Attachment C.7 Landfill

Landfill design, construction, operating and maintenance requirements can be found in Rule 619, 620, 621 and 622 of Michigan administrative rules promulgated pursuant to Part 111, 1994 P.A. 451, as amended. The attachments of Wayne Disposal Inc.'s (WDI) application was created in accordance with these requirements. This attachment is intended to reference the applicable attachments that demonstrate compliance with these requirements.

R 299.9619 Landfills. Rule 619.

(1) Owners or operators of facilities that use landfills to dispose of hazardous waste shall comply with the design and operating requirements of 40 C.F.R. part 264, subpart N, except 40 C.F.R. §264.301(f).

See Attachment B.6. Engineering Drawings, B.10 Construction Certifications, Attachment A.2 Chemical and Physical Waste Analysis Plan, Attachment A.5 Inspection Schedule, and A.11 Closure and Post Closure Care Plan.

(2) In addition to the liner system requirements of 40 C.F.R. §264.301, the owner or operator of a landfill shall design the liner system to meet the requirements of R 299.9620.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(3) All landfills shall contain a leak detection, collection, and removal system beneath the liner system that is designed, constructed, operated, and maintained pursuant to R 299.9622, unless the landfill is exempted pursuant to R 299.9622. 197

See Attachment B.6. Engineering Drawings and Attachment B.5. Environmental Monitoring: Leak Detection Sampling and Analysis Plan.

(4) In addition to the requirements of 40 C.F.R. §264.301(a), the leachate collection and removal system shall include all of the following:

(a) Not less than 30 centimeters of granular material that has a permeability of 1 x 10-2 cm/second or greater, as determined by ASTM standard no. D2434-68, or a layer of geosynthetic drainage materials with a transmissivity of 3 x 10-5 m2 /second or greater covered by a minimum of 30 centimeters of a protective layer of granular material with a permeability of 1 x 10-3 cm/second or greater, as determined by ASTM standard no. D2434-68.

(b) Either of the following:

(i) Provisions for discharging the leachate directly to a wastewater treatment unit.

(ii) Provisions for storing the quantity of leachate that is expected to be generated from all cells during a 24-hour, 100-year storm.

(c) Leachate sumps that have all of the following:

(i) A volume that can properly maintain a leachate head of no more than 30 centimeters (12 inches) on the liner.

(ii) A leachate removal system to remove liquid from the sump.

(iii) A device for continuously monitoring the quantity of leachate in the sump and removed from the landfill.

See Attachment B.6. Engineering Drawings, B.10 Construction Certifications and Attachment B.5. Environmental Monitoring: Leachate Collection and Removal System Sampling and Analysis Plan.

(5) The director may approve alternate design or operating practices to those specified in subrule (4) of this rule if the owner or operator demonstrates to the director that such design and operating practices, together with location characteristics, comply with both of the following requirements:

(a) The alternate design and operating practices shall prevent the migration of any hazardous constituent into the groundwater or surface water at least as effectively as the leachate collection and removal systems specified in subrule (4) of this rule.

(b) The alternate design and operating practices shall allow the detection of leaks of hazardous constituents through the top liner at least as effectively as the leachate collection and removal systems specified in subrule (4) of this rule.

Not Applicable

(6) In addition to the closure and postclosure care requirements of 40 C.F.R. §264.310, the owner or operator of a landfill shall do all of the following with respect to closure and postclosure care:

(a) Close the facility so that the final cover includes all of the following unless the owner or operator substitutes an equivalent design which shall include a flexible membrane liner component with a minimum thickness of 1 millimeter (40 mil), depending on the type of material selected, and demonstrates to the director that it provides equivalent environmental protection:

(i) Compacted clay which is in compliance with the requirements of R 299.9620(3) and which is not less than 90 centimeters thick.

(ii) A flexible membrane liner shall be placed directly over the compacted clay layer required pursuant to subdivision (i).

