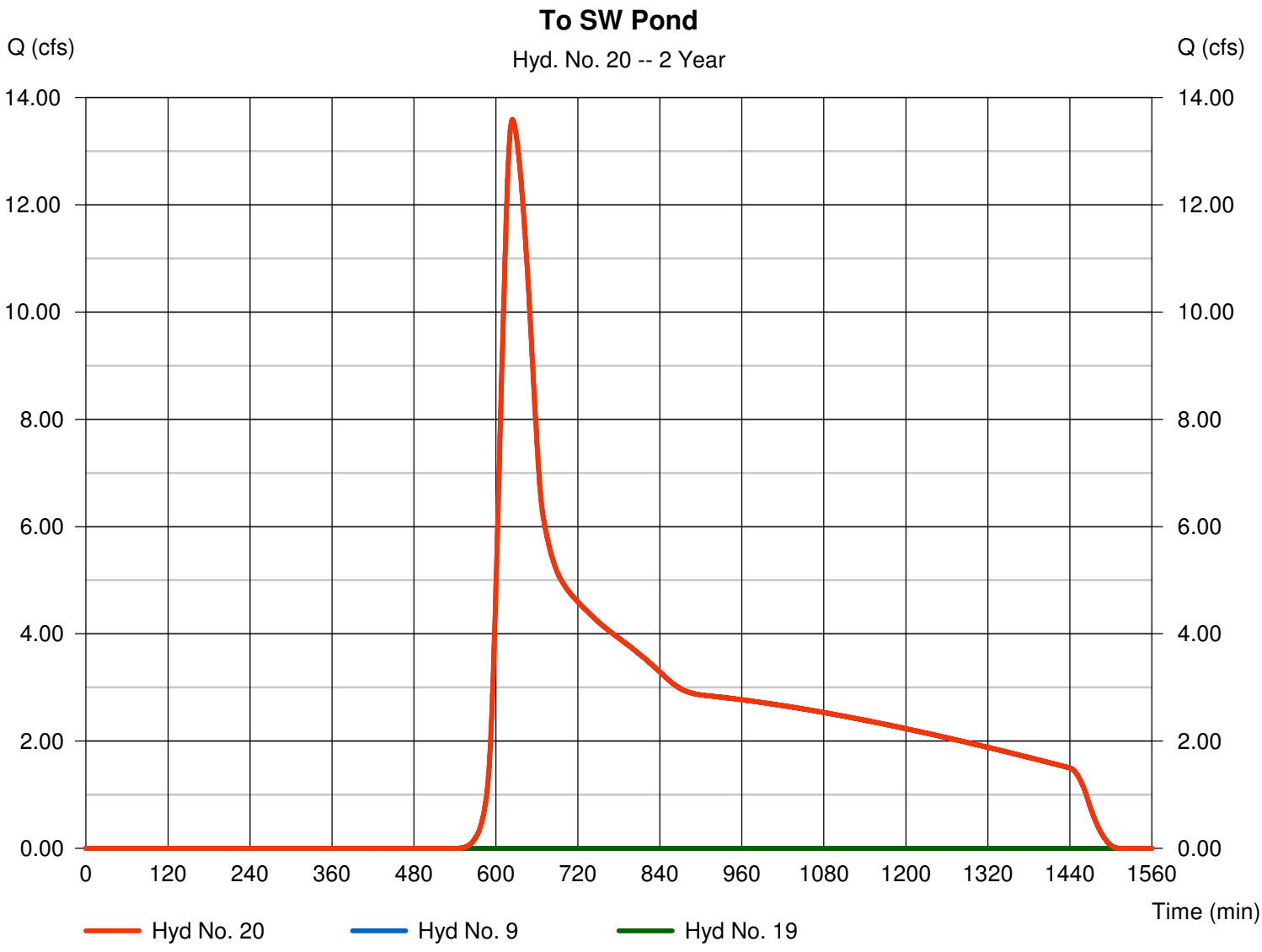
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 20

To SW Pond

Hydrograph type	= Combine	Peak discharge	= 13.59 cfs
Storm frequency	= 2 yrs	Time to peak	= 624 min
Time interval	= 1 min	Hyd. volume	= 176,225 cuft
Inflow hyds.	= 9, 19	Contrib. drain. area	= 126.470 ac



Hydrograph Report

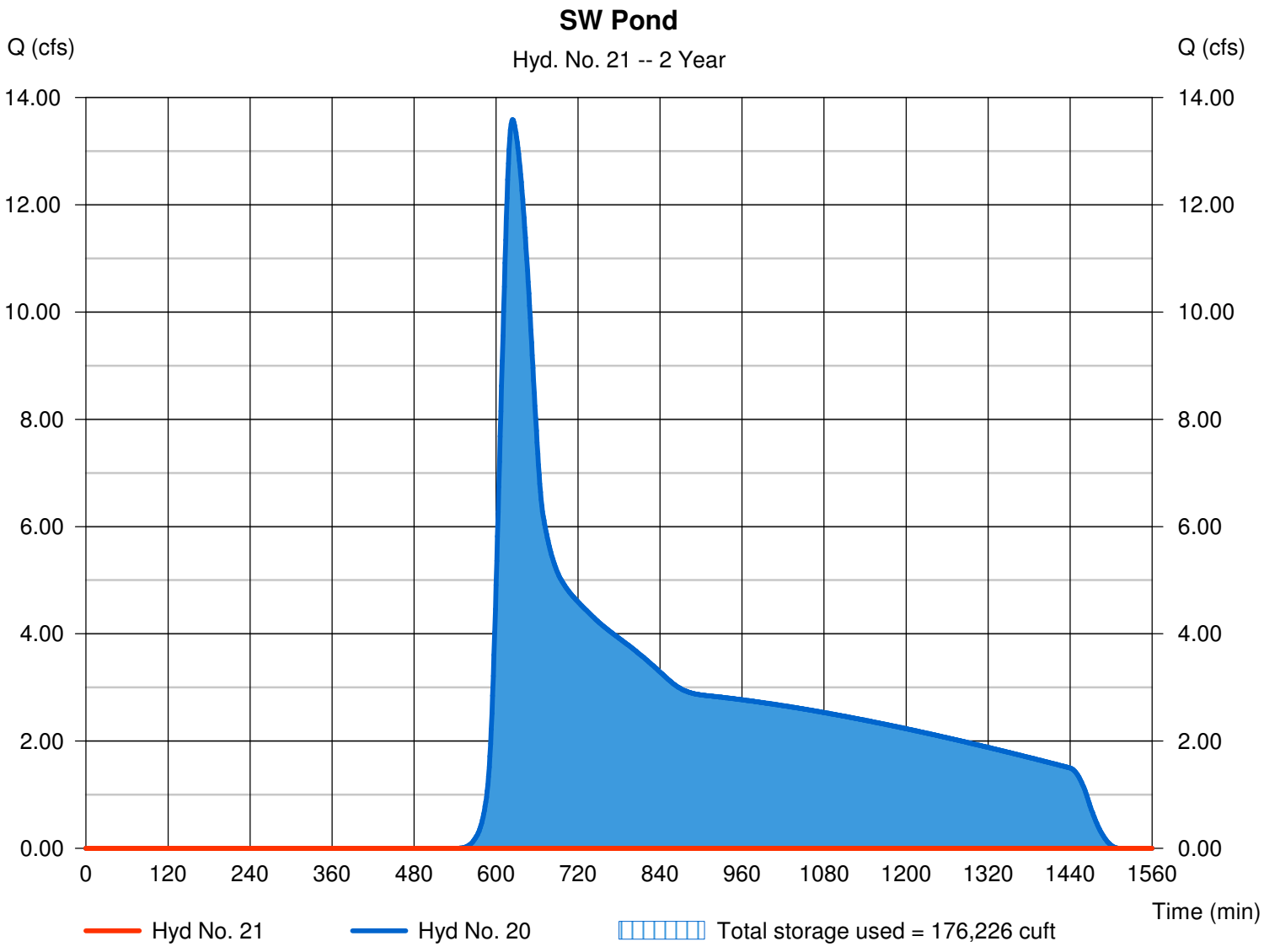
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 21

SW Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	20 - To SW Pond	Max. Elevation	=	2506.35 ft
Reservoir name	=	SouthWest Pond	Max. Storage	=	176,226 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 — Wednesday, Jun 25, 2008

Pond No. 3 - SouthWest Pond

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2502.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2502.00	15,034	0	0
1.00	2503.00	26,138	20,330	20,330
2.00	2504.00	38,072	31,915	52,245
3.00	2505.00	50,089	43,939	96,184
4.00	2506.00	62,491	56,170	152,354
5.00	2507.00	76,076	69,165	221,520
6.00	2508.00	90,282	83,069	304,589
7.00	2509.00	105,939	97,996	402,585
8.00	2510.00	120,316	113,040	515,625
9.00	2511.00	144,498	132,209	647,835
10.00	2512.00	231,172	186,127	833,962
11.00	2513.00	404,160	313,634	1,147,596

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2502.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	2,033	2502.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	4,066	2502.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	6,099	2502.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	8,132	2502.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	10,165	2502.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	12,198	2502.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	14,231	2502.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	16,264	2502.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	18,297	2502.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	20,330	2503.00	---	---	---	---	---	---	---	---	---	---	0.000
1.10	23,521	2503.10	---	---	---	---	---	---	---	---	---	---	0.000
1.20	26,713	2503.20	---	---	---	---	---	---	---	---	---	---	0.000
1.30	29,904	2503.30	---	---	---	---	---	---	---	---	---	---	0.000
1.40	33,096	2503.40	---	---	---	---	---	---	---	---	---	---	0.000
1.50	36,287	2503.50	---	---	---	---	---	---	---	---	---	---	0.000
1.60	39,479	2503.60	---	---	---	---	---	---	---	---	---	---	0.000
1.70	42,670	2503.70	---	---	---	---	---	---	---	---	---	---	0.000
1.80	45,862	2503.80	---	---	---	---	---	---	---	---	---	---	0.000
1.90	49,054	2503.90	---	---	---	---	---	---	---	---	---	---	0.000
2.00	52,245	2504.00	---	---	---	---	---	---	---	---	---	---	0.000
2.10	56,639	2504.10	---	---	---	---	---	---	---	---	---	---	0.000
2.20	61,033	2504.20	---	---	---	---	---	---	---	---	---	---	0.000
2.30	65,427	2504.30	---	---	---	---	---	---	---	---	---	---	0.000
2.40	69,821	2504.40	---	---	---	---	---	---	---	---	---	---	0.000
2.50	74,215	2504.50	---	---	---	---	---	---	---	---	---	---	0.000
2.60	78,608	2504.60	---	---	---	---	---	---	---	---	---	---	0.000
2.70	83,002	2504.70	---	---	---	---	---	---	---	---	---	---	0.000
2.80	87,396	2504.80	---	---	---	---	---	---	---	---	---	---	0.000
2.90	91,790	2504.90	---	---	---	---	---	---	---	---	---	---	0.000
3.00	96,184	2505.00	---	---	---	---	---	---	---	---	---	---	0.000
3.10	101,801	2505.10	---	---	---	---	---	---	---	---	---	---	0.000

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SouthWest Pond

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.20	107,418	2505.20	---	---	---	---	---	---	---	---	---	---	0.000
3.30	113,035	2505.30	---	---	---	---	---	---	---	---	---	---	0.000
3.40	118,652	2505.40	---	---	---	---	---	---	---	---	---	---	0.000
3.50	124,269	2505.50	---	---	---	---	---	---	---	---	---	---	0.000
3.60	129,886	2505.60	---	---	---	---	---	---	---	---	---	---	0.000
3.70	135,503	2505.70	---	---	---	---	---	---	---	---	---	---	0.000
3.80	141,120	2505.80	---	---	---	---	---	---	---	---	---	---	0.000
3.90	146,737	2505.90	---	---	---	---	---	---	---	---	---	---	0.000
4.00	152,354	2506.00	---	---	---	---	---	---	---	---	---	---	0.000
4.10	159,271	2506.10	---	---	---	---	---	---	---	---	---	---	0.000
4.20	166,187	2506.20	---	---	---	---	---	---	---	---	---	---	0.000
4.30	173,104	2506.30	---	---	---	---	---	---	---	---	---	---	0.000
4.40	180,020	2506.40	---	---	---	---	---	---	---	---	---	---	0.000
4.50	186,937	2506.50	---	---	---	---	---	---	---	---	---	---	0.000
4.60	193,853	2506.60	---	---	---	---	---	---	---	---	---	---	0.000
4.70	200,770	2506.70	---	---	---	---	---	---	---	---	---	---	0.000
4.80	207,686	2506.80	---	---	---	---	---	---	---	---	---	---	0.000
4.90	214,603	2506.90	---	---	---	---	---	---	---	---	---	---	0.000
5.00	221,520	2507.00	---	---	---	---	---	---	---	---	---	---	0.000
5.10	229,826	2507.10	---	---	---	---	---	---	---	---	---	---	0.000
5.20	238,133	2507.20	---	---	---	---	---	---	---	---	---	---	0.000
5.30	246,440	2507.30	---	---	---	---	---	---	---	---	---	---	0.000
5.40	254,747	2507.40	---	---	---	---	---	---	---	---	---	---	0.000
5.50	263,054	2507.50	---	---	---	---	---	---	---	---	---	---	0.000
5.60	271,361	2507.60	---	---	---	---	---	---	---	---	---	---	0.000
5.70	279,668	2507.70	---	---	---	---	---	---	---	---	---	---	0.000
5.80	287,975	2507.80	---	---	---	---	---	---	---	---	---	---	0.000
5.90	296,282	2507.90	---	---	---	---	---	---	---	---	---	---	0.000
6.00	304,589	2508.00	---	---	---	---	---	---	---	---	---	---	0.000
6.10	314,389	2508.10	---	---	---	---	---	---	---	---	---	---	0.000
6.20	324,188	2508.20	---	---	---	---	---	---	---	---	---	---	0.000
6.30	333,988	2508.30	---	---	---	---	---	---	---	---	---	---	0.000
6.40	343,788	2508.40	---	---	---	---	---	---	---	---	---	---	0.000
6.50	353,587	2508.50	---	---	---	---	---	---	---	---	---	---	0.000
6.60	363,387	2508.60	---	---	---	---	---	---	---	---	---	---	0.000
6.70	373,187	2508.70	---	---	---	---	---	---	---	---	---	---	0.000
6.80	382,986	2508.80	---	---	---	---	---	---	---	---	---	---	0.000
6.90	392,786	2508.90	---	---	---	---	---	---	---	---	---	---	0.000
7.00	402,585	2509.00	---	---	---	---	---	---	---	---	---	---	0.000
7.10	413,889	2509.10	---	---	---	---	---	---	---	---	---	---	0.000
7.20	425,193	2509.20	---	---	---	---	---	---	---	---	---	---	0.000
7.30	436,497	2509.30	---	---	---	---	---	---	---	---	---	---	0.000
7.40	447,801	2509.40	---	---	---	---	---	---	---	---	---	---	0.000
7.50	459,105	2509.50	---	---	---	---	---	---	---	---	---	---	0.000
7.60	470,409	2509.60	---	---	---	---	---	---	---	---	---	---	0.000
7.70	481,713	2509.70	---	---	---	---	---	---	---	---	---	---	0.000
7.80	493,017	2509.80	---	---	---	---	---	---	---	---	---	---	0.000
7.90	504,321	2509.90	---	---	---	---	---	---	---	---	---	---	0.000
8.00	515,625	2510.00	---	---	---	---	---	---	---	---	---	---	0.000
8.10	528,846	2510.10	---	---	---	---	---	---	---	---	---	---	0.000
8.20	542,067	2510.20	---	---	---	---	---	---	---	---	---	---	0.000
8.30	555,288	2510.30	---	---	---	---	---	---	---	---	---	---	0.000
8.40	568,509	2510.40	---	---	---	---	---	---	---	---	---	---	0.000
8.50	581,730	2510.50	---	---	---	---	---	---	---	---	---	---	0.000
8.60	594,951	2510.60	---	---	---	---	---	---	---	---	---	---	0.000
8.70	608,172	2510.70	---	---	---	---	---	---	---	---	---	---	0.000
8.80	621,393	2510.80	---	---	---	---	---	---	---	---	---	---	0.000
8.90	634,614	2510.90	---	---	---	---	---	---	---	---	---	---	0.000
9.00	647,835	2511.00	---	---	---	---	---	---	---	---	---	---	0.000
9.10	666,447	2511.10	---	---	---	---	---	---	---	---	---	---	0.000
9.20	685,060	2511.20	---	---	---	---	---	---	---	---	---	---	0.000
9.30	703,673	2511.30	---	---	---	---	---	---	---	---	---	---	0.000
9.40	722,286	2511.40	---	---	---	---	---	---	---	---	---	---	0.000
9.50	740,898	2511.50	---	---	---	---	---	---	---	---	---	---	0.000
9.60	759,511	2511.60	---	---	---	---	---	---	---	---	---	---	0.000
9.70	778,124	2511.70	---	---	---	---	---	---	---	---	---	---	0.000
9.80	796,737	2511.80	---	---	---	---	---	---	---	---	---	---	0.000
9.90	815,349	2511.90	---	---	---	---	---	---	---	---	---	---	0.000
10.00	833,962	2512.00	---	---	---	---	---	---	---	---	---	---	0.000
10.10	865,325	2512.10	---	---	---	---	---	---	---	---	---	---	0.000
10.20	896,689	2512.20	---	---	---	---	---	---	---	---	---	---	0.000
10.30	928,052	2512.30	---	---	---	---	---	---	---	---	---	---	0.000
10.40	959,415	2512.40	---	---	---	---	---	---	---	---	---	---	0.000

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SouthWest Pond

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
10.50	990,779	2512.50	---	---	---	---	---	---	---	---	---	---	0.000
10.60	1,022,142	2512.60	---	---	---	---	---	---	---	---	---	---	0.000
10.70	1,053,506	2512.70	---	---	---	---	---	---	---	---	---	---	0.000
10.80	1,084,869	2512.80	---	---	---	---	---	---	---	---	---	---	0.000
10.90	1,116,232	2512.90	---	---	---	---	---	---	---	---	---	---	0.000
11.00	1,147,596	2513.00	---	---	---	---	---	---	---	---	---	---	0.000

...End

Hydrograph Report

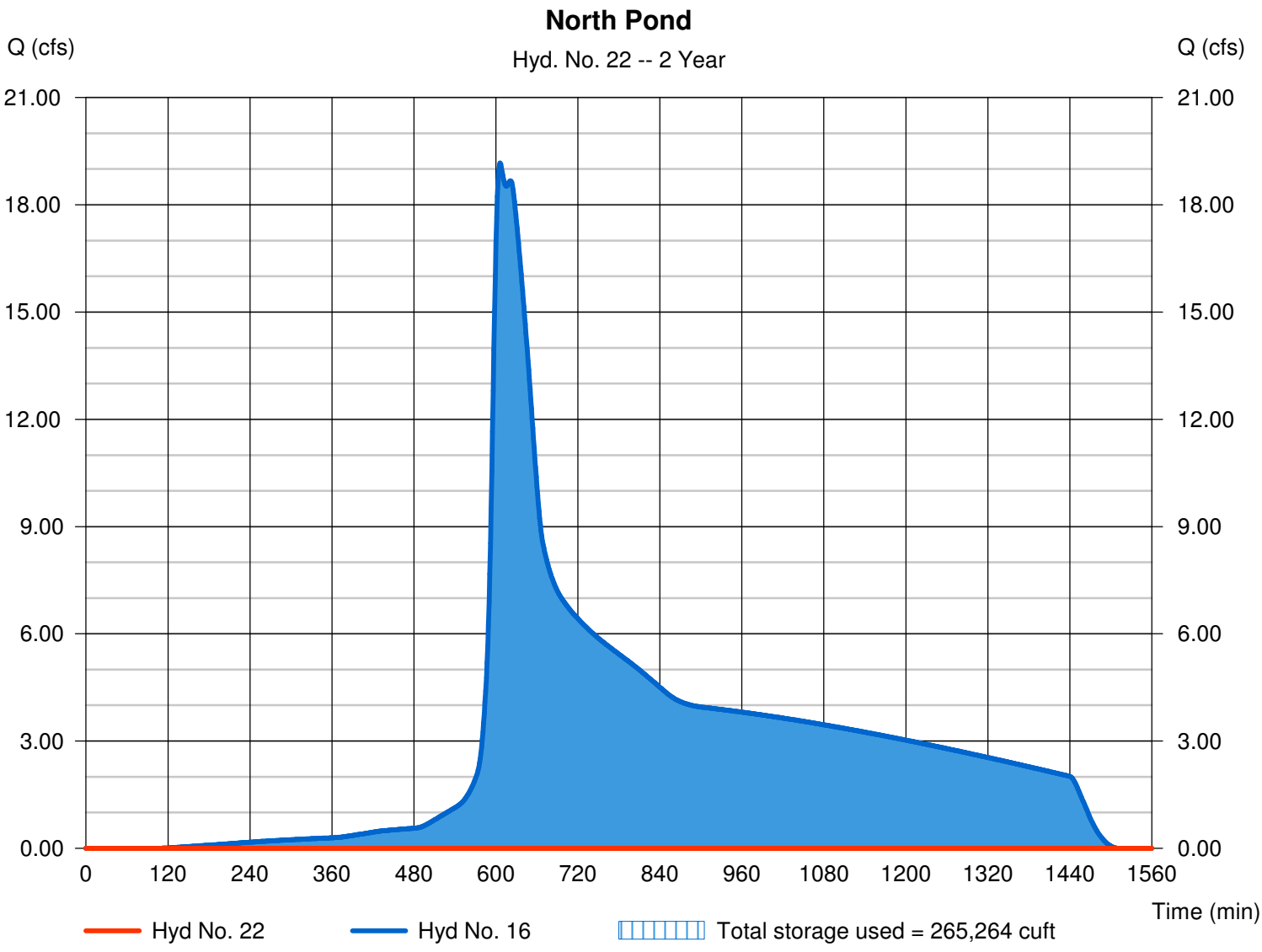
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 22

North Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	16 - To North Pond	Max. Elevation	=	2491.23 ft
Reservoir name	=	North Solar Field Pond	Max. Storage	=	265,264 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Pond No. 4 - North Solar Field Pond

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2485.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2485.00	221	0	0
1.00	2486.00	10,426	4,055	4,055
2.00	2487.00	22,781	16,205	20,259
3.00	2488.00	37,303	29,742	50,001
4.00	2489.00	53,889	45,338	95,339
5.00	2490.00	72,675	63,042	158,381
6.00	2491.00	93,543	82,882	241,263
7.00	2492.00	116,656	104,877	346,139
8.00	2493.00	131,973	124,223	470,363
9.00	2494.00	147,354	139,579	609,942
10.00	2495.00	162,801	154,998	764,940
11.00	2496.00	178,312	170,481	935,420
12.00	2497.00	193,888	186,027	1,121,447
13.00	2498.00	224,742	209,105	1,330,552
14.00	2499.00	329,461	275,410	1,605,962
15.00	2500.00	515,768	419,107	2,025,069

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2485.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	405	2485.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	811	2485.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	1,216	2485.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	1,622	2485.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	2,027	2485.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	2,433	2485.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	2,838	2485.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	3,244	2485.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	3,649	2485.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	4,055	2486.00	---	---	---	---	---	---	---	---	---	---	0.000
1.10	5,675	2486.10	---	---	---	---	---	---	---	---	---	---	0.000
1.20	7,295	2486.20	---	---	---	---	---	---	---	---	---	---	0.000
1.30	8,916	2486.30	---	---	---	---	---	---	---	---	---	---	0.000
1.40	10,536	2486.40	---	---	---	---	---	---	---	---	---	---	0.000
1.50	12,157	2486.50	---	---	---	---	---	---	---	---	---	---	0.000
1.60	13,777	2486.60	---	---	---	---	---	---	---	---	---	---	0.000
1.70	15,398	2486.70	---	---	---	---	---	---	---	---	---	---	0.000
1.80	17,018	2486.80	---	---	---	---	---	---	---	---	---	---	0.000
1.90	18,639	2486.90	---	---	---	---	---	---	---	---	---	---	0.000
2.00	20,259	2487.00	---	---	---	---	---	---	---	---	---	---	0.000
2.10	23,233	2487.10	---	---	---	---	---	---	---	---	---	---	0.000
2.20	26,208	2487.20	---	---	---	---	---	---	---	---	---	---	0.000
2.30	29,182	2487.30	---	---	---	---	---	---	---	---	---	---	0.000
2.40	32,156	2487.40	---	---	---	---	---	---	---	---	---	---	0.000
2.50	35,130	2487.50	---	---	---	---	---	---	---	---	---	---	0.000
2.60	38,104	2487.60	---	---	---	---	---	---	---	---	---	---	0.000
2.70	41,079	2487.70	---	---	---	---	---	---	---	---	---	---	0.000

Continues on next page...

North Solar Field Pond

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
2.80	44,053	2487.80	---	---	---	---	---	---	---	---	---	---	0.000
2.90	47,027	2487.90	---	---	---	---	---	---	---	---	---	---	0.000
3.00	50,001	2488.00	---	---	---	---	---	---	---	---	---	---	0.000
3.10	54,535	2488.10	---	---	---	---	---	---	---	---	---	---	0.000
3.20	59,069	2488.20	---	---	---	---	---	---	---	---	---	---	0.000
3.30	63,603	2488.30	---	---	---	---	---	---	---	---	---	---	0.000
3.40	68,136	2488.40	---	---	---	---	---	---	---	---	---	---	0.000
3.50	72,670	2488.50	---	---	---	---	---	---	---	---	---	---	0.000
3.60	77,204	2488.60	---	---	---	---	---	---	---	---	---	---	0.000
3.70	81,738	2488.70	---	---	---	---	---	---	---	---	---	---	0.000
3.80	86,272	2488.80	---	---	---	---	---	---	---	---	---	---	0.000
3.90	90,805	2488.90	---	---	---	---	---	---	---	---	---	---	0.000
4.00	95,339	2489.00	---	---	---	---	---	---	---	---	---	---	0.000
4.10	101,643	2489.10	---	---	---	---	---	---	---	---	---	---	0.000
4.20	107,948	2489.20	---	---	---	---	---	---	---	---	---	---	0.000
4.30	114,252	2489.30	---	---	---	---	---	---	---	---	---	---	0.000
4.40	120,556	2489.40	---	---	---	---	---	---	---	---	---	---	0.000
4.50	126,860	2489.50	---	---	---	---	---	---	---	---	---	---	0.000
4.60	133,164	2489.60	---	---	---	---	---	---	---	---	---	---	0.000
4.70	139,469	2489.70	---	---	---	---	---	---	---	---	---	---	0.000
4.80	145,773	2489.80	---	---	---	---	---	---	---	---	---	---	0.000
4.90	152,077	2489.90	---	---	---	---	---	---	---	---	---	---	0.000
5.00	158,381	2490.00	---	---	---	---	---	---	---	---	---	---	0.000
5.10	166,669	2490.10	---	---	---	---	---	---	---	---	---	---	0.000
5.20	174,958	2490.20	---	---	---	---	---	---	---	---	---	---	0.000
5.30	183,246	2490.30	---	---	---	---	---	---	---	---	---	---	0.000
5.40	191,534	2490.40	---	---	---	---	---	---	---	---	---	---	0.000
5.50	199,822	2490.50	---	---	---	---	---	---	---	---	---	---	0.000
5.60	208,110	2490.60	---	---	---	---	---	---	---	---	---	---	0.000
5.70	216,398	2490.70	---	---	---	---	---	---	---	---	---	---	0.000
5.80	224,687	2490.80	---	---	---	---	---	---	---	---	---	---	0.000
5.90	232,975	2490.90	---	---	---	---	---	---	---	---	---	---	0.000
6.00	241,263	2491.00	---	---	---	---	---	---	---	---	---	---	0.000
6.10	251,750	2491.10	---	---	---	---	---	---	---	---	---	---	0.000
6.20	262,238	2491.20	---	---	---	---	---	---	---	---	---	---	0.000
6.30	272,726	2491.30	---	---	---	---	---	---	---	---	---	---	0.000
6.40	283,213	2491.40	---	---	---	---	---	---	---	---	---	---	0.000
6.50	293,701	2491.50	---	---	---	---	---	---	---	---	---	---	0.000
6.60	304,189	2491.60	---	---	---	---	---	---	---	---	---	---	0.000
6.70	314,676	2491.70	---	---	---	---	---	---	---	---	---	---	0.000
6.80	325,164	2491.80	---	---	---	---	---	---	---	---	---	---	0.000
6.90	335,652	2491.90	---	---	---	---	---	---	---	---	---	---	0.000
7.00	346,139	2492.00	---	---	---	---	---	---	---	---	---	---	0.000
7.10	358,562	2492.10	---	---	---	---	---	---	---	---	---	---	0.000
7.20	370,984	2492.20	---	---	---	---	---	---	---	---	---	---	0.000
7.30	383,406	2492.30	---	---	---	---	---	---	---	---	---	---	0.000
7.40	395,829	2492.40	---	---	---	---	---	---	---	---	---	---	0.000
7.50	408,251	2492.50	---	---	---	---	---	---	---	---	---	---	0.000
7.60	420,673	2492.60	---	---	---	---	---	---	---	---	---	---	0.000
7.70	433,096	2492.70	---	---	---	---	---	---	---	---	---	---	0.000
7.80	445,518	2492.80	---	---	---	---	---	---	---	---	---	---	0.000
7.90	457,940	2492.90	---	---	---	---	---	---	---	---	---	---	0.000
8.00	470,363	2493.00	---	---	---	---	---	---	---	---	---	---	0.000
8.10	484,321	2493.10	---	---	---	---	---	---	---	---	---	---	0.000
8.20	498,279	2493.20	---	---	---	---	---	---	---	---	---	---	0.000
8.30	512,236	2493.30	---	---	---	---	---	---	---	---	---	---	0.000
8.40	526,194	2493.40	---	---	---	---	---	---	---	---	---	---	0.000
8.50	540,152	2493.50	---	---	---	---	---	---	---	---	---	---	0.000
8.60	554,110	2493.60	---	---	---	---	---	---	---	---	---	---	0.000
8.70	568,068	2493.70	---	---	---	---	---	---	---	---	---	---	0.000
8.80	582,026	2493.80	---	---	---	---	---	---	---	---	---	---	0.000
8.90	595,984	2493.90	---	---	---	---	---	---	---	---	---	---	0.000
9.00	609,942	2494.00	---	---	---	---	---	---	---	---	---	---	0.000
9.10	625,441	2494.10	---	---	---	---	---	---	---	---	---	---	0.000
9.20	640,941	2494.20	---	---	---	---	---	---	---	---	---	---	0.000
9.30	656,441	2494.30	---	---	---	---	---	---	---	---	---	---	0.000
9.40	671,941	2494.40	---	---	---	---	---	---	---	---	---	---	0.000
9.50	687,441	2494.50	---	---	---	---	---	---	---	---	---	---	0.000
9.60	702,941	2494.60	---	---	---	---	---	---	---	---	---	---	0.000
9.70	718,440	2494.70	---	---	---	---	---	---	---	---	---	---	0.000
9.80	733,940	2494.80	---	---	---	---	---	---	---	---	---	---	0.000
9.90	749,440	2494.90	---	---	---	---	---	---	---	---	---	---	0.000
10.00	764,940	2495.00	---	---	---	---	---	---	---	---	---	---	0.000

Continues on next page...

North Solar Field Pond

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
10.10	781,988	2495.10	---	---	---	---	---	---	---	---	---	---	0.000
10.20	799,036	2495.20	---	---	---	---	---	---	---	---	---	---	0.000
10.30	816,084	2495.30	---	---	---	---	---	---	---	---	---	---	0.000
10.40	833,132	2495.40	---	---	---	---	---	---	---	---	---	---	0.000
10.50	850,180	2495.50	---	---	---	---	---	---	---	---	---	---	0.000
10.60	867,228	2495.60	---	---	---	---	---	---	---	---	---	---	0.000
10.70	884,276	2495.70	---	---	---	---	---	---	---	---	---	---	0.000
10.80	901,324	2495.80	---	---	---	---	---	---	---	---	---	---	0.000
10.90	918,372	2495.90	---	---	---	---	---	---	---	---	---	---	0.000
11.00	935,420	2496.00	---	---	---	---	---	---	---	---	---	---	0.000
11.10	954,023	2496.10	---	---	---	---	---	---	---	---	---	---	0.000
11.20	972,626	2496.20	---	---	---	---	---	---	---	---	---	---	0.000
11.30	991,228	2496.30	---	---	---	---	---	---	---	---	---	---	0.000
11.40	1,009,831	2496.40	---	---	---	---	---	---	---	---	---	---	0.000
11.50	1,028,434	2496.50	---	---	---	---	---	---	---	---	---	---	0.000
11.60	1,047,036	2496.60	---	---	---	---	---	---	---	---	---	---	0.000
11.70	1,065,639	2496.70	---	---	---	---	---	---	---	---	---	---	0.000
11.80	1,084,242	2496.80	---	---	---	---	---	---	---	---	---	---	0.000
11.90	1,102,845	2496.90	---	---	---	---	---	---	---	---	---	---	0.000
12.00	1,121,447	2497.00	---	---	---	---	---	---	---	---	---	---	0.000
12.10	1,142,358	2497.10	---	---	---	---	---	---	---	---	---	---	0.000
12.20	1,163,268	2497.20	---	---	---	---	---	---	---	---	---	---	0.000
12.30	1,184,179	2497.30	---	---	---	---	---	---	---	---	---	---	0.000
12.40	1,205,089	2497.40	---	---	---	---	---	---	---	---	---	---	0.000
12.50	1,226,000	2497.50	---	---	---	---	---	---	---	---	---	---	0.000
12.60	1,246,910	2497.60	---	---	---	---	---	---	---	---	---	---	0.000
12.70	1,267,821	2497.70	---	---	---	---	---	---	---	---	---	---	0.000
12.80	1,288,731	2497.80	---	---	---	---	---	---	---	---	---	---	0.000
12.90	1,309,642	2497.90	---	---	---	---	---	---	---	---	---	---	0.000
13.00	1,330,552	2498.00	---	---	---	---	---	---	---	---	---	---	0.000
13.10	1,358,093	2498.10	---	---	---	---	---	---	---	---	---	---	0.000
13.20	1,385,634	2498.20	---	---	---	---	---	---	---	---	---	---	0.000
13.30	1,413,175	2498.30	---	---	---	---	---	---	---	---	---	---	0.000
13.40	1,440,716	2498.40	---	---	---	---	---	---	---	---	---	---	0.000
13.50	1,468,257	2498.50	---	---	---	---	---	---	---	---	---	---	0.000
13.60	1,495,798	2498.60	---	---	---	---	---	---	---	---	---	---	0.000
13.70	1,523,339	2498.70	---	---	---	---	---	---	---	---	---	---	0.000
13.80	1,550,880	2498.80	---	---	---	---	---	---	---	---	---	---	0.000
13.90	1,578,421	2498.90	---	---	---	---	---	---	---	---	---	---	0.000
14.00	1,605,962	2499.00	---	---	---	---	---	---	---	---	---	---	0.000
14.10	1,647,872	2499.10	---	---	---	---	---	---	---	---	---	---	0.000
14.20	1,689,783	2499.20	---	---	---	---	---	---	---	---	---	---	0.000
14.30	1,731,694	2499.30	---	---	---	---	---	---	---	---	---	---	0.000
14.40	1,773,605	2499.40	---	---	---	---	---	---	---	---	---	---	0.000
14.50	1,815,515	2499.50	---	---	---	---	---	---	---	---	---	---	0.000
14.60	1,857,426	2499.60	---	---	---	---	---	---	---	---	---	---	0.000
14.70	1,899,337	2499.70	---	---	---	---	---	---	---	---	---	---	0.000
14.80	1,941,248	2499.80	---	---	---	---	---	---	---	---	---	---	0.000
14.90	1,983,158	2499.90	---	---	---	---	---	---	---	---	---	---	0.000
15.00	2,025,069	2500.00	---	---	---	---	---	---	---	---	---	---	0.000

...End

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	5.892	1	621	86,697	----	------	------	Area 1
2	SCS Runoff	23.38	1	632	400,066	----	------	------	Area 2
3	SCS Runoff	4.637	1	604	40,895	----	------	------	Area 3
4	SCS Runoff	5.746	1	611	67,171	----	------	------	Area 4
5	SCS Runoff	17.62	1	603	145,596	----	------	------	Area 5
6	SCS Runoff	9.048	1	604	79,795	----	------	------	Area 6
7	SCS Runoff	116.35	1	621	1,111,417	----	------	------	Area 7.1
8	SCS Runoff	14.84	1	608	102,012	----	------	------	Area 7.2
9	SCS Runoff	107.45	1	621	1,026,365	----	------	------	Area 8.1
10	SCS Runoff	63.42	1	617	550,629	----	------	------	Area 8.2
11	SCS Runoff	30.14	1	601	170,758	----	------	------	Power Block North
12	SCS Runoff	34.04	1	596	157,405	----	------	------	Power Block South
13	Combine	43.96	1	605	733,522	2, 3, 4, 5, 6,	------	------	To Area 3 pond
14	Combine	126.64	1	620	1,213,428	7, 8,	------	------	Area 7
15	Combine	169.56	1	619	1,576,996	9, 10,	------	------	Area 8
16	Combine	134.95	1	618	1,384,185	11, 14,	------	------	To North Pond
17	Combine	70.16	1	616	708,035	10, 12,	------	------	To SE Pond
18	Reservoir	0.000	1	n/a	0	13	2507.57	733,522	Area 3 pond
19	Reservoir	3.652	1	1442	104,000	17	2512.95	659,778	SE Pond
20	Combine	107.45	1	621	1,130,366	9, 19	------	------	To SW Pond
21	Reservoir	0.000	1	n/a	0	20	2512.95	1,130,366	SW Pond
22	Reservoir	0.000	1	n/a	0	16	2498.20	1,384,187	North Pond

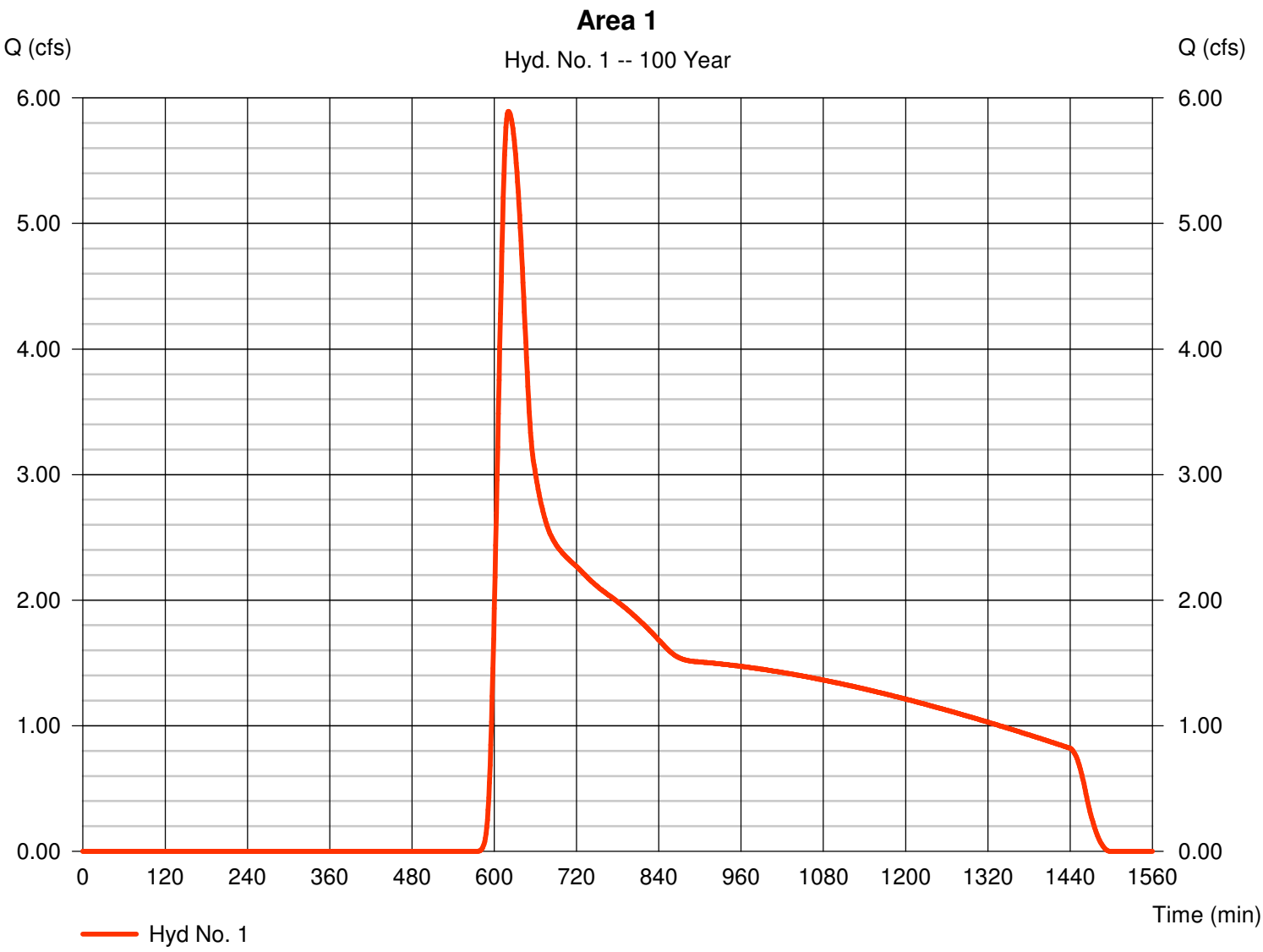
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 1

Area 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.892 cfs
Storm frequency	=	100 yrs	Time to peak	=	621 min
Time interval	=	1 min	Hyd. volume	=	86,697 cuft
Drainage area	=	30.250 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	36.75 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



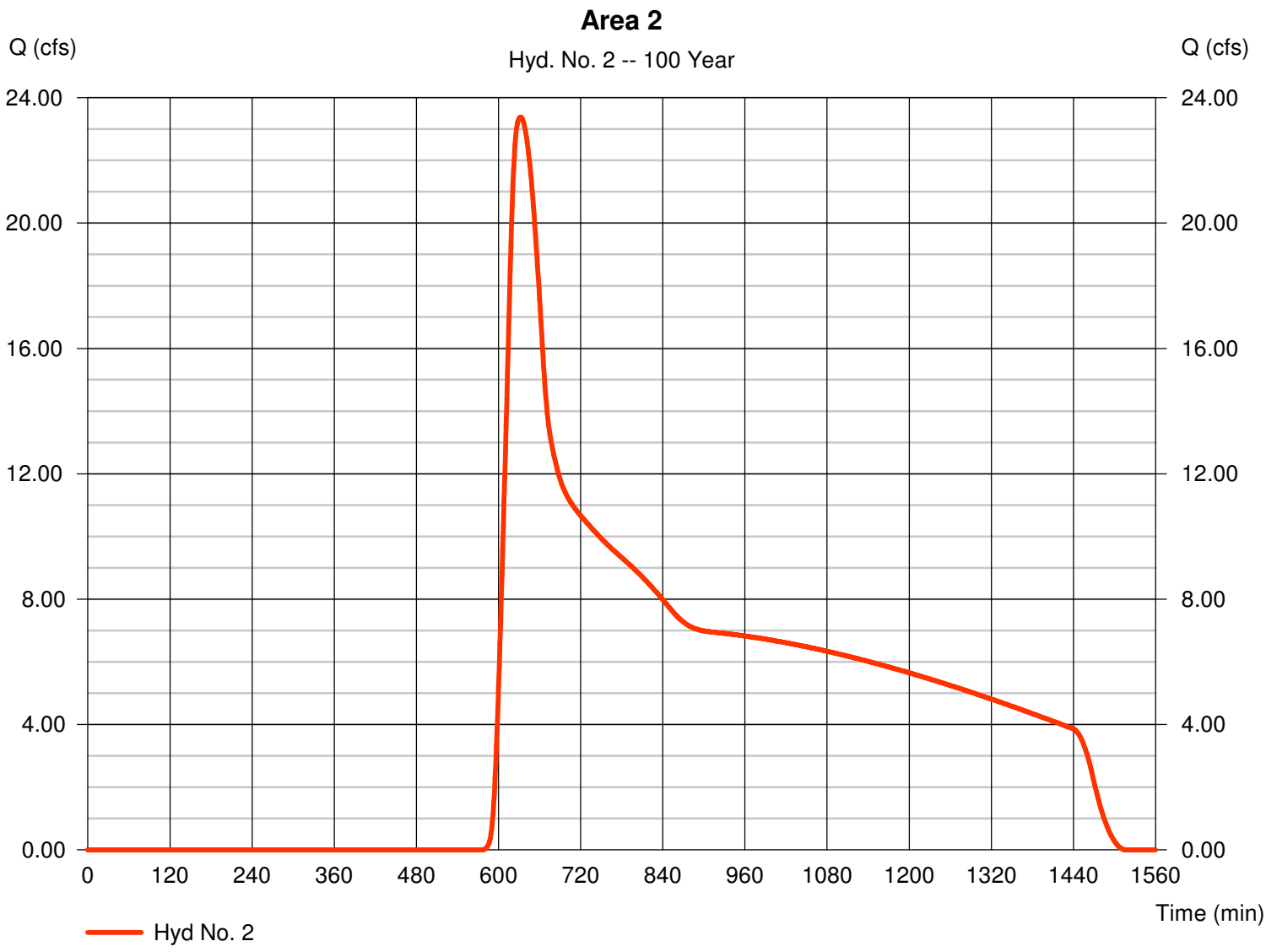
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 2

Area 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	23.38 cfs
Storm frequency	=	100 yrs	Time to peak	=	632 min
Time interval	=	1 min	Hyd. volume	=	400,066 cuft
Drainage area	=	140.990 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	47.60 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



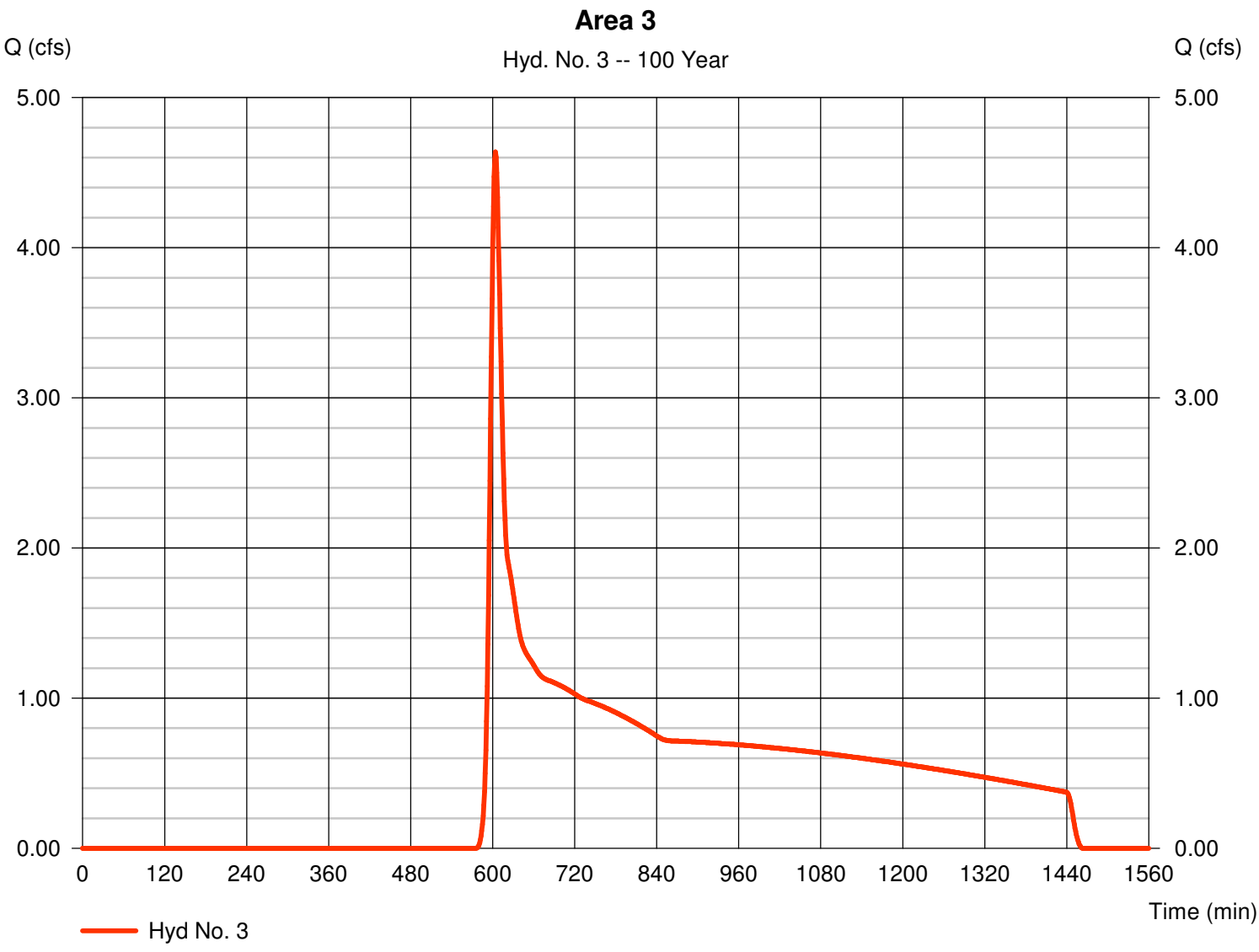
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 3

Area 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.637 cfs
Storm frequency	=	100 yrs	Time to peak	=	604 min
Time interval	=	1 min	Hyd. volume	=	40,895 cuft
Drainage area	=	14.350 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.40 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



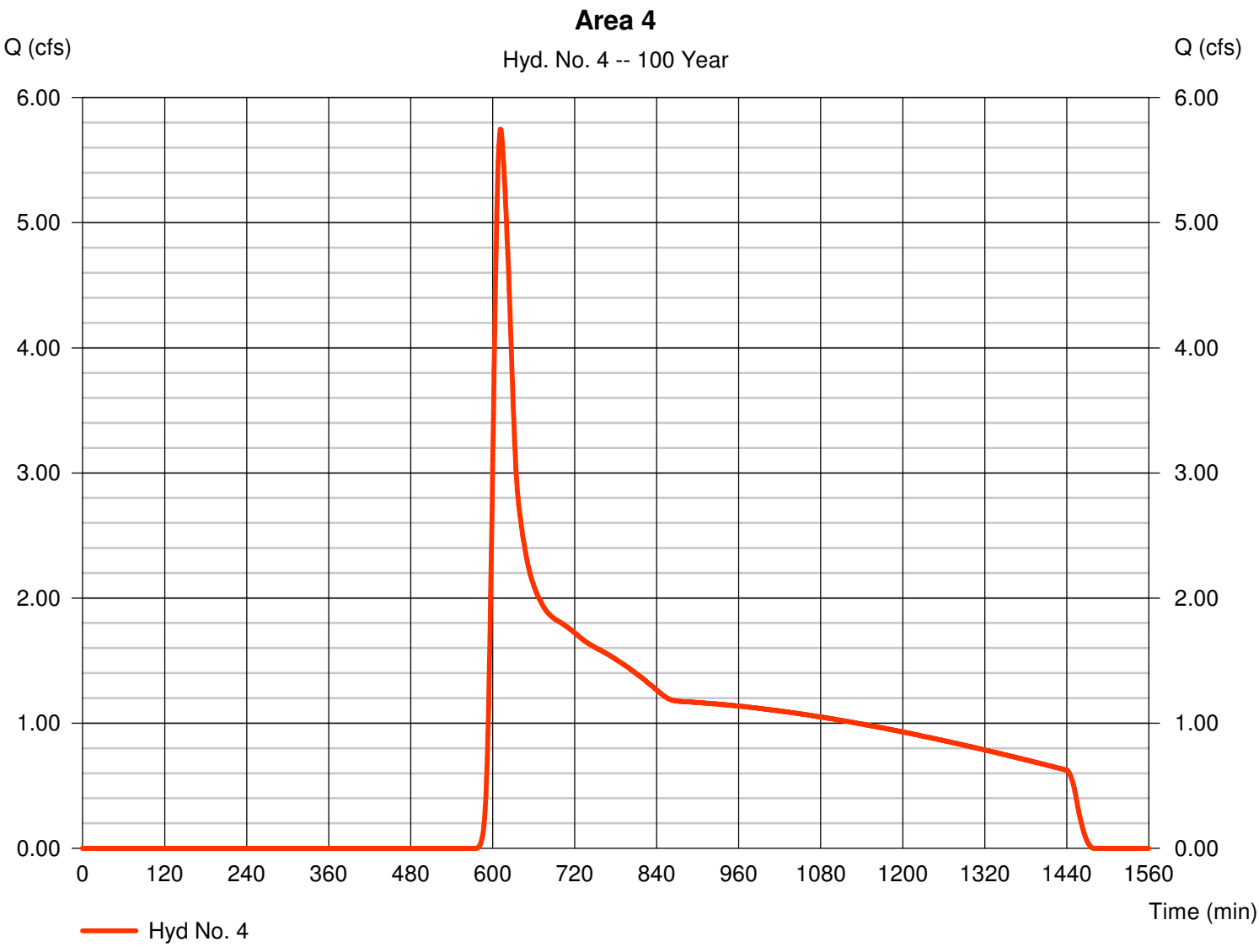
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 4