(iii) Not less than 60 centimeters of additional material, such as topsoil, subsurface drainage media, or cobbles to prevent animal burrowing. The additional material shall be applied in a manner that protects the clay and any synthetic component from the effects of temperature, erosion, and rooted vegetation. For temperature protection, the additional material thickness shall equal not less than 60 centimeters or the maximum depth of frost penetration, whichever is greater. In order to provide a minimum base for root penetration, the top component of the additional material shall consist of not less than 15 centimeters of topsoil. (iv) Slopes of the barrier layer, the drainage layer, and the top of the cover system shall not be less than 4% at any location.

(b) Establish shallow-rooted grasses at the earliest possible time and maintain the vegetation or use other erosion control measures so as to stabilize the cap and prevent erosion. Erosion shall be limited to not more than 2 tons per acre per year based on the universal soil loss equation.

(c) Establish a venting system to prevent the accumulations of gas. The venting system shall be installed in a manner that does not adversely affect the permeability of the cap and, if required pursuant to part 55 of the act, gas emissions shall be monitored, collected, and treated. The director shall exempt the owner or operator from this requirement if the owner or operator demonstrates that gas will not be generated in the landfill.

See Attachment B.6. Engineering Drawings and Attachment A.11 Closure and Post-closure Plan

(7) The director may approve alternative designs and maintenance practices to those specified in subrule (6) of this rule for beneficial uses of closed landfills if the owner or operator demonstrates to the

director that such designs and maintenance practices for the landfill cover system will provide equivalent environmental protection.

See Attachment B.6. Engineering Drawings and Attachment A.11 Closure and Post-closure Plan

R 299.9620 Liner requirements for landfills, surface impoundments, and waste piles.

Rule 620. (1) A liner system shall be located, designed, constructed, and operated so that there is no direct contact between the liners and groundwater in a saturated zone such that moisture content would adversely affect the structural and containment integrity of the liners.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(2) The primary liner for a landfill shall be a composite liner. The composite liner shall be designed to have a flexible membrane liner meeting the requirements of 40 C.F.R. 264, subpart N, directly over compacted clay which is a minimum of 150 centimeters thick and meets the requirements of subrule (3) of this rule.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(3) A compacted clay liner that is designed to meet the requirements of 40 C.F.R. §§264.221, 264.251, and 264.301, which are adopted by reference in R 299.11003, or R 299.9619 shall meet all of the following requirements for that clay liner:

(a) Comply with the criteria for a unified soil classification of CL or CH as determined by the provisions of ASTM standard D2487-11.

(b) Have more than 25% of the soil particles be less than 5 microns in size.

(c) Be placed in horizontal lifts of not more than 25 centimeters and be uniformly and thoroughly compacted to the standards approved in the design. The lift thickness shall not be more than 25 centimeters (six inches) after compaction. However, the material shall not be compacted to less than 90% of the maximum dry density, as determined by the modified proctor test described in the provisions of ASTM standard D1557-12, or 95% of the maximum dry density, as determined by the standard proctor test described in the provisions of ASTM standard D698-12, which are adopted by reference in R 299.11001, and the moisture content shall be within a range of -2% to +5% of the optimum moisture content.

(d) Have a maximum permeability coefficient of 1.0 x 10-7 cm/sec or less at all points.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(4) The waste pile or landfill base floor shall be graded to a minimum slope of 2% in directions perpendicular to the leachate collection pipes to promote drainage. The leachate pipes shall be laid on a slope of 1% or more in a direction to intercept liquid flow. The director may approve an alternate design to those specified in this subrule if the owner or operator demonstrates to the director that such design, together with location characteristics, complies with both of the following requirements:

(a) The alternate design will prevent the migration of any hazardous constituent into the groundwater or surface water at least as effectively the design requirements specified in this subrule.