Area 4

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.746 cfs
Storm frequency	=	100 yrs	Time to peak	=	611 min
Time interval	=	1 min	Hyd. volume	=	67,171 cuft
Drainage area	=	23.570 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	24.70 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



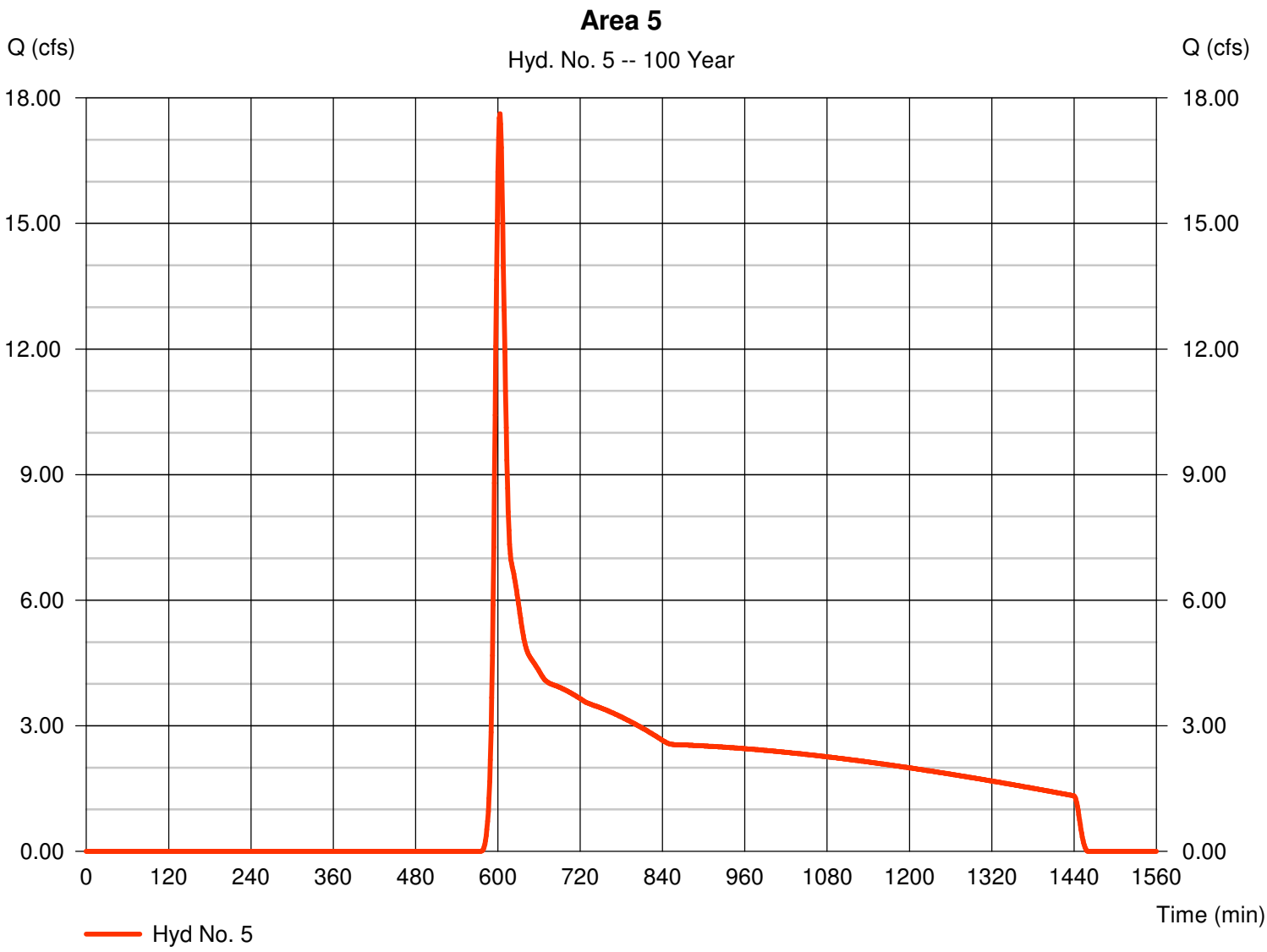
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 5

Area 5

Hydrograph type	=	SCS Runoff	Peak discharge	=	17.62 cfs
Storm frequency	=	100 yrs	Time to peak	=	603 min
Time interval	=	1 min	Hyd. volume	=	145,596 cuft
Drainage area	=	51.900 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.40 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



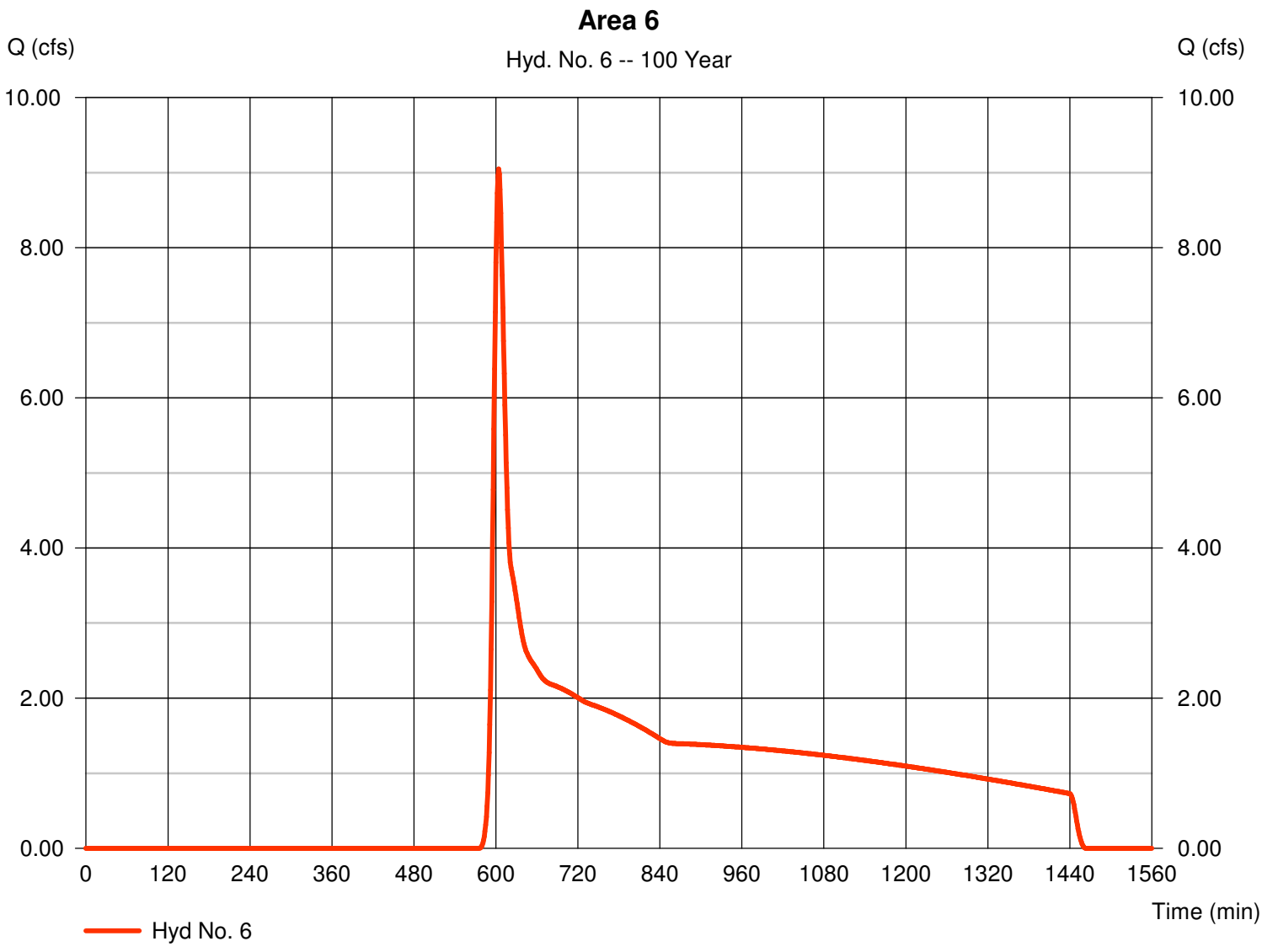
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 6

Area 6

Hydrograph type	=	SCS Runoff	Peak discharge	=	9.048 cfs
Storm frequency	=	100 yrs	Time to peak	=	604 min
Time interval	=	1 min	Hyd. volume	=	79,795 cuft
Drainage area	=	28.000 ac	Curve number	=	63
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.40 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



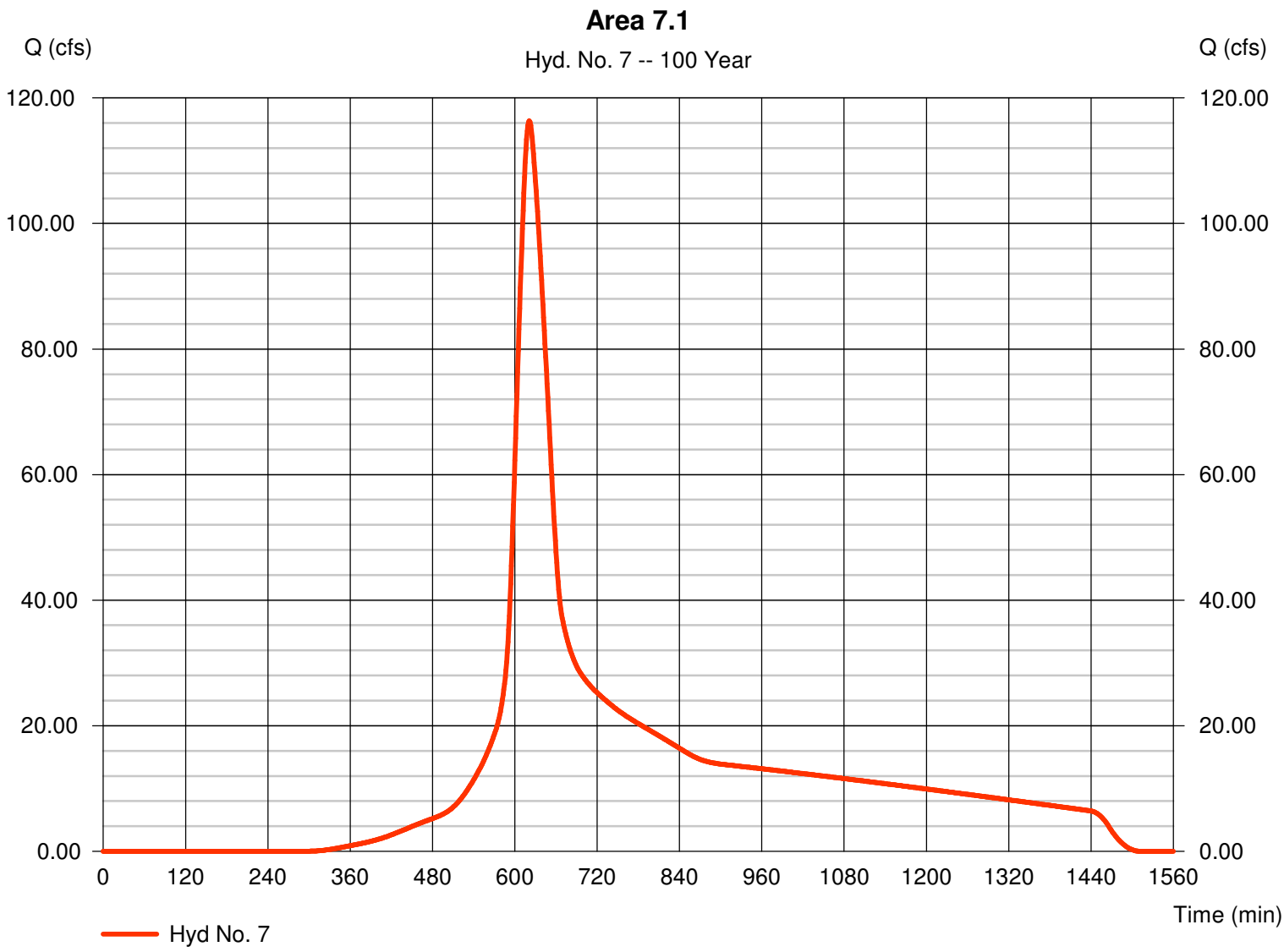
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 7

Area 7.1

Hydrograph type	=	SCS Runoff	Peak discharge	=	116.35 cfs
Storm frequency	=	100 yrs	Time to peak	=	621 min
Time interval	=	1 min	Hyd. volume	=	1,111,417 cuft
Drainage area	=	136.950 ac	Curve number	=	85
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	45.30 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



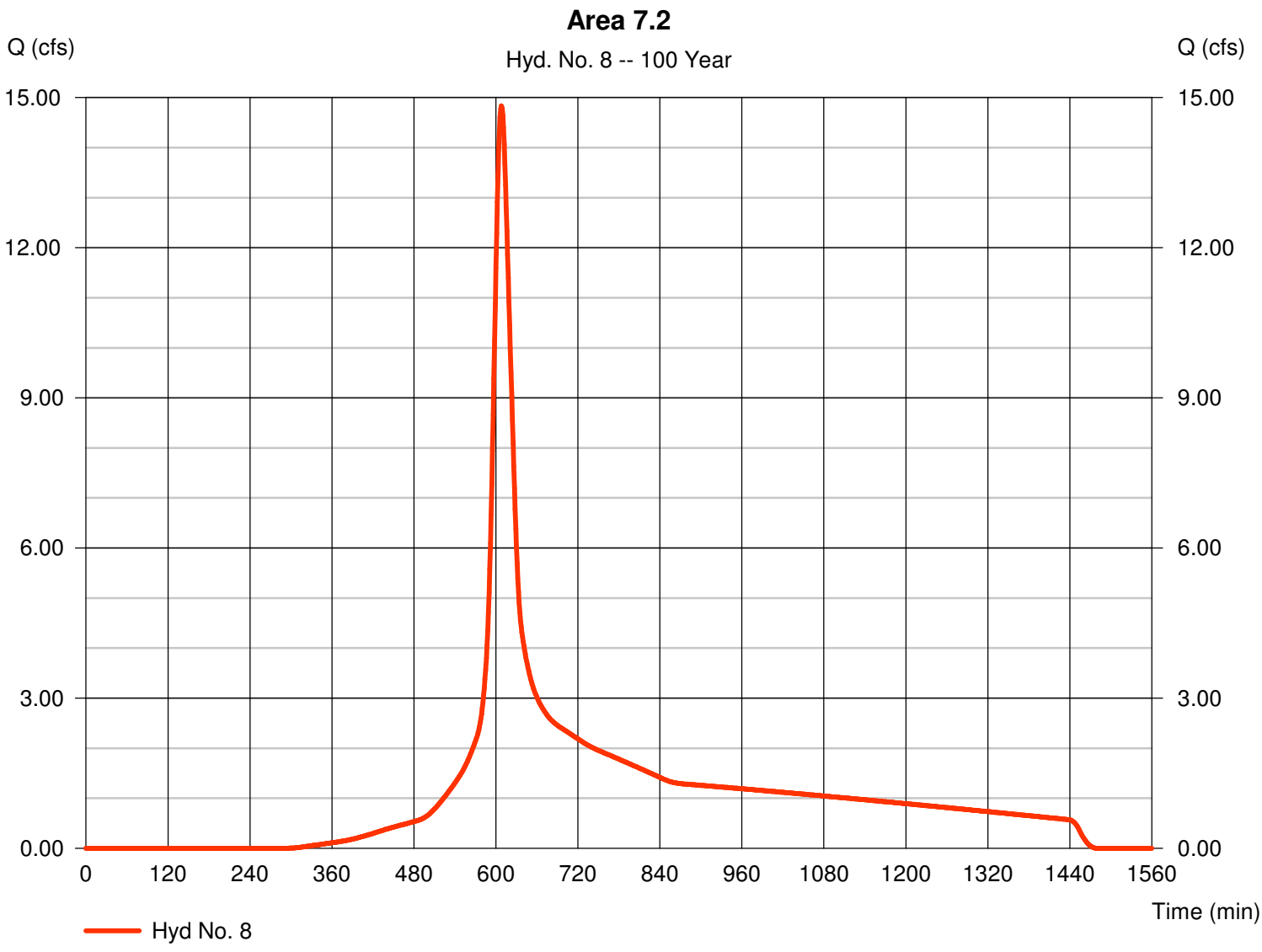
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 8

Area 7.2

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.84 cfs
Storm frequency	=	100 yrs	Time to peak	=	608 min
Time interval	=	1 min	Hyd. volume	=	102,012 cuft
Drainage area	=	12.570 ac	Curve number	=	85
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	25.00 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



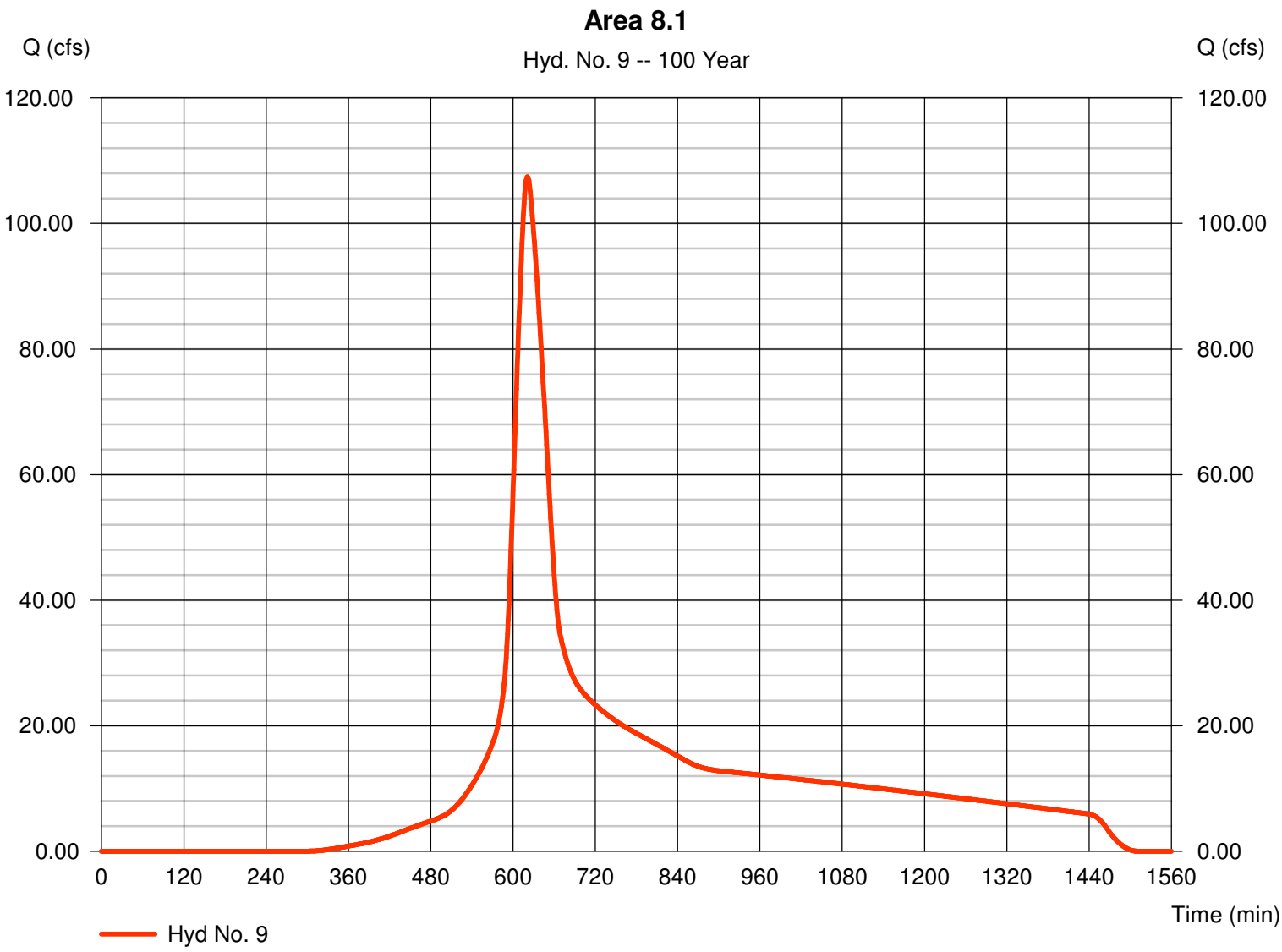
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 9

Area 8.1

Hydrograph type	=	SCS Runoff	Peak discharge	=	107.45 cfs
Storm frequency	=	100 yrs	Time to peak	=	621 min
Time interval	=	1 min	Hyd. volume	=	1,026,365 cuft
Drainage area	=	126.470 ac	Curve number	=	85
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	44.70 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



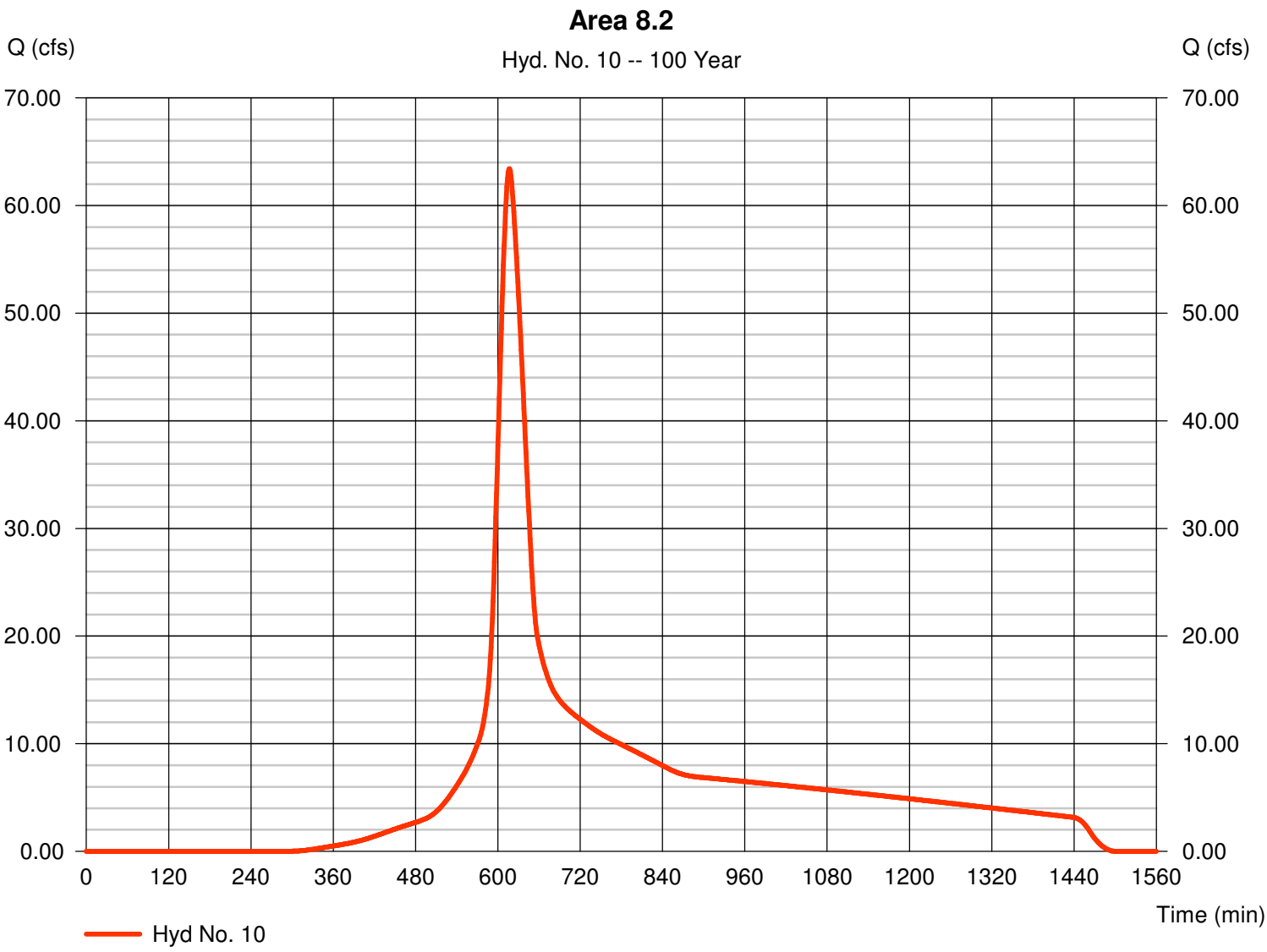
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 10

Area 8.2

Hydrograph type	=	SCS Runoff	Peak discharge	=	63.42 cfs
Storm frequency	=	100 yrs	Time to peak	=	617 min
Time interval	=	1 min	Hyd. volume	=	550,629 cuft
Drainage area	=	68.220 ac	Curve number	=	85
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	37.60 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



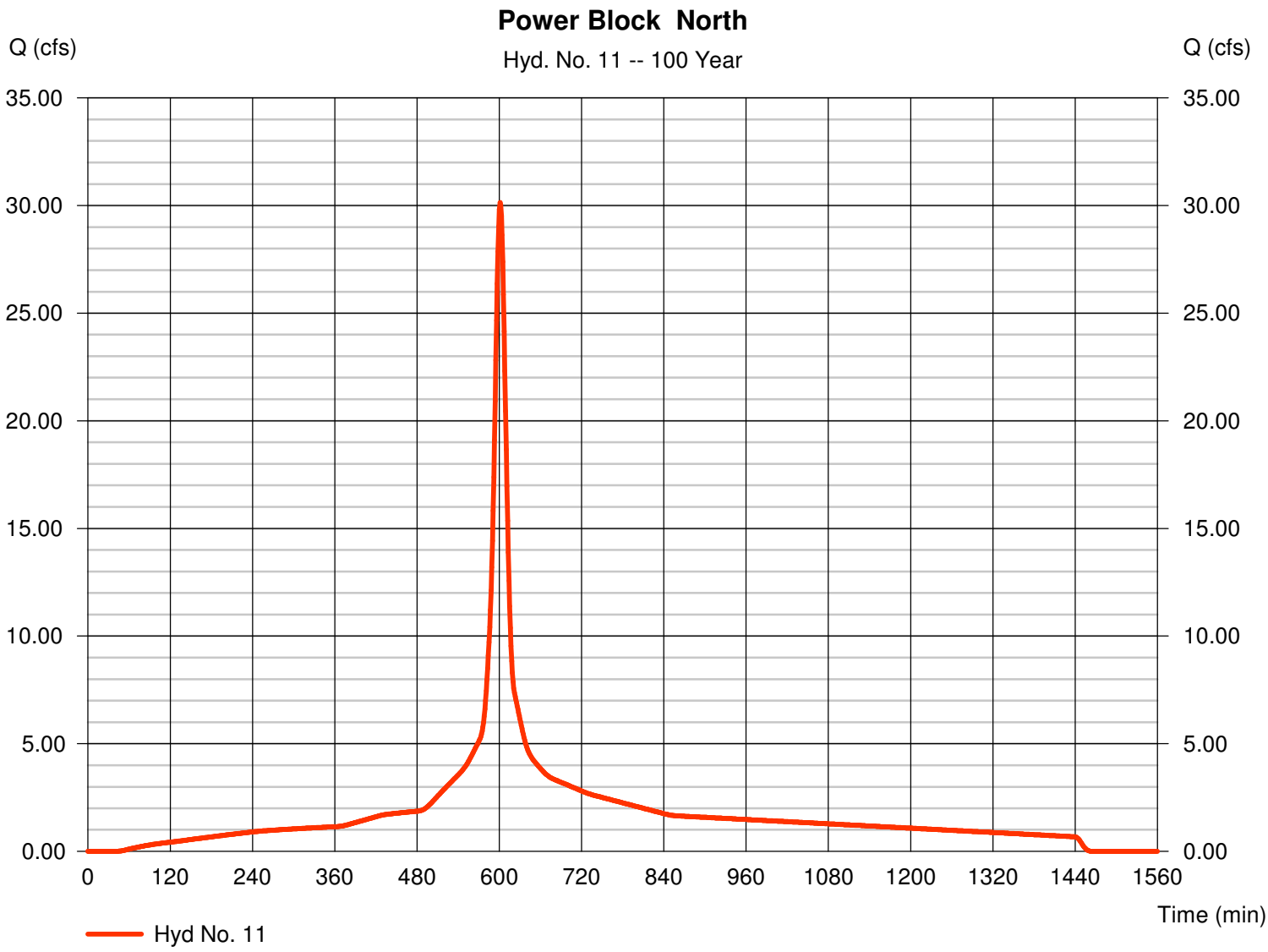
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 11

Power Block North

Hydrograph type	=	SCS Runoff	Peak discharge	=	30.14 cfs
Storm frequency	=	100 yrs	Time to peak	=	601 min
Time interval	=	1 min	Hyd. volume	=	170,758 cuft
Drainage area	=	13.380 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.60 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



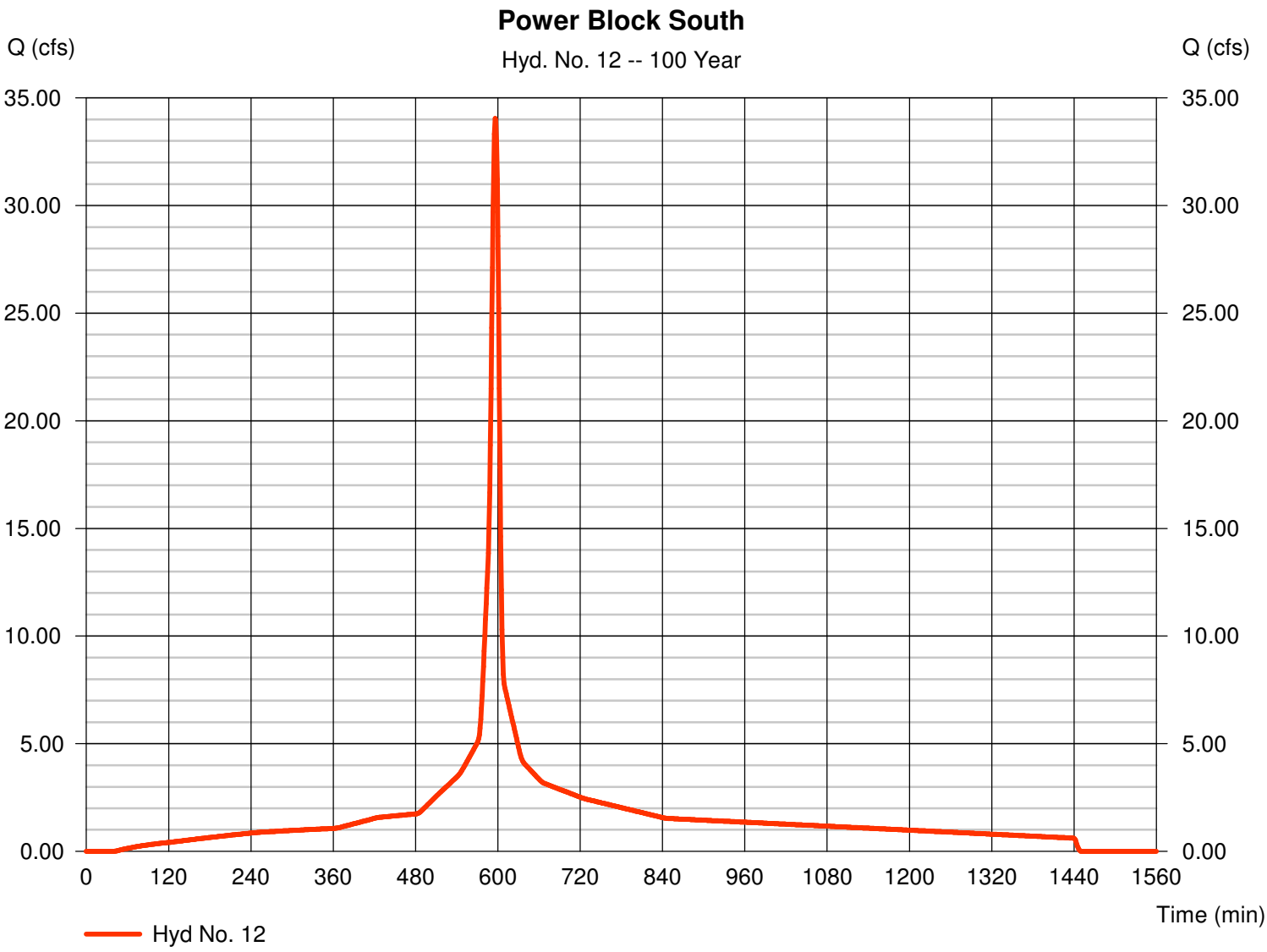
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 12

Power Block South

Hydrograph type	=	SCS Runoff	Peak discharge	=	34.04 cfs
Storm frequency	=	100 yrs	Time to peak	=	596 min
Time interval	=	1 min	Hyd. volume	=	157,405 cuft
Drainage area	=	11.960 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	3.75 in	Distribution	=	Type I
Storm duration	=	24 hrs	Shape factor	=	484



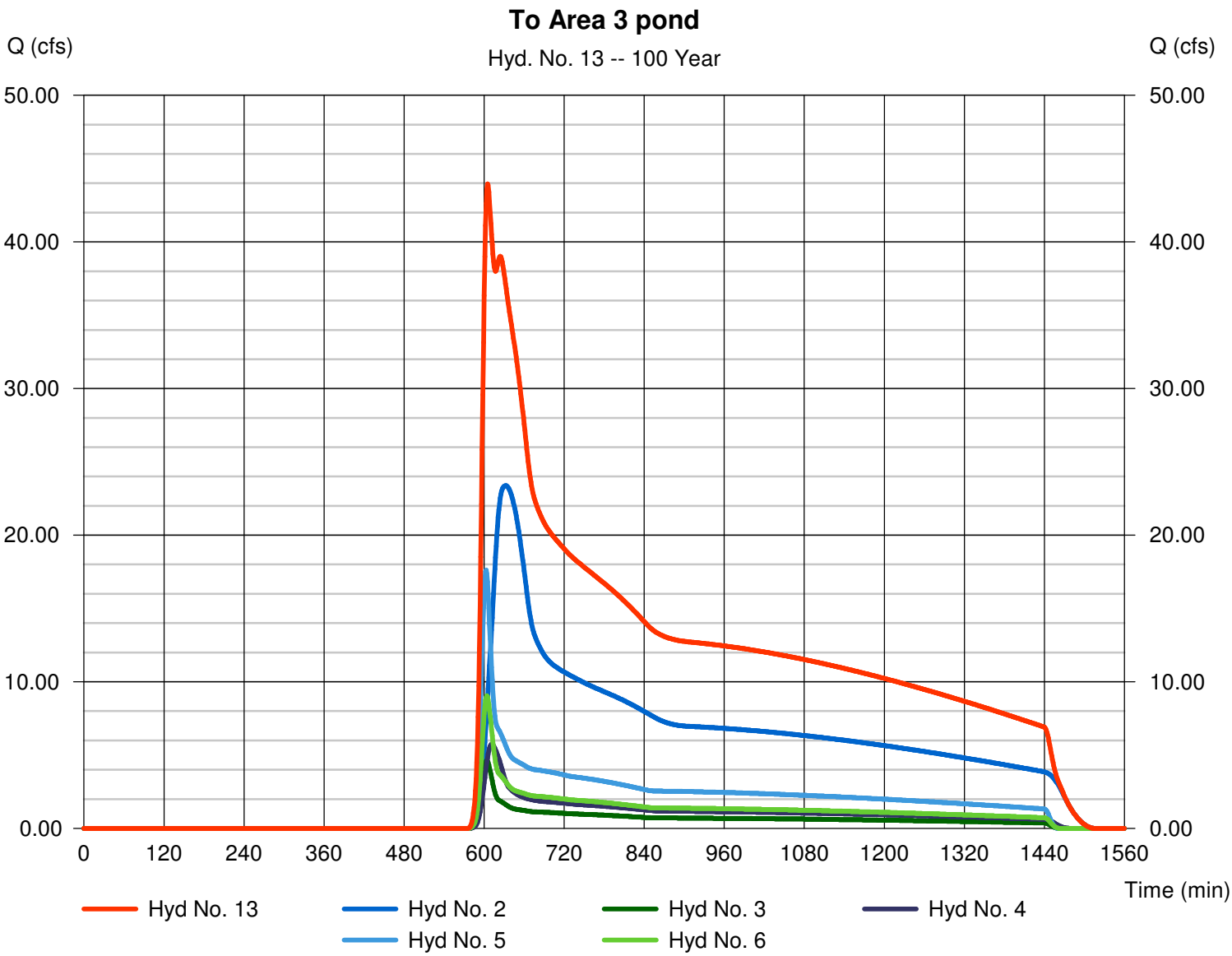
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 13

To Area 3 pond

Hydrograph type	=	Combine	Peak discharge	=	43.96 cfs
Storm frequency	=	100 yrs	Time to peak	=	605 min
Time interval	=	1 min	Hyd. volume	=	733,522 cuft
Inflow hyds.	=	2, 3, 4, 5, 6	Contrib. drain. area	=	258.810 ac



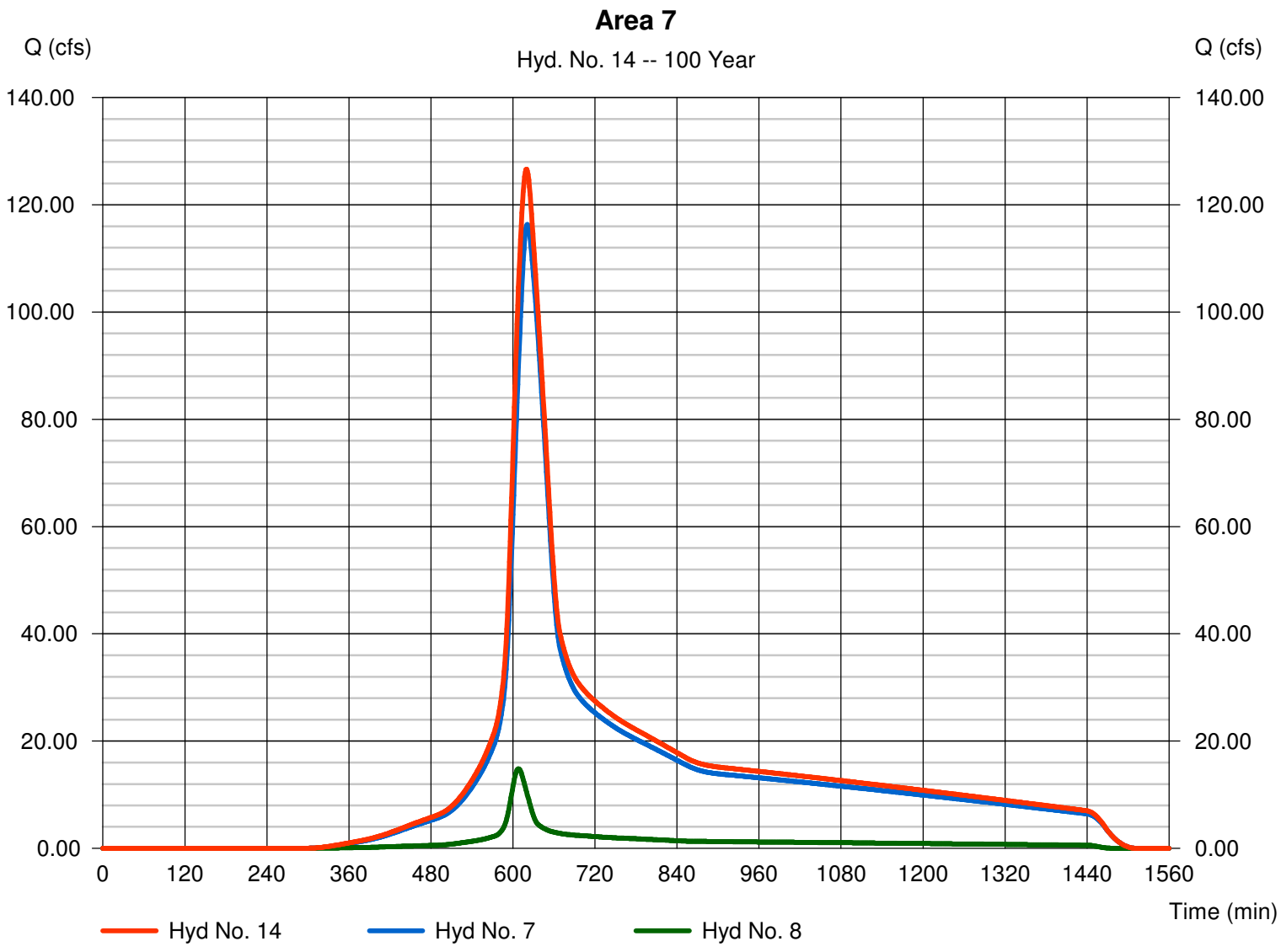
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 14

Area 7

Hydrograph type	= Combine	Peak discharge	= 126.64 cfs
Storm frequency	= 100 yrs	Time to peak	= 620 min
Time interval	= 1 min	Hyd. volume	= 1,213,428 cuft
Inflow hyds.	= 7, 8	Contrib. drain. area	= 149.520 ac



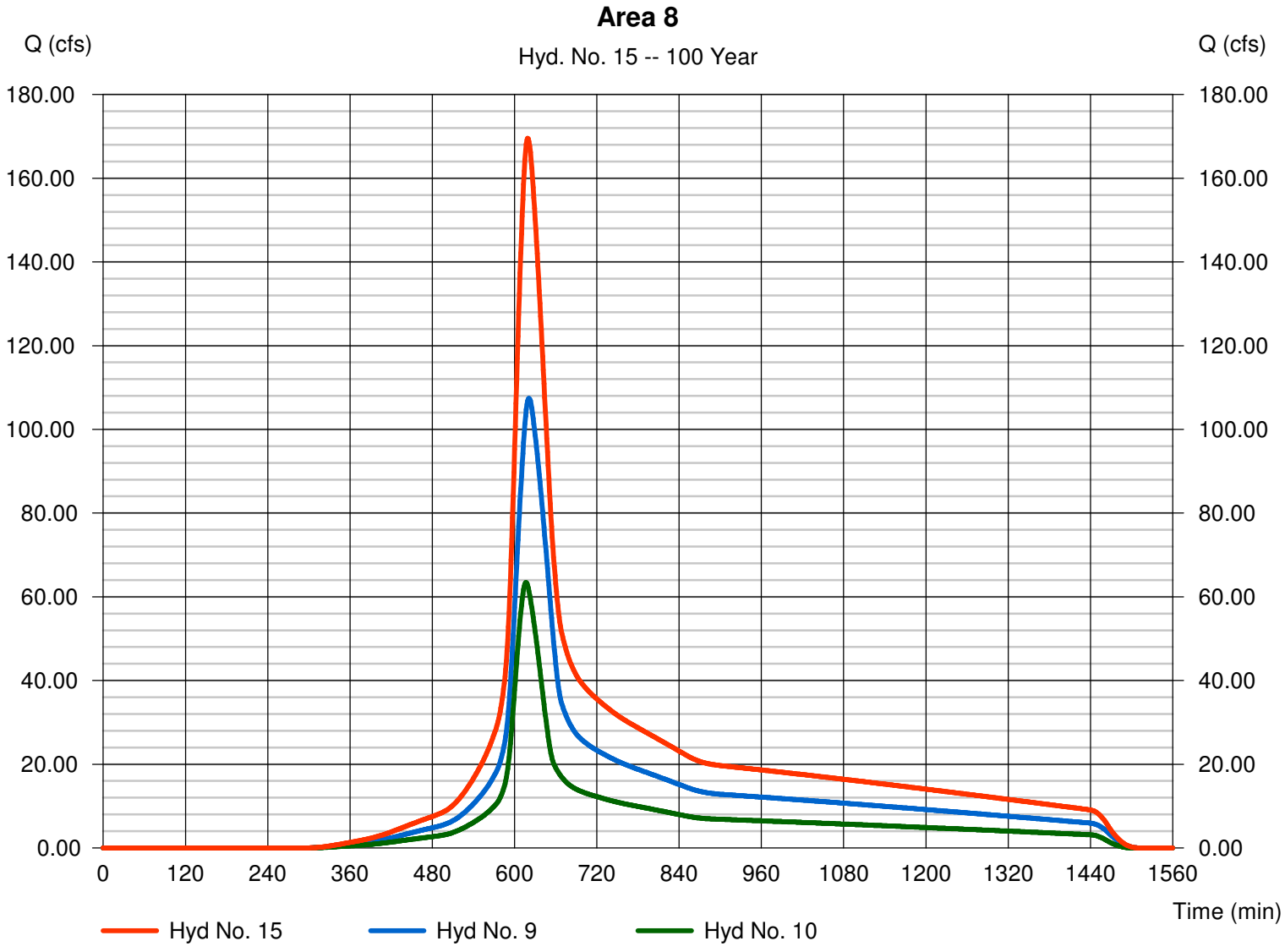
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 15

Area 8

Hydrograph type	=	Combine	Peak discharge	=	169.56 cfs
Storm frequency	=	100 yrs	Time to peak	=	619 min
Time interval	=	1 min	Hyd. volume	=	1,576,996 cuft
Inflow hyds.	=	9, 10	Contrib. drain. area	=	194.690 ac



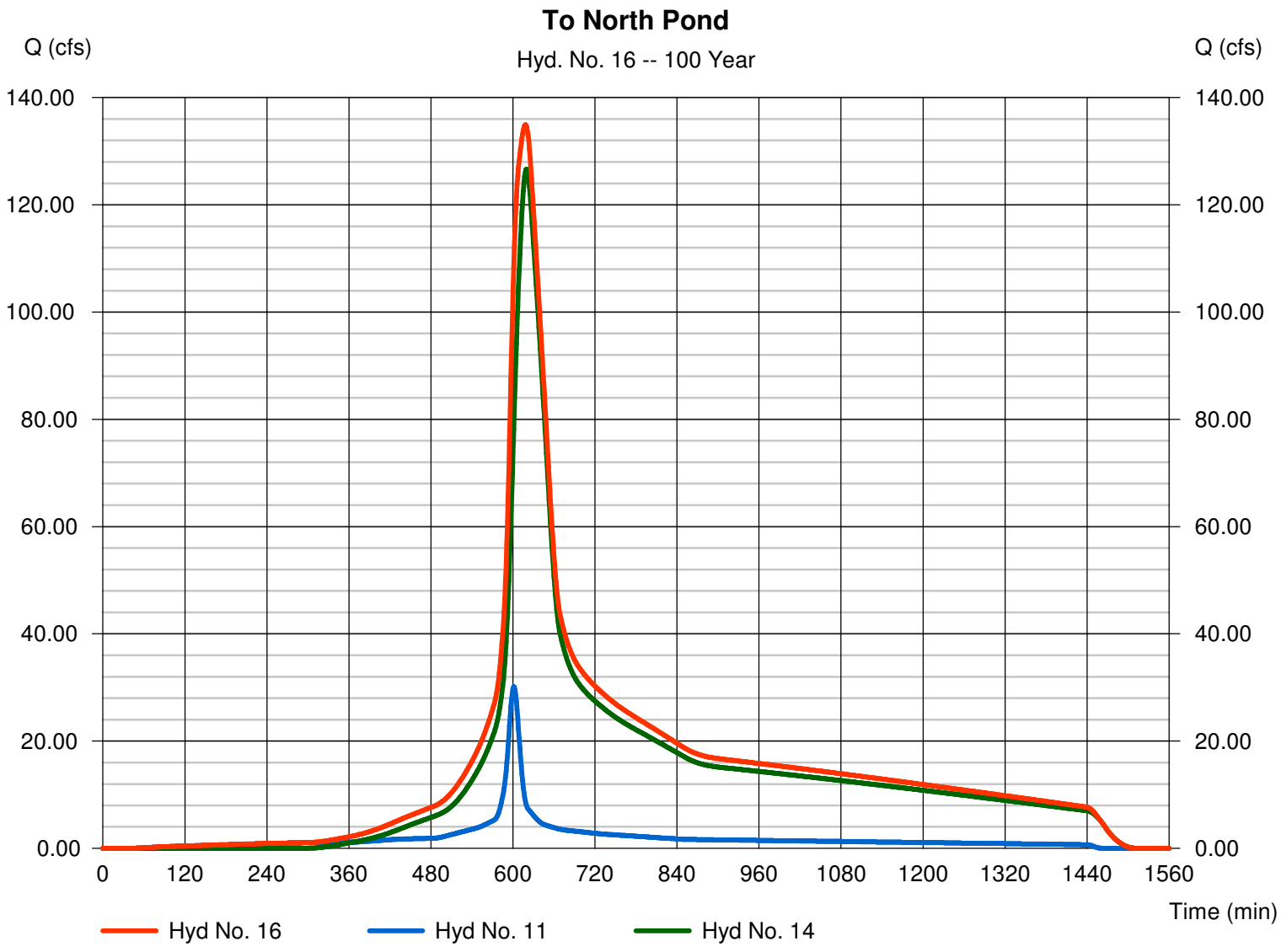
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 16

To North Pond

Hydrograph type	= Combine	Peak discharge	= 134.95 cfs
Storm frequency	= 100 yrs	Time to peak	= 618 min
Time interval	= 1 min	Hyd. volume	= 1,384,185 cuft
Inflow hyds.	= 11, 14	Contrib. drain. area	= 13.380 ac



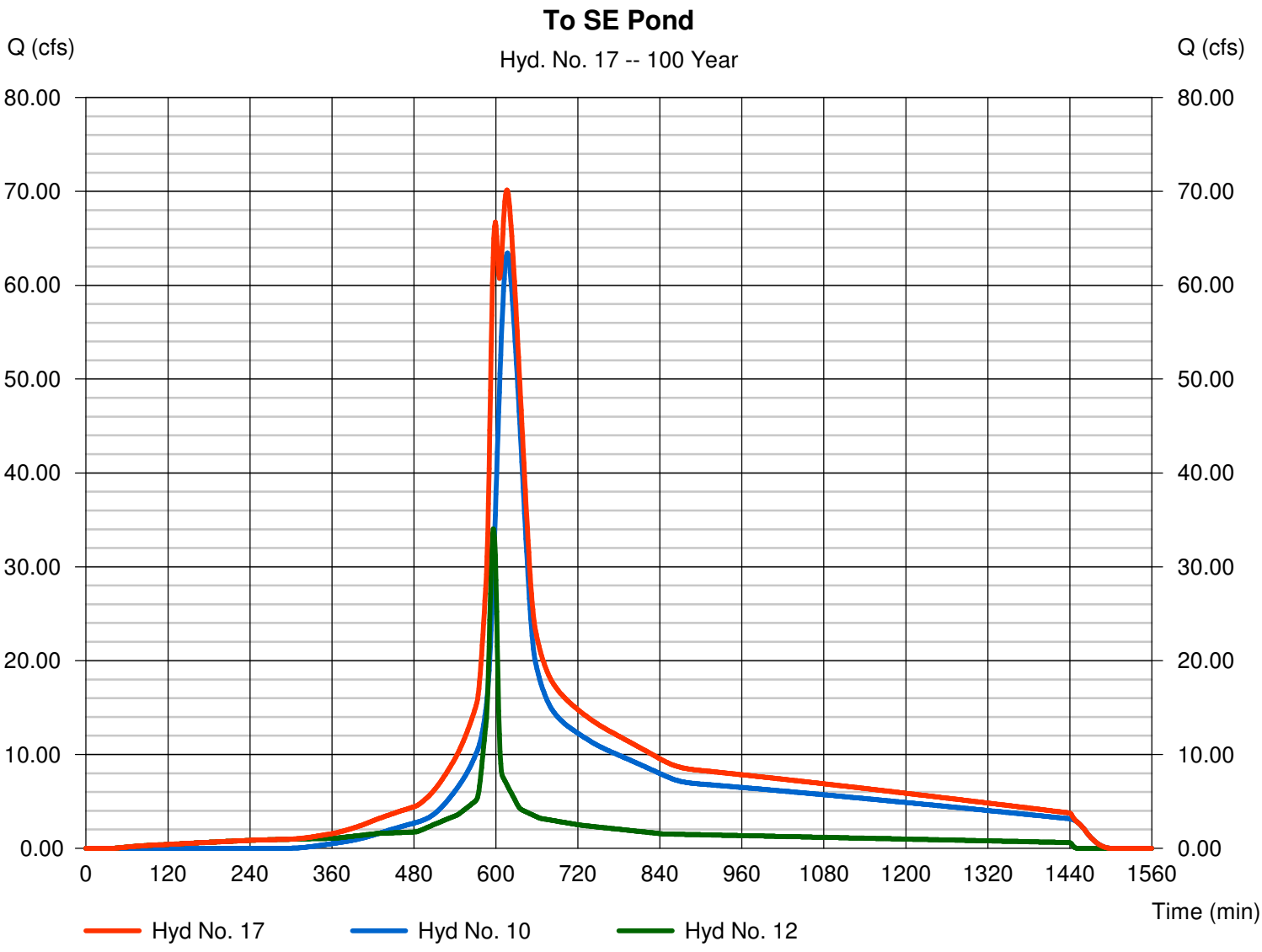
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 17

To SE Pond

Hydrograph type	=	Combine	Peak discharge	=	70.16 cfs
Storm frequency	=	100 yrs	Time to peak	=	616 min
Time interval	=	1 min	Hyd. volume	=	708,035 cuft
Inflow hyds.	=	10, 12	Contrib. drain. area	=	80.180 ac



Hydrograph Report

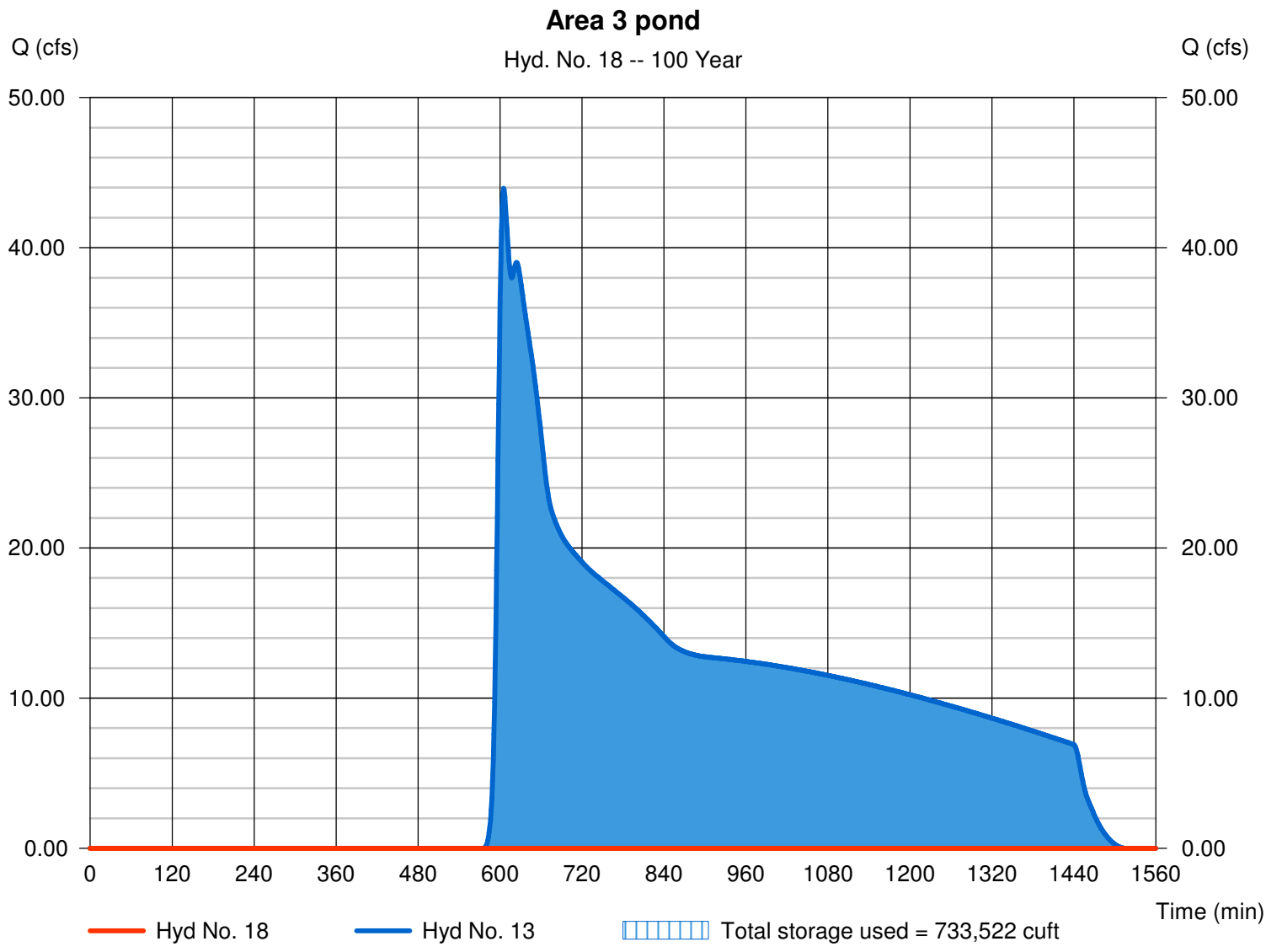
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 18

Area 3 pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	13 - To Area 3 pond	Max. Elevation	=	2507.57 ft
Reservoir name	=	Area 3 ponding	Max. Storage	=	733,522 cuft

Storage Indication method used.