(b) The alternate design will allow the detection of leaks of hazardous constituents through the top liner at least as effectively as the design requirements specified in this rule.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(5) Liner systems and leachate collection systems shall be designed to prevent the damage of the materials of both systems in the event of differential settlement of the foundation under worst case

See Attachment B.6. Engineering Drawings, B.10 Construction Certifications and Attachment B.5. Environmental Monitoring: Leachate Collection and Removal System Sampling and Analysis Plan.

R 299.9621 Quality control for landfills, surface impoundments, and waste piles.

Rule 621. (1) Owners or operators of landfills, surface impoundments, and waste piles shall conduct a quality control program during construction which shall assure all of the following:

(a) That the natural clay base meets or exceeds the thickness and permeability requirements of R 299.9603(5), by doing either of the following:

(i) Obtaining soil borings and determining the natural moisture content as determined by ASTM standard D2216-10, grain size distribution (sieve and hydrometer) as determined by ASTM standards D6913-04 and D7928-16, classification by the unified soil classification system as determined by ASTM standard D2487-11, and Atterburg limits of the soil as determined by ASTM standard D4318-10 at varying depths every 100 feet, and the permeability of an undisturbed sample every 200 feet as determined by ASTM standard D5084-10.

(ii) Utilizing resistivity surveys to replace or supplement borings specified in paragraph (i) of this subdivision. Such resistivity surveys shall employ an electrode spacing to give an effective depth of penetration. A sufficient number of stations shall be used to insure that complete coverage to the edge of the waste management area is provided and correlation with borings or wells is obtained.

(b) That the natural clay base provides an adequate sub-base for overlying liners and leachate collection and removal systems, by evaluating the subgrade conditions for stability and correcting wet or unstable areas.

(c) That compacted clay liners meet or exceed the requirements of R 299.9620(2), by doing all of the following:

(i) Constructing the liner such that the bottom liner and the side wall liner (dike) will be continuous and completely keyed together at all construction joints.

(ii) During winter construction, removing all ice and snow before placing the liner and not using frozen soil in any part of liner.

(iii) Determining the field density-moisture of the liner material by utilizing the provisions of ASTM standard D6938-15 for each 1,000 cubic yards placed, with a minimum of 1 test per day of construction or layer of clay placed.

(iv) Determining the particle size distribution (sieve and hydrometer) according to ASTM standards D6913-04 and D7928-16, Atterburg limits according to ASTM standard D4318-10, and natural moisture content according to ASTM standard D2216-10 of random samples of liner material from each 5,000 cubic yards of material placed.

(v) Redetermining the density of liner materials by the modified proctor test, ASTM standard D1557-12, when the texture of the soil changes and every 5,000 cubic yards placed. (vi) Determining the permeability with water of a soil sample every 10,000 cubic yards placed by using ASTM standard D5084-10, which is adopted by reference in R 299.11001, or other method approved by the director on a sample that is not less than 2.8 inches in diameter.

(vii) Verifying liner thickness and subgrade slope by a final elevation check to ensure that all of the following requirements are met:

(A) The final elevation shall be within plus or minus 0.2 feet of the approved plans.

(B) The slope reduction of the subgrade shall not be greater than 10% of the approved slopes.

(C) The final clay liner thickness shall not be less than the approved thickness at any point. (d) That synthetic liners are properly installed, by doing all of the following:

(i) Properly preparing the foundation for the liner by doing all of the following:

(A) Compacting to the requirements of R 299.9620.

(B) Grading the foundation to a smooth and true line.

(C) Grading consistent with approved plans

(D) Grading the foundation to be free from stones or deleterious material.

(E) Removing any vegetation from the foundation before installation of the liner.

(ii) Insuring that field seaming is done under the direction of a registered professional engineer and when weather conditions are favorable for installation.

(iii) Insuring that field seams, joints, and mechanical seals are properly made by wiping contact surfaces clean of dirt, dust, moisture, or other foreign material, assuring that seaming is done in accordance with manufacturer specifications, and testing all field seams by nondestructive tests approved by the director. (iv) Recording the ambient temperature and liner temperature hourly during liner installation or field seaming.

(e) That leachate collection and leak detection, collection, and removal systems are installed such that the requirements of this rule are met, by doing both of the following:

(i) Making elevation checks at least every 200 feet to verify the appropriate thickness of granular material.

(ii) Sampling randomly at least every 5,000 cubic yards placed to verify the required aggregate classification.

(2) The quality control program required by subrule (1) of this rule shall be documented by written daily records of all work and tests performed during construction. All daily records shall be kept in the operating record for the facility and be made available for inspection by the director or his or her authorized representative.

(3) ASTM standards D2216-10, D2487-11, D1557-12, D2434-68, D4318-10, D5084-10, D6913-04, and D7928-16 are adopted by reference

See Wayne Disposal, Inc. Construction Quality Assurance Plan Master Cell VI (rev. 2, 2025)

R 299.9622 Leak detection systems.

Rule 622. (1) Each new unit and lateral expansion or replacement of an existing unit at a landfill, surface impoundment, waste pile, or land treatment facility shall include a leak detection system capable of detecting, collecting, and removing leaks of hazardous constituents at the earliest practicable time.

(2) If contamination is detected in the leak detection system required by this rule, the owner or operator shall do all of the following:

(a) Immediately notify the director or his or her designee.

(b) Within 30 days, determine what failures have occurred in the liner system.

(c) If failures have occurred, do either of the following on a schedule which insures the protection of human health and the environment:

(i) Repair the failures in the liner system and obtain the certification of a registered professional engineer that, to the best of his or her knowledge and opinion, the failure has been corrected.

(ii) Cease placing waste in the failed unit and take action to prevent the migration of hazardous waste and hazardous waste constituents from the facility.

(3) The director shall grant an exemption from the requirements for a leak detection system if the owner or operator satisfies the waiver requirements for 2 liners and a leachate collection system between such liners established under the provisions of 40 C.F.R. part 264.301.

See Attachment B.6. Engineering Drawings, B.10 Construction Certifications and Attachment B.5. Environmental Monitoring: Leak Detection Sampling and Analysis Plan.

270.21 Specific part B information requirements for landfills

Except as otherwise provided in § 264.1, owners and operators of facilities that dispose of hazardous waste in landfills must provide the following additional information:

(a) A list of the hazardous wastes placed or to be placed in each landfill or landfill cell;

See Attachment A2.B.2 Chemical and Physical Waste Analysis Plan

(b) Detailed plans and an engineering report describing how the landfill is designed and is or will be constructed, operated, and maintained to meet the requirements of §§ 264.19, 264.301, 264.302, and 264.303 of this chapter, addressing the following items:

(1)(i) The liner system (except for an existing portion of a landfill), if the landfill must meet the requirements of § 264.301(a) of this chapter. If an exemption from the requirement for a liner is sought as provided by § 264.301(b) of this chapter, submit detailed plans, and engineering and hydrogeological reports, as appropriate, describing alternate designs and operating practices that will, in conjunction with location aspects, prevent the migration of any hazardous constituents into the ground water or surface water at any future time;

(ii) The double liner and leak (leachate) detection, collection, and removal system, if the landfill must meet the requirements of § 264.301(c) of this chapter. If an exemption from the requirements for double liners and a leak detection, collection, and removal

system or alternative design is sought as provided by § 264.301(d), (e), or (f) of this chapter, submit appropriate information;

(iii) If the leak detection system is located in a saturated zone, submit detailed plans and an engineering report explaining the leak detection system design and operation, and the location of the saturated zone in relation to the leak detection system;

(iv) The construction quality assurance (CQA) plan if required under § 264.19 of this chapter;

(v) Proposed action leakage rate, with rationale, if required under § 264.302 of this chapter, and response action plan, if required under § 264.303 of this chapter;

See Attachment B.6. Engineering Drawings

(2) Control of run-on;

WDI maintains controls for a 25 year, 24 hour storm, per Stormwater Management Plan.