Hydrograph Report

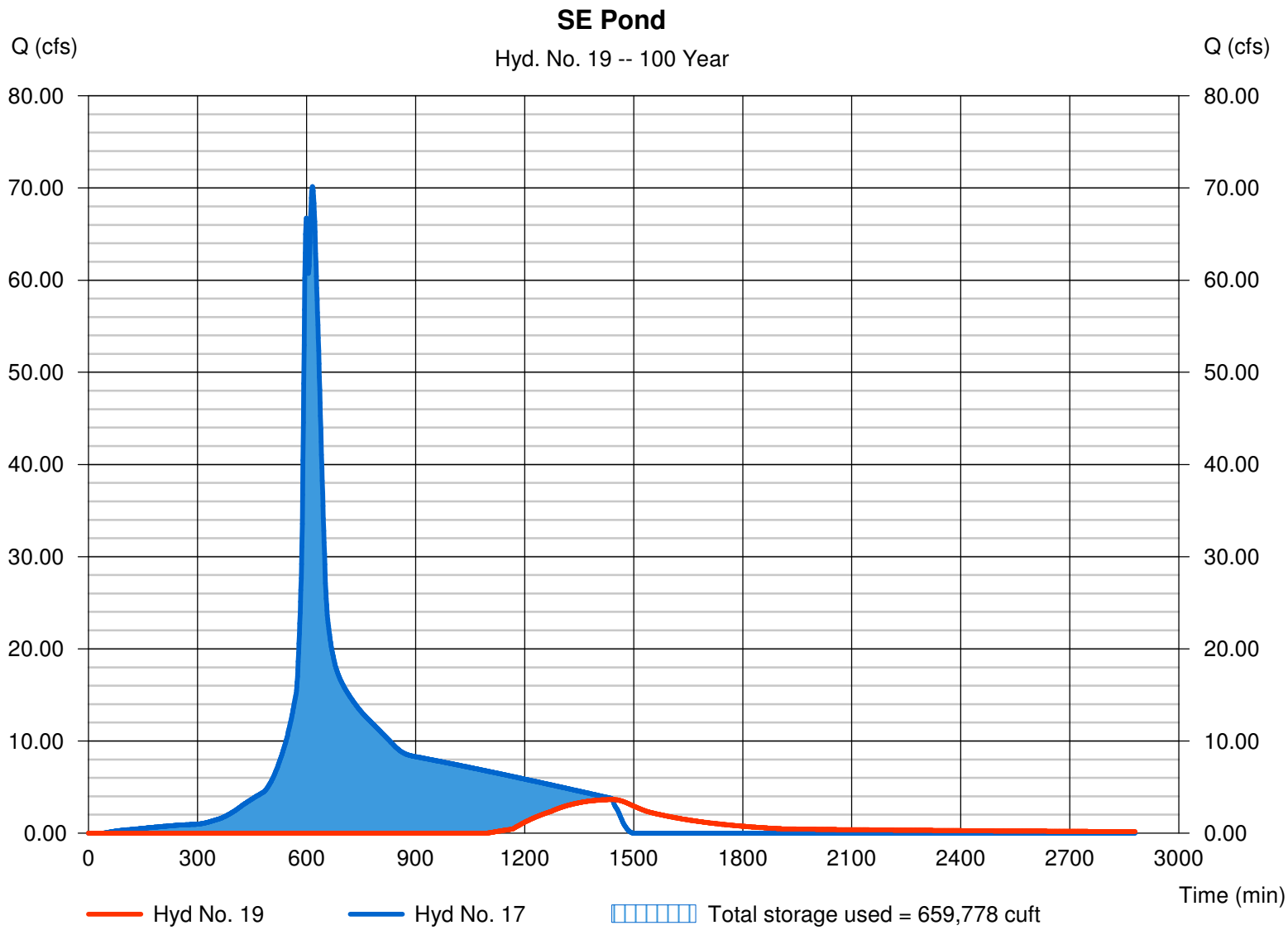
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 19

SE Pond

Hydrograph type	=	Reservoir	Peak discharge	=	3.652 cfs
Storm frequency	=	100 yrs	Time to peak	=	1442 min
Time interval	=	1 min	Hyd. volume	=	104,000 cuft
Inflow hyd. No.	=	17 - To SE Pond	Max. Elevation	=	2512.95 ft
Reservoir name	=	South East Pond 8.2	Max. Storage	=	659,778 cuft

Storage Indication method used.



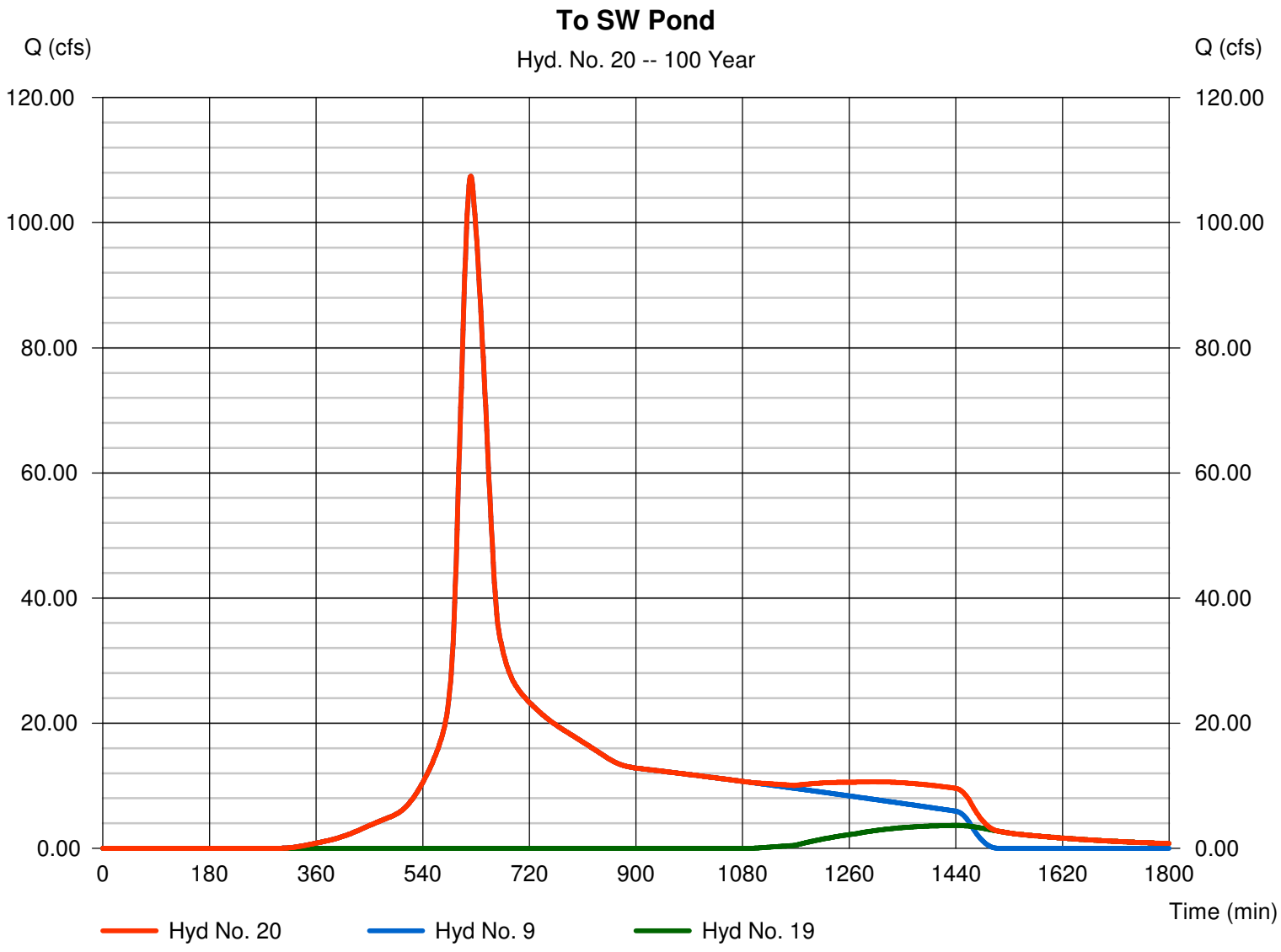
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 20

To SW Pond

Hydrograph type	= Combine	Peak discharge	= 107.45 cfs
Storm frequency	= 100 yrs	Time to peak	= 621 min
Time interval	= 1 min	Hyd. volume	= 1,130,366 cuft
Inflow hyds.	= 9, 19	Contrib. drain. area	= 126.470 ac



Hydrograph Report

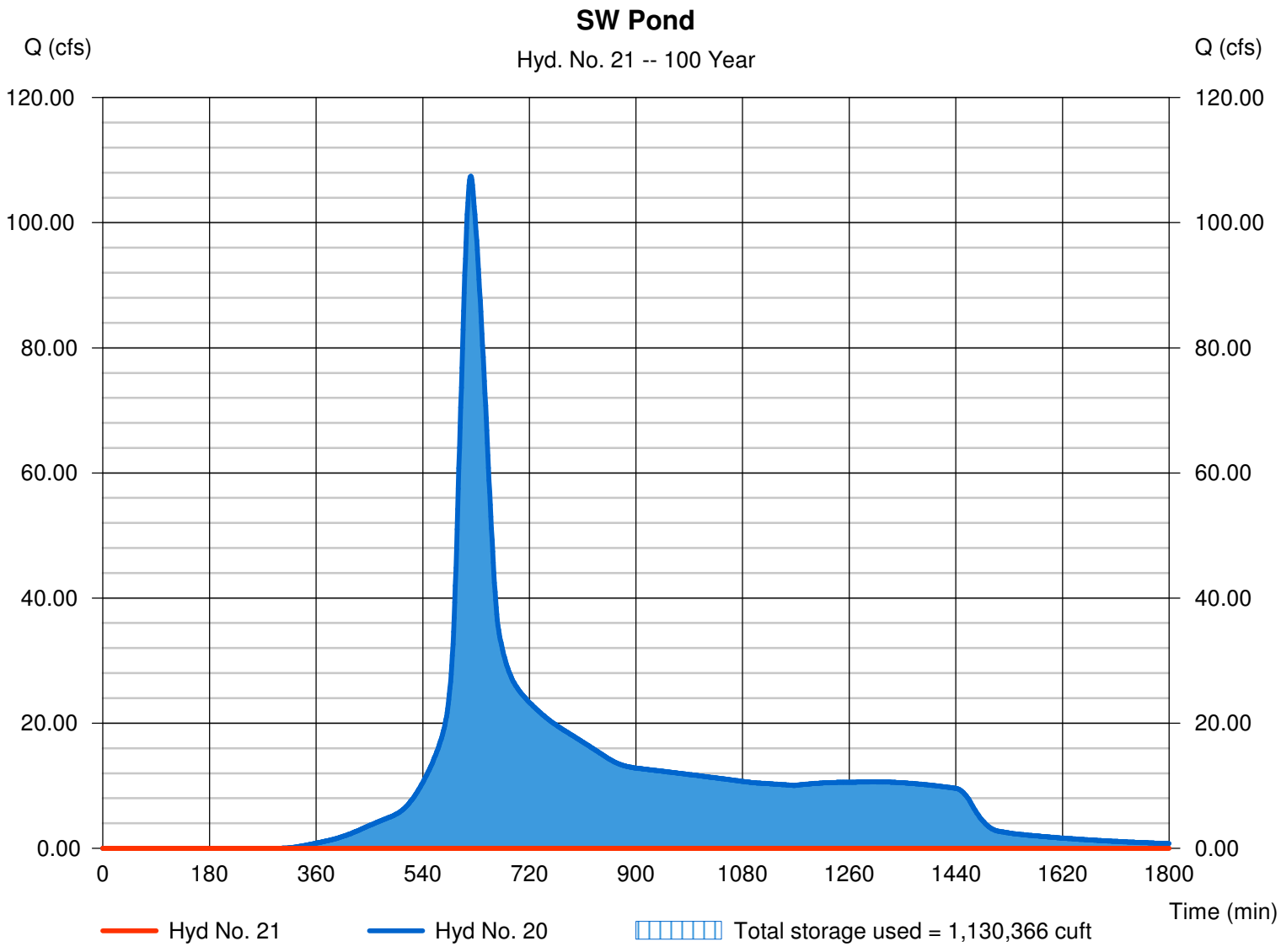
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 21

SW Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	20 - To SW Pond	Max. Elevation	=	2512.95 ft
Reservoir name	=	SouthWest Pond	Max. Storage	=	1,130,366 cuft

Storage Indication method used.



Hydrograph Report

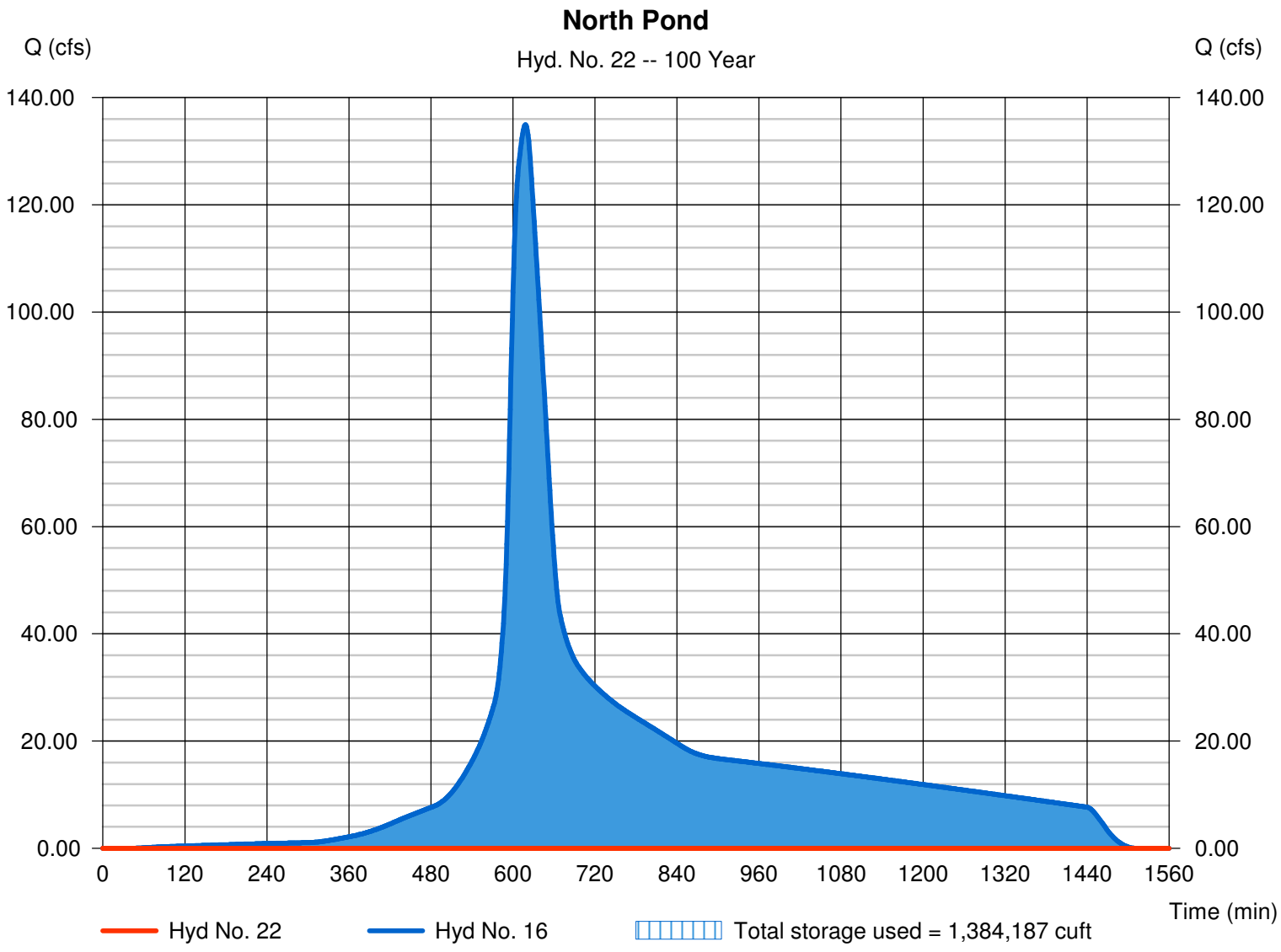
Hydraflow Hydrographs by Intelisolve v9.23 Wednesday, Jun 25, 2008

Hyd. No. 22

North Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	100 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	16 - To North Pond	Max. Elevation	=	2498.20 ft
Reservoir name	=	North Solar Field Pond	Max. Storage	=	1,384,187 cuft

Storage Indication method used.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	24.0939	10.7000	0.8283	--------
3	0.0000	0.0000	0.0000	--------
5	39.1252	10.7000	0.8283	--------
10	50.5834	10.7000	0.8283	--------
25	63.5202	10.7000	0.8283	--------
50	74.6089	10.7000	0.8283	--------
100	84.4654	10.7000	0.8283	--------

File name: palmdale2.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	2.46	1.96	1.64	1.41	1.25	1.12	1.02	0.93	0.86	0.80	0.75	0.71
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	4.00	3.18	2.66	2.29	2.02	1.82	1.65	1.51	1.40	1.30	1.22	1.15
10	5.17	4.11	3.44	2.97	2.62	2.35	2.13	1.96	1.81	1.69	1.58	1.49
25	6.49	5.16	4.32	3.72	3.29	2.95	2.68	2.46	2.27	2.12	1.98	1.87
50	7.62	6.06	5.07	4.37	3.86	3.46	3.15	2.89	2.67	2.49	2.33	2.19
100	8.63	6.86	5.74	4.95	4.37	3.92	3.56	3.27	3.02	2.82	2.64	2.48

Tc = time in minutes. Values may exceed 60.

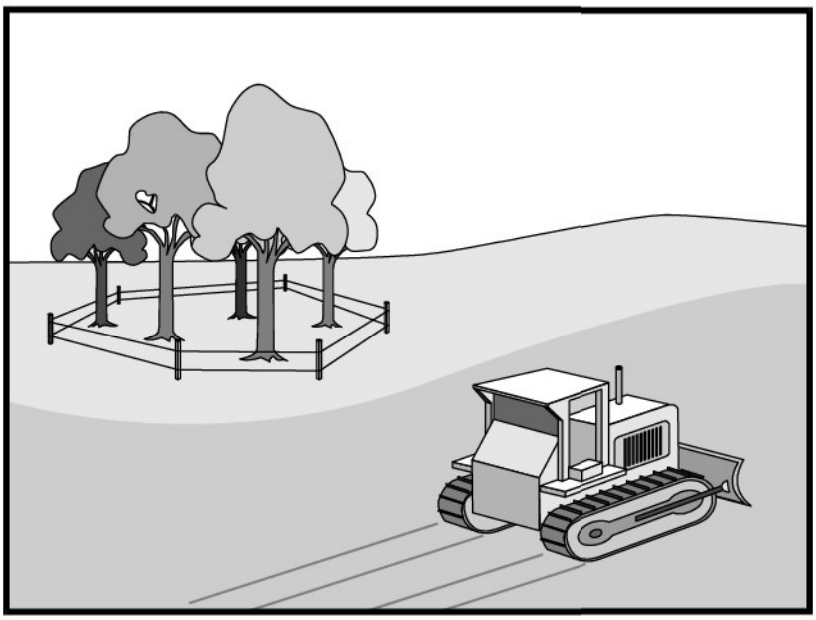
Precip. file name: Palmdale Rainfall2.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.05	1.39	0.00	1.93	2.34	2.88	3.31	3.75
SCS 6-Hr	0.76	0.98	0.00	1.32	1.59	1.97	2.27	2.59
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix D

Best Management Practices

Preservation Of Existing Vegetation EC-2



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.
- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.
- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.
- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

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EC-2 Preservation Of Existing Vegetation

Limitations

- Requires forward planning by the owner/developer, contractor, and design staff.
- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.
  - Orange colored plastic mesh fencing works well.
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization
  - Fertilize stressed or damaged broadleaf trees to aid recovery.
  - Fertilize trees in the late fall or early spring.

- Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.

- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

References

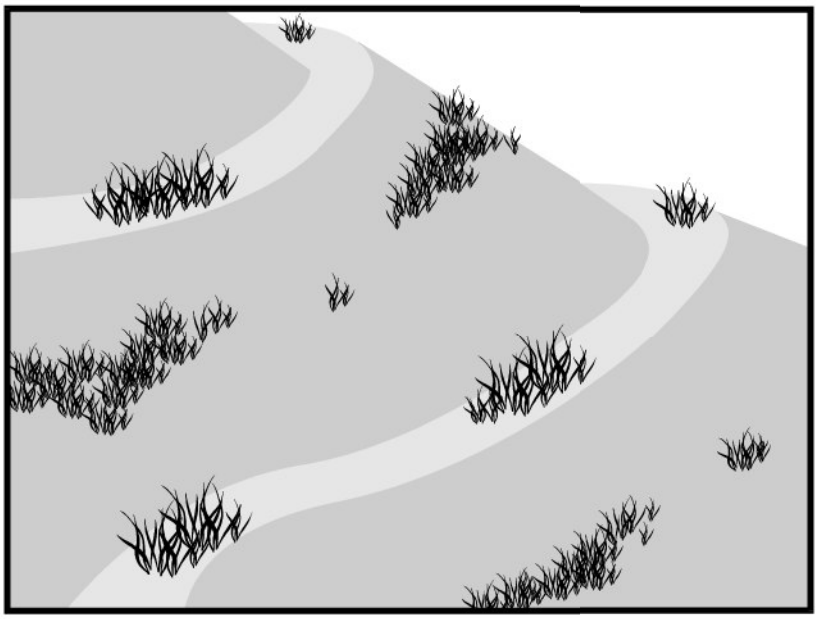
County of Sacramento Tree Preservation Ordinance, September 1981.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydroseeding EC-4



Objectives

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Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

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Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Hydroseeding typically consists of applying a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydro-mulch equipment, to temporarily protect exposed soils from erosion by water and wind.

Suitable Applications

Hydroseeding is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established, and disturbed areas that will be re-disturbed following an extended period of inactivity.

Limitations

- Hydroseeding may be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and coverage to provide adequate erosion control. Otherwise, hydroseeding must be used in conjunction with mulching (i.e., straw mulch).
- Steep slopes are difficult to protect with temporary seeding.
- Temporary seeding may not be appropriate in dry periods without supplemental irrigation.
- Temporary vegetation may have to be removed before permanent vegetation is applied.
- Temporary vegetation is not appropriate for short term inactivity.

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Implementation

In order to select appropriate hydroseeding mixtures, an evaluation of site conditions shall be performed with respect to:

- Soil conditions
- Site topography
- Season and climate
- Vegetation types
- Maintenance requirements
- Sensitive adjacent areas
- Water availability
- Plans for permanent vegetation

The local office of the U.S.D.A. Natural Resources Conservation Service (NRCS) is an excellent source of information on appropriate seed mixes.

The following steps shall be followed for implementation:

- Avoid use of hydroseeding in areas where the BMP would be incompatible with future earthwork activities and would have to be removed.
- Hydroseeding can be accomplished using a multiple step or one step process. The multiple step process ensures maximum direct contact of the seeds to soil. When the one step process is used to apply the mixture of fiber, seed, etc., the seed rate shall be increased to compensate for all seeds not having direct contact with the soil.
- Prior to application, roughen the area to be seeded with the furrows trending along the contours.
- Apply a straw mulch to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow.
- All seeds shall be in conformance with the California State Seed Law of the Department of Agriculture. Each seed bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. The container shall be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. All legume seed shall be pellet inoculated. Inoculant sources shall be species specific and shall be applied at a rate of 2 lb of inoculant per 100 lb seed.
- Commercial fertilizer shall conform to the requirements of the California Food and Agricultural Code. Fertilizer shall be pelleted or granular form.
- Follow up applications shall be made as needed to cover weak spots and to maintain adequate soil protection.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

Costs

Average cost for installation and maintenance may vary from as low as $300 per acre for flat slopes and stable soils, to $1600 per acre for moderate to steep slopes and/or erosive soils.

Hydroseeding		Installed Cost per Acre
High Density	Ornamentals	$400 - $1600
	Turf Species	$350
	Bunch Grasses	$300 - $1300
Fast Growing	Annual	$350 - $650
	Perennial	$300 - $800
Non-Competing	Native	$300 - $1600
	Non-Native	$400 - $500
Sterile	Cereal Grain	$500

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Inspection and Maintenance

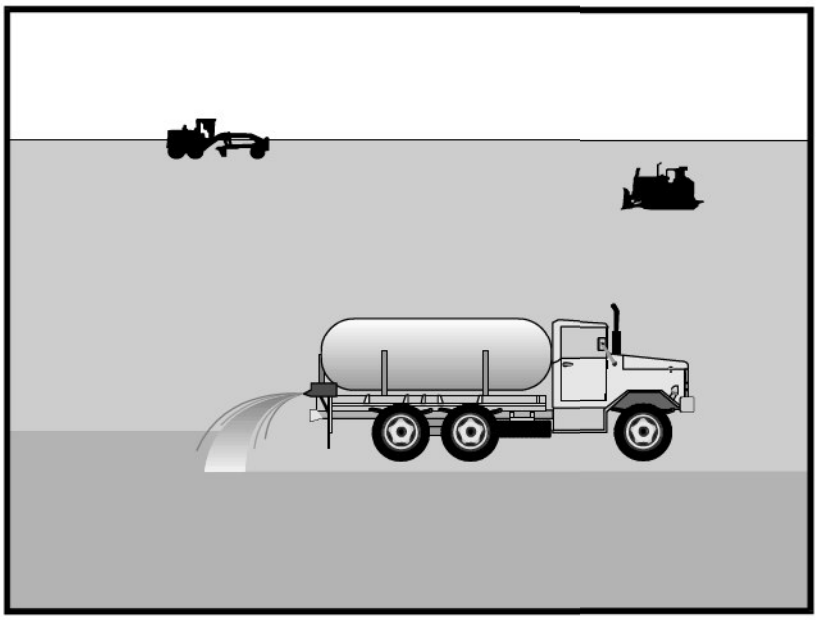
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Where seeds fail to germinate, or they germinate and die, the area must be re-seeded, fertilized, and mulched within the planting season, using not less than half the original application rates.
- Irrigation systems, if applicable, should be inspected daily while in use to identify system malfunctions and line breaks. When line breaks are detected, the system must be shut down immediately and breaks repaired before the system is put back into operation.
- Irrigation systems shall be inspected for complete coverage and adjusted as needed to maintain complete coverage.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Soil Binders EC-5



Objectives

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Legend:

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☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Soil binders consist of applying and maintaining a soil stabilizer to exposed soil surfaces. Soil binders are materials applied to the soil surface to temporarily prevent water induced erosion of exposed soils on construction sites. Soil binders also prevent wind erosion.

Suitable Applications

Soil binders are typically applied to disturbed areas requiring short term temporary protection. Because soil binders can often be incorporated into the work, they are a good alternative to mulches in areas where grading activities will soon resume. Soil binders are also suitable for use on stockpiles.

Limitations

- Soil binders are temporary in nature and may need reapplication.
- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer. Curing time may be 24 hours or longer. Soil binders may need reapplication after a storm event.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.

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- Soil binders do not hold up to pedestrian or vehicular traffic across treated areas.
- Soil binders may not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.
- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.
- Soil binders may not cure if low temperatures occur within 24 hours of application.
- The water quality impacts of soil binders are relatively unknown and some may have water quality impacts due to their chemical makeup.
- A sampling and analysis plan must be incorporated into the SWPPP as soil binders could be a source of non-visible pollutants.

Implementation

General Considerations

- Regional soil types will dictate appropriate soil binders to be used.
- A soil binder must be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and should not stain paved or painted surfaces. Soil binders should not pollute stormwater.
- Some soil binders may not be compatible with existing vegetation.
- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

Selecting a Soil Binder

Properties of common soil binders used for erosion control are provided on Table 1 at the end of this BMP. Use Table 1 to select an appropriate soil binder. Refer to WE-1, Wind Erosion Control, for dust control soil binders.

Factors to consider when selecting a soil binder include the following:

- Suitability to situation - Consider where the soil binder will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the soil binder will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed soil binders.
- Soil types and surface materials - Fines and moisture content are key properties of surface materials. Consider a soil binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials.
- Frequency of application - The frequency of application can be affected by subgrade conditions, surface type, climate, and maintenance schedule. Frequent applications could

lead to high costs. Application frequency may be minimized if the soil binder has good penetration, low evaporation, and good longevity. Consider also that frequent application will require frequent equipment clean up.

Plant-Material Based (Short Lived) Binders

Guar: Guar is a non-toxic, biodegradable, natural galactomannan based hydrocolloid treated with dispersant agents for easy field mixing. It should be mixed with water at the rate of 11 to 15 lb per 1,000 gallons. Recommended minimum application rates are as follows:

Application Rates for Guar Soil Stabilizer

Slope (H:V):	Flat	4:1	3:1	2:1	1:1
lb/acre:	40	45	50	60	70

Psyllium: Psyllium is composed of the finely ground muciloid coating of plantago seeds that is applied as a dry powder or in a wet slurry to the surface of the soil. It dries to form a firm but rewettable membrane that binds soil particles together but permits germination and growth of seed. Psyllium requires 12 to 18 hours drying time. Application rates should be from 80 to 200 lb/acre, with enough water in solution to allow for a uniform slurry flow.

Starch: Starch is non-ionic, cold water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 150 lb/acre. Approximate drying time is 9 to 12 hours.

Plant-Material Based (Long Lived) Binders

Pitch and Rosin Emulsion: Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin should be a minimum of 26% of the total solids content. The soil stabilizer should be non-corrosive, water dilutable emulsion that upon application cures to a water insoluble binding and cementing agent. For soil erosion control applications, the emulsion is diluted and should be applied as follows:

- For clayey soil: 5 parts water to 1 part emulsion
- For sandy soil: 10 parts water to 1 part emulsion

Application can be by water truck or hydraulic seeder with the emulsion and product mixture applied at the rate specified by the manufacturer.

Polymeric Emulsion Blend Binders

Acrylic Copolymers and Polymers: Polymeric soil stabilizers should consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound should be handled and mixed in a manner that will not cause foaming or should contain an anti-foaming agent. The polymeric emulsion should not exceed its shelf life or expiration date; manufacturers should provide the expiration date. Polymeric soil stabilizer should be readily miscible in water, non-injurious to seed or animal life, non-flammable, should provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and should not re-emulsify when cured. The applied compound should air cure within a maximum of 36 to 48 hours. Liquid copolymer should be diluted at a rate of 10 parts water to 1 part polymer and the mixture applied to soil at a rate of 1,175 gallons/acre.

Liquid Polymers of Methacrylates and Acrylates: This material consists of a tackifier/sealer that is a liquid polymer of methacrylates and acrylates. It is an aqueous 100% acrylic emulsion blend of 40% solids by volume that is free from styrene, acetate, vinyl, ethoxylated surfactants or silicates. For soil stabilization applications, it is diluted with water in accordance with manufacturer's recommendations, and applied with a hydraulic seeder at the rate of 20 gallons/acre. Drying time is 12 to 18 hours after application.

Copolymers of Sodium Acrylates and Acrylamides: These materials are non-toxic, dry powders that are copolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient:

Slope Gradient (H:V)	lb/acre
Flat to 5:1	3.0 – 5.0
5:1 to 3:1	5.0 – 10.0
2:2 to 1:1	10.0 – 20.0

Poly-Acrylamide and Copolymer of Acrylamide: Linear copolymer polyacrylamide is packaged as a dry flowable solid. When used as a stand alone stabilizer, it is diluted at a rate of 11lb/1,000 gal of water and applied at the rate of 5.0 lb/acre.

Hydro-Colloid Polymers: Hydro-Colloid Polymers are various combinations of dry flowable poly-acrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 55 to 60 lb/acre. Drying times are 0 to 4 hours.

Cementitious-Based Binders

Gypsum: This is a formulated gypsum based product that readily mixes with water and mulch to form a thin protective crust on the soil surface. It is composed of high purity gypsum that is ground, calcined and processed into calcium sulfate hemihydrate with a minimum purity of 86%. It is mixed in a hydraulic seeder and applied at rates 4,000 to 12,000 lb/acre. Drying time is 4 to 8 hours.

Applying Soil Binders

After selecting an appropriate soil binder, the untreated soil surface must be prepared before applying the soil binder. The untreated soil surface must contain sufficient moisture to assist the agent in achieving uniform distribution. In general, the following steps should be followed:

- Follow manufacturer's written recommendations for application rates, pre-wetting of application area, and cleaning of equipment after use.
- Prior to application, roughen embankment and fill areas.
- Consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders should not be applied during or immediately before rainfall.
- Avoid over spray onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.

- Soil binders should not be applied to frozen soil, areas with standing water, under freezing or rainy conditions, or when the temperature is below 40°F during the curing period.
- More than one treatment is often necessary, although the second treatment may be diluted or have a lower application rate.
- Generally, soil binders require a minimum curing time of 24 hours before they are fully effective. Refer to manufacturer's instructions for specific cure time.
- For liquid agents:
  - Crown or slope ground to avoid ponding.
  - Uniformly pre-wet ground at 0.03 to 0.3 gal/yd^2 or according to manufacturer's recommendations.
  - Apply solution under pressure. Overlap solution 6 to 12 in.
  - Allow treated area to cure for the time recommended by the manufacturer; typically at least 24 hours.
  - Apply second treatment before first treatment becomes ineffective, using 50% application rate.
  - In low humidities, reactivate chemicals by re-wetting with water at 0.1 to 0.2 gal/yd^2.

Costs

Costs vary according to the soil stabilizer selected for implementation. The following are approximate costs:

Soil Binder	Cost per Acre
Plant-Material Based (Short Lived) Binders	$400
Plant-Material Based (Long Lived) Binders	$1,200
Polymeric Emulsion Blend Binders	$400 (1)
Cementitious-Based Binders	$800

(1) $1,200 for Acrylic polymers and copolymers

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Reapply the selected soil binder as needed to maintain effectiveness.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

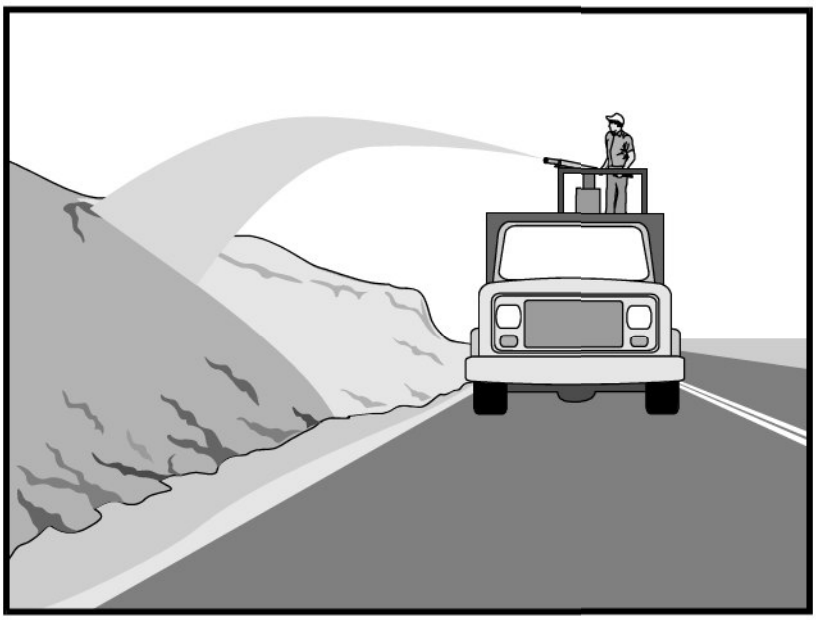
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Table 1 Properties of Soil Binders for Erosion Control

Evaluation Criteria	Binder Type			
	Plant Material Based (Short Lived)	Plant Material Based (Long Lived)	Polymeric Emulsion Blends	Cementitious-Based Binders
Relative Cost	Low	Low	Low	Low
Resistance to Leaching	High	High	Low to Moderate	Moderate
Resistance to Abrasion	Moderate	Low	Moderate to High	Moderate to High
Longevity	Short to Medium	Medium	Medium to Long	Medium
Minimum Curing Time before Rain	9 to 18 hours	19 to 24 hours	0 to 24 hours	4 to 8 hours
Compatibility with Existing Vegetation	Good	Poor	Poor	Poor
Mode of Degradation	Biodegradable	Biodegradable	Photodegradable/ Chemically Degradable	Photodegradable/ Chemically Degradable
Labor Intensive	No	No	No	No
Specialized Application Equipment	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher
Liquid/Powder	Powder	Liquid	Liquid/Powder	Powder
Surface Crusting	Yes, but dissolves on rewetting	Yes	Yes, but dissolves on rewetting	Yes
Clean Up	Water	Water	Water	Water
Erosion Control Application Rate	Varies (1)	Varies (1)	Varies (1)	4,000 to 12,000 lbs/acre

(1) See Implementation for specific rates.

Straw Mulch EC-6



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Legend:

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Targeted Constituents

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Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller or anchoring it with a tackifier stabilizing emulsion. Straw mulch protects the soil surface from the impact of rain drops, preventing soil particles from becoming dislodged.

Suitable Applications

Straw mulch is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established. Straw mulch is typically used for erosion control on disturbed areas until soils can be prepared for permanent vegetation. Straw mulch is also used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

Limitations

- Availability of straw and straw blowing equipment may be limited just prior to the rainy season and prior to storms due to high demand.
- There is a potential for introduction of weed seed and unwanted plant material.
- When straw blowers are used to apply straw mulch, the treatment areas must be within 150 ft of a road or surface capable of supporting trucks.
- Straw mulch applied by hand is more time intensive and potentially costly.

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- Wind may limit application of straw and blow straw into undesired locations.
- May have to be removed prior to permanent seeding or prior to further earthwork.
- "Punching" of straw does not work in sandy soils, necessitating the use of tackifiers.

Implementation

- Straw shall be derived from wheat, rice, or barley. Where required by the plans, specifications, permits, or environmental documents, native grass straw shall be used.
- A tackifier is the preferred method for anchoring straw mulch to the soil on slopes.
- Crimping, punch roller-type rollers, or track walking may also be used to incorporate straw mulch into the soil on slopes. Track walking shall only be used where other methods are impractical.
- Avoid placing straw onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.
- Straw mulch with tackifier shall not be applied during or immediately before rainfall.
- In San Diego, use of straw near wood framed home construction has been frowned on by the Fire Marshall.

Application Procedures

- Apply straw at a minimum rate of 4,000 lb/acre, either by machine or by hand distribution.
- Roughen embankments and fill rills before placing the straw mulch by rolling with a crimping or punching type roller or by track walking.
- Evenly distribute straw mulch on the soil surface.
- Anchor straw mulch to the soil surface by "punching" it into the soil mechanically (incorporating). Alternatively, use a tackifier to adhere straw fibers.
- Methods for holding the straw mulch in place depend upon the slope steepness, accessibility, soil conditions, and longevity.
    - On small areas, a spade or shovel can be used to punch in straw mulch.
    - On slopes with soils that are stable enough and of sufficient gradient to safely support construction equipment without contributing to compaction and instability problems, straw can be "punched" into the ground using a knife blade roller or a straight bladed coulter, known commercially as a "crimper".
    - On small areas and/or steep slopes, straw can also be held in place using plastic netting or jute. The netting shall be held in place using 11 gauge wire staples, geotextile pins or wooden stakes as described in EC-7, Geotextiles and Mats.
    - A tackifier acts to glue the straw fibers together and to the soil surface. The tackifier shall be selected based on longevity and ability to hold the fibers in place. A tackifier is

typically applied at a rate of 125 lb/acre. In windy conditions, the rates are typically 180 lb/acre.

Costs

Average annual cost for installation and maintenance (3-4 months useful life) is $2,500 per acre. Application by hand is more time intensive and potentially costly.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- The key consideration in inspection and maintenance is that the straw needs to last long enough to achieve erosion control objectives.
- Maintain an unbroken, temporary mulched ground cover while disturbed soil areas are inactive. Repair any damaged ground cover and re-mulch exposed areas.
- Reapplication of straw mulch and tackifier may be required to maintain effective soil stabilization over disturbed areas and slopes.

References

Controlling Erosion of Construction Sites, Agricultural Information Bulletin #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

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Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

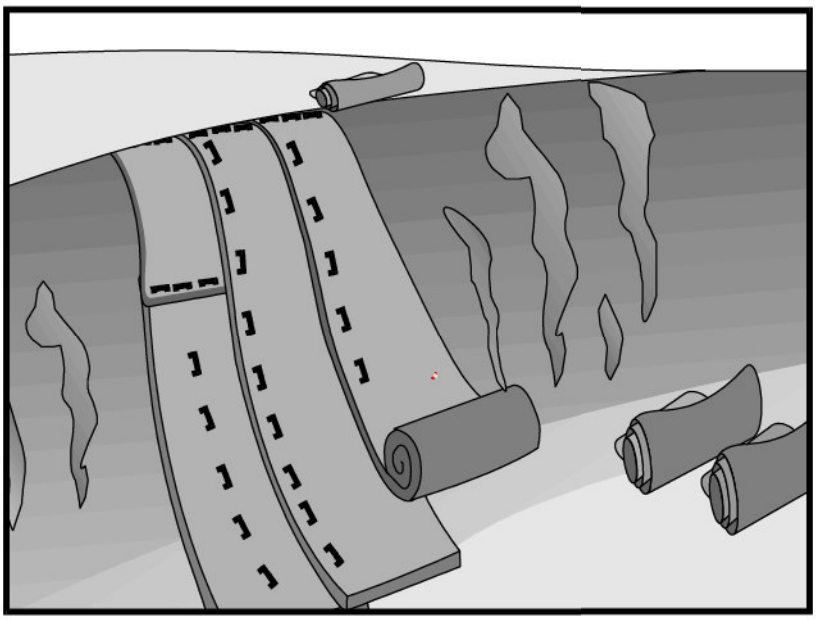
Soil Erosion by Water, Agricultural Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Geotextiles and Mats EC-7



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	3
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-6 Straw Mulch

EC-8 Wood Mulching

Description and Purpose

Mattings of natural materials are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matting may be used to stabilize soils until vegetation is established.

Suitable Applications

Mattings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks where moving water at velocities between 3 ft/s and 6 ft/s are likely to wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. Matting may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). Erosion control matting should be considered when the soils are fine grained and potentially erosive. These measures should be considered in the following situations.

- Steep slopes, generally steeper than 3:1 (H:V)
- Slopes where the erosion potential is high
- Slopes and disturbed soils where mulch must be anchored
- Disturbed areas where plants are slow to develop
- Channels with flows exceeding 3.3 ft/s

- Channels to be vegetated
- Stockpiles
- Slopes adjacent to water bodies of Environmentally Sensitive Areas (ESAs)

Limitations

- Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.
- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes).
- Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs.
- Geotextiles and Mats may delay seed germination, due to reduction in soil temperature.
- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Blankets and mats must be removed and disposed of prior to application of permanent soil stabilization measures.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- The use of plastic should be limited to covering stockpiles or very small graded areas for short periods of time (such as through one imminent storm event) until alternative measures, such as seeding and mulching, may be installed.
- Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.
- Not suitable for areas that have heavy foot traffic (tripping hazard) – e.g., pad areas around buildings under construction.

Implementation

Material Selection

Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness, moisture, weed growth, and availability of materials.

The following natural and synthetic mattings are commonly used:

Geotextiles

- Material should be a woven polypropylene fabric with minimum thickness of 0.06 in., minimum width of 12 ft and should have minimum tensile strength of 150 lbs (warp), 80 lbs (fill) in conformance with the requirements in ASTM Designation: D 4632. The permittivity of the fabric should be approximately 0.07 sec^{-1} in conformance with the requirements in ASTM Designation: D4491. The fabric should have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets must be secured in place with wire staples or sandbags and by keying into tops of slopes to prevent infiltration of surface waters under geotextile. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Geotextiles may be reused if they are suitable for the use intended.

Plastic Covers

- Plastic sheeting should have a minimum thickness of 6 mils, and must be keyed in at the top of slope and firmly held in place with sandbags or other weights placed no more than 10 ft apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in. to 24 in. overlap of all seams. Edges should be embedded a minimum of 6 in. in soil.

- All sheeting must be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures must be repaired immediately. If washout or breakages occur, the material should be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats

- Biodegradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable.

  - **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Excelsior** (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber must be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life. Excelsior blankets should be furnished in rolled strips, a minimum of 48 in. wide, and should have an average weight of 0.8 lb/yd^2, ±10 percent, at the time of manufacture. Excelsior blankets must be secured in place with wire staples. Staples

should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Straw blanket** should be machine produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket. Straw blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Coconut fiber blanket** should be a machine produced mat of 100 percent coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. Coconut fiber blanket should be furnished in rolled strips with a minimum of 6.5 ft wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd^2. Coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Straw coconut fiber blanket** should be machine produced mats of 70 percent straw and 30 percent coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

- **Plastic netting** is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Plastic mesh** is an open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than ¼ in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Bonded synthetic fibers** consist of a three dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil.

- Grade and shape the area of installation.

- Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.

- Prepare seedbed by loosening 2 to 3 in. of topsoil.

Seeding

Seed the area before blanket installation for erosion control and revegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket

installation, all check slots and other areas disturbed during installation must be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Check Slots

Check slots are made of glass fiber strips, excelsior matting strips or tight folded jute matting blanket or strips for use on steep, highly erodible watercourses. The check slots are placed in narrow trenches 6 to 12 in. deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Laying and Securing Matting

- Before laying the matting, all check slots should be installed and the friable seedbed made free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the manufacturer's recommendations.

- Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Anchoring

- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.

- Wire staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length.

- Wire staples and metal stakes should be driven flush to the soil surface.

Installation on Slopes

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly.

- Unroll blanket down slope in the direction of water flow.

- Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft.

- When blankets must be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart.
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
- Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of 1 ½ staples/yd^2.

Installation in Channels

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft intervals along the channels.
- Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in.
- Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap.
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots.
- Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals.
- Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil.
- Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench.

- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement)

- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling just exposing top netting of mat.

Temporary Soil Stabilization Removal

- Temporary soil stabilization removed from the site of the work must be disposed of if necessary.

Costs

Relatively high compared to other BMPs. Biodegradable materials: $0.50 - $0.57/yd^2. Permanent materials: $3.00 - $4.50/yd^2. Staples: $0.04 - $0.05/staple. Approximate costs for installed materials are shown below:

Rolled Erosion Control Products		Installed Cost per Acre
Biodegradable	Jute Mesh	$6,500
	Curled Wood Fiber	$10,500
	Straw	$8,900
	Wood Fiber	$8,900
	Coconut Fiber	$13,000
	Coconut Fiber Mesh	$31,200
	Straw Coconut Fiber	$10,900
Non-Biodegradable	Plastic Netting	$2,000
	Plastic Mesh	$3,200
	Synthetic Fiber with Netting	$34,800
	Bonded Synthetic Fibers	$50,000
	Combination with Biodegradable	$32,000

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Areas where erosion is evident shall be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.
- Make sure matting is uniformly in contact with the soil.
- Check that all the lap joints are secure.
- Check that staples are flush with the ground.
- Check that disturbed areas are seeded.