(3) Control of run-off;

WDI maintains controls for a 100 year, 24 hour storm, per Stormwater Management Plan.

(4) Management of collection and holding facilities associated with run-on and run-off control systems; and

See Storm Water Management Plan

(5) Control of wind dispersal of particulate matter, where applicable;

See Fugitive Dust Plan

(c) A description of how each landfill, including the double liner system, leachate collection and removal system, leak detection system, cover system, and appurtenances for control of run-on and run-off, will be inspected in order to meet the requirements of § 264.303(a), (b), and (c) of this chapter. This information must be included in the inspection plan submitted under § 270.14(b)(5);

See B5 Environmental Monitoring.

(d) A description of how each landfill, including the liner and cover systems, will be inspected in order to meet the requirements of § 264.303 (a) and (b). This information should be included in the inspection plan submitted under § 270.14(b)(5).

See Wayne Disposal, Inc. Construction Quality Assurance Plan Master Cell VI (rev 2, 2025)

(e) Detailed plans and an engineering report describing the final cover which will be applied to each landfill or landfill cell at closure in accordance with § 264.310(a), and a description of how each landfill will be maintained and monitored after closure in accordance with § 264.310(b). This information should be included in the closure and post-closure plans submitted under § 270.14(b)(13).

See Attachment A11 Closure Plan

(f) If ignitable or reactive wastes will be landfilled, an explanation of how the standards of § 264.312 will be complied with;

Not applicable. WDI does not accept waste that is ignitable or reactive until the waste is deactivated.

(g) If incompatible wastes, or incompatible wastes and materials will be landfilled, an explanation of how § 264.313 will be complied with;

Not applicable. WDI does not landfill incompatibles.

(h) If bulk or non-containerized liquid waste or wastes containing free liquids is to be landfilled prior to May 8, 1985, an explanation of how the requirements of § 264.314(a) will be complied with;

WDI does not bulk free liquids.

(i) If containers of hazardous waste are to be landfilled, an explanation of how the requirements of § 264.315 or § 264.316, as applicable, will be complied with.

Containers will be at least 90% full when placed in the landfill or crushed, shredded or similarly reduced in volume to the maximum practical extent before burial in the landfill.

(j) A waste management plan for EPA Hazardous Waste Nos. FO20, FO21, FO22, FO23, FO26, and FO27 describing how a landfill is or will be designed, constructed, operated, and maintained to meet the requirements of § 264.317. This submission must address the following items as specified in § 264.317:

(1) The volume, physical, and chemical characteristics of the wastes, including their potential to migrate through soil or to volatilize or escape into the atmosphere;

(2) The attenuative properties of underlying and surrounding soils or other materials;

(3) The mobilizing properties of other materials co-disposed with these wastes; and

(4) The effectiveness of additional treatment, design, or monitoring techniques.

Waste is placed directly in the active face of the landfill and immediately buried.

WAYNE DISPOSAL, INC.

CONSTRUCTION QUALITY ASSURANCE PLAN

MASTER CELL VI-E, VI-F, and VI-G

2021

Wayne Disposal, Inc.
49350 North I-94 Service Drive
Belleville, Michigan 48111

Rev. 2
May 2025

WAYNE DISPOSAL, INC.
CONSTRUCTION QUALITY ASSURANCE PLAN
MASTER CELL VI-E, VI-F, AND VI-G

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WAYNE DISPOSAL, INC.
CONSTRUCTION QUALITY ASSURANCE PLAN

This Construction Quality Assurance Plan (CQA Plan, Plan) has been prepared for Wayne Disposal, Inc. (WDI). WDI is a licensed Type I hazardous waste disposal facility located in Belleville, Michigan. This CQA Plan has been developed to ensure high quality installation and construction of various landfill components including the foundation liner and final cover systems at WDI. This Plan shall be implemented at the direction of WDI, under the direction of a CQA Officer designated by WDI, who is a registered professional engineer. This Plan addresses the following components:

- Foundation of Master Cell VI-F and Master Cell VI-G:
  - Structural fill including perimeter berms;
  - Attenuation layer;
  - Subgrade;
  - Geosynthetic clay liner;
  - Geomembrane;
  - Geogrid, Geonet, Geotextile, and Geocomposite;
  - Leak detection and leachate collection systems;
  - Granular soils and select aggregate, and
  - Piping.
- Final cover systems over Master Cell VI-E, VI-F, and VI-G.