References

Guides for Erosion and Sediment Controls in California, USDA Soils Conservation Service, January 1991.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

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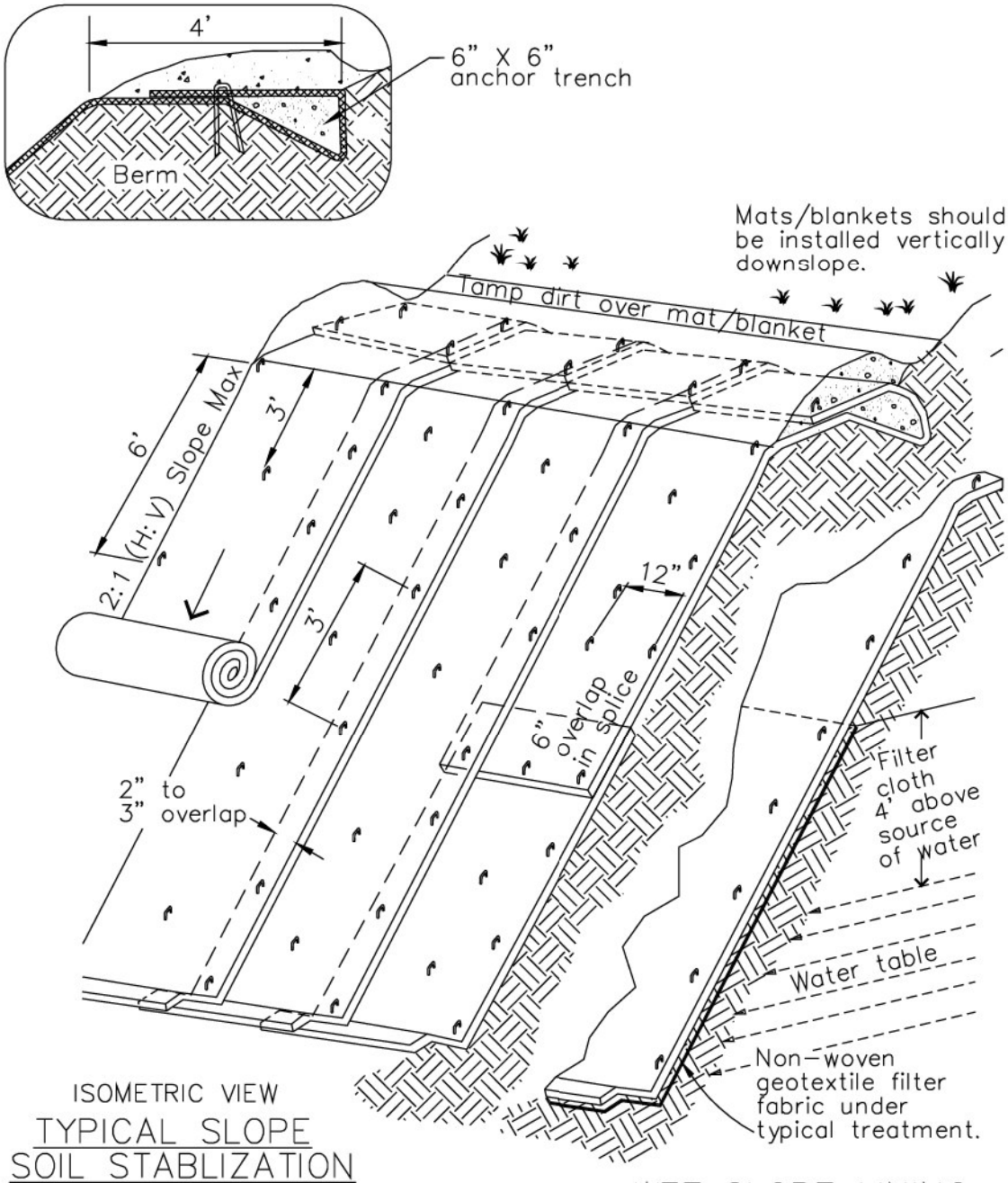


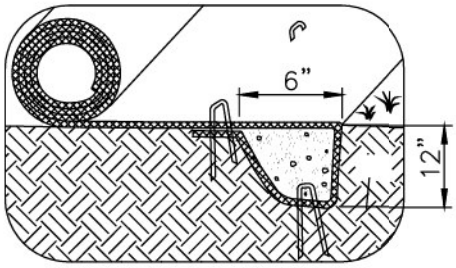
ISOMETRIC VIEW
TYPICAL SLOPE SOIL STABLIZATION
NTS

WET SLOPE LINING
NTS

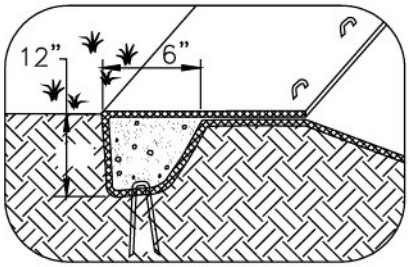
NOTES:

1. Slope surface shall be free of rocks, clods, sticks and grass. Mats/blankets shall have good soil contact.
2. Lay blankets loosely and stake or staple to maintain direct contact with the soil. Do not stretch.
3. Install per manufacturer's recommendations

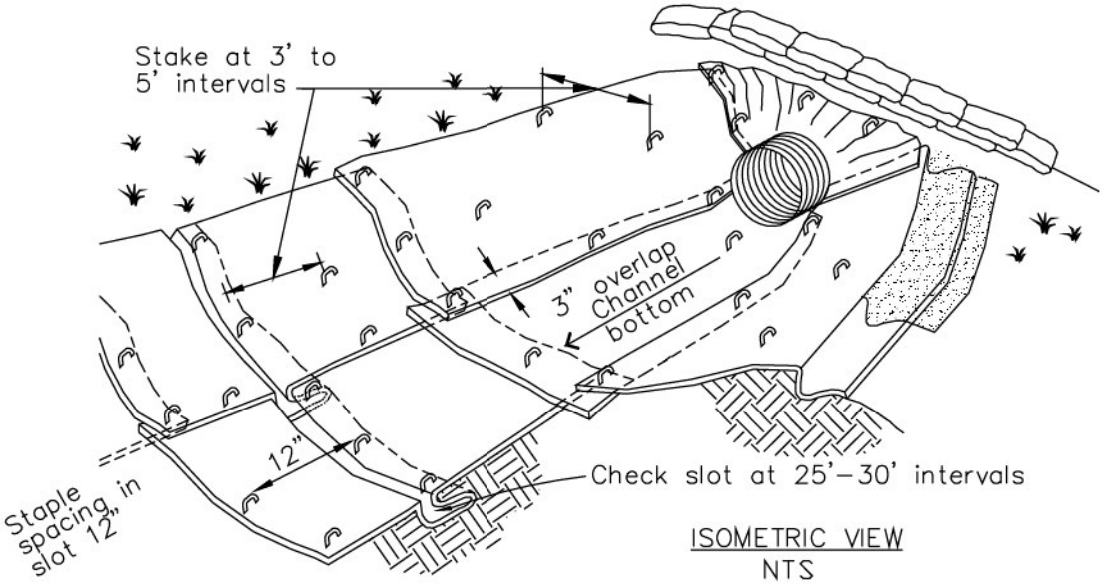
TYPICAL INSTALLATION DETAIL



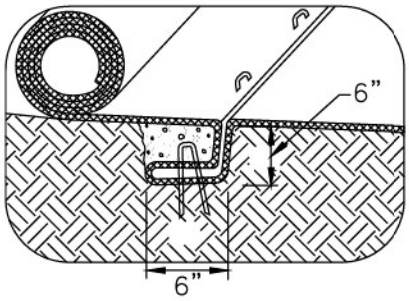
INITIAL CHANNEL ANCHOR TRENCH
NTS



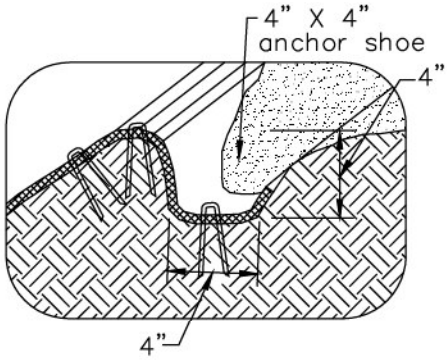
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
NTS



ISOMETRIC VIEW
NTS



INTERMITTENT CHECK SLOT
NTS



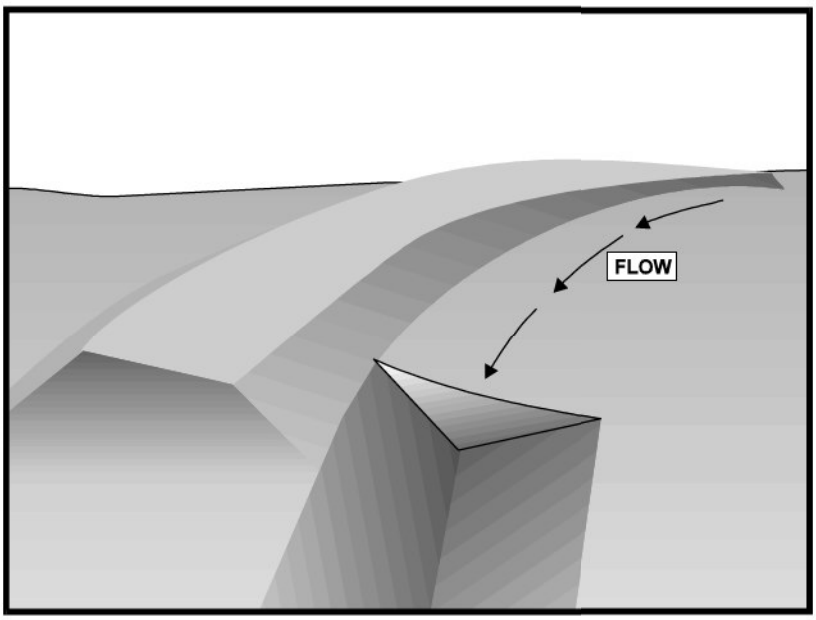
LONGITUDINAL ANCHOR TRENCH
NTS

NOTES:

1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.
3. Install per manufacturer's recommendations

TYPICAL INSTALLATION DETAIL

Earth Dikes and Drainage Swales EC-9



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

An earth dike is a temporary berm or ridge of compacted soil used to divert runoff or channel water to a desired location. A drainage swale is a shaped and sloped depression in the soil surface used to convey runoff to a desired location. Earth dikes and drainage swales are used to divert off site runoff around the construction site, divert runoff from stabilized areas and disturbed areas, and direct runoff into sediment basins or traps.

Suitable Applications

Earth dikes and drainage swales are suitable for use, individually or together, where runoff needs to be diverted from one area and conveyed to another.

- Earth dikes and drainage swales may be used:
  - To convey surface runoff down sloping land
  - To intercept and divert runoff to avoid sheet flow over sloped surfaces
  - To divert and direct runoff towards a stabilized watercourse, drainage pipe or channel
  - To intercept runoff from paved surfaces
  - Below steep grades where runoff begins to concentrate
  - Along roadways and facility improvements subject to flood drainage

- At the top of slopes to divert runon from adjacent or undisturbed slopes
- At bottom and mid slope locations to intercept sheet flow and convey concentrated flows
- Divert sediment laden runoff into sediment basins or traps

Limitations

Dikes should not be used for drainage areas greater than 10 acres or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately, which adds cost and maintenance concerns.
- Diverted stormwater may cause downstream flood damage.
- Dikes should not be constructed of soils that may be easily eroded.
- Regrading the site to remove the dike may add additional cost.
- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales must conform to local floodplain management requirements.
- Earth dikes/drainage swales are not suitable as sediment trapping devices.
- It may be necessary to use other soil stabilization and sediment controls such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales, and ditches.

Implementation

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert stormwater to a sediment trapping device or a stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off site and from undisturbed areas away from disturbed areas and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff. A dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike at the top of a slope can divert runoff to a location where it can be brought to the bottom of the slope (see EC-11, Slope Drains). A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and

compacted by a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded and remain in place until post construction BMPs are installed and the slopes are stabilized.

Diversion practices concentrate surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale must be directed onto a stabilized area or into a grade stabilization structure. If significant erosion will occur, a swale should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization. Any drain or swale that conveys sediment laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

General

- Care must be applied to correctly size and locate earth dikes, drainage swales. Excessively steep, unlined dikes, and swales are subject to erosion and gully formation.
- Conveyances should be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, overtopping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff onto other property without securing written authorization from the property owner.
- When possible, install and utilize permanent dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Earth Dikes

Temporary earth dikes are a practical, inexpensive BMP used to divert stormwater runoff. Temporary diversion dikes should be installed in the following manner:

- All dikes should be compacted by earth moving equipment.
- All dikes should have positive drainage to an outlet.
- All dikes should have 2:1 or flatter side slopes, 18 in. minimum height, and a minimum top width of 24 in. Wide top widths and flat slopes are usually needed at crossings for construction traffic.
- The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a Sediment Trap (SE-3) or Sediment Basin (SE-2) when either the dike channel or the drainage area above the dike are not adequately stabilized.

- Temporary stabilization may be achieved using seed and mulching for slopes less than 5% and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain.
- If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

Channel Grade	Riprap Stabilization
0.5-1.0%	4 in. Rock
1.1-2.0%	6 in. Rock
2.1-4.0%	8 in. Rock
4.1-5.0%	8 in. -12 in. Riprap

- The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment.
- Filter cloth may be used to cover dikes in use for long periods.
- Construction activity on the earth dike should be kept to a minimum.

Drainage Swales

Drainage swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost effective diversion.

Standard engineering design criteria for small open channel and closed conveyance systems should be used (see the local drainage design manual). Unless local drainage design criteria state otherwise, drainage swales should be designed as follows:

- No more than 5 acres may drain to a temporary drainage swale.
- Place drainage swales above or below, not on, a cut or fill slope.
- Swale bottom width should be at least 2 ft
- Depth of the swale should be at least 18 in.
- Side slopes should be 2:1 or flatter.
- Drainage or swales should be laid at a grade of at least 1 percent, but not more than 15 percent.
- The swale must not be overtopped by the peak discharge from a 10-year storm, irrespective of the design criteria stated above.
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built.
- Compact any fill material along the path of the swale.

- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent. For temporary swales, geotextiles and mats (EC-7) may provide immediate stabilization.
- Irrigation may be required to establish sufficient vegetation to prevent erosion.
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- Permanent drainage facilities must be designed by a professional engineer (see the local drainage design criteria for proper design).
- At a minimum, the drainage swale should conform to predevelopment drainage patterns and capacities.
- Construct the drainage swale with a positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the drainage swale can reach an erosive velocity.

Costs

- Cost ranges from $15 to $55 per ft for both earthwork and stabilization and depends on availability of material, site location, and access.
- Small dikes: $2.50 - $6.50/linear ft; Large dikes: $2.50/yd^3.
- The cost of a drainage swale increases with drainage area and slope. Typical swales for controlling internal erosion are inexpensive, as they are quickly formed during routine earthwork.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction

References

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursetynsky, P.E., McGraw Hill Book Company, 1986.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

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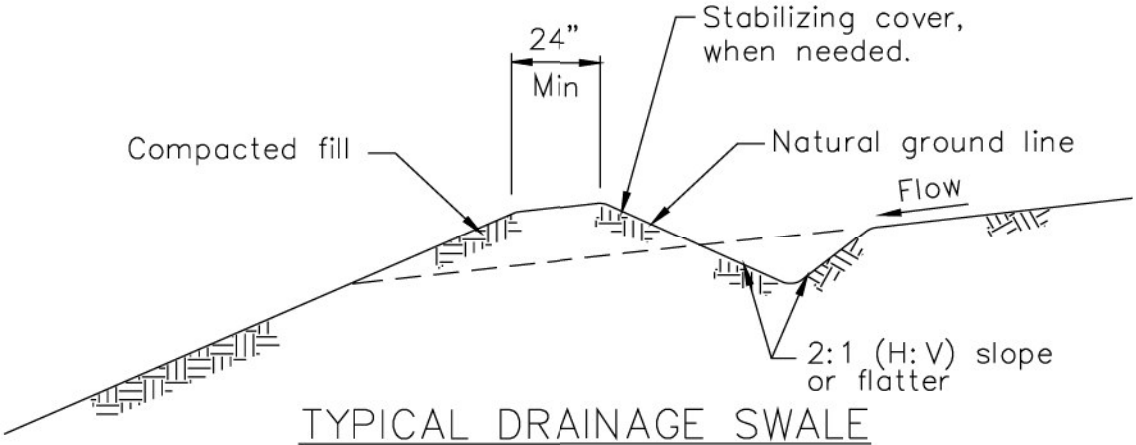
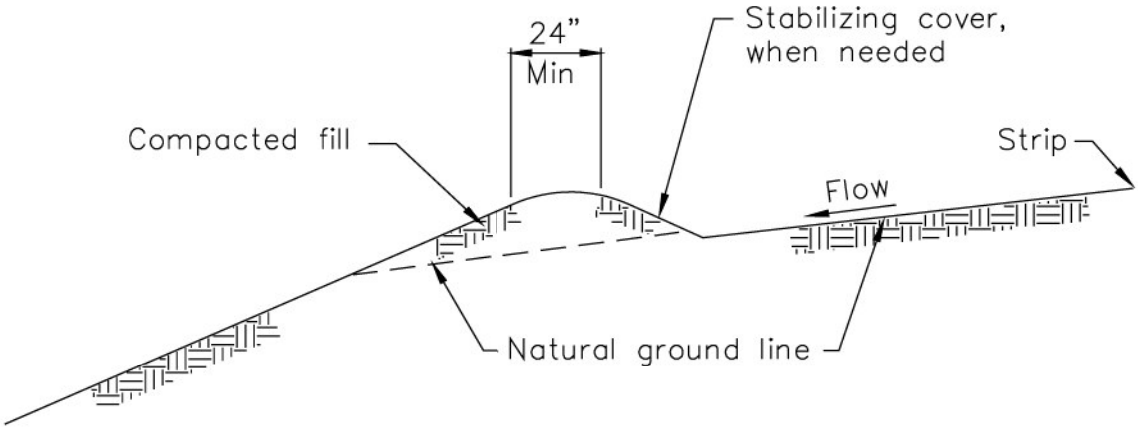


TYPICAL DRAINAGE SWALE
NOT TO SCALE

NOTES:

1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade.



TYPICAL EARTH DIKE
NOT TO SCALE

Dewatering Operations NS-2

Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Description and Purpose

Dewatering operations are practices that manage the discharge of pollutants when non-stormwater and accumulated precipitation must be removed from a work location so that construction work may be accomplished.

Suitable Applications

These practices are implemented for discharges of non-stormwater from construction sites. Non-stormwaters include, but are not limited to, groundwater, water from cofferdams, water diversions, and waters used during construction activities that must be removed from a work area.

Practices identified in this section are also appropriate for implementation when managing the removal of accumulated precipitation (stormwater) from depressed areas at a construction site.

Limitations

- Site conditions will dictate design and use of dewatering operations.
- The controls discussed in this best management practice (BMP) address sediment only.
- The controls detailed in this BMP only allow for minimal settling time for sediment particles. Use only when site conditions restrict the use of the other control methods.
- Dewatering operations will require, and must comply with, applicable local permits.

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

SE-5: Fiber Roll

SE-6: Gravel Bag Berm

SE-9: Straw Bale Barrier

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- Avoid dewatering discharges where possible by using the water for dust control, by infiltration, etc.

Implementation

- Dewatering non-stormwater cannot be discharged without prior notice to and approval from the Regional Water Quality Control Board (RWQCB) and local stormwater management agency. This includes stormwater that is co-mingled with groundwater or other non-stormwater sources. Once the discharge is allowed, appropriate BMPs must be implemented to ensure the discharge complies with all permit requirements and regional and watershed-specific requirements.

- RWQCB may require a separate NPDES permit prior to the dewatering discharge of non-stormwater. These permits will have specific testing, monitoring, and discharge requirements and can take significant time to obtain.

- The flow chart shown in Figure 1 should be utilized to guide dewatering operations.

- The owner will coordinate monitoring and permit compliance.

- Additional permits or permissions from other agencies may be required for dewatering cofferdams or diversions.

- Dewatering discharges must not cause erosion at the discharge point.

A variety of methods can be used to treat water during dewatering operations. Several devices are presented below and provide options to achieve sediment removal. The size of particles present in the sediment and Permit or receiving water limitations on sediment are key considerations for selecting sediment treatment option(s); in some cases, the use of multiple devices may be appropriate.

Sediment Basin (see also SE-2)

Description:

- A sediment basin is a temporary basin with a controlled release structure that is formed by excavation or construction of an embankment to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment basins are generally larger than Sediment Traps (SE-3).

Appropriate Applications:

- Effective for the removal of gravel, sand, silt, some metals that settle out with the sediment, and trash.

Implementation:

- Excavation and construction of related facilities is required.

- Temporary sediment basins must be fenced if safety is a concern.

- Outlet protection is required to prevent erosion at the outfall location.

Maintenance:

- Maintenance is required for safety fencing, vegetation, embankment, inlet and outfall structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-half.

Sediment Trap (See also SE-3)

Description:

- A sediment trap is a temporary basin formed by excavation and/or construction of an earthen embankment across a waterway or low drainage area to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment traps are generally smaller than Sediment Basins (SE-2).

Appropriate Applications:

Effective for the removal of large and medium sized particles (sand and gravel) and some metals that settle out with the sediment.

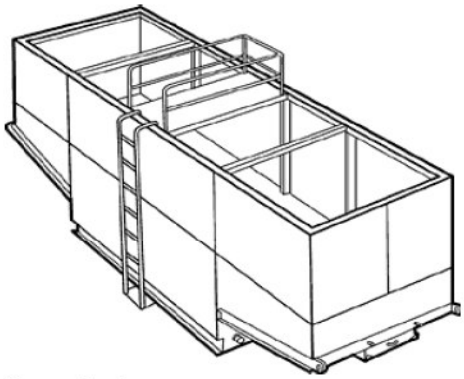
Implementation:

- Excavation and construction of related facilities is required.
- Trap inlets should be located to maximize the travel distance to the trap outlet.
- Use rock or vegetation to protect the trap outlets against erosion.

Maintenance:

- Maintenance is required for vegetation, embankment, inlet and outfall structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-third.

Weir Tanks



Description:

- A weir tank separates water and waste by using weirs. The configuration of the weirs (over and under weirs) maximizes the residence time in the tank and determines the waste to be removed from the water, such as oil, grease, and sediments.

Appropriate Applications:

- The tank removes trash, some settleable solids (gravel, sand, and silt), some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Oil and grease disposal must be by licensed waste disposal company.

Dewatering Tanks

Description:

- A dewatering tank removes debris and sediment. Flow enters the tank through the top, passes through a fabric filter, and is discharged through the bottom of the tank. The filter separates the solids from the liquids.

Appropriate Applications:

- The tank removes trash, gravel, sand, and silt, some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

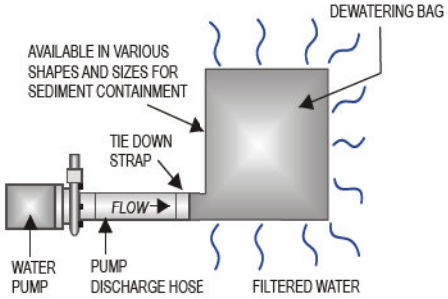
Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Oil and grease disposal must be by licensed waste disposal company.

Gravity Bag Filter



Description:

- A gravity bag filter, also referred to as a dewatering bag, is a square or rectangular bag made of non-woven geotextile fabric that collects sand, silt, and fines.

Appropriate Applications:

- Effective for the removal of sediments (gravel, sand, and silt). Some metals are removed with the sediment.

Implementation:

- Water is pumped into one side of the bag and seeps through the bottom and sides of the bag.
- A secondary barrier, such as a rock filter bed or straw/hay bale barrier, is placed beneath and beyond the edges of the bag to capture sediments that escape the bag.

Maintenance:

- Inspection of the flow conditions, bag condition, bag capacity, and the secondary barrier is required.
- Replace the bag when it no longer filters sediment or passes water at a reasonable rate.
- The bag is disposed of offsite.

Sand Media Particulate Filter

Description:

- Water is treated by passing it through canisters filled with sand media. Generally, sand filters provide a final level of treatment. They are often used as a secondary or higher level of treatment after a significant amount of sediment and other pollutants have been removed using other methods.

Appropriate Applications:

- Effective for the removal of trash, gravel, sand, and silt and some metals, as well as the reduction of biochemical oxygen demand (BOD) and turbidity.
- Sand filters can be used for stand-alone treatment or in conjunction with bag and cartridge filtration if further treatment is required.
- Sand filters can also be used to provide additional treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.

Maintenance:

- The filters require regular service to monitor and maintain the level of the sand media. If subjected to high loading rates, filters can plug quickly.
- Venders generally provide data on maximum head loss through the filter. The filter should be monitored daily while in use, and cleaned when head loss reaches target levels.
- If cleaned by backwashing, the backwash water may need to be hauled away for disposal, or returned to the upper end of the treatment train for another pass through the series of dewatering BMPs.

Pressurized Bag Filter

Description:

- A pressurized bag filter is a unit composed of single filter bags made from polyester felt material. The water filters through the unit and is discharged through a header. Vendors provide bag filters in a variety of configurations. Some units include a combination of bag filters and cartridge filters for enhanced contaminant removal.

Appropriate Applications:

- Effective for the removal of sediment (sand and silt) and some metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Oil absorbent bags are available for hydrocarbon removal.

- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.

Maintenance:

- The filter bags require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Cartridge Filter

Description:

- Cartridge filters provide a high degree of pollutant removal by utilizing a number of individual cartridges as part of a larger filtering unit. They are often used as a secondary or higher (polishing) level of treatment after a significant amount of sediment and other pollutants are removed. Units come with various cartridge configurations (for use in series with bag filters) or with a larger single cartridge filtration unit (with multiple filters within).

Appropriate Applications:

- Effective for the removal of sediment (sand, silt, and some clays) and metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Hydrocarbons can effectively be removed with special resin cartridges.

- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance.

Maintenance:

- The cartridges require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Costs

- Sediment controls are low to high cost measures depending on the dewatering system that is selected. Pressurized filters tend to be more expensive than gravity settling, but are often more effective. Simple tanks are generally rented on a long-term basis (one or more months) and can range from $360 per month for a 1,000 gallon tank to $2,660 per month for a 10,000 gallon tank. Mobilization and demobilization costs vary considerably.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Unit-specific maintenance requirements are included with the description of each unit.
- Sediment removed during the maintenance of a dewatering device may be either spread onsite and stabilized, or disposed of at a disposal site as approved by the owner.
- Sediment that is commingled with other pollutants must be disposed of in accordance with all applicable laws and regulations and as approved by the owner.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

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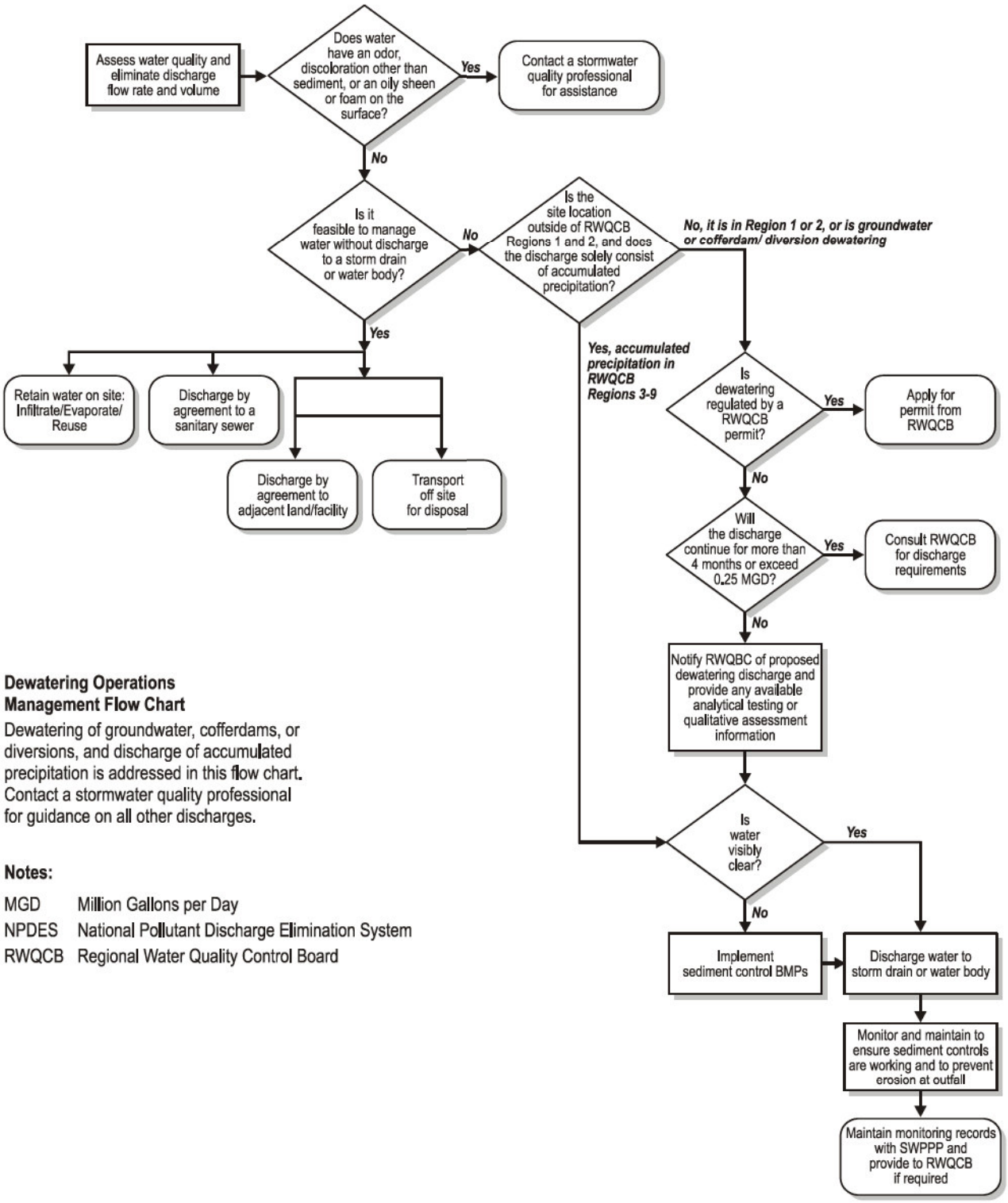


Dewatering Operations Management Flow Chart

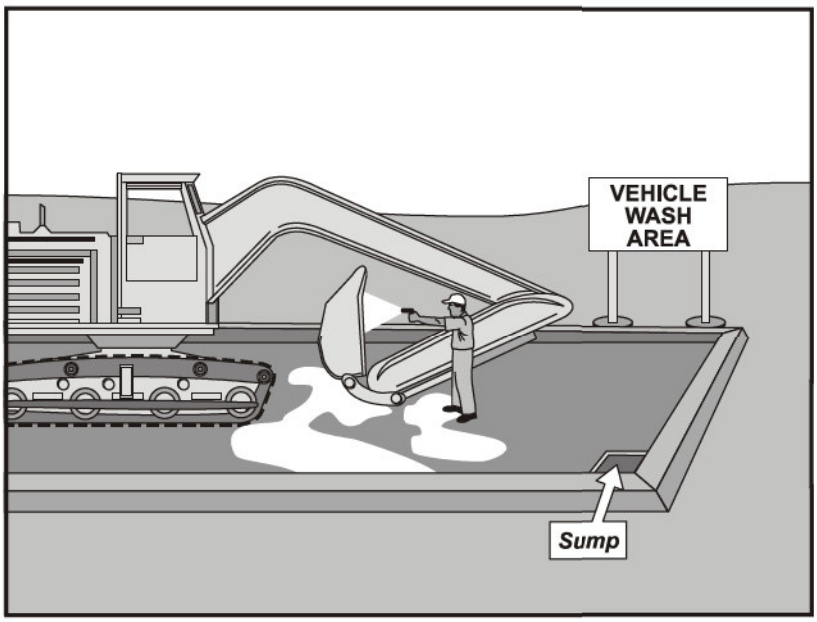
Dewatering of groundwater, cofferdams, or diversions, and discharge of accumulated precipitation is addressed in this flow chart. Contact a stormwater quality professional for guidance on all other discharges.

Notes:

MGD Million Gallons per Day
NPDES National Pollutant Discharge Elimination System
RWQCB Regional Water Quality Control Board

Figure 1
Operations Flow Chart

Vehicle and Equipment Cleaning NS-8



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

If washing operations are to take place onsite, then:

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- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates.
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried, and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited.
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff
  - Configured with a sump to allow collection and disposal of wash water
  - No discharge of wash waters to storm drains or watercourses
  - Used only when necessary
- When cleaning vehicles and equipment with water:
  - Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered
  - Use positive shutoff valve to minimize water usage
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater

Costs

Cleaning vehicles and equipment at an offsite facility may reduce overall costs for vehicle and equipment cleaning by eliminating the need to provide similar services onsite. When onsite cleaning is needed, the cost to establish appropriate facilities is relatively low on larger, long-duration projects, and moderate to high on small, short-duration projects.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspection and maintenance is minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

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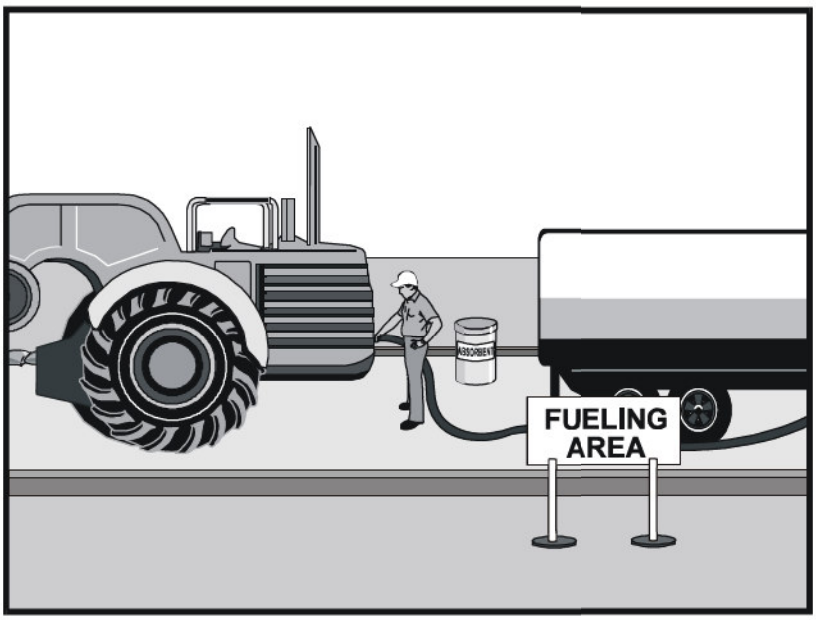
Vehicle and Equipment Fueling NS-9



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage "topping-off" of fuel tanks.

- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should be disposed of properly after use.
- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.
- Dedicated fueling areas should be protected from stormwater runon and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- All of the above measures are low cost except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.

Inspection and Maintenance

- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.
- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

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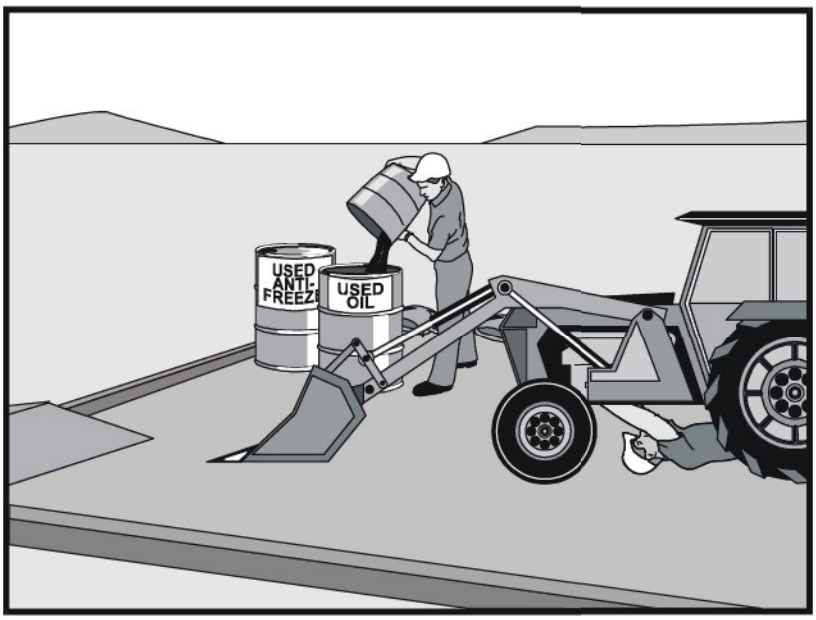
Vehicle & Equipment Maintenance NS-10



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8, Vehicle and Equipment Cleaning, and NS-9, Vehicle and Equipment Fueling.

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NS-10 Vehicle & Equipment Maintenance

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.
- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.
- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

NS-10 Vehicle & Equipment Maintenance

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Keep ample supplies of spill cleanup materials onsite.
- Maintain waste fluid containers in leak proof condition.
- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

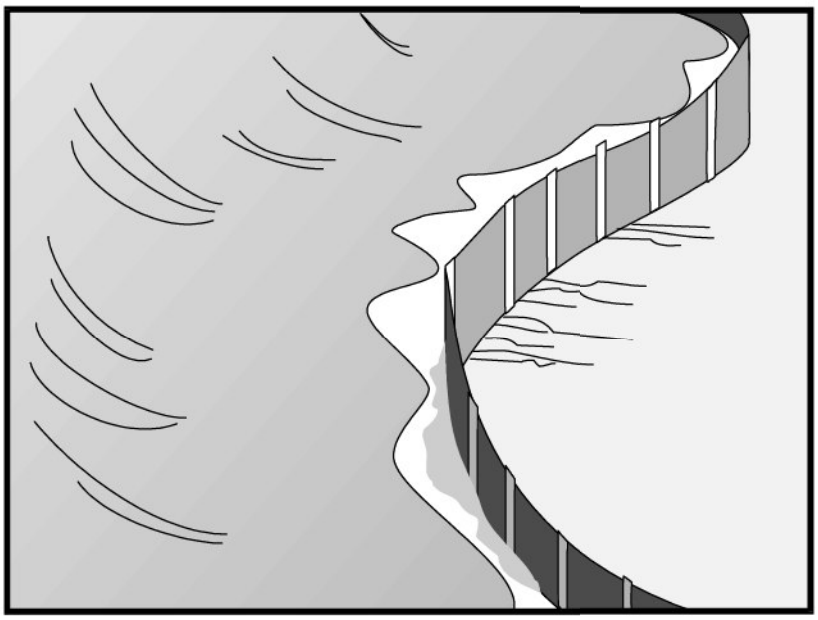
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Silt Fence SE-1



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

A silt fence is made of a filter fabric that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They should also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.

- Do not use in locations where ponded water may cause flooding.
- Do not place fence on a slope, or across any contour line. If not installed at the same elevation throughout, silt fences will create erosion.
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.
  - Not effective unless trenched and keyed in.
  - Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
  - Do not allow water depth to exceed 1.5 ft at any point.

Implementation

General

A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

Silt fences are preferable to straw bale barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw bale barriers, there are many instances where silt fences have been improperly installed. The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs.
- Don't use in streams, channels, or anywhere flow is concentrated. Don’t use silt fences to divert flow.
- Don't use below slopes subject to creep, slumping, or landslides.
- Select filter fabric that retains 85% of soil by weight, based on sieve analysis, but that is not finer than an equivalent opening size of 70.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.

- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.
- Silt fences should remain in place until the disturbed area is permanently stabilized.

Design and Layout

Selection of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer should specify a filter fabric that retains the soil found on the construction site yet that it has openings large enough to permit drainage and prevent clogging. The following criteria is recommended for selection of the equivalent opening size:

1. If 50 percent or less of the soil, by weight, will pass the U.S. Standard Sieve No. 200, select the EOS to retain 85 % of the soil. The EOS should not be finer than EOS 70.
2. For all other soil types, the EOS should be no larger than the openings in the U.S. Standard Sieve No. 70 except where direct discharge to a stream, lake, or wetland will occur, then the EOS should be no larger than Standard Sieve No. 100.

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100. If 85% or more of a soil, by weight, passes through the openings in a No. 200 sieve, filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large and they would clog the fabric quickly if the EOS were small enough to capture the soil.

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 °F to 120 °F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Materials

- Silt fence fabric should be woven polypropylene with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D4491.

- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

- There are new products that may use prefabricated plastic holders for the silt fence and use bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement.

Installation Guidelines

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line the proposed silt fence.

- Bottom of the silt fence should be keyed-in a minimum of 12 in.

- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.

- When standard strength filter fabric is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the mesh support fence may be eliminated. Filter fabric should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.

- The trench should be backfilled with compacted native material.

- Construct silt fences with a setback of at least 3 ft from the toe of a slope. Where a silt fence is determined to be not practicable due to specific site conditions, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and difficult to maintain.

- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.

Costs

- Average annual cost for installation and maintenance (assumes 6 month useful life): $7 per lineal foot ($850 per drainage acre). Range of cost is $3.50 - $9.10 per lineal foot.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed of, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence must be inspected and maintained.
- Holes, depressions, or other ground disturbance caused by the removal of the silt fences should be backfilled and repaired.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Sedimentation and Erosion Control Practices, and Inventory of Current Practices (Draft), UESPA, 1990.

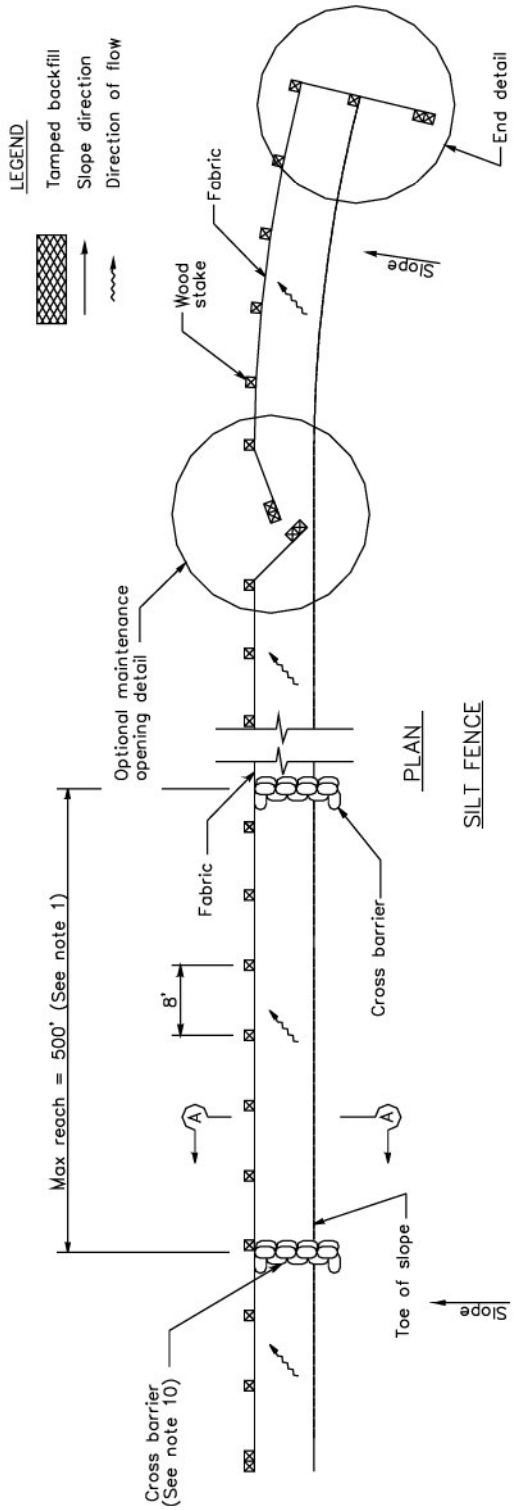
Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

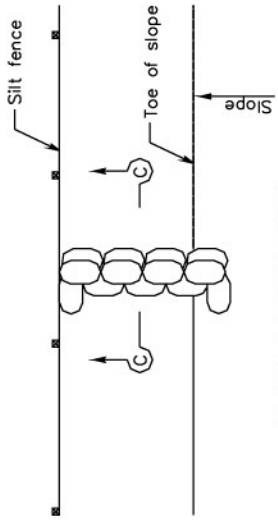
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

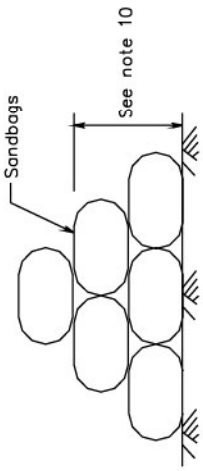
Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

U.S. Environmental Protection Agency (USEPA). Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

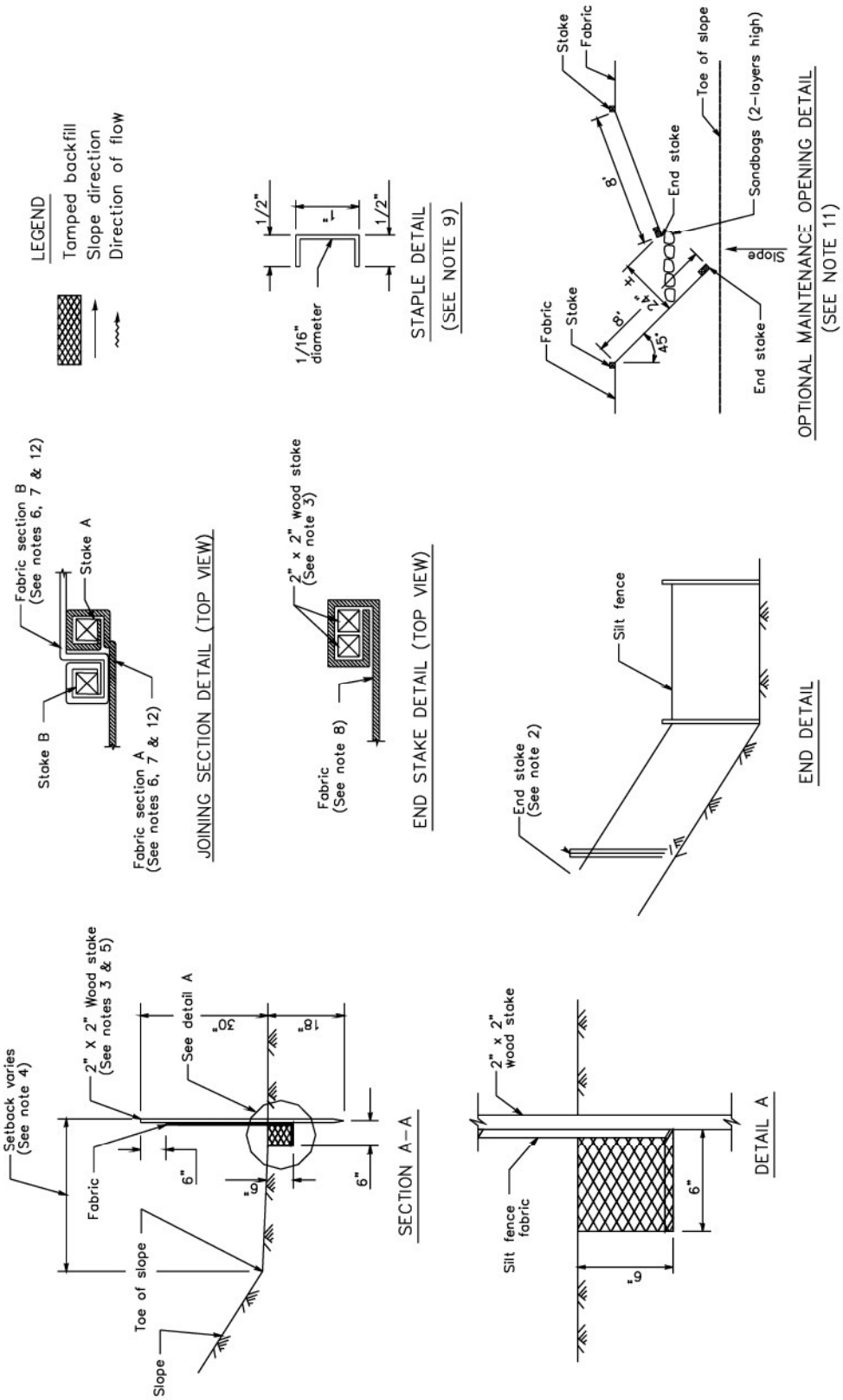




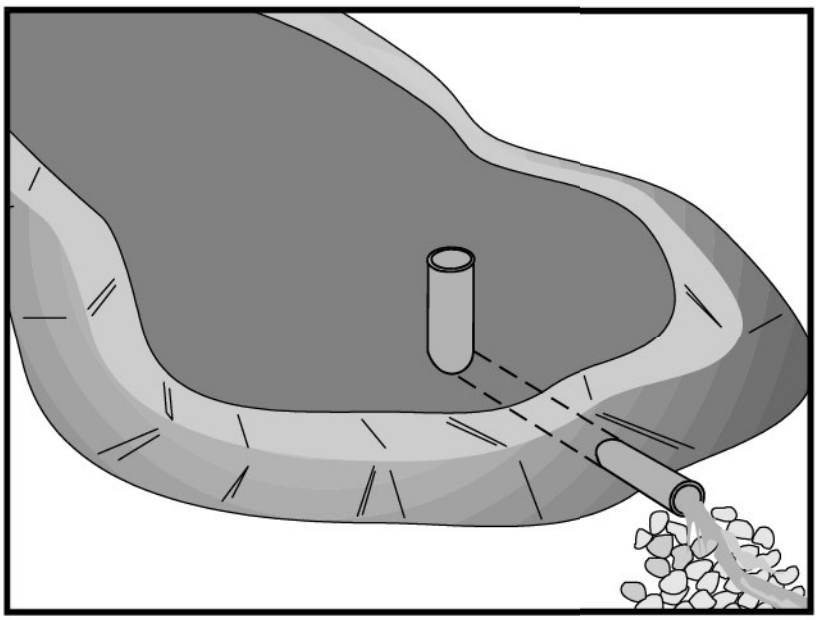


NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'.
2. The last 8'–0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'–0" maximum and shall be positioned on downstream side of fence.
6. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential flow–through of sediment at joint. The tops of the stakes shall be secured with wire.
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples.
9. Minimum 4 staples per stake. Dimensions shown are typical.
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset to eliminate gaps.


LEGEND
Tamped backfill
Slope direction
Direction of flow
Fabric section B (See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A (See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
1/2"
1"
1/2"
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
2" x 2" wood stake (See note 3)
Fabric (See note 8)
END STAKE DETAIL (TOP VIEW)
Stake
Fabric
Toe of slope
8'
End stake
Sandbags (2-layers high)
Slope
Fabric
Stake
8'
4'
2'
45°
End stake
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Silt fence
End stake (See note 2)
END DETAIL
Setback varies (See note 4)
2" X 2" Wood stake (See notes 3 & 5)
See detail A
30"
10"
Fabric
6"
6"
6"
Toe of slope
Slope
SECTION A–A
2" x 2" wood stake
Silt fence fabric
6"
6"
DETAIL A

Sediment Basin SE-2



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres
- At the outlet of large disturbed watersheds, as necessary
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of

public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the SWPPP and in the construction specifications.

- Generally, sediment basins are limited to drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern, basin may require protective fencing.
- Sediment basins designed according to this handbook are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical treatment is used in addition to the sediment basin.
- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from Division of Safety of Dams.
- Standing water may cause mosquitoes or other pests to breed.
- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure with a design life of 12 to 28 months in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet.