1 RESPONSIBILITY AND AUTHORITY

This section contains a general description of the responsibility and authority of the parties involved in construction projects. All parties involved in construction projects at WDI shall comply with the responsibilities presented in this section.

1.1 Owner

Wayne Disposal, Inc. (WDI) is the Owner/Operator to whom all subcontractors are directly responsible. Referred to herein as WDI, WDI will employ all parties performing work described in this Plan.

1.2 Construction Contractor

The Construction Contractor may be one or several parties. The Owner may hire a General Contractor who shall assume responsibility for the entire construction project, including the hiring and managing of subcontractors. If the Owner does not hire a General Contractor to manage the project, construction projects shall, at a minimum, involve an Earthwork Contractor and a Geosynthetics Contractor.

The Earthwork Contractor is responsible for the proper construction of the earthwork-related portions of the liner and/or final cover system. These tasks could include site preparation, excavation, pre-processing of soil materials, backfilling, placement and compaction of soil components, grading the construction area, placement of granular materials, protection of the soil components during construction, stormwater management/dewatering and placement of vegetative cover.

The Geosynthetics Contractor is contracted directly by the Owner or Subcontracted to the General Contractor to install the specified geosynthetic materials. The Geosynthetics Contractor is responsible for supplying all labor and equipment needed to install the geosynthetic materials which meet the project standards as well as all geosynthetic materials not supplied by Others.

1.3 Design Engineer

The Design Engineer is responsible for the project design and shall prepare the project plans and drawings. The design shall meet the approved permit plans and Owner's operational and performance requirements for the landfill. Additionally, the Design Engineer is responsible for the review, generation, and approval of all design and/or specification modifications which apply to the design. The Design Engineer reports directly to the Owner.

1.4 Construction Quality Assurance Consultant

The Construction Quality Assurance (CQA) Consultant is responsible for the implementation of the CQA Plan for the construction project. The CQA Consultant shall be responsible for construction monitoring to observe compliance with the project plans, drawings, and the CQA Plan. The CQA Consultant shall observe and document the completion of each component of the project prior to the placement of subsequent components. Specific duties of the CQA Consultant include observation of construction materials, documentation of construction conditions, performance testing in accordance with project plans and the CQA Plan, documentation that construction is performed in substantial conformance with the approved project plans and drawings, preparation of as-constructed records, and preparation of a final construction documentation report detailing the observations and testing associated with the construction.

1.5 Construction Quality Assurance Officer

The CQA Officer shall be a Professional Engineer registered in the State of Michigan with experience in civil engineering and construction projects. The CQA Officer is typically an employee of the CQA Consultant. The CQA Officer is responsible for the overall coordination of documentation submitted in support of the CQA. Additionally, the CQA Officer is responsible for implementation of this CQA Plan and shall certify that the construction of project components is performed in substantial conformance with the project plans and drawings.

1.6 Surveyor

The Surveyor shall provide equipment and personnel needed to perform surveying activities as required by the construction project.

1.7 Testing Laboratory

The Testing Laboratory is responsible for providing soil and/or geosynthetic testing as required in the project plans and drawings.

2 DOCUMENTATION

The CQA Consultant shall prepare a daily written summary report for each day's construction and monitoring activities. The daily reports shall contain, at a minimum, the following information:

1. Date, project name, location, unit or area under construction, personnel involved in major activities, and other relevant identification information.
2. Name and title of the construction supervisor.
3. Description of weather conditions including maximum and minimum temperatures, and amount of precipitation, if any.
4. Time work starts and ends each construction day. Additionally, include any stoppages in work due to weather conditions or insufficient equipment or personnel.
5. Specific work units and locations of construction underway during that day.
6. Equipment and personnel being utilized in each work task, including subcontractors.
7. Identification of areas or units of work being inspected.
8. Chronological description of progress.
9. Description of off-site materials received, including any quality control data provided by the supplier.
10. Calibrations conducted for field test equipment.
11. Decisions made regarding approval of units of material or work, and/or corrective action, to be taken in areas that require rework.
12. Laboratory samples collected, identified, forwarded to the testing laboratory, and identity of the laboratory.
13. Results of monitoring activities and data, including material delivery report, geomembrane deployment, trial weld information, geomembrane seaming and repair

records, non-destructive seam testing, destructive sample records, soil placement, test pad information, and soil samples/tests taken. This data shall be maintained on appropriate forms and shall be cross-referenced, as necessary.

2.1 Report Forms and Record Keeping Documents

The CQA Consultant is responsible for preparing all field report forms, checklists, and data sheets to substantiate that the required construction monitoring tasks have been implemented. Typically, these report forms and checklists shall include: Daily Field Report, Design and/or Specification Modification/Clarification Form, and Photographic Records.

2.2 Identification and Resolution of Construction Challenges

A challenge is defined as material or workmanship that does not meet the requirements of the project plans or the CQA Plan, or any obvious defect in material or workmanship, even if there is conformance with the above referenced plans.

At a minimum, identification and resolution shall be documented in written communication with the Owner and shall include:

1. A description of the problem or deficiency
2. A discussion of the probable cause of the problem or deficiency.
3. Reference to any test results or retests performed.
4. Detailed description of measures implemented to resolve the problem and prevent recurrence.

2.3 Final Construction Report

Upon completion of the construction project, the CQA Consultant shall prepare a final construction report for the Owner. At a minimum, the final construction report shall contain the following information:

1. A description of the construction project and activities.
2. Project parties.
3. Project submittals.
4. As-constructed report to document elevations and locations of the construction project. Record drawings shall indicate the following information: (1) dimensions and elevations of each landfill cell; (2) the location and elevation of sumps and leachate collection pipelines; and (3) the surface elevation of the final cover system. Tolerance requirements for the surveyed components are listed in the respective Sections of this Plan.
5. Field test data summaries including sample numbers, test locations, lift, and pass/fail status for each test.
6. Laboratory samples collected and test results reported by the laboratory.
7. Diagrams which indicate location of tests, as necessary.
8. Geomembrane drawings that show the location of destructive tests, repairs, and panel layouts including the panel number and including the panel layout floor plans of the existing cells that tie-in to the newly constructed cell if the drawings of the geomembrane panels placed in the existing cell can be found.
9. Summary of construction problems/deficiencies that were identified and resolutions of the problems/deficiencies, as necessary.
10. Documentation that all applicable project plans, drawings, and the CQA Plan were met.

11. A certification by the CQA Officer that the construction meets the requirements of the applicable Rules, permits, and plans.

3 PROJECT MEETINGS

3.1 Preconstruction Meeting

After the Owner selects the contractor(s) for the construction project, and prior to initiation of any construction activities, a Preconstruction Meeting may be conducted to review the scope of the project. The meeting may be attended by all parties involved. The CQA Consultant shall document the Preconstruction Meeting discussions which may include the following topics:

1. Roles and responsibilities of all parties as defined in the project plans, and CQA Plan.
2. Lines of communication and authority.
3. Testing frequency and procedures.
4. Procedures for documentation and report submittals.
5. Coordination of work effort.
6. Project schedule.
7. On-site safety.
9. Soil requirements and specifications.
10. Geosynthetic requirements and specifications.
11. Equipment and usage.
12. Procedures for final acceptance of work.