Many development projects in California will be required by local ordinances to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70-80 % of the sediment that flows into them if designed according to this handbook. Therefore, they should be used in conjunction with erosion control practices such as

temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations are generally low areas. Drainage into the basin can be improved by the use of earth dikes and drainage swales (see BMP EC-9). The basin must not be located in a stream but it should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

- Construct before clearing and grading work begins when feasible.
- Do not locate in a stream.
- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Large basins are subject to state and local dam safety requirements.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

Sediment basins must be designed in accordance with Section A of the State of California NPDES General Permit for Stormwater Discharges Associated with Construction Activities (General Permit) where sediment basins are the only control measure proposed for the site. If there is insufficient area to construct a sediment basin in accordance with the General Permit requirements, then the alternate design standards specified herein may be used.

Sediment basins designed per the General Permit shall be designed as follows:

Option 1:

Pursuant to local ordinance for sediment basin design and maintenance, provided that the design efficiency is as protective or more protective of water quality than Option 3.

OR

Option 2:

Sediment basin(s), as measured from the bottom of the basin to the principal outlet, shall have at least a capacity equivalent to 3,600 cubic feet (133 yd^3) of storage per acre draining into the sediment basin. The length of the basin shall be more than twice the width of the basin. The

length is determined by measuring the distance between the inlet and the outlet; and the depth must not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency.

OR

Option 3:
Sediment basin(s) shall be designed using the standard equation:

$$As=1.2Q/Vs \qquad \text{(Eq. 1)}$$

Where:

As = Minimum surface area for trapping soil particles of a certain size

Vs = Settling velocity of the design particle size chosen

Q = C I A

Where

Q = Discharge rate measured in cubic feet per second

C = Runoff coefficient

I = Precipitation intensity for the 10-year, 6-hour rain event

A = Area draining into the sediment basin in acres

The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm [or 0.0004 in.]) particle, and the *Vs* used shall be 100 percent of the calculated settling velocity.

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity). The basin(s) shall be located on the site where it can be maintained on a year-round basis and shall be maintained on a schedule to retain the 2 ft of capacity.

OR

Option 4:
The use of an equivalent surface area design or equation, provided that the design efficiency is as protective or more protective of water quality than Option 3.

Other design considerations are:

- The volume of the settling zone should be sized to capture runoff from a 2-year storm or other appropriate design storms specified by the local agency. A detention time of 24 to 40 hours should allow 70 to 80 % of sediment to settle.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 ft deep.
  - A settling zone at least 2 ft deep.
- The length to settling depth ratio (L/SD) should be less than 200.
- Sediment basins are best used in conjunction with erosion controls. Sediment basins that will be used as the only means of treatment, without upstream erosion and sediment controls, must be designed according to the four options required by the General Permit (see Options 1-4 above). Sediment basins that are used in conjunction with upstream erosion and sediment controls should be designed to have a capacity equivalent to 67 yd^3 of sediment storage per acre of contributory area.
- The length of the basin should be more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet.
- The depth must be no less than 3 ft.
- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- Basins should be designed to drain within 72 hours following storm events. If a basin fails to drain within 72 hours, it must be pumped dry.
- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.
  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap.
  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.
- Rock or vegetation should be used to protect the basin inlet and slopes against erosion.
- A forebay, constructed upstream of the basin may be provided to remove debris and larger particles.

- The outflow from the sediment basin should be provided with velocity dissipation devices (see BMP EC-10) to prevent erosion and scouring of the embankment and channel.
- Basin inlets should be located to maximize travel distance to the basin outlet.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen; although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.
- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The outlet should be designed to drain the basin within 24 to 72 hours (also referred to as "drawdown time"). The 24-hour limit is specified to provide adequate settling time; the 72-hour limit is specified to mitigate vector control concerns.
- The two most common outlet problems that occur are: (1) the capacity of the outlet is too great resulting in only partial filling of the basin and drawdown time less than designed for; and (2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, the following outlet types are recommended for use: (1) a single orifice outlet with or without the protection of a riser pipe, and (2) perforated riser. Design guidance for single orifice and perforated riser outlets follow:
  - *Flow Control Using a Single Orifice At The Bottom Of The Basin (Figure 1)*: The outlet control orifice should be sized using the following equation:

$$a = \frac{2A(H - Ho)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7x10^{-5})A(H - Ho)^{0.5}}{CT} \qquad \text{(Eq. 2)}$$

where:

a = area of orifice (ft^2)

A = surface area of the basin at mid elevation (ft^2)

C = orifice coefficient

T = drawdown time of full basin (hrs)

g = gravity (32.2 ft/s²)

H = elevation when the basin is full (ft)

Ho = final elevation when basin is empty (ft)

With a drawdown time of 40 hours, the equation becomes:

$$a = \frac{(1.75x10^{-6})A(H - Ho)^{0.5}}{C} \qquad \text{(Eq. 3)}$$

- *Flow Control Using Multiple Orifices (see Figure2):*

$$a_t = \frac{2A(h_{\max})}{3600CT(2g[h_{\max} - h_{centroid\ of\ orifices}])^{0.5}} \qquad \text{(Eq. 4)}$$

With terms as described above except:

a_t = total area of orifices

h_{max} = maximum height from lowest orifice to the maximum water surface (ft)

$h_{centroid\ of\ orifices}$ = height from the lowest orifice to the centroid of the orifice configuration (ft)

Allocate the orifices evenly on two rows; separate the holes by 3x hole diameter vertically, and by 120 degrees horizontally (refer to Figure 2).

Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

Care must be taken in the selection of "C"; 0.60 is most often recommended and used. However, based on actual tests, GKY (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:

C = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or

C = 0.80 when the material is thicker than the orifice diameter

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods (see local flood control agency).
- Areas under embankments must be cleared and stripped of vegetation.
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

Average annual costs for installation and maintenance (2 year useful life) are:

- Basin less than 50,000 ft^3: Range, \$0.24 - \$1.58/ft^3. Average, \$0.73 per ft^3. \$400 - \$2,400, \$1,200 average per drainage acre.
- Basin size greater than 50,000 ft^3: Range, \$0.12 – \$0.48/ft^3. Average, \$0.36 per ft^3. \$200 - \$800, \$600 average per drainage acre.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at appropriate locations.
- Remove standing water from basin within 72 hours after accumulation.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

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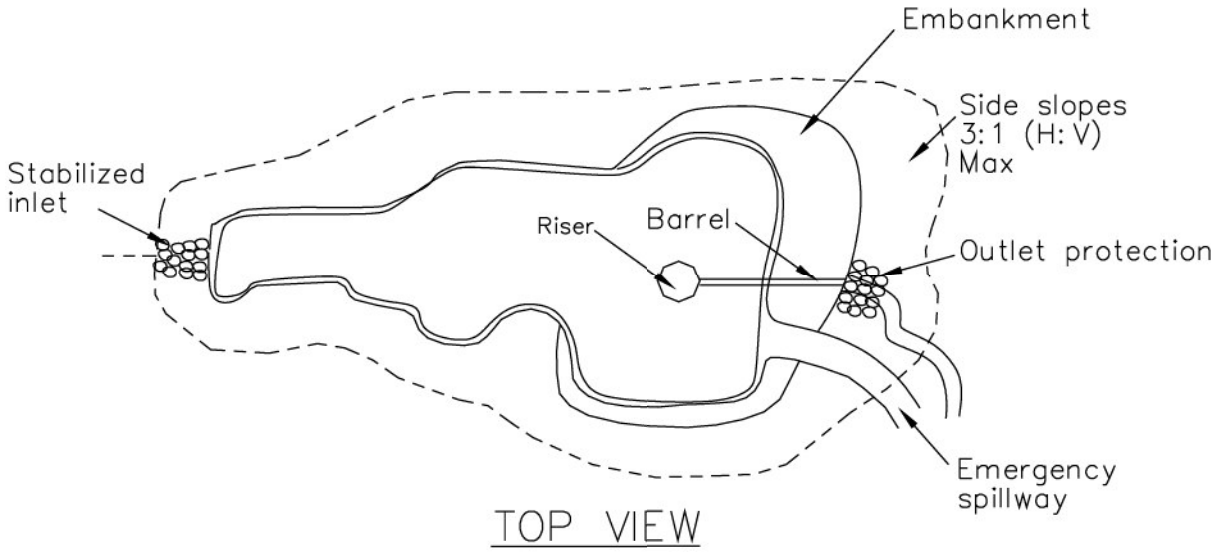
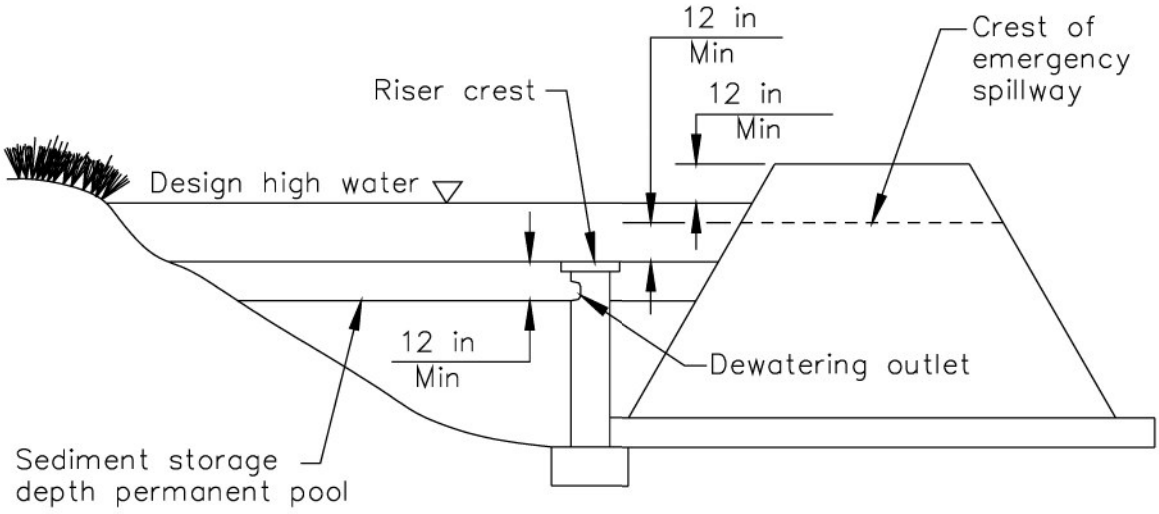




NOTE:
This outlet provides no drainage for permanent pool.

FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN
SINGLE ORIFICE DESIGN
NOT TO SCALE

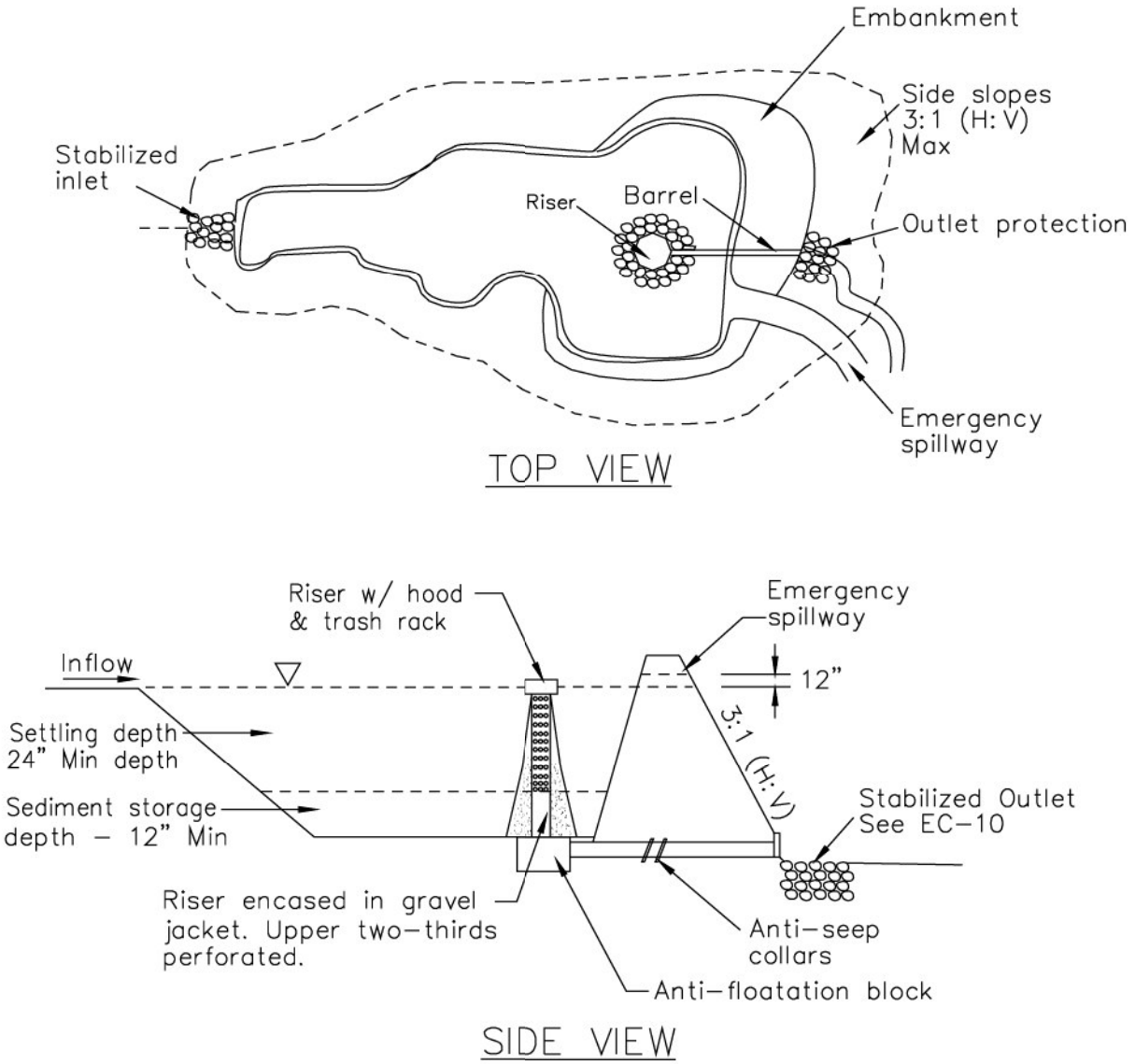


FIGURE 2: TYPICAL TEMPORARY SEDIMENT BASIN

MULTIPLE ORIFICE DESIGN

NOT TO SCALE

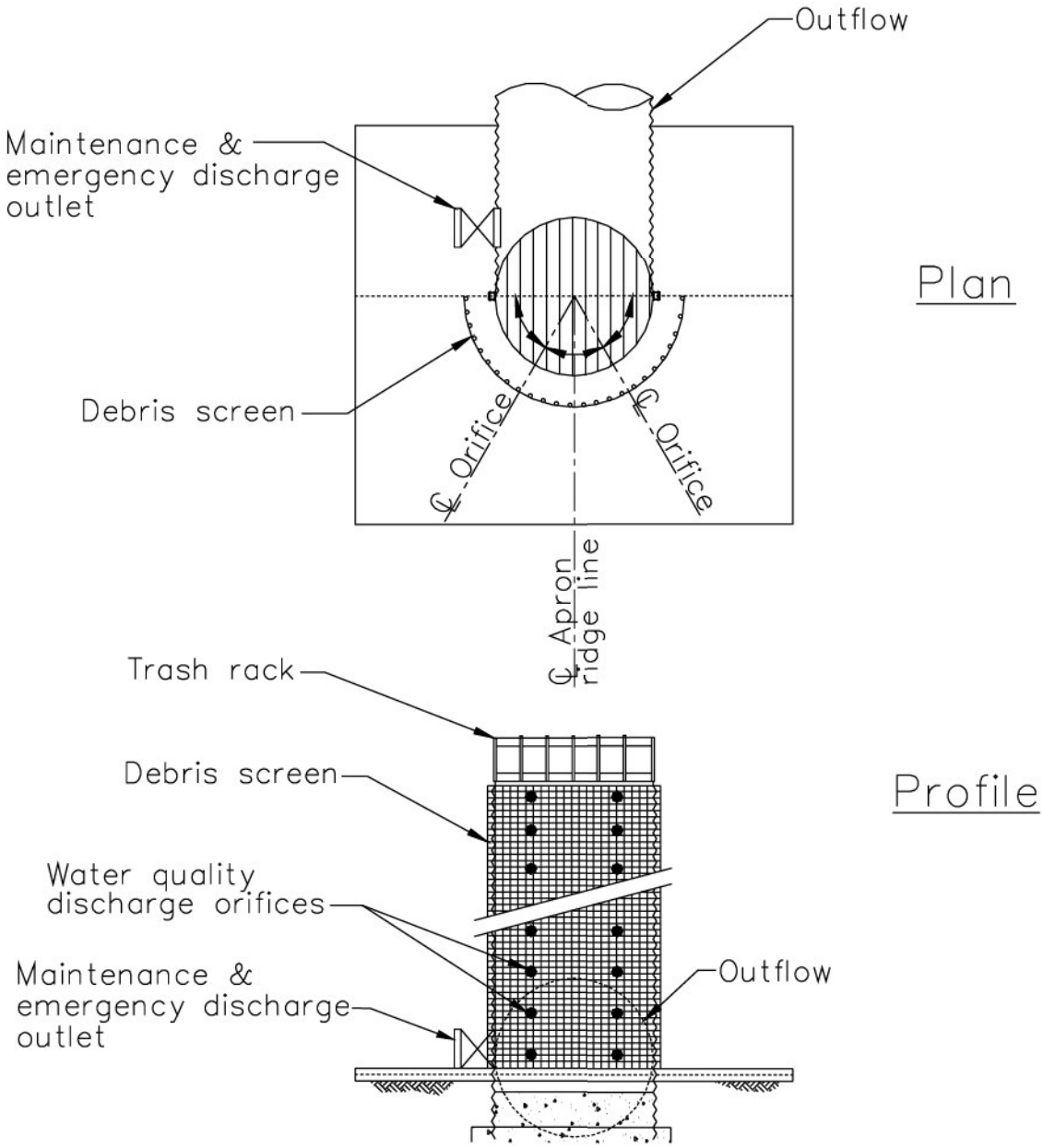
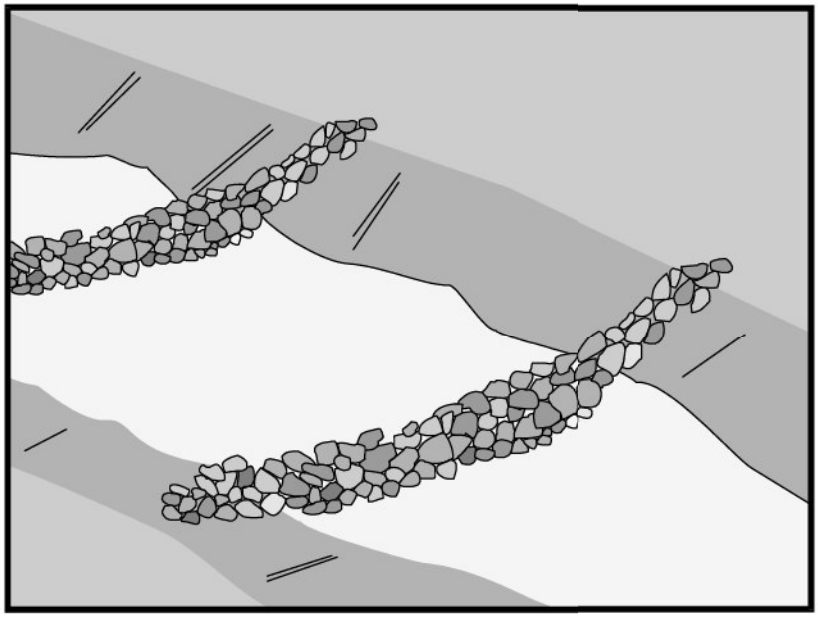


FIGURE 3: MULTIPLE ORIFICE OUTLET RISER

NOT TO SCALE

Check Dams SE-4



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.

Limitations

- Not to be used in live streams or in channels with extended base flows.

- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Reduced slopes reduce the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Use of check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity must be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, there are several options:

- Don't use check dams. Consider alternative BMPs.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center section of the dam should be lower than the edge sections so that the check dam will direct flows to the center of the ditch or swale.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products manufactured specifically for use as check dams are also being used, and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Straw bales can also be used for check dams and can work if correctly installed; but in practice, straw bale check dams have a high failure rate. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam must completely span the ditch

or swale to prevent washout. The rock used must be large enough to stay in place given the expected design flow through the channel.

Log check dams are usually constructed of 4 to 6 in. diameter logs. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

Gravel bag and sandbag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet.

Manufactured products should be installed in accordance with the manufacturer's instructions.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- Backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap must be cleaned following each storm event.
- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.
- Gravel bags may be used as check dams with the following specifications:

Materials

Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms. Sandbags used for check dams should conform to SE-8, Sandbag Barrier. Fiber rolls used for check dams should conform to SE-5, Fiber Rolls. Straw bales used for check dams should conform to SE-9, Straw Bale Barrier.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section. Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Fiber rolls and straw bales must be trenched in and firmly staked in place.

Costs

Cost consists of only installation costs if materials are readily available. If material must be imported, costs may increase. For material costs, see SE-5, SE-6, SE-8 and SE-9.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Replace missing rock, bags, bales, etc. Replace bags or bales that have degraded or have become damaged.
- If the check dam is used as a sediment capture device, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References

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Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

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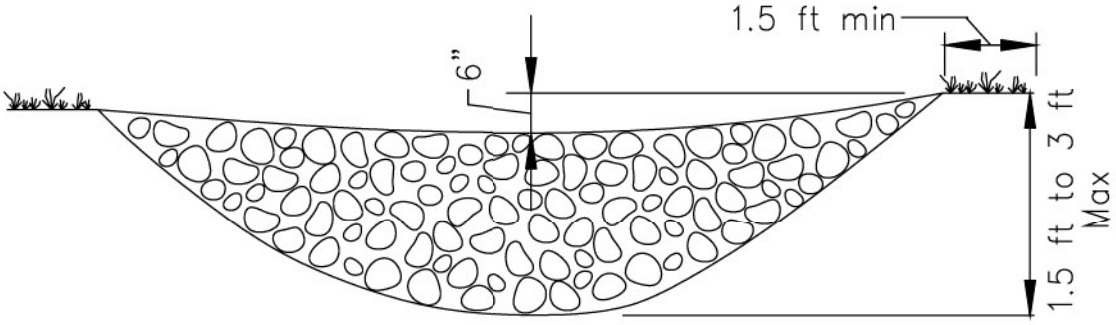
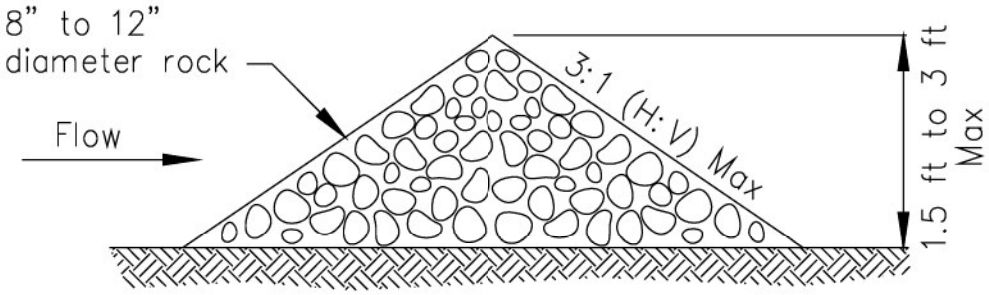
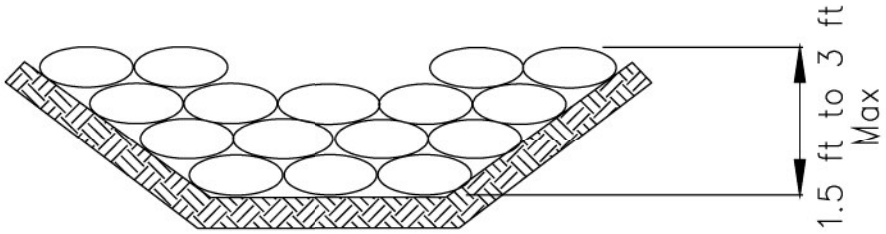


ELEVATION



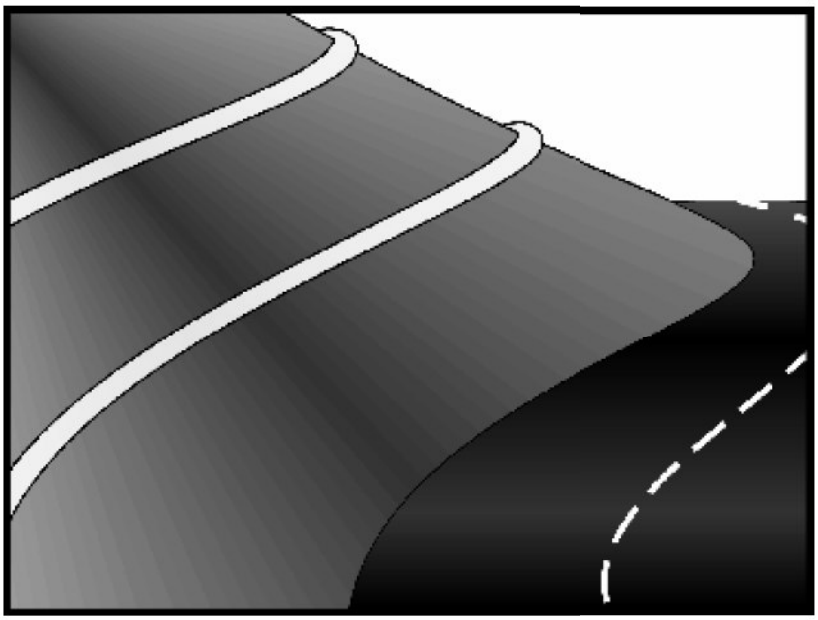
TYPICAL ROCK CHECK DAM SECTION

ROCK CHECK DAM
NOT TO SCALE



GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE

Fiber Rolls SE-5



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

A fiber roll consists of straw, flax, or other similar materials bound into a tight tubular roll. When fiber rolls are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
- At the end of a downward slope where it transitions to a steeper slope
- Along the perimeter of a project
- As check dams in unlined ditches
- Down-slope of exposed soil areas
- Around temporary stockpiles

Limitations

- Fiber rolls are not effective unless trenched

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- Fiber rolls at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20 in. diameter or installations achieving the same protection (i.e. stacked smaller diameter fiber rolls, etc.).
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.

Implementation

Fiber Roll Materials

- Fiber rolls should be either prefabricated rolls or rolled tubes of erosion control blanket.

Assembly of Field Rolled Fiber Roll

- Roll length of erosion control blanket into a tube of minimum 8 in. diameter.
- Bind roll at each end and every 4 ft along length of roll with jute-type twine.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into a 2 to 4 in. deep trench with a width equal to the diameter of the fiber roll.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.

Removal

- Fiber rolls are typically left in place.

- If fiber rolls are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

Costs

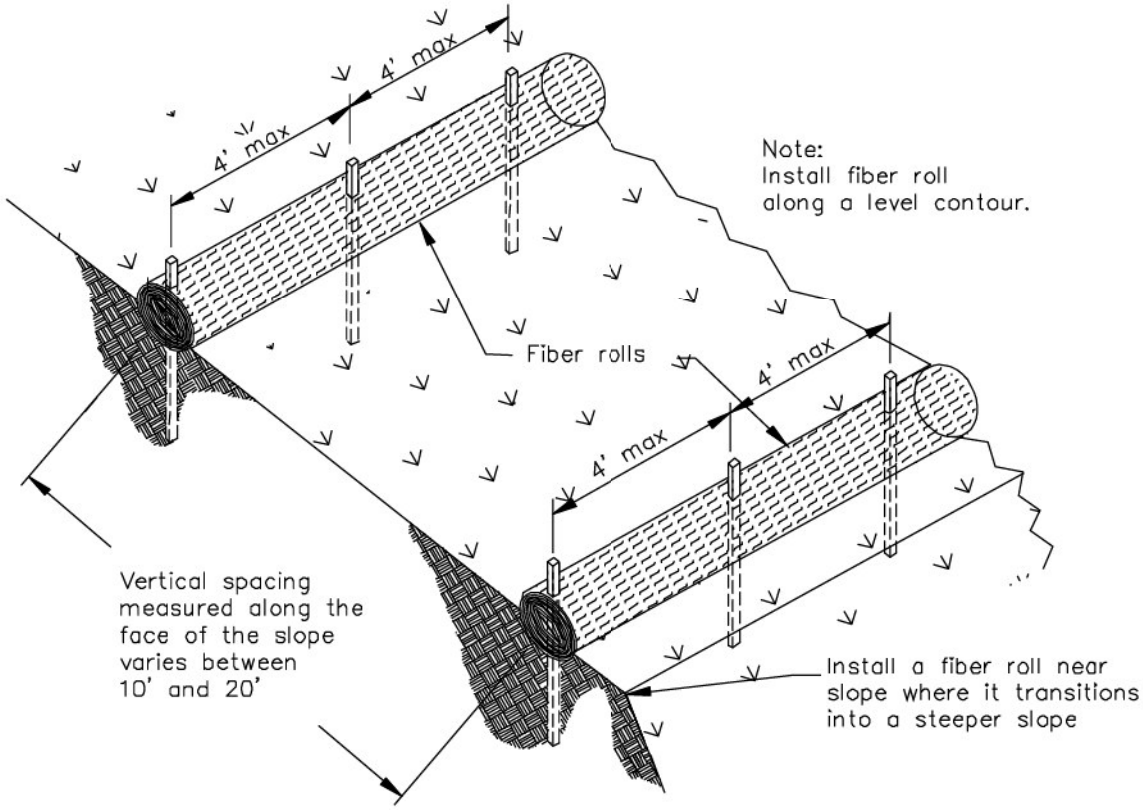
Material costs for fiber rolls range from $20 - $30 per 25 ft roll.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage depth, usually one-half the distance between the top of the fiber roll and the adjacent ground surface. Sediment removed during maintenance may be incorporated into earthwork on the site of disposed at an appropriate location.
- If fiber rolls are used for erosion control, such as in a mini check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.

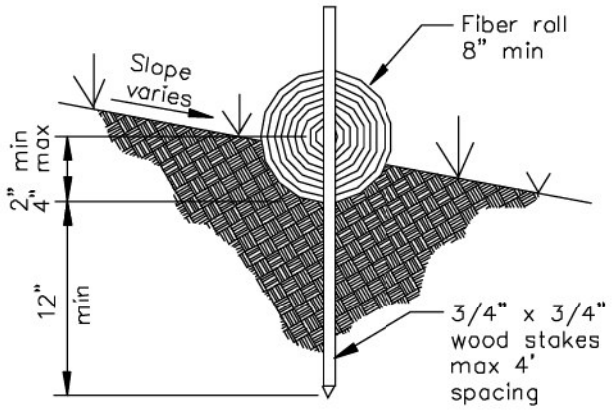
References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



TYPICAL FIBER ROLL INSTALLATION

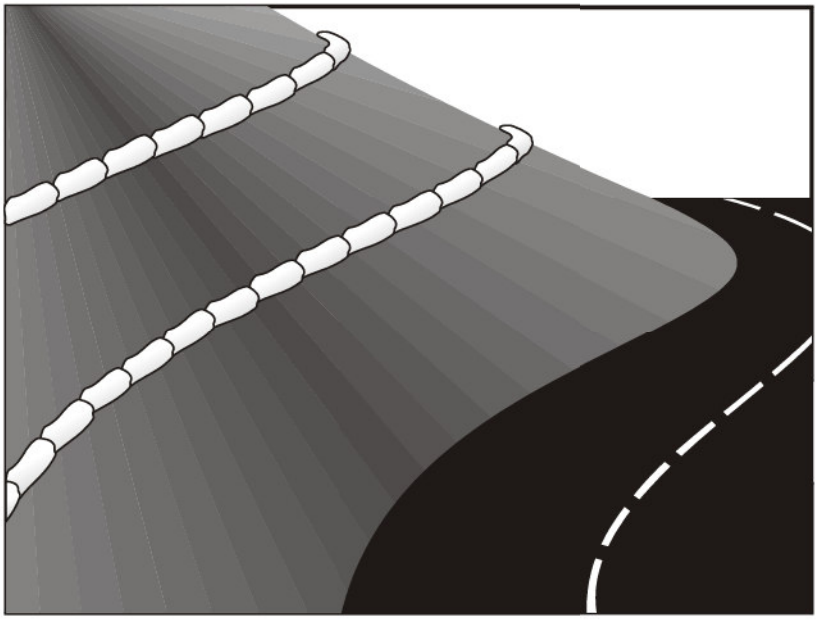
N.T.S.



ENTRENCHMENT DETAIL

N.T.S.

Gravel Bag Berm SE-6



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flows, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:

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- Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the filter, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Berms may have limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

A gravel bag berm consists of a row of open graded gravel–filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers, but are more porous.

Design and Layout

- Locate gravel bag berms on level contours.
  - Slopes between 20:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the slope toe.
  - Slopes 2:1 (H:V) or steeper: Gravel bags should be placed at a maximum interval of 25 ft (a closer spacing is more effective), with the first row placed the slope toe.
- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.

- For installation near the toe of the slope, consider moving the gravel bag barriers away from the slope toe to facilitate cleaning. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Top width = 12 in. minimum for one or two layer construction
  - Side slopes = 2:1 or flatter
- In Construction Traffic Areas:
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Top width = 12 in. minimum for one or two layer construction.
  - Side slopes = 2:1 or flatter.
- Butt ends of bags tightly
- On multiple row, or multiple layer construction, overlapp butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

Materials

- ***Bag Material:*** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.
- ***Bag Size:*** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.
- ***Fill Material:*** Fill material should be 0.5 to 1 in. Class 2 aggregate base, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Costs

Gravel filter: Expensive, since off-site materials, hand construction, and demolition/removal are usually required. Material costs for gravel bags are average of $2.50 per empty gravel bag. Gravel costs range from $20-$35 per yd^3.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.
- Reshape or replace gravel bags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove gravel bag berms when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

Handbook of Steel Drainage and Highway Construction, American Iron and Steel Institute, 1983.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Street Sweeping and Vacuuming SE-7

Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TR	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.

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- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.
- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from $58/hour (3 yd^3 hopper) to $88/hour (9 yd^3 hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

Inspection and Maintenance

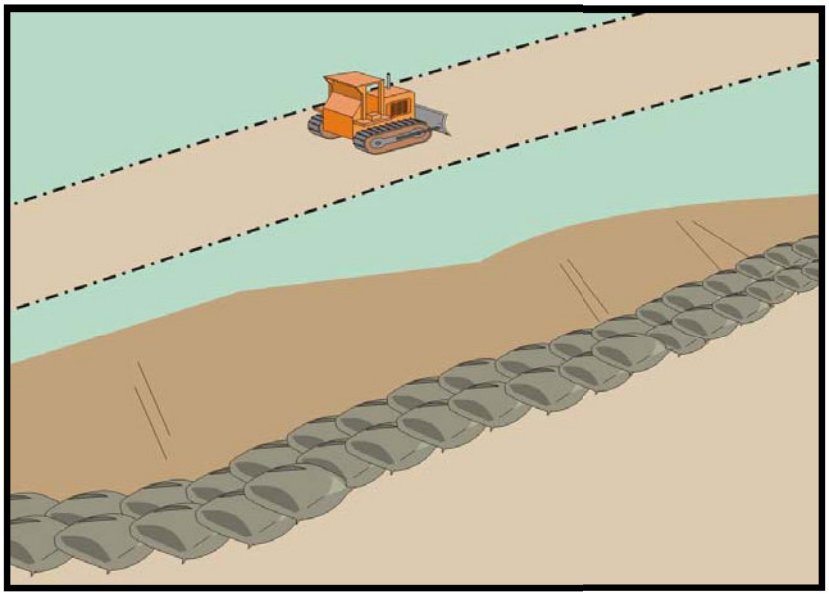
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Sandbag Barrier SE-8



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-9 Straw Bale Barrier

Description and Purpose

A sandbag barrier is a series of sand-filled bags placed on a level contour to intercept sheet flows. Sandbag barriers pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Sandbag barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow

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- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

- It is necessary to limit the drainage area upstream of the barrier to 5 acres.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor intensive.
- Barriers may have limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.
- Burlap should not be used for sandbags.

Implementation

General

A sandbag barrier consists of a row of sand-filled bags placed on a level contour. When appropriately placed, a sandbag barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. While the sand-filled bags are porous, the fine sand tends to quickly plug with sediment, limiting the rate of flow through the barrier. If a porous barrier is desired, consider SE-1, Silt Fence, SE-5, Fiber Rolls, SE-6, Gravel Bag Berms, or SE-9, Straw Bale Barriers. Sandbag barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets which erode rills, and ultimately gullies, into disturbed, sloped soils. Sandbag barriers are similar to ground bag berms, but less porous.

Design and Layout

- Locate sandbag barriers on a level contour.
  - Slopes between 20:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the slope toe.
  - Slopes 2:1 (H:V) or steeper: Sandbags should be placed at a maximum interval of 25 ft (a closer spacing is more effective), with the first row placed near the slope toe.
- Turn the ends of the sandbag barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the barrier away from the slope toe to facilitate cleaning. To prevent flow behind the barrier, sandbags can be placed perpendicular to the barrier to serve as cross barriers.
- Drainage area should not exceed 5 acres.

- Stack sandbags at least three bags high.
- Butt ends of bags tightly.
- Overlapp butt joints of row beneath with each successive row.
- Use a pyramid approach when stacking bags.
- In non-traffic areas
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Side slope = 2:1 or flatter
- In construction traffic areas
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Side slopes = 2:1 or flatter.

Materials

- ***Sandbag Material:*** Sandbag should be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap may not acceptable in some jurisdictions.
- ***Sandbag Size:*** Each sand-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.
- ***Fill Material:*** All sandbag fill material should be non-cohesive, Class 1 or Class 2 permeable material free from clay and deleterious material.

Costs

Sandbag barriers are more costly, but typically have a longer useful life than other barriers. Empty sandbags cost $0.25 - $0.75. Average cost of fill material is $8 per yd^3. Pre-filled sandbags are more expensive at $1.50 - $2.00 per bag.

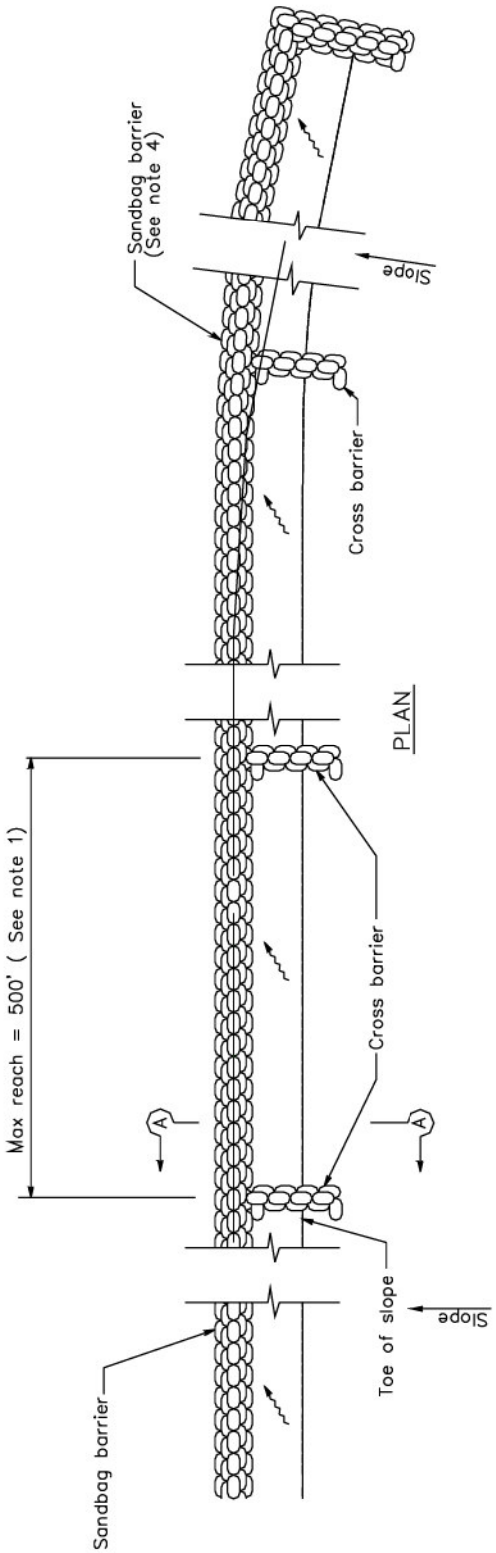
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Sandbags exposed to sunlight will need to be replaced every two to three months due to degradation of the bags.
- Reshape or replace sandbags as needed.

- Repair washouts or other damage as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove sandbags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

References

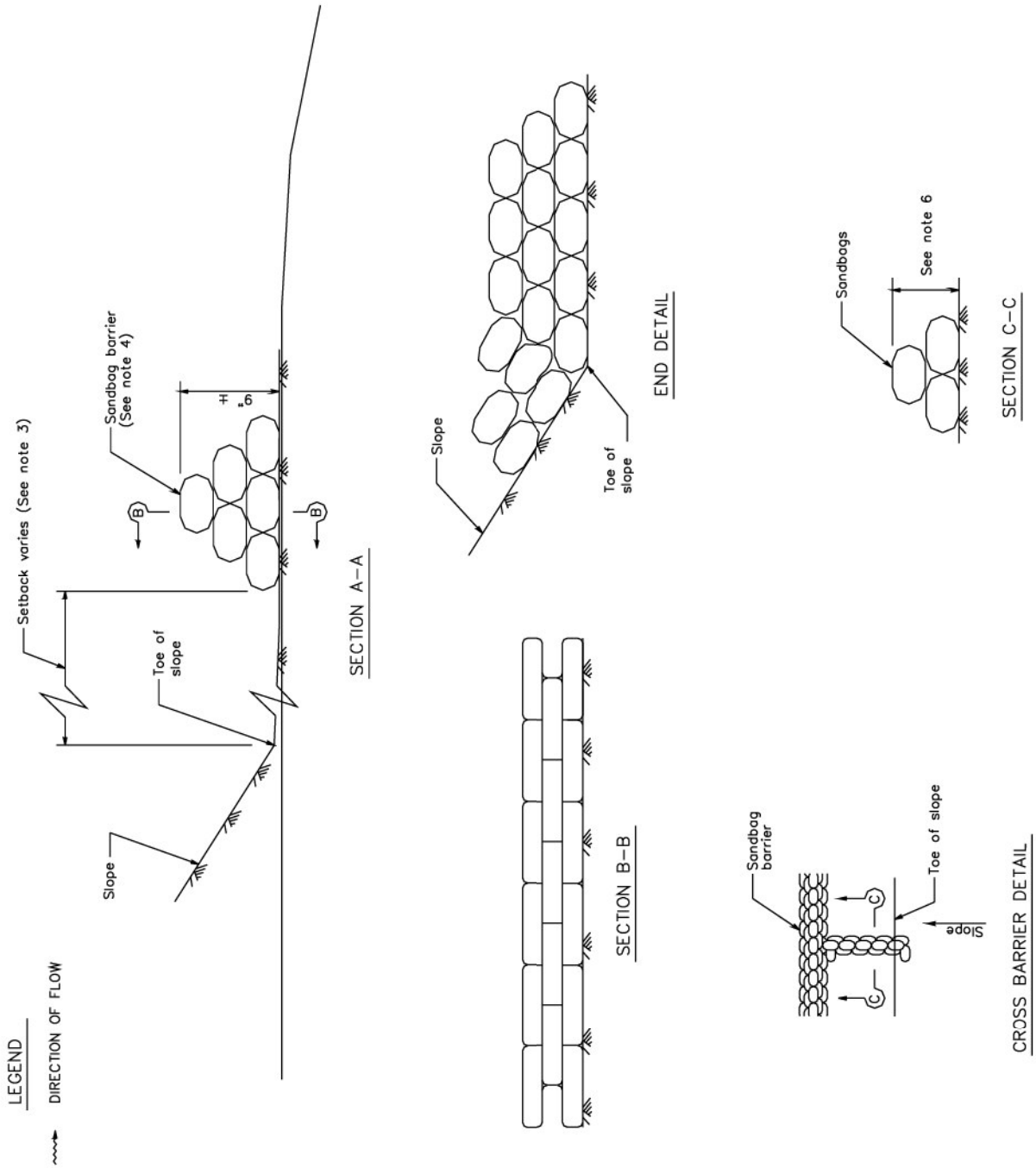
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



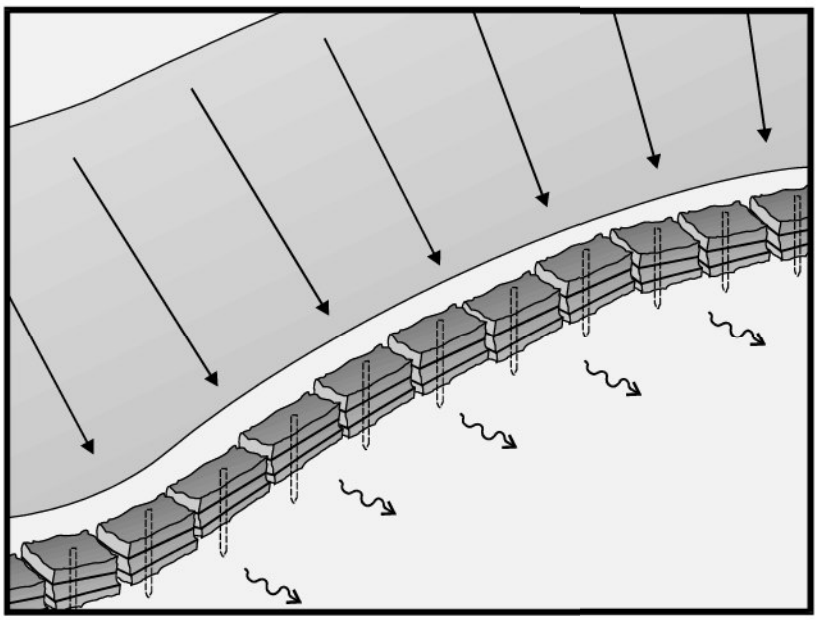
SANDBAG BARRIER

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. Place sandbags tightly.
3. Dimension may vary to fit field condition.
4. Sandbag barrier shall be a minimum of 3 bags high.
5. The end of the barrier shall be turned up slope.
6. Cross barriers shall be a min of 1/2 and a max of 2/3 the height of the linear barrier.
7. Sandbag rows and layers shall be staggered to eliminate gaps.


LEGEND
DIRECTION OF FLOW
Setback varies (See note 3)
Sandbag barrier (See note 4)
9"
B
B
Toe of slope
Slope
SECTION A–A
Slope
Toe of slope
END DETAIL
SECTION B–B
Sandbags
See note 6
SECTION C–C
Sandbag barrier
C
C
Toe of slope
Slope
CROSS BARRIER DETAIL

Straw Bale Barrier SE-9



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A straw bale barrier is a series of straw bales placed on a level contour to intercept sheet flows. Straw bale barriers pond sheet- flow runoff, allowing sediment to settle out.

Suitable Applications

Straw bale barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow

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- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

Straw bale barriers:

- Are not to be used for extended periods of time because they tend to rot and fall apart
- Are suitable only for sheet flow on slopes of 10 % or flatter
- Are not appropriate for large drainage areas, limit to one acre or less
- May require constant maintenance due to rotting
- Are not recommended for concentrated flow, inlet protection, channel flow, and live streams
- Cannot be made of bale bindings of jute or cotton
- Require labor-intensive installation and maintenance
- Cannot be used on paved surfaces
- Should not to be used for drain inlet protection
- Should not be used on lined ditches
- May introduce undesirable non-native plants to the area

Implementation

General

A straw bale barrier consists of a row of straw bales placed on a level contour. When appropriately placed, a straw bale barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. Straw bale barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils.

Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainage ways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow. Use of straw bale barriers in accordance with this BMP should produce acceptable results.

Design and Layout

- Locate straw bale barriers on a level contour.
  - Slopes up to 10:1 (H:V): Straw bales should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the toe of slope.
  - Slopes greater than 10:1 (H:V): Not recommended.

- Turn the ends of the straw bale barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the barrier away from the slope toe to facilitate cleaning. To prevent flow behind the barrier, sand bags can be placed perpendicular to the barrier to serve as cross barriers.
- Drainage area should not exceed 1 acre, or 0.25 acre per 100 ft of barrier.
- Maximum flow path to the barrier should be limited to 100 ft.
- Straw bale barriers should consist of two parallel rows.
  - Butt ends of bales tightly
  - Stagger butt joints between front and back row
  - Each row of bales must be trenched in and firmly staked
- Straw bale barriers are limited in height to one bale laid on its side.
- Anchor bales with either two wood stakes or four bars driven through the bale and into the soil. Drive the first stake towards the butt joint with the adjacent bale to force the bales together.
- See attached figure for installation details.

Materials

- ***Straw Bale Size:*** Each straw bale should be a minimum of 14 in. wide, 18 in. in height, 36 in. in length and should have a minimum mass of 50 lbs. The straw bale should be composed entirely of vegetative matter, except for the binding material.
- ***Bale Bindings:*** Bales should be bound by steel wire, nylon or polypropylene string placed horizontally. Jute and cotton binding should not be used. Baling wire should be a minimum diameter of 14 gauge. Nylon or polypropylene string should be approximately 12 gauge in diameter with a breaking strength of 80 lbs force.
- ***Stakes:*** Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Steel bar reinforcement should be equal to a #4 designation or greater. End protection should be provided for any exposed bar reinforcement.

Costs

Straw bales cost $5 - $7 each. Adequate labor should be budgeted for installation and maintenance.

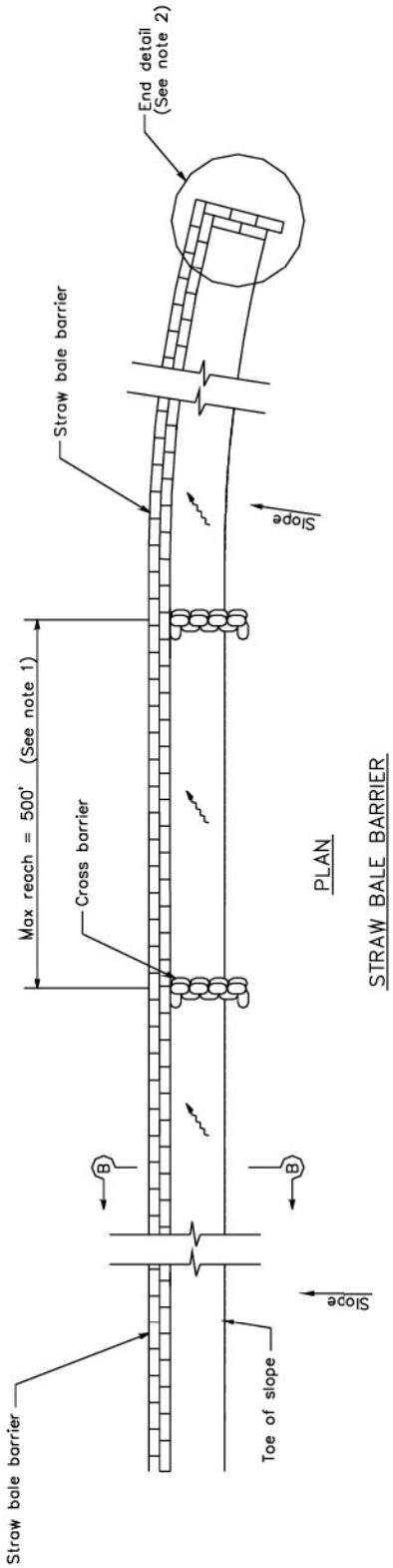
Inspection and Maintenance

Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Straw bales degrade, especially when exposed to moisture. Rotting bales will need to be replaced on a regular basis.
- Replace or repair damaged bales as needed.
- Repair washouts or other damages as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove straw bales when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



PLAN

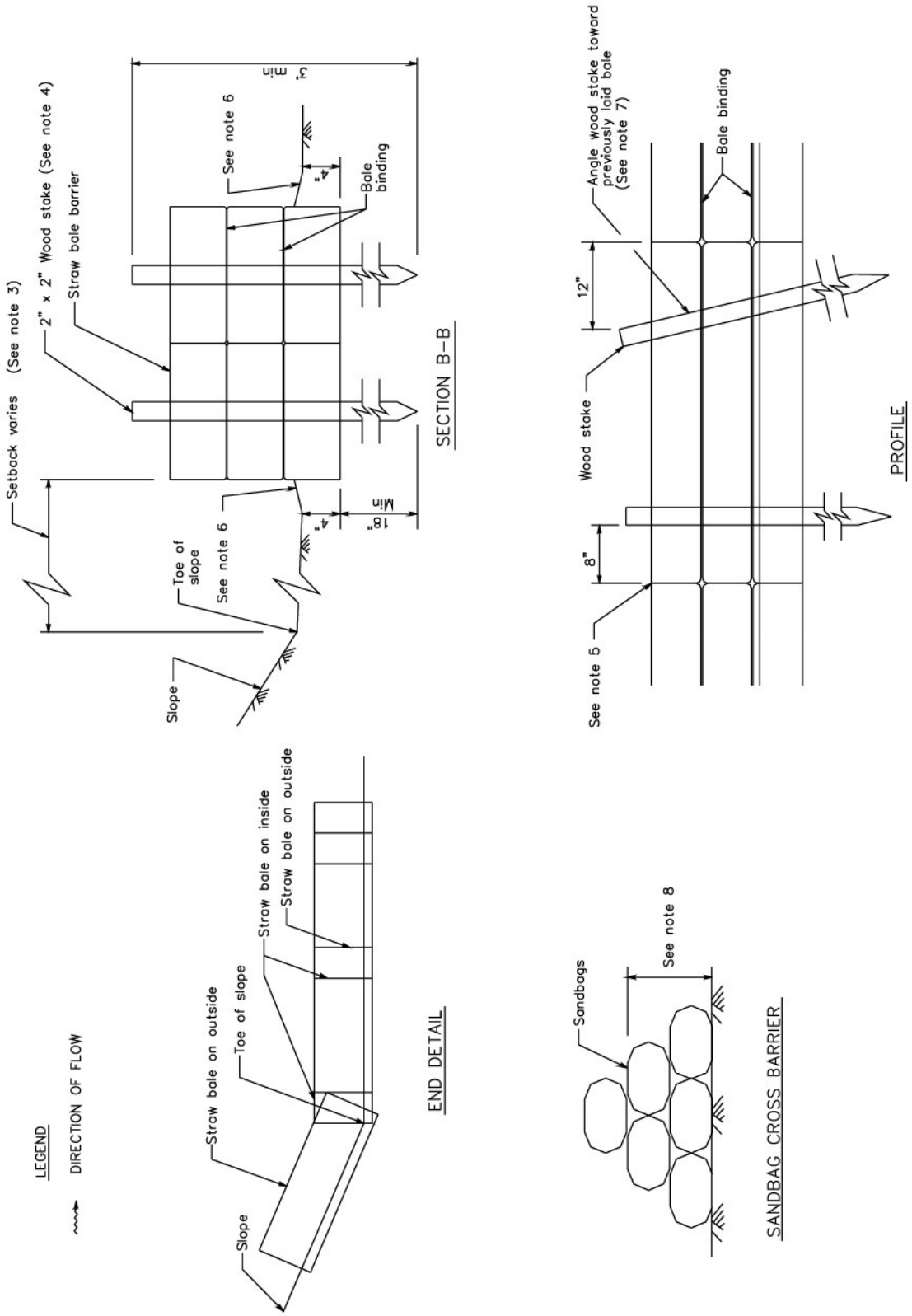
STRAW BALE BARRIER

LEGEND

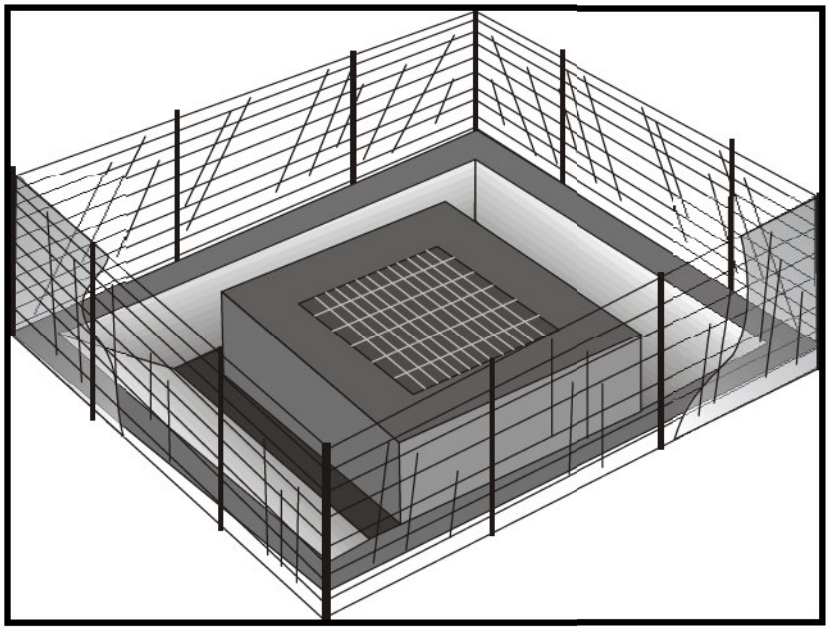
DIRECTION OF FLOW

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. The end of barrier shall be turned up slope.
3. Dimension may vary to fit field condition.
4. Stake dimensions are nominal.
5. Place straw bales tightly together.
6. Tamp embedment spoils against sides of installed bales.
7. Drive angled wood stake before vertical stake to ensure tight abutment to adjacent bale.
8. Sandbag cross barriers should be a min of 1/2 and a max of 2/3 the height of the linear barrier.
9. Sandbag rows and layers should be offset to eliminate gaps.


Setback varies (See note 3)
2" x 2" Wood stake (See note 4)
Straw bale barrier
3' Min
See note 6
4"
Bale binding
SECTION B-B
Toe of slope
See note 6
4"
18" Min
Slope
Angle wood stake toward previously laid bale (See note 7)
Bale binding
12"
Wood stake
8"
See note 5
PROFILE
LEGEND
DIRECTION OF FLOW
Straw bale on outside
Toe of slope
Straw bale on inside
Straw bale on outside
Slope
END DETAIL
Sandbags
See note 8
SANDBAG CROSS BARRIER

Storm Drain Inlet Protection SE-10



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle. Some filter configurations also remove sediment by filtering, but usually the ponding action results in the greatest sediment reduction.

Suitable Applications

Every storm drain inlet receiving sediment-laden runoff should be protected.

Limitations

- Drainage area should not exceed 1 acre.
- Straw bales, while potentially effective, have not produced in practice satisfactory results, primarily due to improper installation.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.
- Inlet protection usually requires other methods of temporary protection to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are

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expected, use other onsite sediment trapping techniques in conjunction with inlet protection.

- Frequent maintenance is required.
- For drainage areas larger than 1 acre, runoff should be routed to a sediment-trapping device designed for larger flows. See BMPs SE-2, Sediment Basin, and SE-3, Sediment Traps.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capability is needed.

Implementation

General

Large amounts of sediment may enter the storm drain system when storm drains are installed before the upslope drainage area is stabilized, or where construction is adjacent to an existing storm drain. In cases of extreme sediment loading, the storm drain itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through SE-2, Sediment Basin or SE-3, Sediment Trap. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Inlet protection methods not presented in this handbook should be approved by the local stormwater management agency.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed and which method to use.

- Limit upstream drainage area to 1 acre maximum. For larger drainage areas, use SE-2, Sediment Basin, or SE-3, Sediment Trap, upstream of the inlet protection device.
- The key to successful and safe use of storm drain inlet protection devices is to know where runoff will pond or be diverted.
  - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
  - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the

inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desired areas, and prevent or control diversions.

- Four types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.
  - Filter Fabric Fence: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.
  - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (SE-3).
  - Gravel bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5 cfs, and where overtopping is required to prevent flooding.
  - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Provide area around the inlet for water to pond without flooding structures and property.
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed) 1 to 2 ft with 2:1 side slopes around the inlet.

Installation

- ***DI Protection Type 1 - Filter Fabric Fence*** - The filter fabric fence (Type 1) protection is shown in the attached figure. Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place filter fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced.
  1. Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.
  2. Place 2 in. by 2 in. wooden stakes around the perimeter of the inlet a maximum of 3 ft apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes must be at least 48 in.
  3. Lay fabric along bottom of trench, up side of trench, and then up stakes. See SE-1, Silt Fence, for details. The maximum silt fence height around the inlet is 24 in.
  4. Staple the filter fabric (for materials and specifications, see SE-1, Silt Fence) to wooden stakes. Use heavy-duty wire staples at least 1 in. in length.
  5. Backfill the trench with gravel or compacted earth all the way around.
- ***DI Protection Type 2 - Excavated Drop Inlet Sediment Trap*** - The excavated drop inlet sediment trap (Type 2) is shown in the attached figures. Install filter fabric fence in

accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd^3/acre of drainage area.

- ***DI Protection Type 3 - Gravel bag*** - The gravel bag barrier (Type 3) is shown in the figures. Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with SE-6, Gravel Bag Berm. Gravel bags should be used due to their high permeability.

  1. Use sand bag made of geotextile fabric (not burlap) and fill with 0.75 in. rock or 0.25 in. pea gravel.
  2. Construct on gently sloping street.
  3. Leave room upstream of barrier for water to pond and sediment to settle.
  4. Place several layers of sand bags – overlapping the bags and packing them tightly together.
  5. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.

- ***DI Protection Type 4 – Block and Gravel Filter*** - The block and gravel filter (Type 4) is shown in the figures. Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction.

  1. Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.
  2. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.
  3. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
  4. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.

Costs

- Average annual cost for installation and maintenance (one year useful life) is $200 per inlet.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Filter Fabric Fences. If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes.

- Gravel Filters. If the gravel becomes clogged with sediment, it must be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.

- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site ore disposed at an appropriate location.

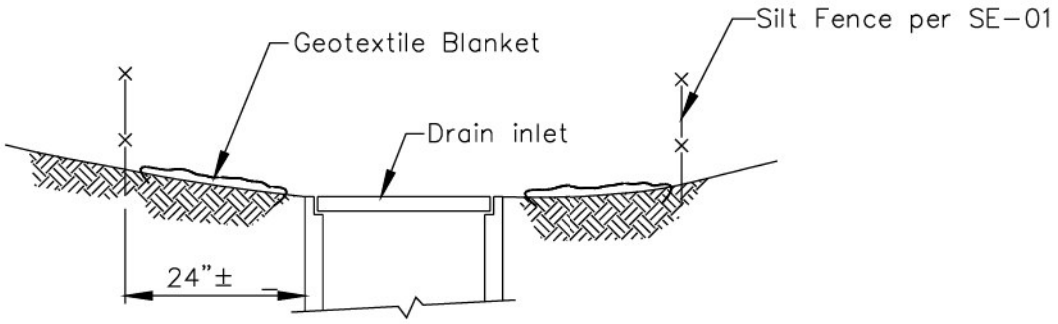
- Remove storm drain inlet protection once the drainage area is stabilized.

  - Clean and regrade area around the inlet and clean the inside of the storm drain inlet as it must be free of sediment and debris at the time of final inspection.

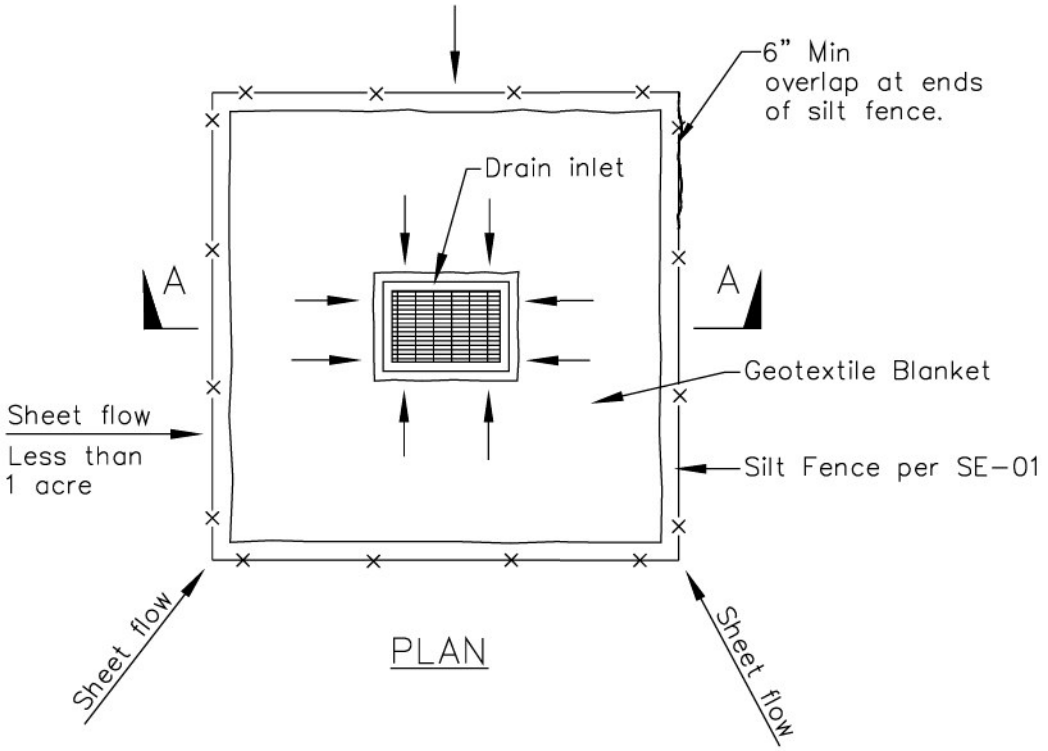
References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.



SECTION A–A

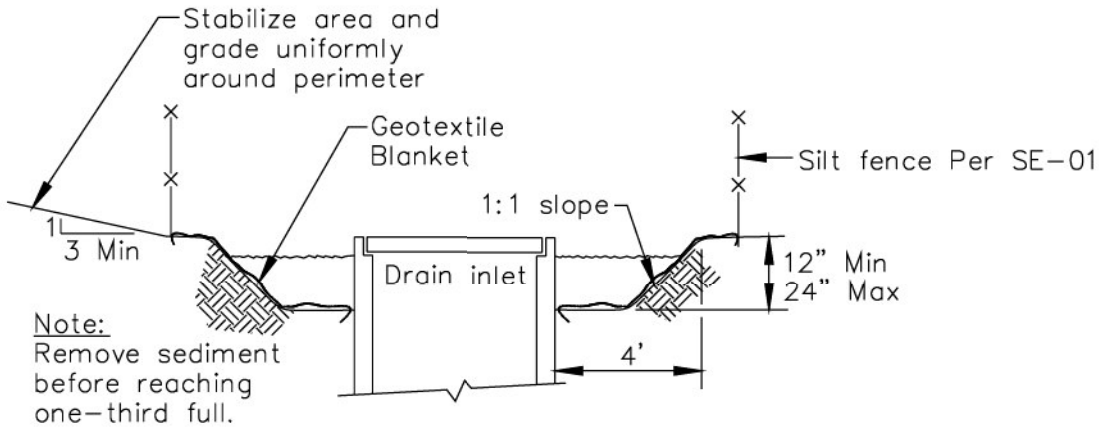


PLAN

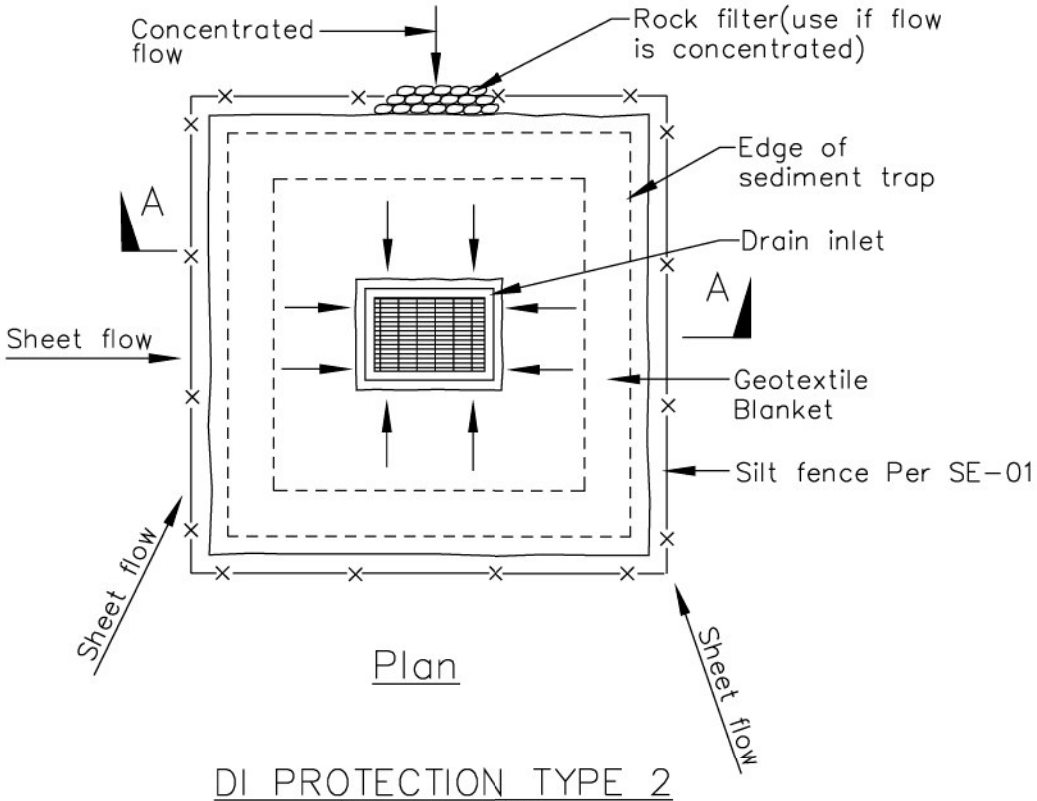
DI PROTECTION TYPE 1
NOT TO SCALE

NOTES:

1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable with concentrated flows.



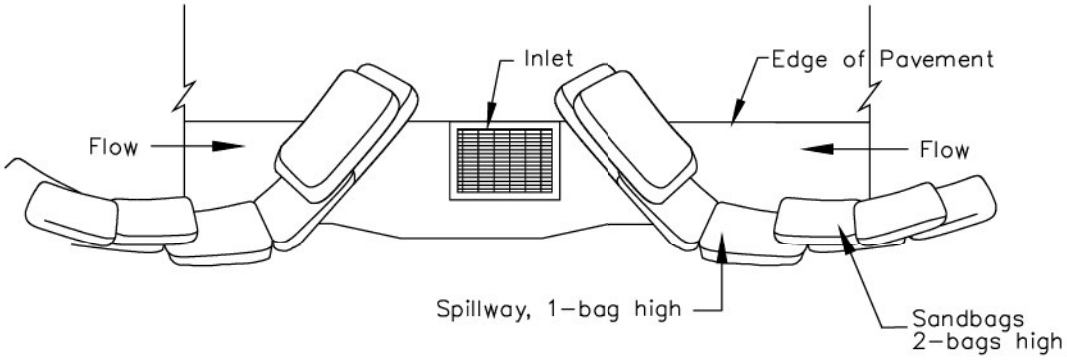
Section A–A



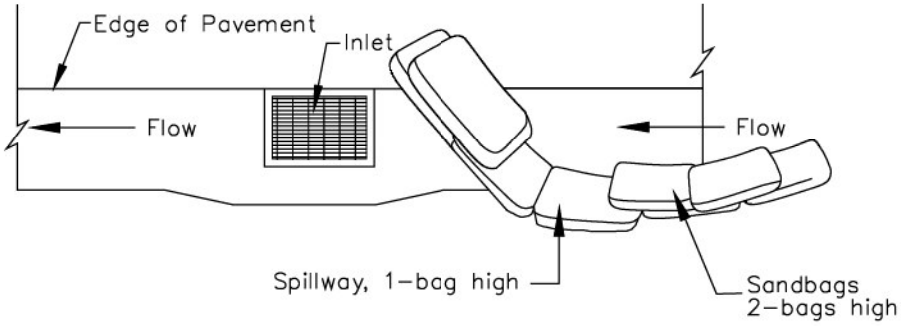
Plan

DI PROTECTION TYPE 2
NOT TO SCALE

Notes
1. For use in cleared and grubbed and in graded areas.
2. Shape basin so that longest inflow area faces longest length of trap.
3. For concentrated flows, shape basin in 2:1 ratio with length oriented towards direction of flow.



TYPICAL PROTECTION FOR INLET ON SUMP

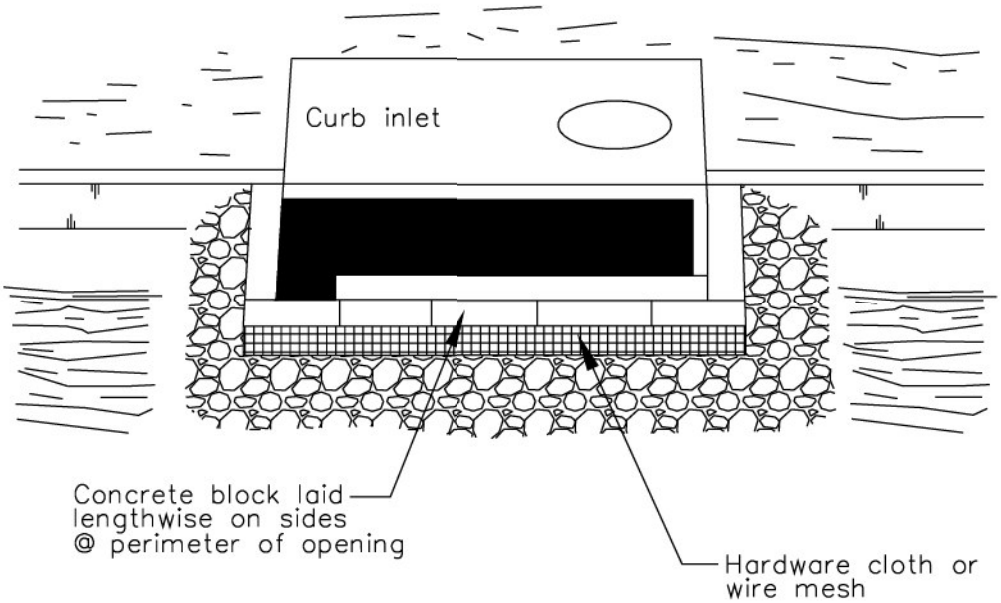


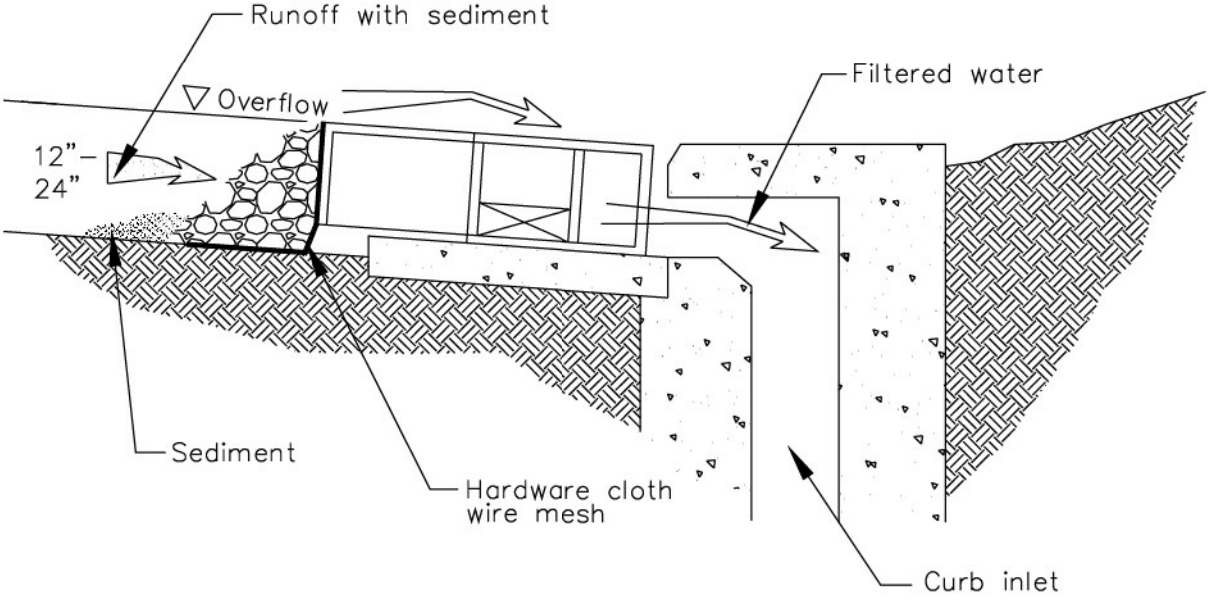
TYPICAL PROTECTION FOR INLET ON GRADE

NOTES:

1. Intended for short-term use.
2. Use to inhibit non-storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

DI PROTECTION TYPE 3
NOT TO SCALE



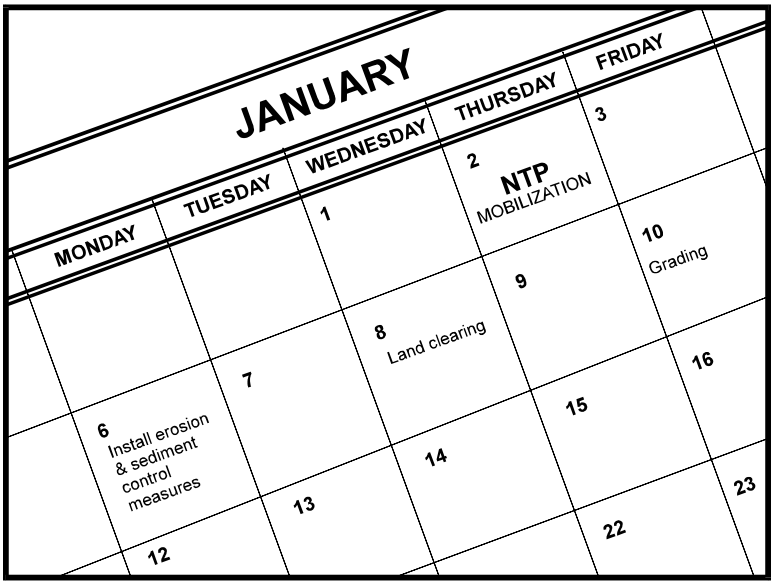


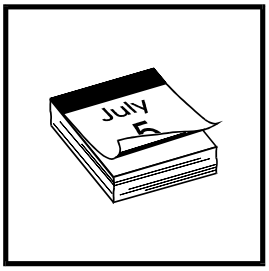
DI PROTECTION – TYPE 4

NOT TO SCALE

Scheduling

SS-1





Standard Symbol

BMP Objectives

- Soil Stabilization
- Sediment Control
- Tracking Control
- Wind Erosion Control
- Non-Storm Water Management
- Materials and Waste Management

Definition and Purpose

This best management practice (BMP) involves developing, for every project, a schedule that includes sequencing of construction activities with the implementation of construction site BMPs such as temporary soil stabilization (erosion control) and temporary sediment controls measures. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Appropriate Applications

Construction sequencing shall be scheduled to minimize land disturbance for all projects during the rainy and non-rainy season. Appropriate BMPs shall be implemented during both rainy and non-rainy seasons.

Limitations

None identified.

Standards and Specifications

- Developing a schedule and planning the project are the very first steps in an effective storm water program. The schedule shall clearly show how the rainy season relates to soil-disturbing and re-stabilization activities. The construction schedule shall be incorporated into the SWPPP or WPCP.

- The schedule shall include detail on the rainy season implementation and deployment of:

  – Temporary soil stabilization BMPs.

  – Temporary sediment control BMPs.

  – Tracking control BMPs.

  – Wind erosion control BMPs.

- Non-storm water BMPs.
- Waste management and materials pollution control BMPs.

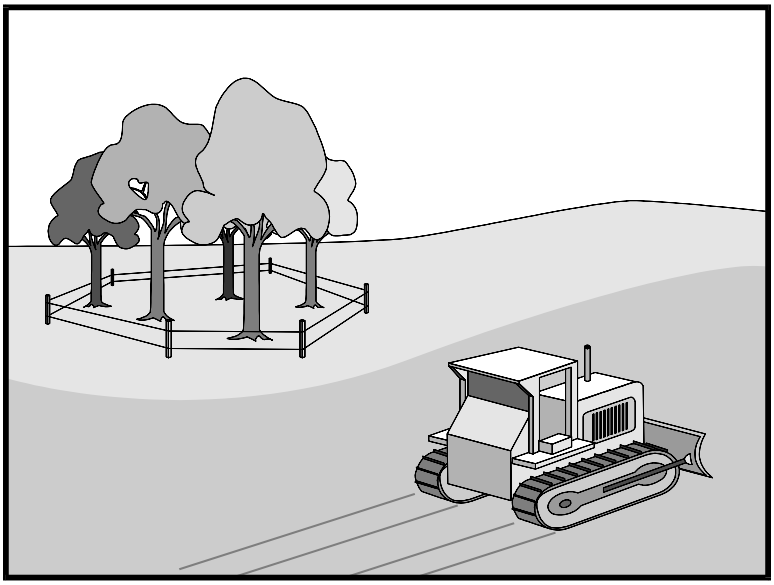
- Schedule shall also include dates for significant long-term operations or activities that may have planned non-storm water discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, bridge cleaning, etc.
- Schedule work to minimize soil disturbing activities during the rainy season.
- Develop the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, pouring foundations, installing utilities, etc., to minimize the active construction area during the rainy season.
- Schedule major grading operations for the non-rainy season when practical.
- Stabilize non-active areas within 14 days from the cessation of soil-disturbing activities or one day prior to the onset of precipitation, whichever occurs first.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment controls and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year-round to deploy soil stabilization and sediment control practices as required by Section 2 of this Manual. Erosion may be caused during dry seasons by unseasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year-round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Sequence trenching activities so that most open portions are closed before new trenching begins.
- Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
- Consider scheduling when establishing permanent vegetation (appropriate planting time for specified vegetation).
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.

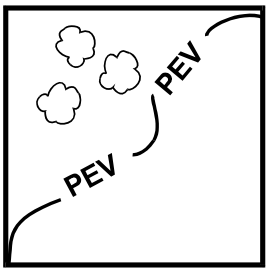
Maintenance and Inspection

- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted or when directed by the Resident Engineer (RE).
- The Special Provisions require annual submittal of a rainy season implementation schedule. Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

Preservation of Existing Vegetation

SS-2





Standard Symbol

BMP Objectives

- Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ● Non-Storm Water Management
- ○ Materials and Waste Management
- ○

Definition and Purpose

Preservation of existing vegetation is the identification and protection of desirable vegetation that provides erosion and sediment control benefits.

Appropriate Applications

- Preserve existing vegetation at areas on a site where no construction activity is planned or will occur at a later date. Specifications for preservation of existing vegetation can be found in Standard Specifications, Section 7-1.11.
- On a year-round basis, temporary fencing shall be provided prior to the commencement of clearing and grubbing operations or other soil-disturbing activities in areas.
- Clearing and grubbing operations should be staged to preserve existing vegetation.

Limitations

Protection of existing vegetation requires planning, and may limit the area available for construction activities.

Standards and Specifications

Timing

- Preservation of existing vegetation shall be provided prior to the commencement of clearing and grubbing operations or other soil-disturbing activities in areas identified on the plans to be preserved, especially on areas designated as Environmentally Sensitive Areas (ESAs).
- Preservation of existing vegetation shall conform to scheduling requirements set forth in the special provisions.

Design and Layout

- Mark areas to be preserved with temporary fencing made of orange polypropylene that is stabilized against ultraviolet light. The temporary fencing shall be at least 1 meter (3.2. ft) tall and shall have openings not larger than 50 mm by 50 mm (2 in by 2 in).

- Fence posts shall be either wood or metal, at the Contractor's discretion, as appropriate for the intended purpose. The post spacing and depth shall be adequate to completely support the fence in an upright position.

- Minimize the disturbed areas by locating temporary roadways to avoid stands of trees and shrubs and to follow existing contours to reduce cutting and filling.

- Consider the impact of grade changes to existing vegetation and the root zone.

Installation

- Construction materials, equipment storage, and parking areas shall be located where they will not cause root compaction.

- Keep equipment away from trees to prevent trunk and root damage.

- Maintain existing irrigation systems.

- Employees and subcontractors shall be instructed to honor protective devices. No heavy equipment, vehicular traffic, or storage piles of any construction materials shall be permitted within the drip line of any tree to be retained. Removed trees shall not be felled, pushed, or pulled into any retained trees. Fires shall not be permitted within 30 m (100 ft) of the drip line of any retained trees. Any fires shall be of limited size, and shall be kept under continual surveillance. No toxic or construction materials (including paint, acid, nails, gypsum board, chemicals, fuels, and lubricants) shall be stored within 15 m (50 ft) of the drip line of any retained trees, nor disposed of in any way which would injure vegetation.

Trenching and Tunneling

- Trenching shall be as far away from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching and/or tunneling near or under trees to be retained, tunnels shall be at least 450 mm (18 in) below the ground surface, and not below the tree center to minimize impact on the roots.

- Tree roots shall not be left exposed to air; they shall be covered with soil as soon as possible, protected, and kept moistened with wet burlap or peat moss until the tunnel and/or trench can be completed.

- The ends of damaged or cut roots shall be cut off smoothly.

- Trenches and tunnels shall be filled as soon as possible. Careful filling and tamping will eliminate air spaces in the soil which can damage roots.

- Remove any trees intended for retention if those trees are damaged seriously enough to affect their survival. If replacement is desired or required, the new tree shall be of similar species, and at least 50 mm (2 in) caliper, unless

otherwise required by the contract documents.

- After all other work is complete, fences and barriers shall be removed last. This is because protected trees may be destroyed by carelessness during the final cleanup and landscaping.

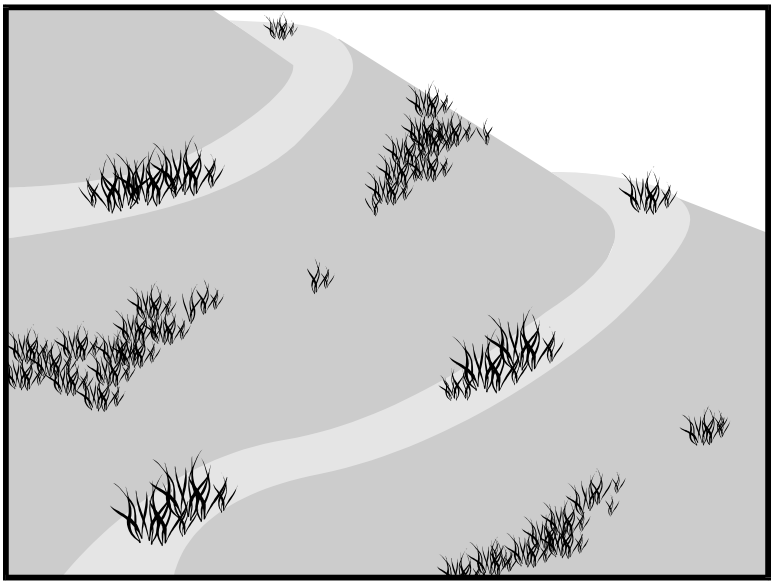
Maintenance and Inspection

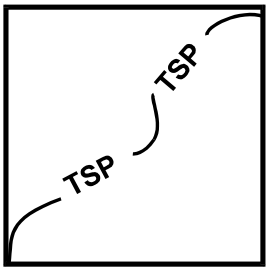
During construction, the limits of disturbance shall remain clearly marked at all times. Irrigation or maintenance of existing vegetation shall conform to the requirements in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below shall be followed:

- Serious tree injuries shall be attended to by an arborist.
- During construction, District Environmental shall be contacted to ensure that ESAs are protected.

Hydroseeding

SS-4





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Hydroseeding typically consists of applying a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydro-mulch equipment, which temporarily protects exposed soils from erosion by water and wind. This is one of five temporary soil stabilization alternatives to consider.

Appropriate Applications

- Hydroseeding is applied on disturbed soil areas requiring temporary protection until permanent vegetation is established or disturbed soil areas that must be re-disturbed following an extended period of inactivity.

Limitations

- Hydroseeding may be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and erosion control. Otherwise, hydroseeding must be used in conjunction with a soil binder or mulching (i.e., straw mulch), refer to BMP SS-5, Table 1 for options.
- Steep slopes are difficult to protect with temporary seeding.
- Temporary seeding may not be appropriate in dry periods without supplemental irrigation.
- Temporary vegetation may have to be removed before permanent vegetation is applied.
- Temporary vegetation is not appropriate for short-term inactivity.

Standards and Specifications

To select appropriate hydroseeding mixtures, an evaluation of site conditions shall be performed with respect to:

- Soil conditions
- Site topography
- Season and climate
- Vegetation types
- Maintenance requirements
- Sensitive adjacent areas
- Water availability
- Plans for permanent vegetation

■ Selection of hydroseeding mixtures shall be approved by the District Landscape Architect and the Construction Storm Water Coordinator.

The following steps shall be followed for implementation:

■ Seed mix shall comply with the Standard Specifications Section 20-2.10, and the project's special provisions.

■ Hydroseeding can be accomplished using a multiple-step or one-step process; refer to the special provisions for specified process. The multiple-step process ensures maximum direct contact of the seeds to soil. When the one-step process is used to apply the mixture of fiber, seed, etc., the seed rate shall be increased to compensate for all seeds not having direct contact with the soil.

■ Prior to application, roughen the slope, fill area, or area to be seeded with the furrows trending along the contours. Rolling with a crimping or punching type roller or track walking is required on all slopes prior to hydroseeding. Track walking shall only be used where other methods are impractical.

■ Apply a straw mulch to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow, refer to Standard Specifications Sections 20-2.06 and 20-3.03.

■ All seeds shall be in conformance with the California State Seed Law of the Department of Agriculture. Each seed bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test; provide the Resident Engineer (RE) with such documentation. The container shall be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. All legume seed shall be pellet-inoculated. Inoculant sources shall be species-specific and shall be applied at a rate of 2 kg of inoculant per 100 kg of seed (2-lb inoculant per 100-lb seed), refer to Standard Specifications Section 20-2.10.

■ Commercial fertilizer shall conform to the requirements of the California Food and Agricultural Code. Fertilizer shall be pelleted or granular form.

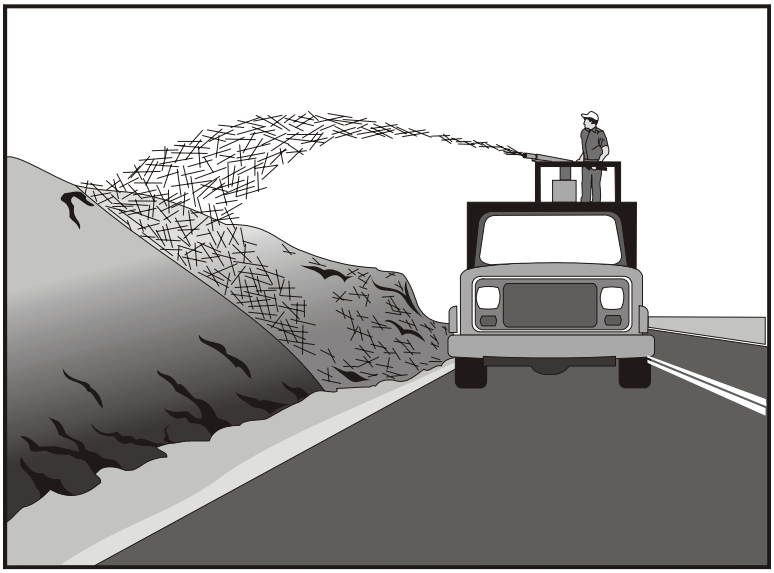
- Follow-up applications shall be made as needed to cover weak spots, and to maintain adequate soil protection.
- Avoid over-spray onto the traveled way, sidewalks, lined drainage channels, and existing vegetation.

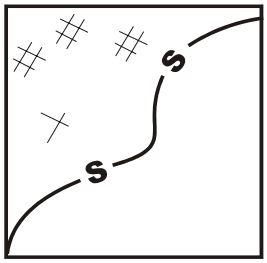
Maintenance and Inspection

- All seeded areas shall be inspected for failures and re-seeded, fertilized, and mulched within the planting season, using not less than half the original application rates. Any temporary revegetation efforts that do not provide adequate cover must be reapplied at a scheduled recommended by the Caltrans Landscape Architect or RE.
- After any rainfall event, the Contractor is responsible for maintaining all slopes to prevent erosion.

Straw Mulch

SS-6





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller or anchoring it with a stabilizing emulsion. This is one of five temporary soil stabilization alternatives to consider.

Appropriate Applications

- Straw mulch is typically used for soil stabilization as a temporary surface cover on disturbed areas until soils can be prepared for revegetation and permanent vegetation is established.
- Also typically used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

Limitations

- Availability of erosion control contractors and straw may be limited prior to the rainy season due to high demand.
- There is a potential for introduction of weed-seed and unwanted plant material.
- When straw blowers are used to apply straw mulch, the treatment areas must be within 45 m (150 ft) of a road or surface capable of supporting trucks.
- Straw mulch applied by hand is more time intensive and potentially costly.
- May have to be removed prior to permanent seeding or soil stabilization.
- “Punching” of straw does not work in sandy soils.

Standards and Specifications

- Straw shall be derived from wheat, rice, or barley.
- All materials shall conform to Standard Specifications Sections 20-2.06, 20-2.07 and 20-2.11.
- A tackifier is the preferred method for anchoring straw mulch to the soil on slopes.
- Crimping, punch roller-type rollers, or track-walking may also be used to incorporate straw mulch into the soil on slopes. Track walking shall only be used where other methods are impractical.
- Avoid placing straw onto the traveled way, sidewalks, lined drainage channels, sound walls, and existing vegetation.
- Straw mulch with tackifier shall not be applied during or immediately before rainfall.

Application Procedures

- Apply loose straw at a minimum rate of 3,570 kg/ha (4,000 lb/ac), or as indicated in the project's special provisions, either by machine or by hand distribution.
- If stabilizing emulsion will be used to anchor the straw mulch in lieu of incorporation, roughen embankment or fill areas by rolling with a crimping or punching-type roller or by track walking before placing the straw mulch. Track walking should only be used where rolling is impractical.
- The straw mulch must be evenly distributed on the soil surface.
- Anchor the mulch in place by using a tackifier or by "punching" it into the soil mechanically (incorporating).
- A tackifier acts to glue the straw fibers together and to the soil surface. The tackifier shall be selected based on longevity and ability to hold the fibers in place.
- A tackifier is typically applied at a rate of 140 kg/ha (125 lb/ac). In windy conditions, the rates are typically 200 kg/ha (178 lb/ac).
- Methods for holding the straw mulch in place depend upon the slope steepness, accessibility, soil conditions and longevity. If the selected method is incorporation of straw mulch into the soil, then do as follows:
  - Applying and incorporating straw shall follow the requirements in Standard Specifications Section 20-3.03.
  - On small areas, a spade or shovel can be used.

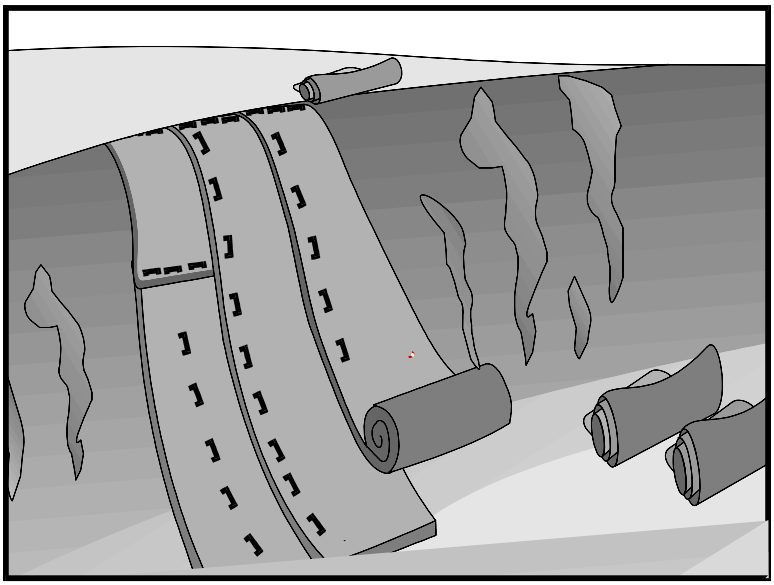
- On slopes with soils, which are stable enough and of sufficient gradient to safely support construction equipment without contributing to compaction and instability problems, straw can be "punched" into the ground using a knife-blade roller or a straight bladed coulter, known commercially as a "crimper."
- On small areas and/or steep slopes, straw can also be held in place using plastic netting or jute. The netting shall be held in place using 11 gauge wire staples, geotextile pins or wooden stakes. Refer to BMP SS-7, "Geotextiles, Plastic Covers and Erosion Control Blankets/Mats."

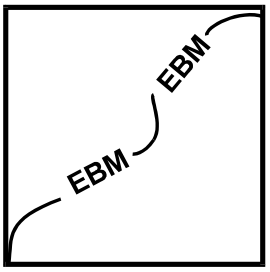
Maintenance and Inspections

- The key consideration in Maintenance and Inspection is that the straw needs to last long enough to achieve erosion control objectives.
- Maintain an unbroken, temporary mulched ground cover while DSAs are non-active. Repair any damaged ground cover and re-mulch exposed areas.
- Reapplication of straw mulch and tackifier may be required by the Resident Engineer (RE) to maintain effective soil stabilization over disturbed areas and slopes.
- After any rainfall event, the Contractor is responsible for maintaining all slopes to prevent erosion.

Geotextiles, Mats, Plastic Covers and Erosion Control Blankets

SS-7





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

This Best Management Practice (BMP) involves the placement of geotextiles, mats, plastic covers, or erosion control blankets to stabilize disturbed soil areas and protect soils from erosion by wind or water. This is one of five temporary soil stabilization alternatives to consider.

Appropriate Applications

These measures are used when disturbed soils may be particularly difficult to stabilize, including the following situations:

- Steep slopes, generally steeper than 1:3 (V:H).
- Slopes where the erosion potential is high.
- Slopes and disturbed soils where mulch must be anchored.
- Disturbed areas where plants are slow to develop.
- Channels with flows exceeding 1.0 m/s (3.3 ft/s).
- Channels to be vegetated.
- Stockpiles.
- Slopes adjacent to water bodies of Environmentally Sensitive Areas (ESAs).

Limitations

- Blankets and mats are more expensive than other erosion control measures, due to labor and material costs. This usually limits their application to areas inaccessible to hydraulic equipment, or where other measures are not applicable, such as channels.
- Blankets and mats are generally not suitable for excessively rocky sites, or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Blankets and mats must be removed and disposed of prior to application of permanent soil stabilization measures.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- The use of plastic shall be limited to covering stockpiles, or very small graded areas for short periods of time (such as through one imminent storm event), until alternative measures, such as seeding and mulching, may be installed.
- Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.

Standards and Specifications

Material Selection

There are many types of erosion control blankets and mats, and selection of the appropriate type shall be based on the specific type of application and site conditions. Selection(s) made by the Contractor must be approved by the Resident Engineer (RE); certification of compliance shall be in accordance with Standard Specifications Section 6-1.07.

Geotextiles

- Material shall be a woven polypropylene fabric with minimum thickness of 1.5 mm (0.06 inch), minimum width of 3.7 m (12 ft) and shall have minimum tensile strength of 0.67 kN (warp) 0.36 kN (fill) in conformance with the requirements in ASTM Designation: D 4632. The permittivity of the fabric shall be approximately 0.07 sec –1 in conformance with the requirements in ASTM Designation: D4491. The fabric shall have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets shall be secured in place with wire staples or sandbags and by keying into tops of slopes and edges to prevent infiltration of surface waters under Geotextile. Staples shall be made of 3.05-mm (0.12-inch) steel wire and shall be U-shaped with 200-mm (8-inch) legs and 50-mm (2-inch) crown.
- Geotextiles may be reused if, in the opinion of the RE, they are suitable for the use intended.

Plastic Covers

- Plastic sheeting shall have a minimum thickness of 6 mil, and shall be keyed in at the top of slope and firmly held in place with sandbags or other weights placed no more than 3 m (10 ft) apart. Seams are typically taped or weighted down their entire length, and there shall be at least a 300 mm to 600 mm (12 to 24 inches) overlap of all seams. Edges shall be embedded a minimum of 150 mm (6 inches) in soil.

- All sheeting shall be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures shall be repaired immediately. If washout or breakages occurs, the material shall be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats

- Biodegradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. For an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable.

  – **Jute** is a natural fiber that is made into a yarn, which is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which shall be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  – **Excelsior (curled wood fiber)** blanket material shall consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 150 mm (6 inches) or longer. The excelsior blanket shall be of consistent thickness. The wood fiber shall be evenly distributed over the entire area of the blanket. The top surface of the blanket shall be covered with a photodegradable extruded plastic mesh. The blanket shall be smolder resistant without the use of chemical additives and shall be non-toxic and non-injurious to plant and animal life. Excelsior blanket shall be furnished in rolled strips, a minimum of 1220 mm (48 inches) wide, and shall have an average weight of 0.5 kg/m^2 (12 lb/ft^2), ±10 percent, at the time of manufacture. Excelsior blankets shall be secured in place with wire staples. Staples shall be made of 3.05-mm (0.12 inch) steel wire and shall be U-shaped with 200-mm (8-inch) legs and 50-mm (2-inch) crown.

- **Straw blanket** shall be machine-produced mats of straw with a lightweight biodegradable netting top layer. The straw shall be attached to the netting with biodegradable thread or glue strips. The straw blanket shall be of consistent thickness. The straw shall be evenly distributed over the entire area of the blanket. Straw blanket shall be furnished in rolled strips a minimum of 2 m (6.5 ft) wide, a minimum of 25 m (80 ft) long and a minimum of 0.27 kg/m2 (6.4 lb/ft2). Straw blankets shall be secured in place with wire staples. Staples shall be made of 3.05-mm (0.12 inch) steel wire and shall be U-shaped with 200-mm (8-inch) legs and 50-mm (2-inch) crown.

- **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance revegetation. The material is furnished in rolled strips, which shall be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Coconut fiber blanket** shall be machine-produced mats of 100% coconut fiber with biodegradable netting on the top and bottom. The coconut fiber shall be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket shall be of consistent thickness. The coconut fiber shall be evenly distributed over the entire area of the blanket. Coconut fiber blanket shall be furnished in rolled strips with a minimum of 2 m (6.5 ft) wide, a minimum of 25 m (80 ft) long and a minimum of 0.27-kg/m2 (6.4 lb/ft2). Coconut fiber blankets shall be secured in place with wire staples. Staples shall be made of 3.05-mm (0.12 inch) steel wire and shall be U-shaped with 200-mm (8-inch) legs and 50-mm (2-inch) crown.

- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which shall be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Straw coconut fiber blanket** shall be machine-produced mats of 70% straw and 30% coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber shall be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket shall be of consistent thickness. The straw and coconut fiber shall be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket shall be furnished in rolled strips a minimum of 2 m (6.5 ft) wide, a minimum of 25 m (80 ft) long and a minimum of 0.27 kg/m2 (6.4 lb/ft2). Straw coconut fiber blankets shall be secured in place with wire staples. Staples shall be made of 3.05-mm (0.12-inch) steel wire and shall be U-shaped with 200-mm (8-inch) legs and 50-mm (2-inch) crown.

- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

  - **Plastic netting** is a lightweight biaxially-oriented netting designed for securing loose mulches like straw to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which shall be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Plastic mesh** is an open-weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than 0.5 cm (0.2 inch). It is used with revegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which shall be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three-dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be revegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which shall be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Bonded synthetic fibers** consist of a three-dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90% open area, which facilitates root growth. Its tough root-reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that shall be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high-strength continuous-filament geomatrix or net stitched to the bottom. The material is designed to enhance revegetation. The material is furnished in rolled strips, which shall be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil.
- Grade and shape the area of installation.
- Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.
- Prepare seedbed by loosening 50 mm (2 in) to 75 mm (3 in) of topsoil.

Seeding

Seed the area before blanket installation for erosion control and revegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all check slots and other areas disturbed during installation must be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Anchoring

- U-shaped wire staples, metal geotextile stake pins or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.
- Staples shall be made of 3.05 mm (0.12 inch) steel wire and shall be U-shaped with 200-mm (8-inch) legs and 50-mm (2-inch) crown.
- Metal stake pins shall be 5 mm (0.188 in) diameter steel with a 40 mm (1.5 in) steel washer at the head of the pin.
- Wire staples and metal stakes shall be driven flush to the soil surface.
- All anchors shall be 150 mm (6 in) to 450 mm (18 in) long and have sufficient ground penetration to resist pullout. Longer anchors may be required for loose soils.

Installation on Slopes

Installation shall be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 150 mm (6 in) deep by 150 mm (6 in) wide trench. Backfill trench and tamp earth firmly.
- Unroll blanket downslope in the direction of water flow.

- Overlap the edges of adjacent parallel rolls 50 mm (2 in) to 75 mm (3 in) and staple every 1 m (3 ft).
- When blankets must be spliced, place blankets end over end (shingle style) with 150 mm (6 in) overlap. Staple through overlapped area, approximately 300 mm (12 in) apart.
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
- Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples shall be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (V:H) to 1:2 (V:H), require a minimum of 2 staples/m2 (2 staples/yd2). Moderate slopes, 1:2 (V:H) to 1:3 (V:H), require a minimum of 1½ staples/m2 (1 ½ staples/yd2), placing 1 staple/m (1 staple/yd) on centers. Gentle slopes require a minimum of 1 staple/m2 (1 staple/yd2).

Installation in Channels

Installation shall be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 300 mm (12 in) deep and 150 mm (6 in) wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 150 mm (6 in) deep and 150 mm (6 in) wide across the channel at 8 m to 10 m (25 ft to 30 ft) intervals along the channels.
- Cut longitudinal channel anchor slots 100 mm (4 in) deep and 100 mm (4 in) wide along each side of the installation to bury edges of matting, whenever possible extend matting 50 mm (2 in) to 75 mm (3 in) above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 300 mm (12 in) intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 75 mm (3 in).
- Secure these initial ends of mats with anchors at 300 mm (12 in) intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 75 mm (3 in) overlap.

- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 300 mm (12 in) intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.

- Alternate method for non-critical installations: Place two rows of anchors on 150 mm (6 in) centers at 8 m (25 ft) to 10 m (30 ft) intervals in lieu of excavated check slots.

- Shingle-lap spliced ends by a minimum of 300 mm (12 in) apart on 300 mm (12 in) intervals.

- Place edges of outside mats in previously excavated longitudinal slots, anchor using prescribed staple pattern, backfill and compact soil.

- Anchor, fill and compact upstream end of mat in a 300 mm (12 in) by 150 mm (6 in) terminal trench.

- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.

- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement)

- Always consult the manufacturer's recommendations for installation.

- Do not drive tracked or heavy equipment over mat.

- Avoid any traffic over matting if loose or wet soil conditions exist.

- Use shovels, rakes or brooms for fine grading and touch up.

- Smooth out soil filling, just exposing top netting of mat.

Temporary Soil Stabilization Removal

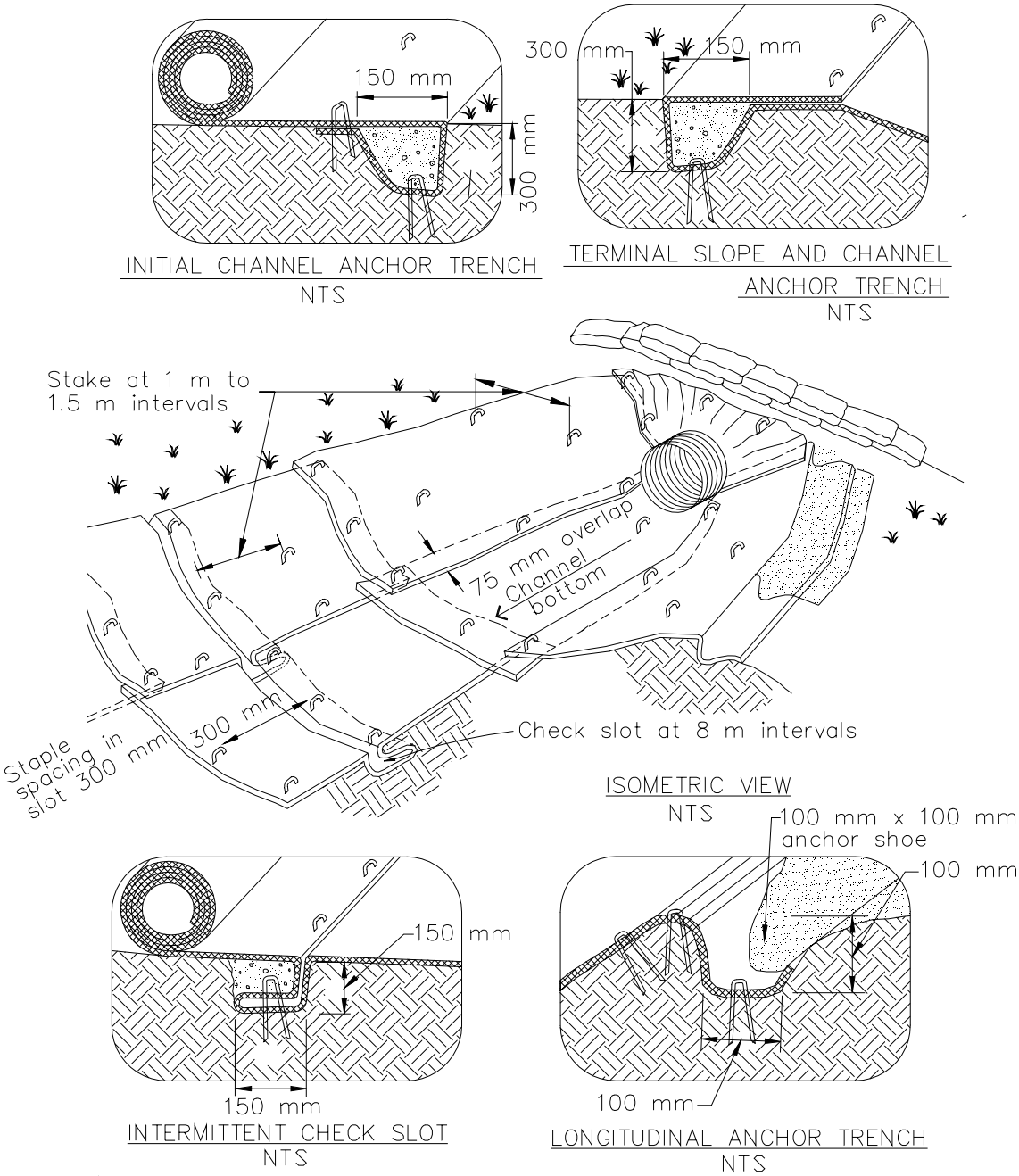
- When no longer required for the work, temporary soil stabilization shall become the property of the Contractor. Temporary soil stabilization removed from the site of the work shall be disposed of outside the highway right-of-way in conformance with the provisions in Standard Specifications Section 7-1.13. If approved by the RE, the contractor may leave the temporary soil stabilizer in place.

Maintenance and Inspection

Areas treated with temporary soil stabilization shall be inspected as specified in the special provisions. Areas treated with temporary soil stabilization shall be maintained to provide adequate erosion control. Temporary soil stabilization shall be reapplied or replaced on exposed soils when area becomes exposed or exhibits visible erosion.

- All blankets and mats shall be inspected periodically after installation.
- Installation shall be inspected after significant rain storms to check for erosion and undermining. Any failures shall be repaired immediately.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.

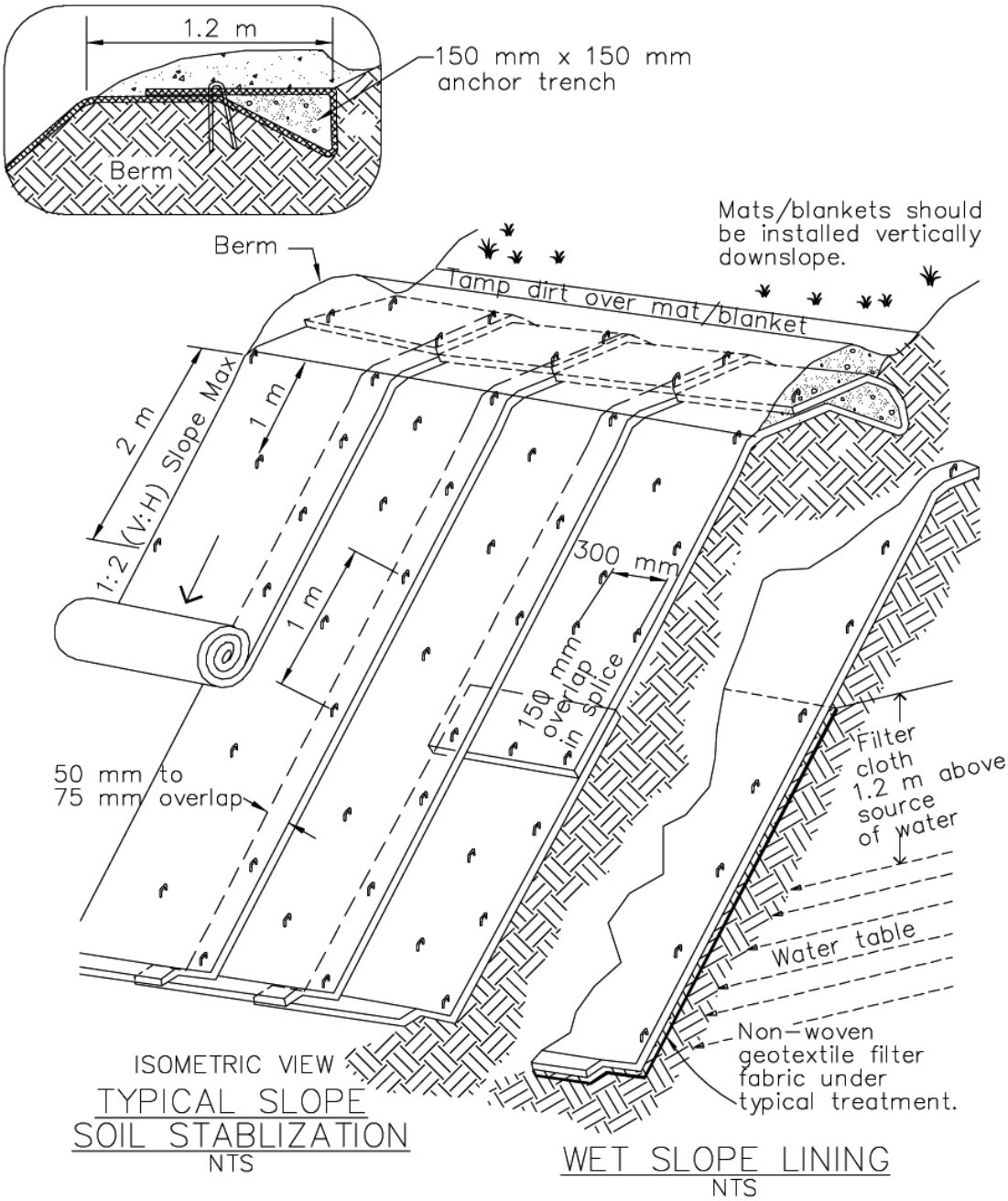
Typical Installation Detail



NOTES:

1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.
3. Install per manufacturer's recommendations

Typical Installation Detail

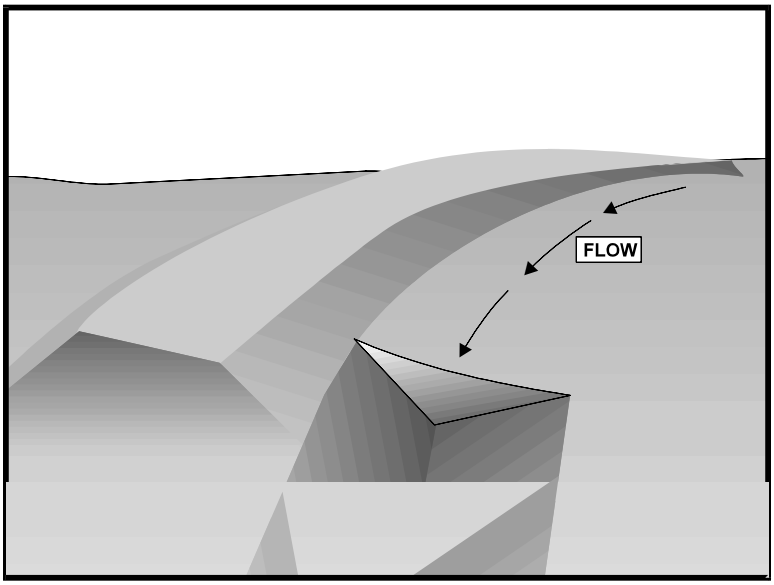


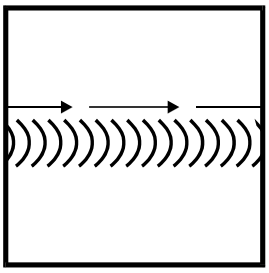
NOTES:

1. Slope surface shall be free of rocks, clods, sticks and grass. Mats/blankets shall have good soil contact.
2. Lay blankets loosely and stake or staple to maintain direct contact with the soil. Do not stretch.
3. Install per manufacturer's recommendations

Earth Dikes/Drainage Swales and Lined Ditches

SS-9





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

These are structures that intercept, divert and convey surface run-on, generally sheet flow, to prevent erosion.

Appropriate Applications

- Earth dikes/drainage swales and lined ditches may be used to:
  - Convey surface runoff down sloping land.
  - Intercept and divert runoff to avoid sheet flow over sloped surfaces.
  - Divert and direct runoff towards a stabilized watercourse, drainage pipe or channel.
  - Intercept runoff from paved surfaces.
- Earth dikes/drainage swales and lined ditches also may be used:
  - Below steep grades where runoff begins to concentrate.
  - Along roadways and facility improvements subject to flood drainage.
  - At the top of slopes to divert run-on from adjacent or undisturbed slopes.
  - At bottom and mid-slope locations to intercept sheet flow and convey concentrated flows.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Resident Engineer (RE).

Earth Dikes/Drainage Swales and Lined Ditches

SS-9

Limitations

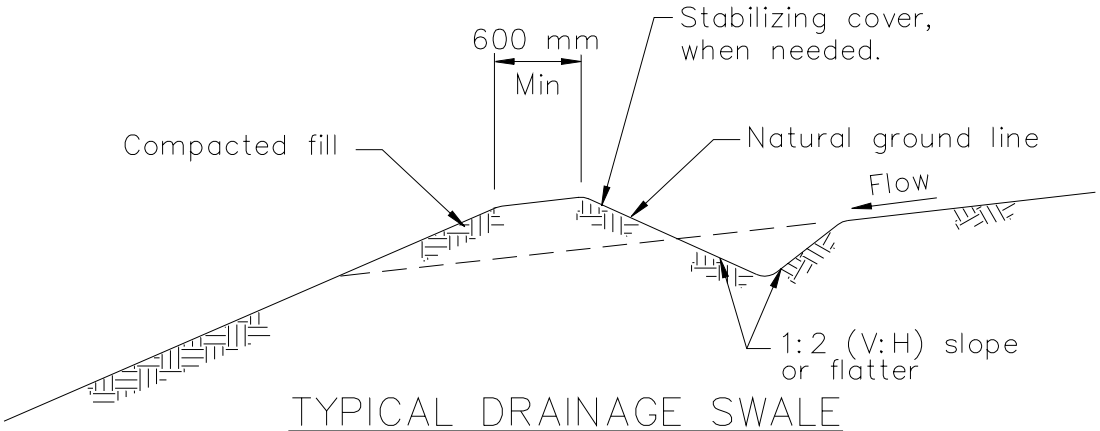
- Earth dikes/drainage swales and lined ditches are not suitable as sediment trapping devices.
- May be necessary to use other soil stabilization and sediment controls, such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales and ditches.

Standards and Specifications

- Care must be applied to correctly size and locate earth dikes, drainage swales and lined ditches. Excessively steep, unlined dikes and swales are subject to erosion and gully formation.
- Conveyances shall be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, over topping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff from the highway right-of-way onto other property.
- When possible, install and utilize permanent dikes, swales and ditches early in the construction process.
- Provide stabilized outlets. Refer to SS-10, "Outlet Protection/Velocity/ Dissipation Devices."

Maintenance and Inspections

- Inspect temporary measures prior to the rainy season, after rainfall events, and regularly (approximately once per week) during the rainy season.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment, and repair linings and embankments as needed or as directed by the RE.
- Temporary conveyances shall be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

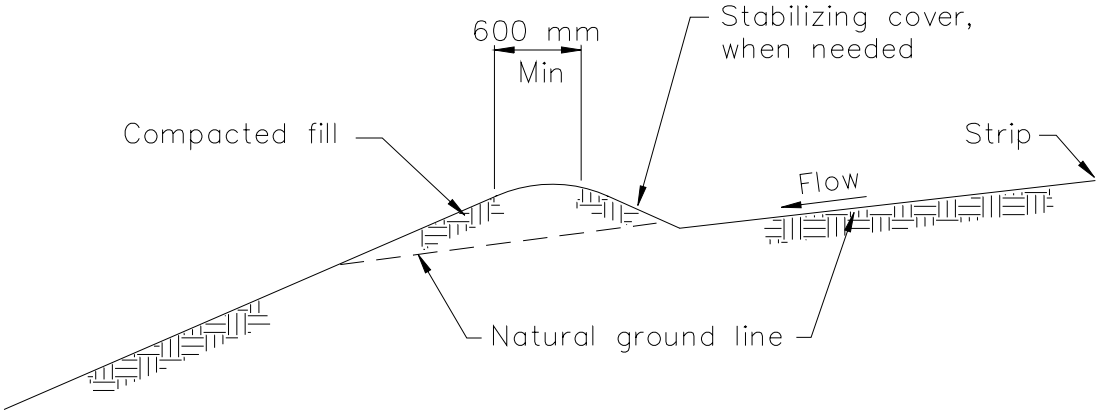


TYPICAL DRAINAGE SWALE

NOT TO SCALE

NOTES:

1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade, in conformance with Section 19–5 of the Caltrans Standard Specifications.

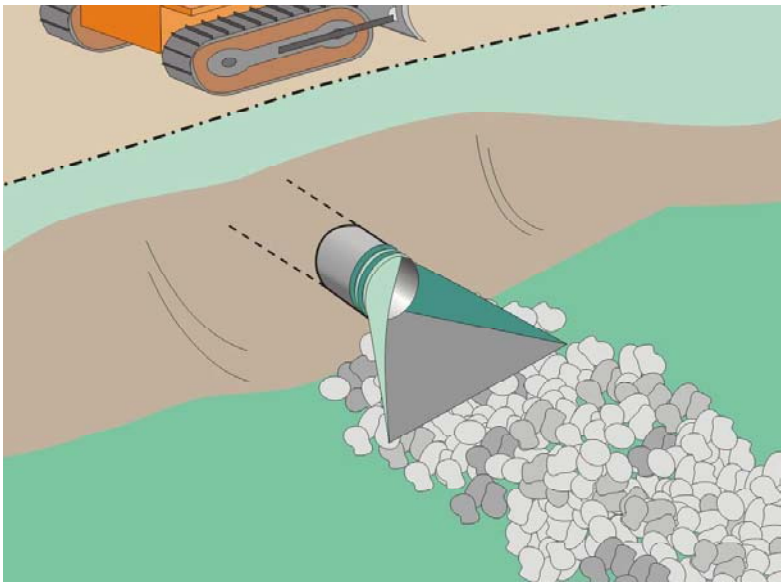


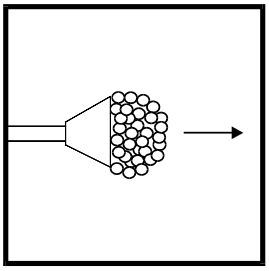
TYPICAL EARTH DIKE

NOT TO SCALE

Outlet Protection/Velocity Dissipation Devices

SS-10





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

These devices are placed at pipe outlets to prevent scour and reduce the velocity and/or energy of storm water flows.

Appropriate Applications

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits or channels.
  - Outlets located at the bottom of mild to steep slopes.
  - Discharge outlets that carry continuous flows of water.
  - Outlets subject to short, intense flows of water, such as flash floods.
  - Points where lined conveyances discharge to unlined conveyances.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Resident Engineer (RE).

Limitations

- Loose rock may have stones washed away during high flows.
- Grouted riprap may break up in areas of freeze and thaw.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.

Outlet Protection/Velocity Dissipation Devices

SS-10

Standards and Specifications

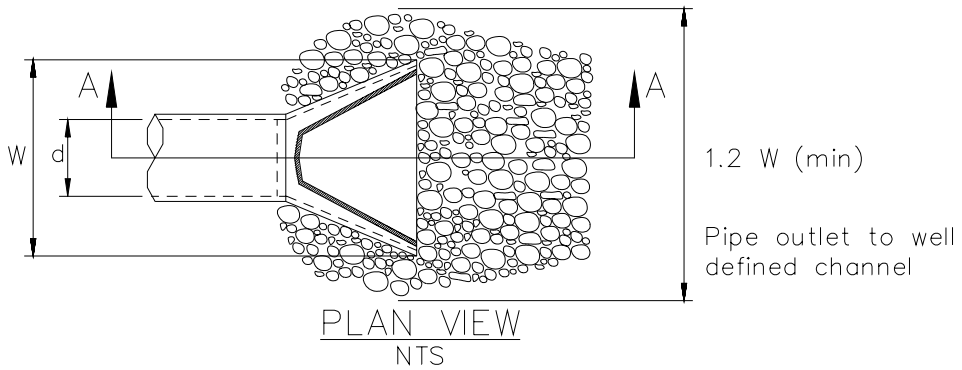
- There are many types of energy dissipaters, with rock being the one that is represented in the figure on Page 3. Please note that this is only one example and the RE may approve other types of devices proposed by the contractor.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction.
- Carefully place riprap to avoid damaging the filter fabric.
- For proper operation of apron:
  - Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron.
  - If size of apron riprap is large, protect underlying filter fabric with a gravel blanket.
- Outlets on slopes steeper than 10% shall have additional protection.

Maintenance and Inspection

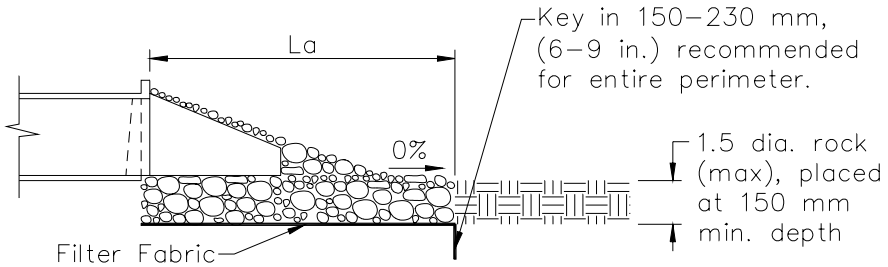
- Inspect temporary measures prior to the rainy season, after rainfall events, and regularly (approximately once per week) during the rainy season.
- Inspect apron for displacement of the riprap and/or damage to the underlying fabric. Repair fabric and replace riprap that has washed away.
- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.
- Temporary devices shall be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

Outlet Protection/Velocity Dissipation Devices

SS-10



PLAN VIEW
NTS

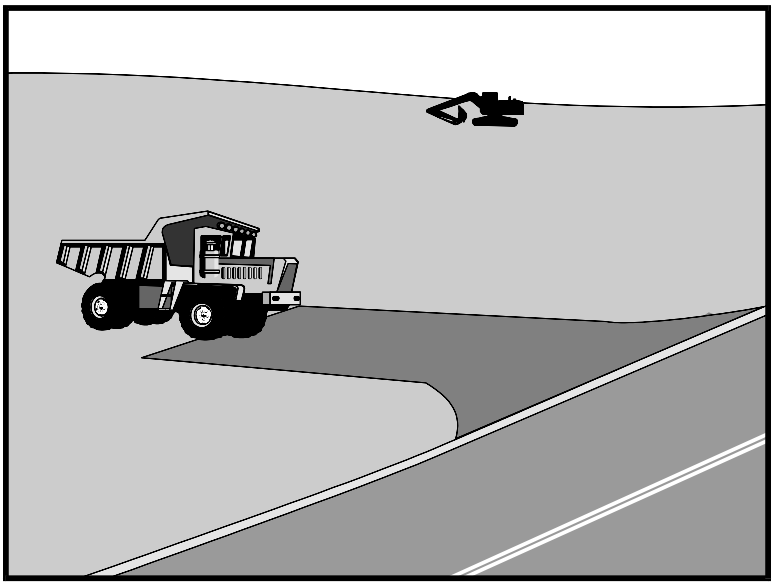


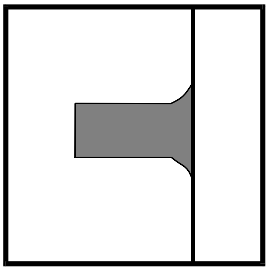
SECTION A–A
NTS

Pipe Diameter mm	Discharge m^3/s	Apron Length, La m	Rip Rap D_{50} Diameter Min mm
300	0.14	3	100
	0.28	4	150
450	0.28	3	150
	0.57	5	200
	0.85	7	300
	1.13	8	400
600	0.85	5	200
	1.13	8	200
	1.42	8	300
	1.70	9	400
For larger or higher flows, consult a Registered Civil Engineer			

Source: USDA – SCS

Stabilized Construction Entrance/Exit TC-1





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ● Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Appropriate Applications

- Use at construction sites:
  - Where dirt or mud can be tracked onto public roads.
  - Adjacent to water bodies.
  - Where poor soils are encountered.
  - Where dust is a problem during dry weather conditions.
- This BMP may be implemented on a project-by-project basis in addition to other BMPs when determined necessary and feasible by the Resident Engineer (RE).

Limitations

- Site conditions will dictate design and need.

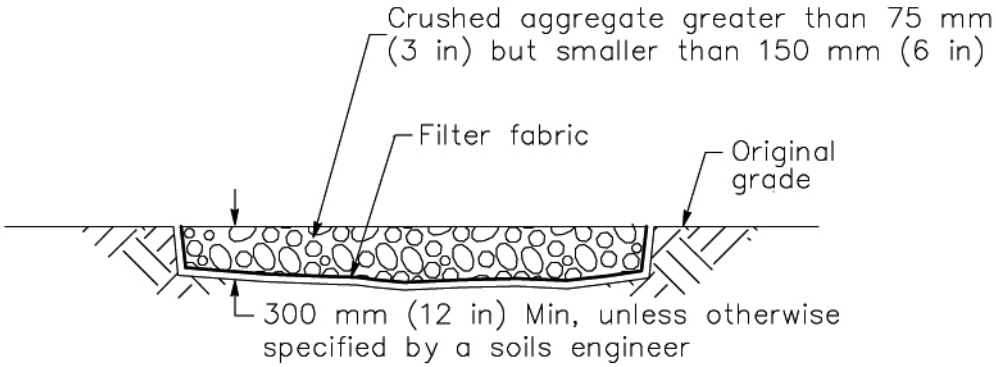
Standards and Specifications

- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment-trapping device before discharge.
- Design stabilized entrance/exit to support the heaviest vehicles and equipment that will use it.

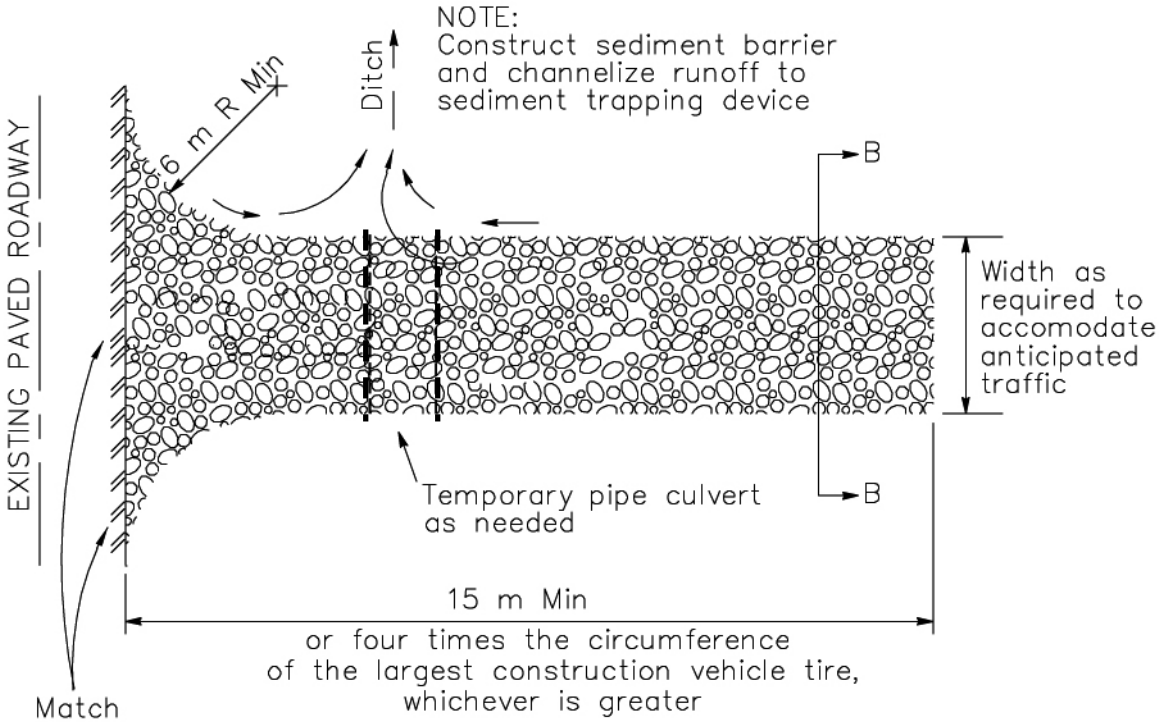
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. The use of asphalt concrete (AC) grindings for stabilized construction access/roadway is not allowed.
- Use of constructed/manufactured steel plates with ribs for entrance/exit access is allowed with written approval from the RE.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 300 mm (12 in) depth, or place aggregate to a depth recommended by the RE. Crushed aggregate greater than 75 mm (3 inches) and smaller than 150 mm (6 inches) shall be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Implement BMP SC-7, "Street Sweeping and Vacuuming" as needed and as required.
- Require all employees, subcontractors, and suppliers to utilize the stabilized construction access.
- All exit locations intended to be used continuously and for a period of time shall have stabilized construction entrance/exit BMPs (TC-1 "Stabilized Construction Entrance/Exit" or TC-3 "Entrance/Outlet Tire Wash").

Maintenance and Inspection

- Inspect routinely for damage and assess effectiveness of the BMP. Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment or as directed by the RE.
- Keep all temporary roadway ditches clear.
- Inspect for damage and repair as needed.

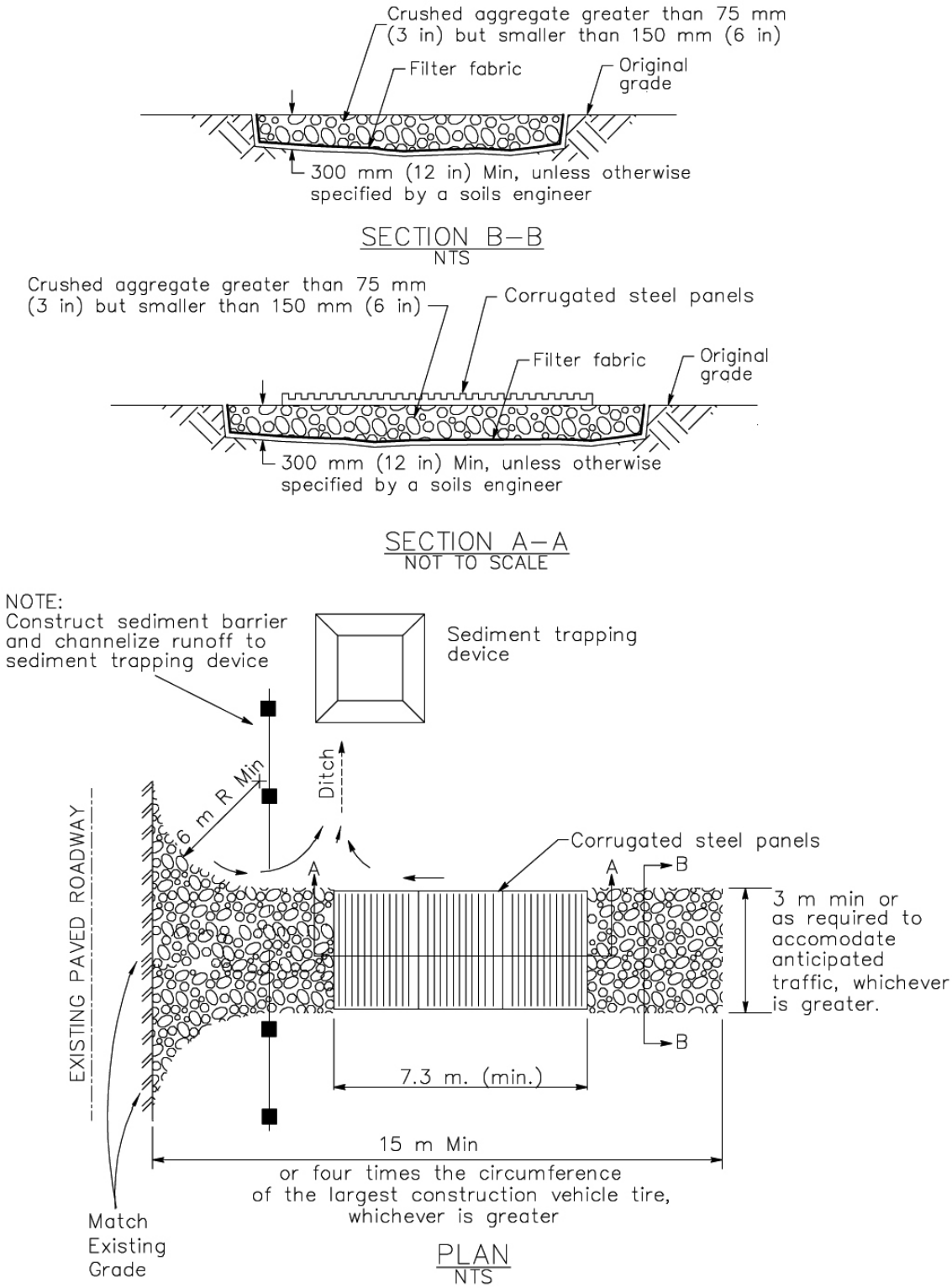


SECTION B–B
NTS



PLAN
NTS

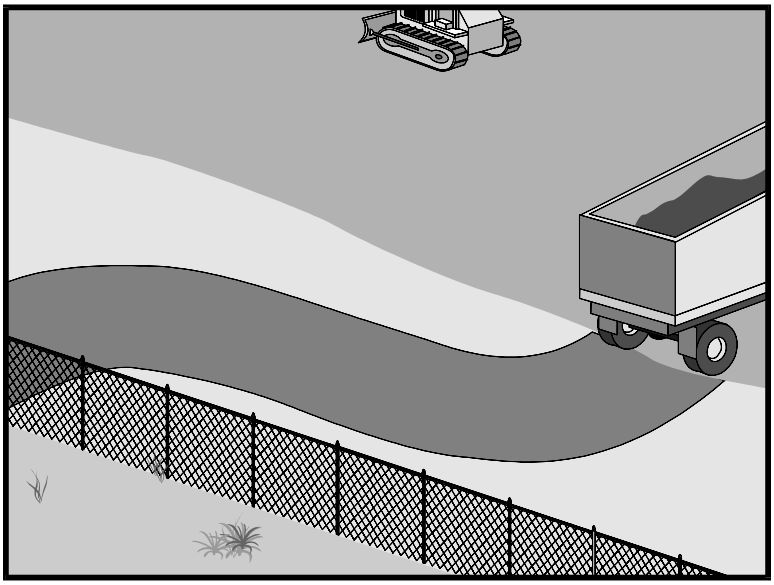
Stabilized Contraction Entrance/Exit (Type 1)

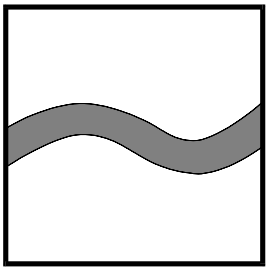


Stabilized Construction Entrance/Exit (Type 2)

Stabilized Construction Roadway

TC-2





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ● Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A stabilized construction roadway is a temporary access road. It is designed for the control of dust and erosion created by vehicular tracking.

Appropriate Applications

- Construction roadways and short-term detour roads:
  - Where mud tracking is a problem during wet weather.
  - Where dust is a problem during dry weather.
  - Adjacent to water bodies.
  - Where poor soils are encountered.
  - Where there are steep grades and additional traction is needed.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Resident Engineer (RE).

Limitations

- Materials will likely need to be removed prior to final project grading and stabilization.
- Site conditions will dictate design and need.
- May not be applicable to very short duration projects.
- Limit speed of vehicles to control dust.

Standards and Specifications

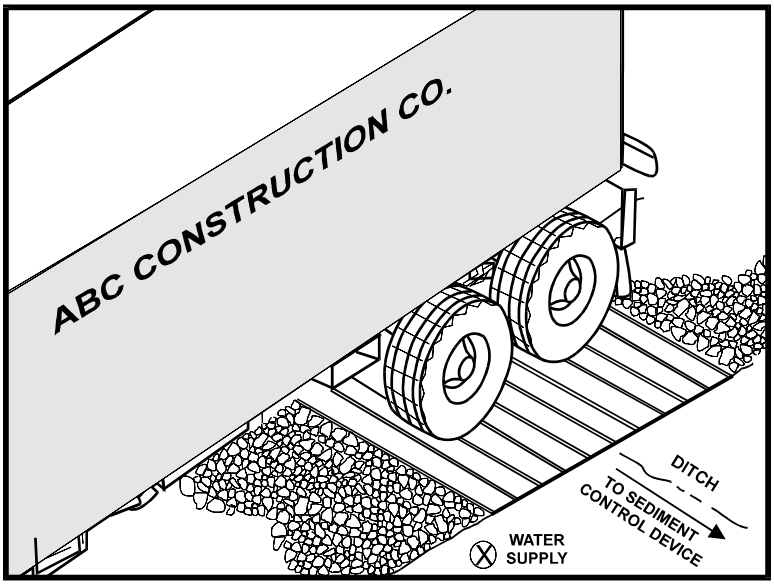
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support the heaviest vehicles and equipment that will use it.
- Stabilize roadway using aggregate, asphalt concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphalt concrete (AC) grindings for stabilized construction roadway is not allowed.
- Coordinate materials with those used for stabilized construction entrance/exit points.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 300 mm (12 in) depth, or place aggregate to a depth recommended by the RE or Construction Storm Water Coordinator. Crushed aggregate greater than 75 mm (3 inches) and smaller than 150 mm (6 inches) shall be used.

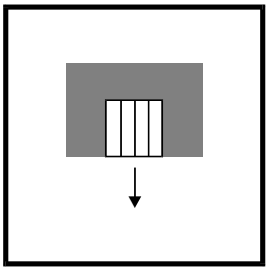
Maintenance and Inspection

- Inspect routinely for damage and repair as needed, or as directed by the RE.
- Keep all temporary roadway ditches clear.
- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.

Entrance/Outlet Tire Wash

TC-3





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ● Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and undercarriages, and to prevent sediment from being transported onto public roadways.

Appropriate Applications

- Tire washes may be used on construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Resident Engineer (RE).

Limitations

- Requires a supply of wash water.
- Requires a turnout or doublewide exit to avoid having entering vehicles drive through the wash area.

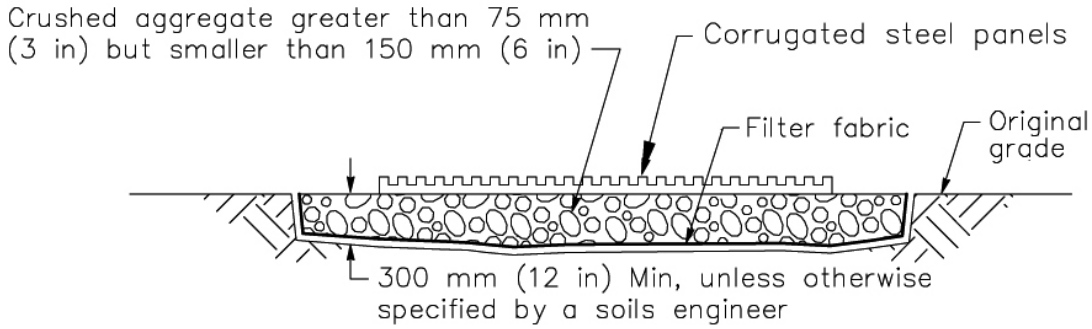
Standards and Specifications

- Incorporate with a stabilized construction entrance/exit. See BMP TC-1, "Stabilized Construction Entrance/Exit."
- Construct on level ground when possible, on a pad of coarse aggregate, greater than 75 mm (3 inches) and smaller than 150 mm (6 inches). A geotextile fabric shall be placed below the aggregate.
- Wash rack shall be designed and constructed/manufactured for anticipated traffic loads.
- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device. The drainage ditch shall be of sufficient grade, width, and depth to carry the wash runoff.

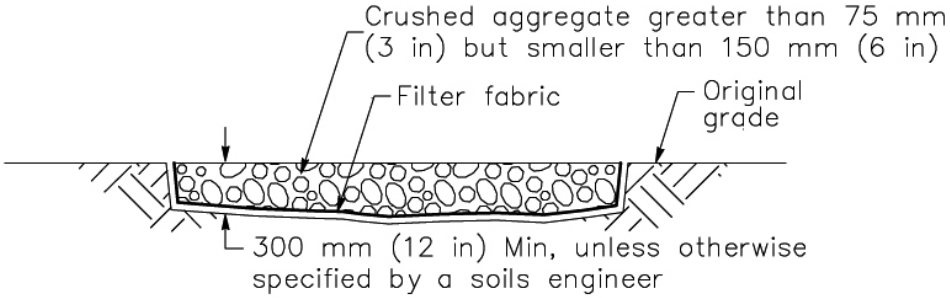
- Require all employees, subcontractors, and others that leave the site with mud-caked tires and/or undercarriages to use the wash facility.
- Implement BMP SC-7, “Street Sweeping and Vacuuming” as needed.
- Use of constructed or prefabricated steel plate with ribs for entrance/exit access is allowed with written approval of RE.

Maintenance and Inspection

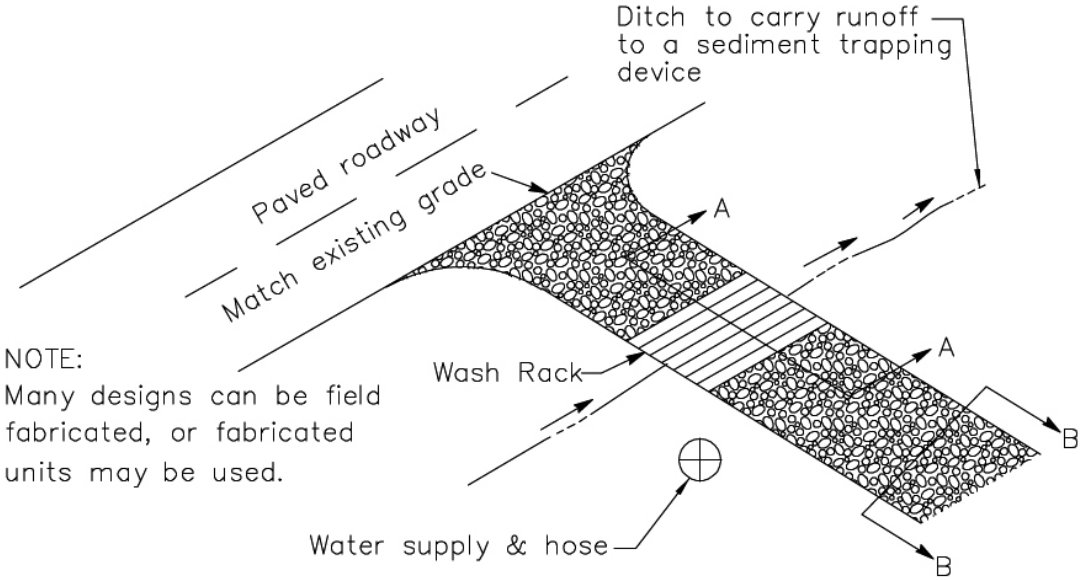
- Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance.
- Inspect routinely for damage and repair as needed.



SECTION A–A
NOT TO SCALE

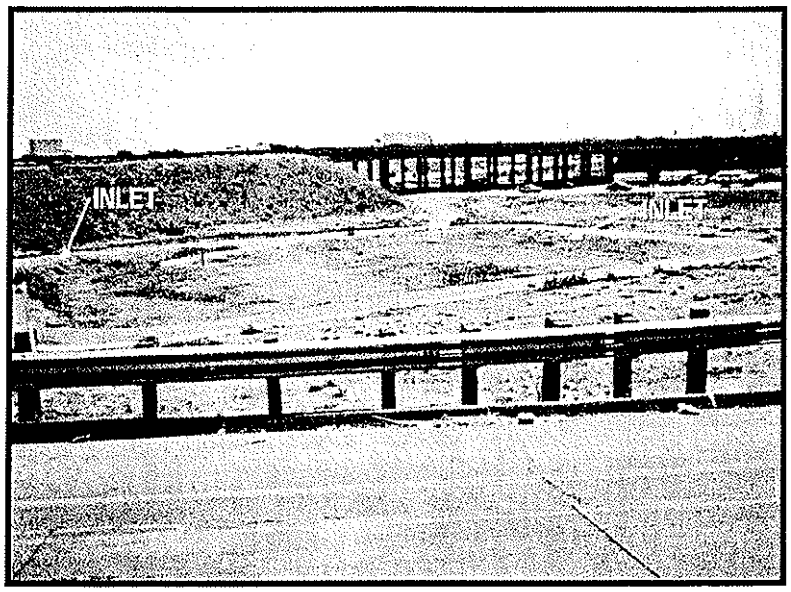


SECTION B–B
NTS



TYPICAL TIRE WASH
NOT TO SCALE

Infiltration Basin TC-11



Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

Targeted Constituents

☑	Sediment	■
☑	Nutrients	■
☑	Trash	■
☑	Metals	■
☑	Bacteria	■
☑	Oil and Grease	■
☑	Organics	■

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

California Experience

Infiltration basins have a long history of use in California, especially in the Central Valley. Basins located in Fresno were among those initially evaluated in the National Urban Runoff Program and were found to be effective at reducing the volume of runoff, while posing little long-term threat to groundwater quality (EPA, 1983; Schroeder, 1995). Proper siting of these devices is crucial as underscored by the experience of Caltrans in siting two basins in Southern California. The basin with marginal separation from groundwater and soil permeability failed immediately and could never be rehabilitated.

Advantages

- Provides 100% reduction in the load discharged to surface waters.
- The principal benefit of infiltration basins is the approximation of pre-development hydrology during which a

significant portion of the average annual rainfall runoff is infiltrated and evaporated rather than flushed directly to creeks.

- If the water quality volume is adequately sized, infiltration basins can be useful for providing control of channel forming (erosion) and high frequency (generally less than the 2-year) flood events.

Limitations

- May not be appropriate for industrial sites or locations where spills may occur.
- Infiltration basins require a minimum soil infiltration rate of 0.5 inches/hour, not appropriate at sites with Hydrologic Soil Types C and D.
- If infiltration rates exceed 2.4 inches/hour, then the runoff should be fully treated prior to infiltration to protect groundwater quality.
- Not suitable on fill sites or steep slopes.
- Risk of groundwater contamination in very coarse soils.
- Upstream drainage area must be completely stabilized before construction.
- Difficult to restore functioning of infiltration basins once clogged.

Design and Sizing Guidelines

- Water quality volume determined by local requirements or sized so that 85% of the annual runoff volume is captured.
- Basin sized so that the entire water quality volume is infiltrated within 48 hours.
- Vegetation establishment on the basin floor may help reduce the clogging rate.

Construction/Inspection Considerations

- Before construction begins, stabilize the entire area draining to the facility. If impossible, place a diversion berm around the perimeter of the infiltration site to prevent sediment entrance during construction or remove the top 2 inches of soil after the site is stabililized. Stabilize the entire contributing drainage area, including the side slopes, before allowing any runoff to enter once construction is complete.
- Place excavated material such that it can not be washed back into the basin if a storm occurs during construction of the facility.
- Build the basin without driving heavy equipment over the infiltration surface. Any equipment driven on the surface should have extra-wide ("low pressure") tires. Prior to any construction, rope off the infiltration area to stop entrance by unwanted equipment.
- After final grading, till the infiltration surface deeply.
- Use appropriate erosion control seed mix for the specific project and location.

Performance

As water migrates through porous soil and rock, pollutant attenuation mechanisms include precipitation, sorption, physical filtration, and bacterial degradation. If functioning properly, this approach is presumed to have high removal efficiencies for particulate pollutants and moderate removal of soluble pollutants. Actual pollutant removal in the subsurface would be expected to vary depending upon site-specific soil types. This technology eliminates discharge to surface waters except for the very largest storms; consequently, complete removal of all stormwater constituents can be assumed.

There remain some concerns about the potential for groundwater contamination despite the findings of the NURP and Nightingale (1975; 1987a,b,c; 1989). For instance, a report by Pitt et al. (1994) highlighted the potential for groundwater contamination from intentional and unintentional stormwater infiltration. That report recommends that infiltration facilities not be sited in areas where high concentrations are present or where there is a potential for spills of toxic material. Conversely, Schroeder (1995) reported that there was no evidence of groundwater impacts from an infiltration basin serving a large industrial catchment in Fresno, CA.

Siting Criteria

The key element in siting infiltration basins is identifying sites with appropriate soil and hydrogeologic properties, which is critical for long term performance. In one study conducted in Prince George's County, Maryland (Galli, 1992), all of the infiltration basins investigated clogged within 2 years. It is believed that these failures were for the most part due to allowing infiltration at sites with rates of less than 0.5 in/hr, basing siting on soil type rather than field infiltration tests, and poor construction practices that resulted in soil compaction of the basin invert.

A study of 23 infiltration basins in the Pacific Northwest showed better long-term performance in an area with highly permeable soils (Hilding, 1996). In this study, few of the infiltration basins had failed after 10 years. Consequently, the following guidelines for identifying appropriate soil and subsurface conditions should be rigorously adhered to.

- Determine soil type (consider RCS soil type 'A, B or C' only) from mapping and consult USDA soil survey tables to review other parameters such as the amount of silt and clay, presence of a restrictive layer or seasonal high water table, and estimated permeability. The soil should not have more than 30% clay or more than 40% of clay and silt combined. Eliminate sites that are clearly unsuitable for infiltration.

- Groundwater separation should be at least 3 m from the basin invert to the measured ground water elevation. There is concern at the state and regional levels of the impact on groundwater quality from infiltrated runoff, especially when the separation between groundwater and the surface is small.

- Location away from buildings, slopes and highway pavement (greater than 6 m) and wells and bridge structures (greater than 30 m). Sites constructed of fill, having a base flow or with a slope greater than 15% should not be considered.

- Ensure that adequate head is available to operate flow splitter structures (to allow the basin to be offline) without ponding in the splitter structure or creating backwater upstream of the splitter.

- Base flow should not be present in the tributary watershed.

Secondary Screening Based on Site Geotechnical Investigation

- At least three in-hole conductivity tests shall be performed using USBR 7300-89 or Bouwer-Rice procedures (the latter if groundwater is encountered within the boring), two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m. The tests shall measure permeability in the side slopes and the bed within a depth of 3 m of the invert.

- The minimum acceptable hydraulic conductivity as measured in any of the three required test holes is 13 mm/hr. If any test hole shows less than the minimum value, the site should be disqualified from further consideration.

- Exclude from consideration sites constructed in fill or partially in fill unless no silts or clays are present in the soil boring. Fill tends to be compacted, with clays in a dispersed rather than flocculated state, greatly reducing permeability.

- The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Additional Design Guidelines

(1) Basin Sizing - The required water quality volume is determined by local regulations or sufficient to capture 85% of the annual runoff.

(2) Provide pretreatment if sediment loading is a maintenance concern for the basin.

(3) Include energy dissipation in the inlet design for the basins. Avoid designs that include a permanent pool to reduce opportunity for standing water and associated vector problems.

(4) Basin invert area should be determined by the equation:

$$A = \frac{WQV}{kt}$$

where A = Basin invert area (m^2)

WQV = water quality volume (m^3)

k = 0.5 times the lowest field-measured hydraulic conductivity (m/hr)

t = drawdown time (48 hr)

(5) The use of vertical piping, either for distribution or infiltration enhancement shall not be allowed to avoid device classification as a Class V injection well per 40 CFR146.5(e)(4).

Maintenance

Regular maintenance is critical to the successful operation of infiltration basins. Recommended operation and maintenance guidelines include:

- Inspections and maintenance to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.
- Observe drain time for the design storm after completion or modification of the facility to confirm that the desired drain time has been obtained.
- Schedule semiannual inspections for beginning and end of the wet season to identify potential problems such as erosion of the basin side slopes and invert, standing water, trash and debris, and sediment accumulation.
- Remove accumulated trash and debris in the basin at the start and end of the wet season.
- Inspect for standing water at the end of the wet season.
- Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of the basin.
- If erosion is occurring within the basin, revegetate immediately and stabilize with an erosion control mulch or mat until vegetation cover is established.
- To avoid reversing soil development, scarification or other disturbance should only be performed when there are actual signs of clogging, rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a very light tractor.

Cost

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about $2 per ft (adjusted for inflation) of storage for a 0.25-acre basin (SWRPC, 1991). As with other BMPs, these published cost estimates may deviate greatly from what might be incurred at a specific site. For instance, Caltrans spent about $18/ft^3 for the two infiltration basins constructed in southern California, each of which had a water quality volume of about 0.34 ac.-ft. Much of the higher cost can be attributed to changes in the storm drain system necessary to route the runoff to the basin locations.

Infiltration basins typically consume about 2 to 3% of the site draining to them, which is relatively small. Additional space may be required for buffer, landscaping, access road, and fencing. Maintenance costs are estimated at 5 to 10% of construction costs.

One cost concern associated with infiltration practices is the maintenance burden and longevity. If improperly maintained, infiltration basins have a high failure rate. Thus, it may be necessary to replace the basin with a different technology after a relatively short period of time.

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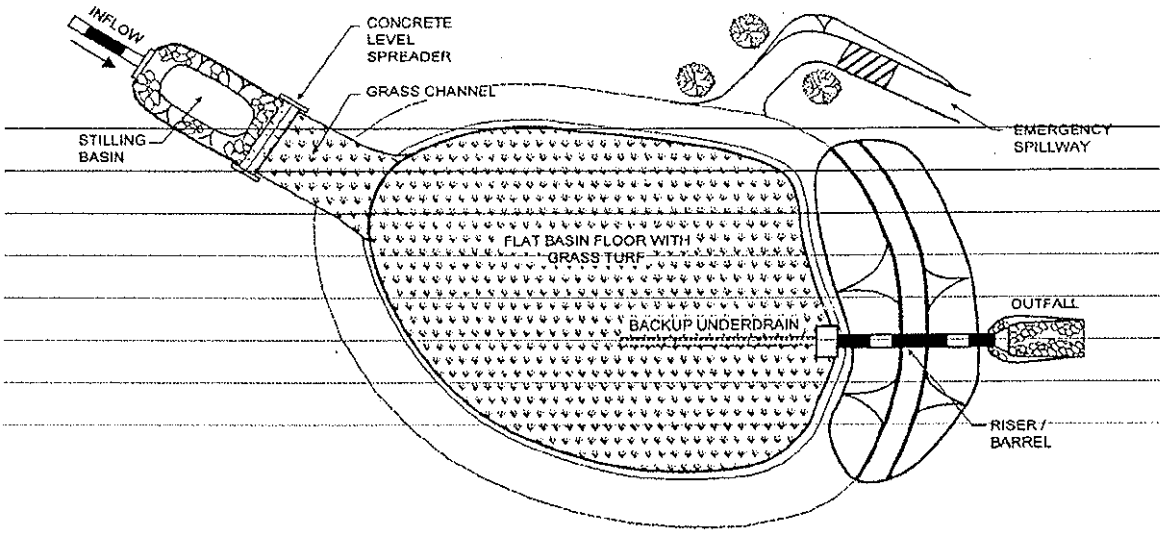
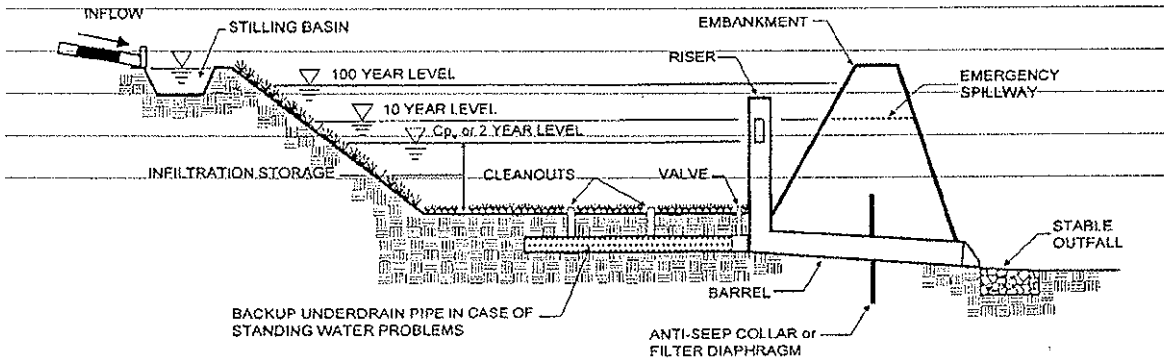


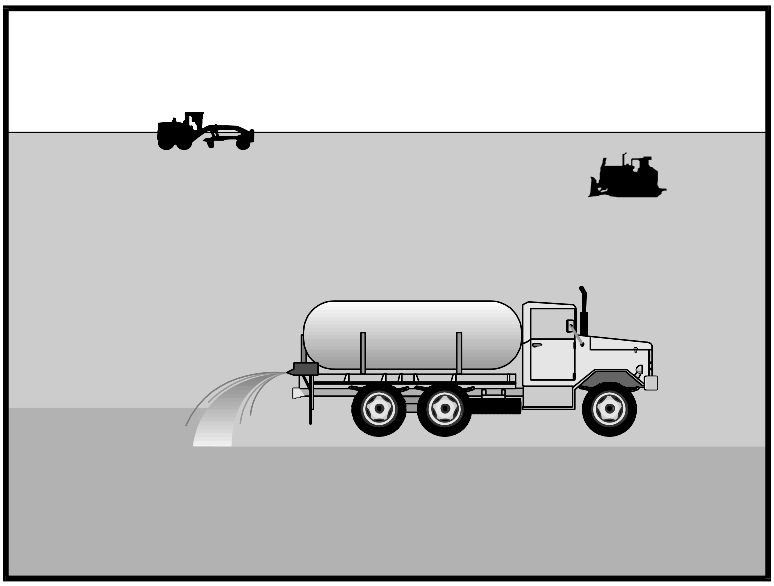
PLAN VIEW

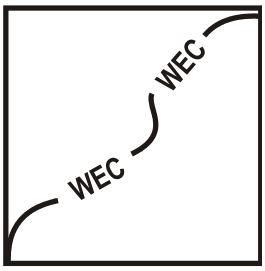


PROFILE

Wind Erosion Control

WE-1





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Wind erosion control consists of applying water and/or other dust palliatives as necessary to prevent or alleviate erosion by the forces of wind. Dust control shall be applied in accordance with Caltrans standard practices. Covering of small stockpiles or areas is an alternative to applying water or other dust palliatives.

Appropriate Applications

- This practice is implemented on all exposed soils subject to wind erosion.

Limitations

- Effectiveness depends on soil, temperature, humidity and wind velocity.

Standards and Specifications

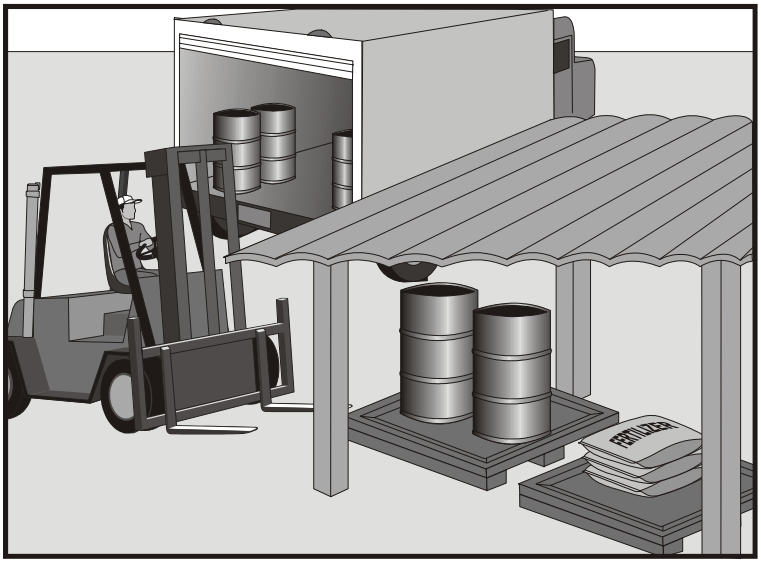
- Water shall be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment shall be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit shall be available at all times to apply water or dust palliative to the project.
- If reclaimed water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality Control Board requirements. Non-potable water shall not be conveyed in tanks or drain pipes that will be used to convey potable water and there shall be no connection between potable and non-potable supplies. Non-potable tanks, pipes and other conveyances shall be marked "NON-POTABLE WATER - DO NOT DRINK."
- Materials applied as temporary soil stabilizers and soil binders will also provide wind erosion control benefits.

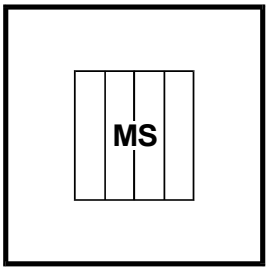
Maintenance and Inspection

- Check areas that have been protected to ensure coverage.

Material Delivery and Storage

WM-1





Standard Symbol

BMP Objectives

- ○ Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ● Non-Storm Water Management
- ● Materials and Waste Management

Definition and Purpose

Procedures and practices for the proper handling and storage of materials in a manner that minimizes or eliminates the discharge of these materials to the storm drain system or to watercourses.

Appropriate Applications

These procedures are implemented at all construction sites with delivery and storage of the following:

- Hazardous chemicals such as:
  - Acids,
  - lime,
  - glues,
  - adhesives,
  - paints,
  - solvents, and
  - curing compounds.
- Soil stabilizers and binders.
- Fertilizers.
- Detergents.
- Plaster.
- Petroleum products such as fuel, oil, and grease.
- Asphalt and concrete components.
- Pesticides and herbicides.

- Other materials that may be detrimental if released to the environment.

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds must meet building & fire code requirements.

Standards and Specifications

General

- Train employees and subcontractors on the proper material delivery and storage practices.
- Temporary storage area shall be located away from vehicular traffic.
- Material Safety Data Sheets (MSDS) shall be supplied to the Resident Engineer (RE) for all materials stored.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall be placed in temporary containment facilities for storage.
- Throughout the rainy season, each temporary containment facility shall have a permanent cover and side wind protection or be covered during non-working days and prior to and during rain events.
- A temporary containment facility shall provide for a spill containment volume able to contain precipitation from a 24-hour, 25-year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility shall be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids shall be sent to an approved disposal site.
- Sufficient separation shall be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, shall not be stored in the same temporary containment facility.
- Materials shall be stored in their original containers and the original product labels shall be maintained in place in a legible condition. Damaged or otherwise illegible labels shall be replaced immediately.

-
- Bagged and boxed materials shall be stored on pallets and shall not be allowed to accumulate on the ground. To provide protection from wind and rain, throughout the rainy season, bagged and boxed materials shall be covered during non-working days and prior to rain events.
- Stockpiles shall be protected in accordance with BMP WM-3, "Stockpile Management."
- Minimize the material inventory stored on-site (e.g., only a few days supply).
- Have proper storage instructions posted at all times in an open and conspicuous location.
- Do not store hazardous chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and when possible, under cover in secondary containment.
- Keep hazardous chemicals well labeled and in their original containers.
- Keep ample supply of appropriate spill clean up material near storage areas.
- Also see BMP WM-6, "Hazardous Waste Management", for storing of hazardous materials.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored on-site.
- Employees trained in emergency spill clean-up procedures shall be present when dangerous materials or liquid chemicals are unloaded.

Spill Clean-up

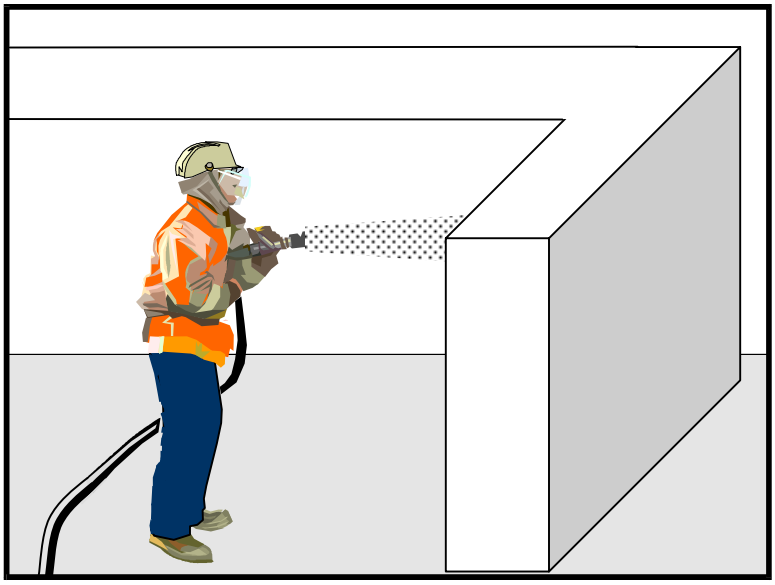
- Contain and clean up any spill immediately.
- If significant residual materials remain on the ground after construction is complete, properly remove and dispose any hazardous materials or contaminated soil.
- See BMP WM-4, "Spill Prevention and Control", for spills of chemicals and/or hazardous materials.

Maintenance and Inspection

- Storage areas shall be kept clean, well organized, and equipped with ample clean-up supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners shall be repaired or replaced as needed to maintain proper function.
- Inspect storage areas before and after rainfall events, and at least weekly during other times. Collect and place into drums any spills or accumulated rainwater.

Material Use

WM-2



Standard Symbol

BMP Objectives

- ○ Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ● Non-Storm Water Management
- ● Materials and Waste Management

Definition and Purpose

These are procedures and practices for use of construction material in a manner that minimizes or eliminates the discharge of these materials to the storm drain system or to watercourses.

Appropriate Applications

This BMP applies to all construction projects. These procedures apply when the following materials are used or prepared on site:

- Hazardous chemicals such as:

  Acids,
  lime,
  glues,
  adhesives,
  paints,
  solvents, and
  curing compounds.

- Soil stabilizers and binders.
- Fertilizers.
- Detergents.
- Plaster.
- Petroleum products such as fuel, oil, and grease.
- Asphalt and concrete components.
- Pesticides and herbicides.
- Other materials that may be detrimental if released to the environment.

Limitations

- Safer alternative building and construction products may not be available or suitable in every instance.

Standards and Specifications

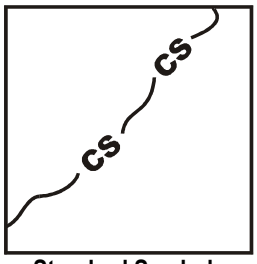
- Material Safety Data Sheets (MSDS) shall be supplied to the Resident Engineer (RE) for all materials.
- Latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, may be disposed of with other construction debris.
- Do not remove the original product label, it contains important safety and disposal information. Use the entire product before disposing of the container.
- Mix paint indoors, or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain or watercourse. Dispose of any paint thinners, residue and sludge(s), that cannot be recycled, as hazardous waste.
- For water-based paint, clean brushes to the extent practical, and rinse to a drain leading to a sanitary sewer where permitted, or into a concrete washout pit. For oil-based paints, clean brushes to the extent practical and filter and reuse thinners and solvents.
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials.
- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible. Reduce or eliminate use of hazardous materials on-site when practical.
- Do not over-apply fertilizers and pesticides. Prepare only the amount needed. Strictly follow the recommended usage instructions. Apply surface dressings in smaller applications, as opposed to large applications, to allow time for it to work in and to avoid excess materials being carried off-site by runoff.
- Application of herbicides and pesticides shall be performed by a licensed applicator.
- Contractors are required to complete the “Report of Chemical Spray Forms” when spraying herbicides and pesticides.
- Keep an ample supply of spill clean up material near use areas. Train employees in spill clean up procedures.
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry.

Maintenance and Inspections

- Spot check employees and subcontractors monthly throughout the job to ensure appropriate practices are being employed.

Stockpile Management

WM-3



Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ● Materials and Waste Management

Definition and Purpose

Stockpile management procedures and practices are designed to reduce or eliminate air and storm water pollution from stockpiles of soil, and paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate subbase or pre-mixed aggregate, asphalt binder (so called "cold mix" asphalt) and pressure treated wood.

Appropriate Applications

Implemented in all projects that stockpile soil and other materials.

Limitations

- None identified

Standards and Specifications

- Protection of stockpiles is a year-round requirement.
- Locate stockpiles a minimum of 15 m (50 ft)away from concentrated flows of storm water, drainage courses, and inlets.
- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information see BMP WE-1, "Wind Erosion Control."
- Stockpiles of contaminated soil shall be managed in accordance with BMP WM-7, "Contaminated Soil Management."
- Bagged materials should be placed on pallets and under cover.

Protection of Non-Active Stockpiles

Non-active stockpiles of the identified materials shall be protected further as follows:

- ***Soil stockpiles:***
  - During the rainy seasons, soil stockpiles shall be covered or protected with soil stabilization measures and a temporary perimeter sediment barrier at all times.
  - During the non-rainy season, soil stockpiles shall be covered and protected with a temporary perimeter sediment barrier prior to the onset of precipitation.
- ***Stockpiles of portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate subbase:***
  - During the rainy season, the stockpiles shall be covered or protected with a temporary perimeter sediment barrier at all times.
  - During the non-rainy season, the stockpiles shall be covered or protected with a temporary perimeter sediment barrier prior to the onset of precipitation.
- ***Stockpiles of "cold mix":***
  - During the rainy season, cold mix stockpiles shall be placed on and covered with plastic or comparable material at all times.
  - During the non-rainy season, cold mix stockpiles shall be placed on and covered with plastic or comparable material prior to the onset of precipitation.
- ***Stockpiles/Storage of pressure treated wood with copper, chromium, and arsenic or ammonical, copper, zinc, and arsenate:***
  - During the rainy season, treated wood shall be covered with plastic or comparable material at all times.
  - During the non-rainy season, treated wood shall be covered with plastic or comparable material and shall be placed on pallets prior to the onset of precipitation.

Protection of Active Stockpiles

Active stockpiles of the identified materials shall be protected further as follows:

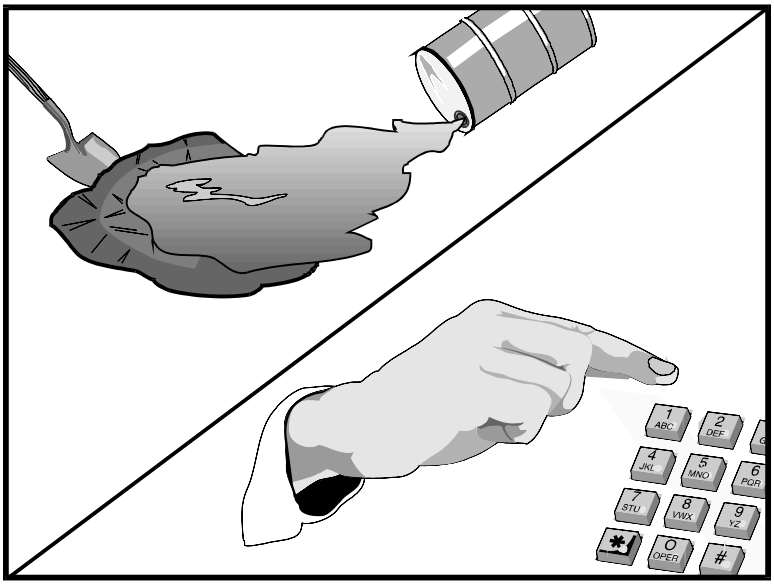
- All stockpiles shall be covered, stabilized, or protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Stockpiles of "cold mix" shall be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Maintenance and Inspections

- Repair and/or replace perimeter controls and covers as needed, or as directed by the RE, to keep them functioning properly. Sediment shall be removed when sediment accumulation reaches one-third (1/3) of the barrier height.

Spill Prevention and Control

WM-4



Standard Symbol

BMP Objectives

- ○ Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ● Non-Storm Water Management
- ● Materials and Waste Management

Definition and Purpose

These procedures and practices are implemented to prevent and control spills in a manner that minimizes or prevents the discharge of spilled material to the drainage system or watercourses.

Appropriate Application

This best management practice (BMP) applies to all construction projects. Spill control procedures are implemented anytime chemicals and/or hazardous substances are stored. Substances may include, but are not limited to:

- Soil stabilizers/binders.
- Dust Palliatives.
- Herbicides.
- Growth inhibitors.
- Fertilizers.
- Deicing/anti-icing chemicals.
- Fuels.
- Lubricants.
- Other petroleum distillates.

To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110, 117, and 302, and sanitary and septic wastes shall be contained and cleaned up immediately.

Limitations

- This BMP only applies to spills caused by the contractor.
- Procedures and practices presented in this BMP are general. Contractor shall identify appropriate practices for the specific materials used or stored on-site.

Standards and Specifications

- To the extent that it doesn't compromise clean up activities, spills shall be covered and protected from storm water run-on during rainfall.
- Spills shall not be buried or washed with water.
- Used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose shall be stored and disposed of in conformance with the special provisions.
- Water used for cleaning and decontamination shall not be allowed to enter storm drains or watercourses and shall be collected and disposed of in accordance with BMP WM-10, "Liquid Waste Management."
- Water overflow or minor water spillage shall be contained and shall not be allowed to discharge into drainage facilities or watercourses.
- Proper storage, clean-up and spill reporting instruction for hazardous materials stored or used on the project site shall be posted at all times in an open, conspicuous and accessible location.
- Waste storage areas shall be kept clean, well organized and equipped with ample clean-up supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers and liners shall be repaired or replaced as needed to maintain proper function.

Education

- Educate employees and subcontractors on what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- The Contractor's Water Pollution Control Manager (WPCM) shall oversee and enforce proper spill prevention and control measures.

Cleanup and Storage Procedures

- Minor Spills
  - Minor spills typically involve small quantities of oil, gasoline, paint, etc., which can be controlled by the first responder at the discovery of the spill.
  - Use absorbent materials on small spills rather than hosing down or burying the spill.
  - Remove the absorbent materials promptly and dispose of properly.
  - The practice commonly followed for a minor spill is:
    - Contain the spread of the spill.
    - Recover spilled materials.
    - Clean the contaminated area and/or properly dispose of contaminated materials.
- Semi-Significant Spills
  - Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.
  - Clean up spills immediately:
    - Notify the project foreman immediately. The foreman shall notify the Resident Engineer (RE).
    - Contain spread of the spill.
    - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
    - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
    - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

- Significant/Hazardous Spills
  - For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps shall be taken:
    - Notify the RE immediately and follow up with a written report.
    - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
    - Notify the Governor's Office of Emergency Services Warning Center, (805) 852-7550.
    - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor shall notify the National Response Center at (800) 424-8802.
    - Notification shall first be made by telephone and followed up with a written report.
    - The services of a spills contractor or a Haz-Mat team shall be obtained immediately. Construction personnel shall not attempt to clean up the spill until the appropriate and qualified staff have arrived at the job site.
    - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, RWQCB, etc.

Maintenance and Inspection

- Verify weekly that spill control clean up materials are located near material storage, unloading, and use areas.
- Update spill prevention and control plans and stock appropriate clean-up materials whenever changes occur in the types of chemicals used or stored onsite.

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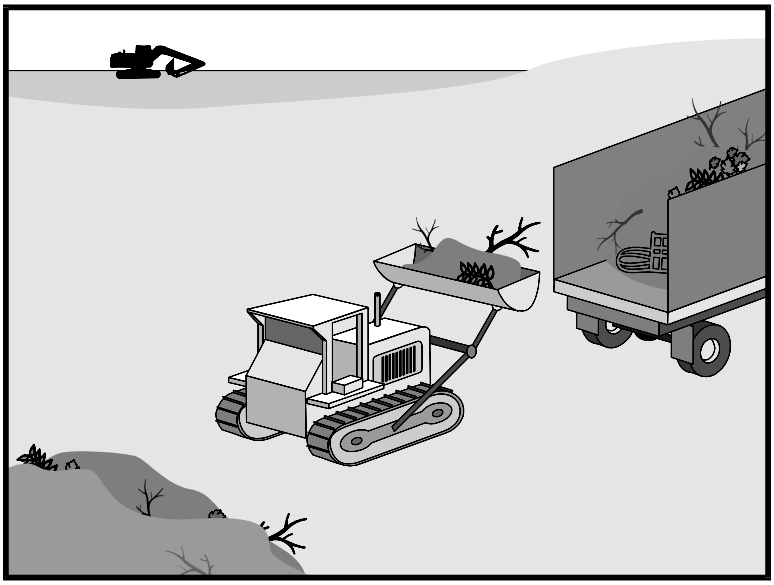
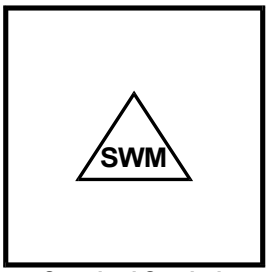
Solid Waste Management

WM-5





Standard Symbol

BMP Objectives

- ○ Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ● Non-Storm Water Management
- ● Materials and Waste Management

Definition and Purpose

Solid waste management procedures and practices are designed to minimize or eliminate the discharge of pollutants to the drainage system or to watercourses as a result of the creation, stockpiling, or removal of construction site wastes.

Appropriate Applications

Solid waste management procedures and practices are implemented on all construction projects that generate solid wastes.

Solid wastes include but are not limited to:

- Construction wastes including brick, mortar, timber, steel and metal scraps, sawdust, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials.
- Highway planting wastes, including vegetative material, plant containers, and packaging materials.
- Litter, including food containers, beverage cans, coffee cups, paper bags, plastic wrappers, and smoking materials, including litter generated by the public.

Limitations

- Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Standards and Specifications

Education

- The Contractor's Water Pollution Control Manager (WPCM) shall oversee and enforce proper solid waste procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Wherever possible, minimize production of solid waste materials.

Collection, Storage, and Disposal

- Dumpsters of sufficient size and number shall be provided to contain the solid waste generated by the project and properly serviced.
- Littering on the project site shall be prohibited.
- To prevent clogging of the storm drainage system litter and debris removal from drainage grates, trash racks, and ditch lines shall be a priority.
- Trash receptacles shall be provided in the Contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Construction debris and litter from work areas within the construction limits of the project site shall be collected and placed in watertight dumpsters at least weekly regardless of whether the litter was generated by the Contractor, the public, or others. Collected litter and debris shall not be placed in or next to drain inlets, storm water drainage systems or watercourses.
- Full dumpsters shall be removed from the project site and the contents shall be disposed of outside the highway right-of-way in conformance with the provisions in the Standard Specifications Section 7-1.13.
- Litter stored in collection areas and containers shall be handled and disposed of by trash hauling contractors.
- Construction debris and waste shall be removed from the site every two weeks or as directed by the RE.

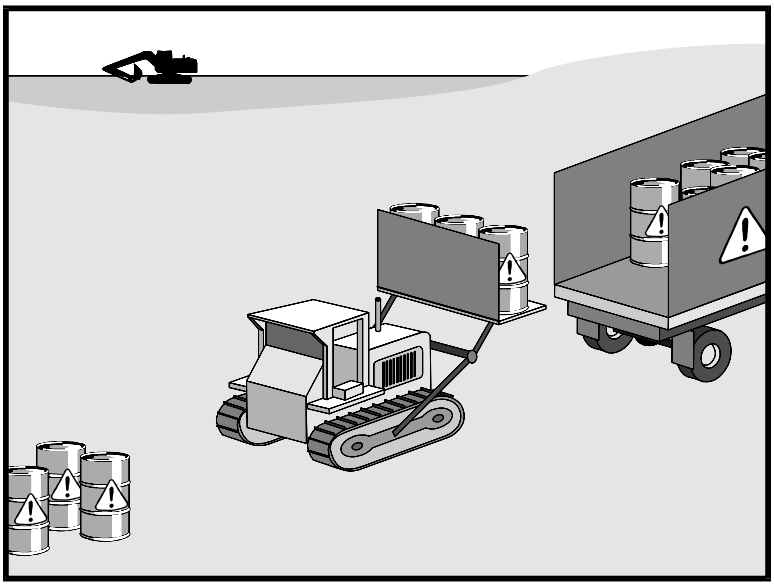
- Construction material visible to the public shall be stored or stacked in an orderly manner to the satisfaction of the RE.
- Storm water run-on shall be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas shall be located at least 15 m (50 ft) from drainage facilities and watercourses and shall not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters shall be securely covered from wind and rain by covering the waste with tarps or plastic sheeting or protected in conformance with the applicable Disturbed Soil Area protection section.
- Dumpster washout on the project site is not allowed.
- Notify trash hauling contractors that only watertight dumpsters are acceptable for use on-site.
- Plan for additional containers during the demolition phase of construction.
- Plan for more frequent pickup during the demolition phase of construction.
- Construction waste shall be stored in a designated area approved by the RE.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Keep the site clean of litter debris.
- Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Dispose of non-hazardous waste in accordance with Standard Specification 7-1.13, Disposal of Material Outside the Highway Right of Way.
- For disposal of hazardous waste, see BMP WM-6, “Hazardous Waste Management.” Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
- Salvage or recycle useful vegetation debris, packaging and/or surplus building materials when practical. For example, trees and shrubs from land clearing can be converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

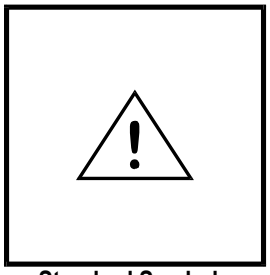
Maintenance and Inspection

- The WPCM shall monitor onsite solid waste storage and disposal procedures.
- Police site for litter and debris.

Hazardous Waste Management

WM-6





Standard Symbol

BMP Objectives

- ○ Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ● Non-Storm Water Management
- ● Materials and Waste Management

Definition and Purpose

These are procedures and practices to minimize or eliminate the discharge of pollutants from construction site hazardous waste to the storm drain systems or to watercourses.

Appropriate Applications

- This best management practice (BMP) applies to all construction projects.
- Hazardous waste management practices are implemented on construction projects that generate waste from the use of:
  - Petroleum Products,
  - Asphalt Products,
  - Concrete Curing Compounds,
  - Pesticides,
  - Acids,
  - Paints,
  - Stains,
  - Solvents,
  - Wood Preservatives,
  - Roofing Tar, or
  - Any materials deemed a hazardous waste in California, Title 22 Division 4.5, or listed in 40 CFR Parts 110, 117, 261, or 302.

Limitations

- Nothing in this BMP relieves the Contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to BMP WM-7, "Contaminated Soil Management," and the project special provisions.

Standards and Specifications

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The Contractor's Water Pollution Control Manager (WPCM) shall oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.

Storage Procedures

- Wastes shall be stored in sealed containers constructed of a suitable material and shall be labeled as required by Title 22 CCR, Division 4.5 and 49 CFR Parts 172,173, 178, and 179.
- All hazardous waste shall be stored, transported, and disposed as required in Title 22 CCR, Division 4.5 and 49 CFR 261-263.
- Waste containers shall be stored in temporary containment facilities that shall comply with the following requirements:
  - Temporary containment facility shall provide for a spill containment volume able to contain precipitation from a 24-hour, 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.

- Temporary containment facility shall be impervious to the materials stored there for a minimum contact time of 72 hours.
- Temporary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks accumulated rainwater and spills shall be placed into drums after each rainfall. These liquids shall be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids shall be sent to an approved disposal site.
- Sufficient separation shall be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, shall not be stored in the same temporary containment facility.
- Throughout the rainy season, temporary containment facilities shall be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs. A storage facility having a solid cover and sides is preferred to a temporary tarp. Storage facilities shall be equipped with adequate ventilation.

- Drums shall not be overfilled and wastes shall not be mixed.
- Unless watertight, containers of dry waste shall be stored on pallets.
- Paint brushes and equipment for water and oil based paints shall be cleaned within a contained area and shall not be allowed to contaminate site soils, watercourses or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused shall be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths shall be disposed of as solid waste.
- Ensure that adequate hazardous waste storage volume is available.
- Ensure that hazardous waste collection containers are conveniently located.
- Designate hazardous waste storage areas on site away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
- Minimize production or generation of hazardous materials and hazardous waste on the job site.
- Use containment berms in fueling and maintenance areas and where the potential for spills is high.

- Segregate potentially hazardous waste from non-hazardous construction site debris.
- Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.
- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.

Disposal Procedures

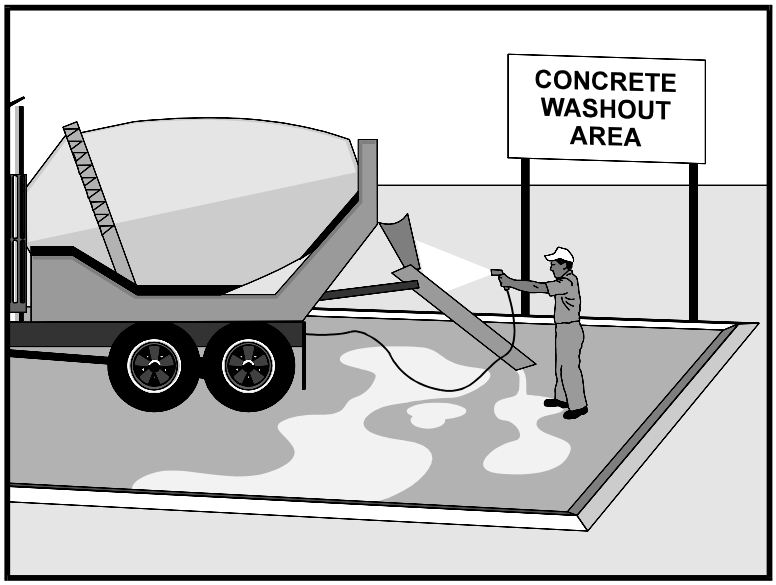
- Waste shall be disposed of outside the highway right-of-way within 90 days of being generated, or as directed by the Resident Engineer (RE). In no case shall hazardous waste storage exceed requirements in Title 22 CCR, Section 66262.34.
- Waste shall be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A Department of Health Services (DHS) certified laboratory shall sample waste and classify it to determine the appropriate disposal facility.
- Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for solid waste construction debris.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Recycle any useful material such as used oil or water-based paint when practical.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

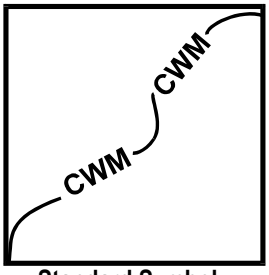
Maintenance and Inspection

- A foreman and/or construction supervisor shall monitor on-site hazardous waste storage and disposal procedures.
- Waste storage areas shall be kept clean, well organized, and equipped with ample clean-up supplies as appropriate for the materials being stored.
- Storage areas shall be inspected in conformance with the provisions in the contract documents.
- Perimeter controls, containment structures, covers, and liners shall be repaired or replaced as needed to maintain proper function.
- Hazardous spills shall be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
- The National Response Center, at (800) 424-8802, shall be notified of spills of Federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302.
- Copy of the hazardous waste manifests shall be provided to the RE.

Concrete Waste Management

WM-8





Standard Symbol

BMP Objectives

- ○ Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ● Non-Storm Water Management
- ● Materials and Waste Management

Definition and Purpose

These are procedures and practices that are designed to minimize or eliminate the discharge of concrete waste materials to the storm drain systems or watercourses.

Appropriate Applications

- Concrete waste management procedures and practices are implemented on construction projects where concrete is used as a construction material or where concrete dust and debris result from demolition activities.
- Where slurries containing portland cement concrete (PCC) or asphalt concrete (AC) are generated, such as from sawcutting, coring, grinding, grooving, and hydro-concrete demolition.
- Where concrete trucks and other concrete-coated equipment are washed on site, when approved by the Resident Engineer (RE). See also NS-8, “Vehicle and Equipment Cleaning."
- Where mortar-mixing stations exist.

Limitations

- None identified.

Standards and Specifications

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.
- The Contractor’s Water Pollution Control Manager (WPCM) shall oversee and enforce concrete waste management procedures.

Concrete Slurry Wastes

- PCC and AC waste shall not be allowed to enter storm drains or watercourses.

- PCC and AC waste shall be collected and properly disposed of outside the highway right-of-way in conformance with Standard Specifications Section 7-1.13 or placed in a temporary concrete washout facility as shown in the figures on Pages 5 and 6.

- Disposal of hardened PCC and AC waste shall be in conformance with Standard Specifications Section 15-3.02.

- A sign shall be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities as shown on Page 6.

- A foreman and/or construction supervisor shall monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.

- Do not allow saw-cut PCC slurry to enter storm drains or watercourses. See also BMP NS-3, "Paving and Grinding Operations;" and BMP WM-10, "Liquid Waste Management." Residue from grinding operations shall be picked up by means of a vacuum attachment to the grinding machine. Saw cutting residue shall not be allowed to flow across the pavement, and shall not be left on the surface of the pavement.

- Vacuum slurry residue and dispose in a temporary facility (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allow slurry to dry. Dispose of dry slurry residue in accordance with BMP WM-5, "Solid Waste Management", or, for on-site disposal, in accordance with Standard Specification 15-3.02, Removal Methods.

- Collect and dispose of residue from grooving and grinding operations in accordance with Standard Specifications Section 42-1.02 and 42-2.02.

Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures

- Temporary concrete washout facilities shall be located a minimum of 15 m (50 ft) from storm drain inlets, open drainage facilities, and watercourses, unless determined infeasible by the RE. Each facility shall be located away from construction traffic or access areas to prevent disturbance or tracking.

- A sign shall be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities. The sign shall be installed as shown on the plans and in conformance with the provisions in Standard Specifications Section 56-2, Roadside Signs.

- Temporary concrete washout facilities shall be constructed above grade or below grade at the option of the Contractor. Temporary concrete washout facilities shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

- Temporary washout facilities shall have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.

- Perform washout of concrete mixer trucks in designated areas only.

- Wash concrete only from mixer truck chutes into approved concrete washout facility. Washout may be collected in an impermeable bag for disposal.

- Pump excess concrete in concrete pump bin back into concrete mixer truck.

- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed offsite.

- Once concrete wastes are washed into the designated area and allowed to harden, the concrete shall be broken up, removed, and disposed of per BMP WM-5, "Solid Waste Management", and in conformance with the provisions in Standard Specifications Section 15-3.02, "Removal Methods."

Temporary Concrete Washout Facility Type "Above Grade"

- Temporary concrete washout facility Type "Above Grade" shall be constructed as shown on Page 5 or 6, with a recommended minimum length and minimum width of 3 m (10 ft), but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations. The length and width of a facility may be increased, at the Contractor's expense, upon approval from the RE.

- Straw bales, wood stakes, and sandbag materials shall conform to the provisions in BMP SC-9, "Straw Bale Barrier."

- Plastic lining material shall be a minimum of 10-mil polyethylene sheeting and shall be free of holes, tears or other defects that compromise the impermeability of the material.

- Portable delineators shall conform to the provisions in Standard Specifications Section 12-3.04, "Portable Delineators.". The delineator bases shall be cemented to the pavement in the same manner as provided for cementing pavement markers to pavement in Standard Specifications Section 85-1.06, "Placement." Portable delineators shall be applied only to a clean, dry surface.

Temporary Concrete Washout Facility (Type Below Grade)

- Temporary concrete washout facility Type "Below Grade" shall be constructed as shown on page 6, with a recommended minimum length and minimum width of 3m (10 ft). The quantity and volume shall be sufficient to contain all liquid and concrete waste generated by washout operations. The length and width of a facility may be increased, at the Contractor's expense, upon approval of the RE. Lath and flagging shall be commercial type.

- Plastic lining material shall be a minimum of 10-mil polyethylene sheeting and shall be free of holes, tears or other defects that compromise the impermeability of the material.

- The soil base shall be prepared free of rocks or other debris that may cause tears or holes in the plastic lining material.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, as determined by the RE, the hardened concrete shall be removed and disposed of in conformance with the provisions in Standard Specifications Section 15-3.02. Disposal of PCC slurries or liquid waste shall be disposed of outside the highway right-of-way in conformance with provisions of Standard Specifications Section 7-1-13. Materials used to construct temporary concrete washout facilities shall become the property of the Contractor, shall be removed from the site of the work, and shall be disposed of outside the highway right-of-way in conformance with the provisions of the Standard Specifications, Section 7-1.13.

- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities shall be backfilled and repaired in conformance with the provisions in Standard Specifications Section 15-1.02, "Preservation of Property."

Maintenance and Inspection

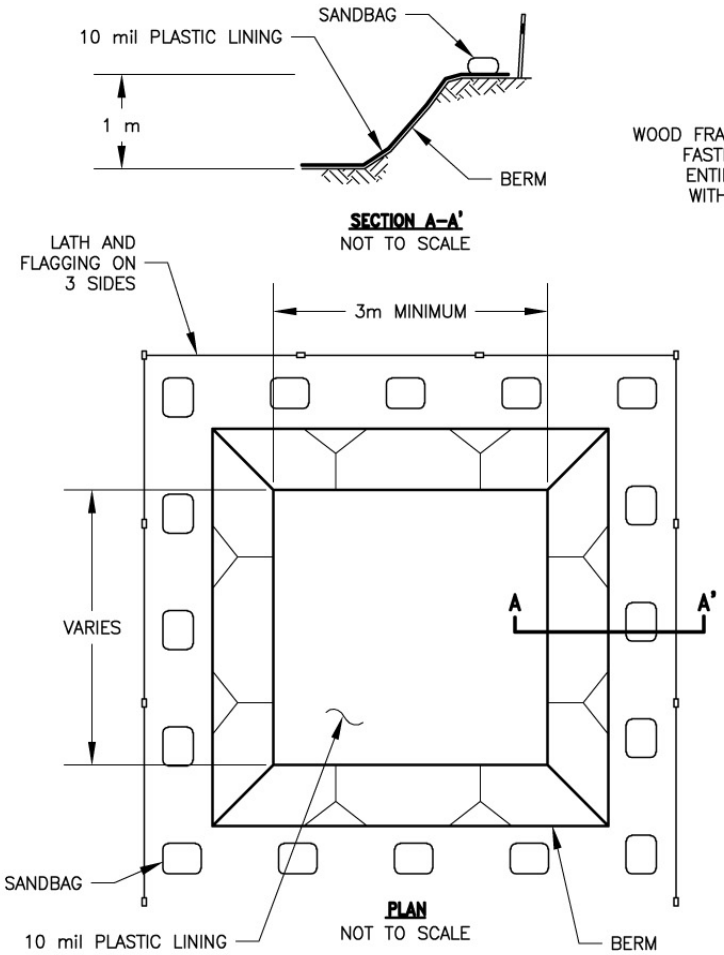
- The Contractor's Water Pollution Control Manager (WPCM) shall monitor on site concrete waste storage and disposal procedures at least weekly or as directed by the RE.

- The WPCM shall monitor concrete working tasks, such as saw cutting, coring, grinding and grooving daily to ensure proper methods are employed or as directed by the RE.

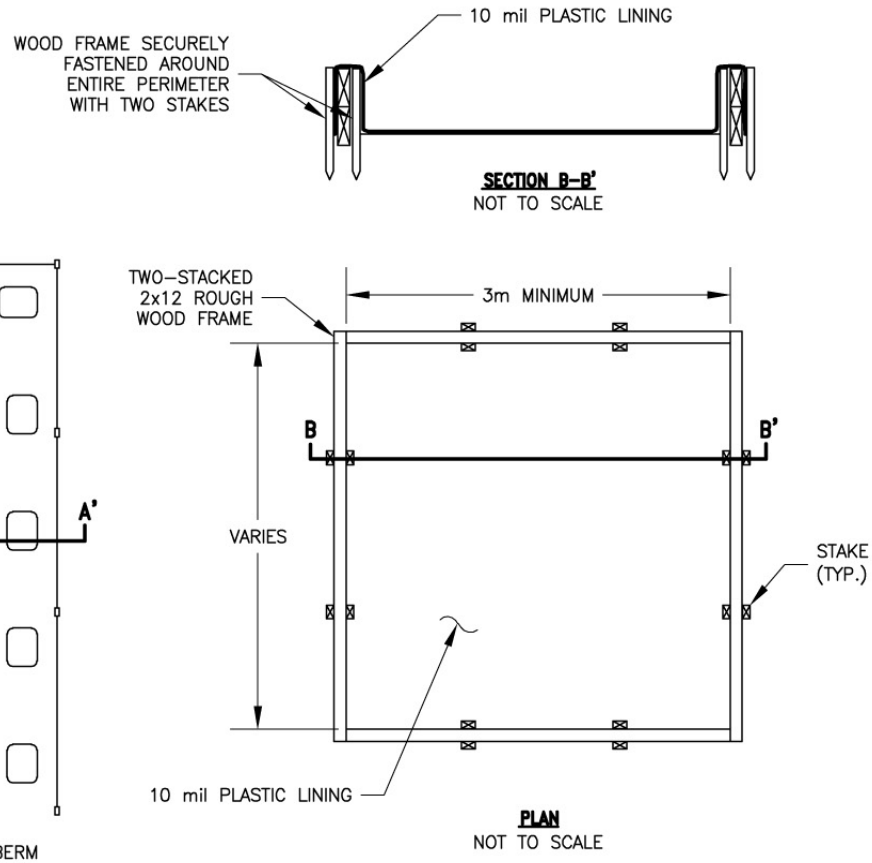
- Temporary concrete washout facilities shall be maintained to provide adequate holding capacity with a minimum freeboard of 100 mm (4 inches) for above grade facilities and 300 mm (12 inches) for below grade facilities. Maintaining temporary concrete washout facilities shall include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials shall be removed and disposed of in conformance with the provisions in Standard Specifications Section 15-3.02, "Removal Methods."

- Existing facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.

- Temporary concrete washout facilities shall be inspected for damage (i.e. tears in PVC liner, missing sand bags, etc.). Damaged facilities shall be repaired.



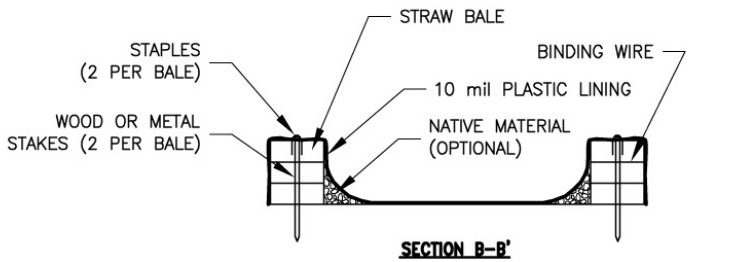
TYPE "BELOW GRADE"



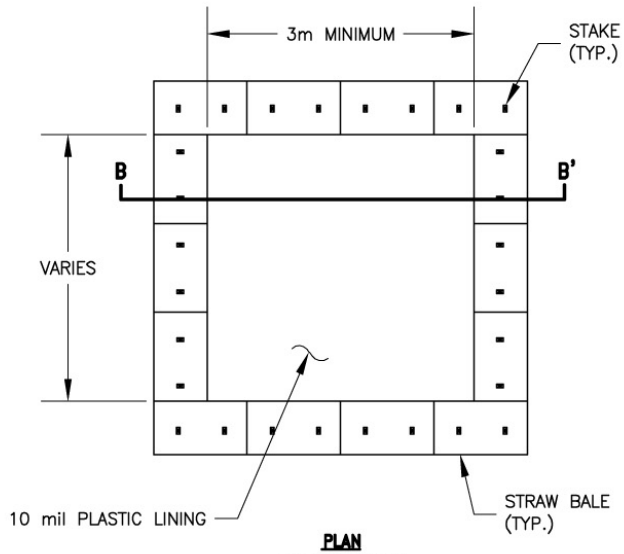
TYPE "ABOVE GRADE" WITH WOOD PLANKS

NOTES:

1. ACTUAL LAYOUT DETERMINED IN THE FIELD.
2. THE CONCRETE WASHOUT SIGN (SEE PAGE 6) SHALL BE INSTALLED WITHIN 10 m OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

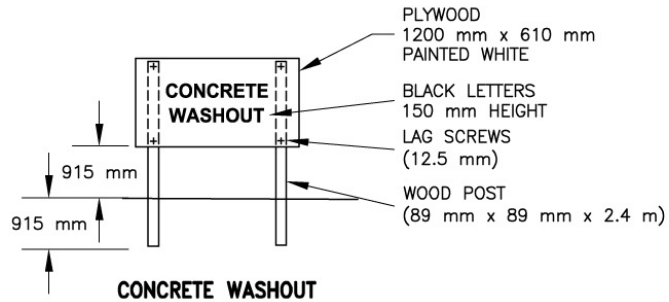


SECTION B–B'
NOT TO SCALE

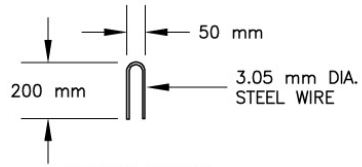


PLAN
NOT TO SCALE

TYPE "ABOVE GRADE" WITH STRAW BALES



CONCRETE WASHOUT SIGN DETAIL (OR EQUIVALENT)



STAPLE DETAIL

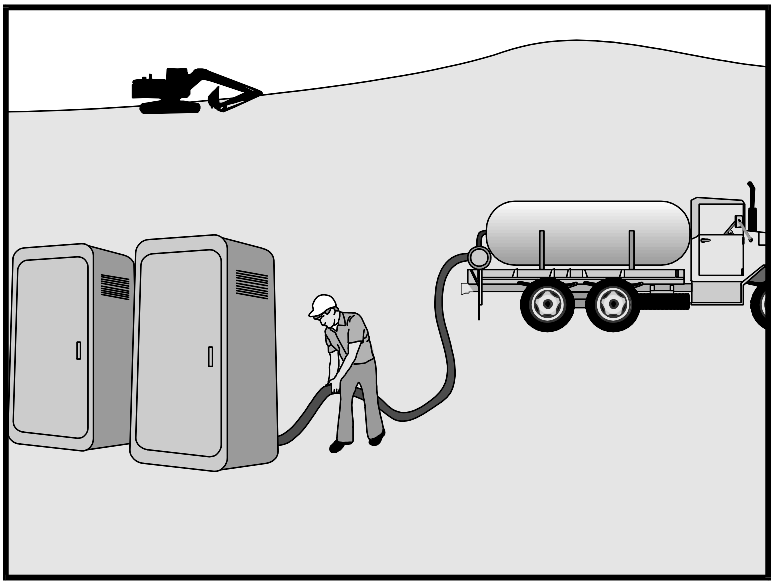
NOTES:

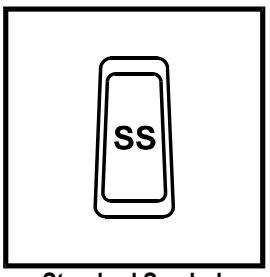
1. ACTUAL LAYOUT DETERMINED IN THE FIELD.
2. THE CONCRETE WASHOUT SIGN (SEE FIG. 4–15) SHALL BE INSTALLED WITHIN 10 m OF THE TEMPORARY CONCRETE WASHOUT FACILITIY.

CALTRANS/FIG4–14.DWG SAC 8–14–02

Sanitary/Septic Waste Management

WM-9





Standard Symbol

BMP Objectives

- ○ Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ● Non-Storm Water Management
- ● Materials and Waste Management

Definition and Purpose

Procedures and practices to minimize or eliminate the discharge of construction site sanitary/septic waste materials to the storm drain system or to watercourses.

Appropriate Applications

Sanitary/septic waste management practices are implemented on all construction sites that use temporary or portable sanitary/septic waste systems.

Limitations

- None identified.

Standards and Specifications

Education

- Educate employees, subcontractors, and suppliers on sanitary/septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary/septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary/septic waste.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Storage and Disposal Procedures

- Temporary sanitary facilities shall be located away from drainage facilities, watercourses, and from traffic circulation. When subjected to high winds or risk.

- Wastewater shall not be discharged or buried within the highway right-of-way.
- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, shall comply with the local health agency, city, county, and sewer district requirements.
- If using an on site disposal system, such as a septic system, comply with local health agency requirements.
- Properly connect temporary sanitary facilities that discharge to the sanitary sewer system to avoid illicit discharges.
- Ensure that sanitary/septic facilities are maintained in good working order by a licensed service.
- Use only reputable, licensed sanitary/septic waste haulers.

Maintenance and Inspection

- The Contractor's Water Pollution Control Manager (WPCM) shall monitor onsite sanitary/septic waste storage and disposal procedures at least weekly.