3.2 Weekly Progress Meetings

Routine weekly progress meetings may be held and attended by the Owner, the Contractor(s), the CQA Consultant, and the CQA Officer, as appropriate to agenda topics for each meeting. Additionally, the attendance of subcontractor(s), supplier(s), or the Surveyor may be necessary. The weekly meetings may be held to review the construction progress of the previous week, the status of the project schedule, construction challenges

and resolutions, and the proposed construction schedule for the next week. The weekly progress meeting will be documented by the CQA Consultant.

3.3 Challenge Resolution Meeting

A challenge resolution meeting between appropriate parties may be held as necessary to review any construction issue that has been identified. The intent of the meeting is to identify, isolate, and resolve the challenge to meet the specifications of the project. This meeting shall be documented by the CQA Consultant.

4 FOUNDATION FOR MASTER CELL VI-F AND VI-G

The foundation for Master Cell VI-F shall be formed on native ground and on the closed Master Cell IV. The foundation for Master Cell VI-G shall be formed on native ground and on the closed Master Cell I. Where the foundation is formed over native ground, vegetation and topsoil shall be stripped and the underlying soils excavated to meet design specifications. Where the foundation is formed over closed cells, vegetation and topsoil shall be stripped from the existing cover and the foundation shall be regraded prior to placing components of the new cell.

4.1 Inspection of Foundation Surface

The foundation surface for placement of new cell components will be visually inspected by the CQA Consultant to locate unacceptable foundation conditions. Unacceptable foundation surface conditions include but are not limited to moisture seeps and soft spots identified during proof rolling of the subgrade. Where unacceptable foundation surface conditions exist, the surface shall be re-compacted or over-excavated. When the foundation is over-excavated, the resulting excavation may be backfilled with structural fill if the excavation is in existing clay materials or may be backfilled with existing waste if the excavation is in the existing underlying waste mass. Requirements for waste fill will be specified on the project Plans and drawings.

5 STRUCTURAL FILL

Structural fill consists of granular and/or cohesive soils used to construct the perimeter berm, cell floor, and other earthwork. The soil used in the construction of structural fill shall be relatively free of organic material, debris, or other deleterious material such that none of these deleterious materials are visible in the completed layer and do not penetrate the overlying layers. Material used as structural fill must meet the requirements of the project plans and drawings.

5.1 Pre-Construction Testing

For every structural fill material type, source, or when visual observations indicate that a change has occurred in the soils, obtain a soil sample and perform the following tests. These tests must be performed and acceptable results obtained prior to construction.

The CQA Consultant shall perform the following:

1. Index Testing
    - Natural Moisture Content according to ASTM D2216. One test per 5,000 cubic yards of material.
    - Grain Size according to ASTM D6913. One test per 5,000 cubic yards of material.
    - Atterberg Limits according to ASTM D4318. One test per 5,000 cubic yards of cohesive soil material.
    - Unified Soil Classification according to ASTM D2487. One test per 5,000 cubic yards of material.
2. Compaction Testing
    - Modified Proctor Compaction Test according to ASTM D1557. One test per 5,000 cubic yards of material.

3. Strength Testing

Reconstituted test specimens shall be prepared according to the results of the compaction test(s). Initial specimens shall be prepared at 90% of maximum dry unit weight and optimum moisture content according to the results of the ASTM D1557 compaction test(s). Subsequent test specimens may be prepared at different moisture contents to establish the maximum acceptable value for compaction. The laboratory may consider preparing a range of different moisture contents (such as +0, +4, +6% of ASTM D1557 optimum moisture content) for this purpose so that the resulting strength-based compaction criteria are comprehensive. Subsequent test specimens may also be prepared to greater unit weights as needed to achieve the minimum required strength. Reconstituted test specimens shall be subject to one of the following tests, depending on the character of the sample:

- One test per 10,000 cubic yards of material.
- Unconfined Compressive Strength (for samples exhibiting cohesive or cementing behavior only) according to ASTM D2166. A minimum passing result is 3,000 pounds per square foot (psf). If the strength tests fail to meet the minimum required strength, the samples shall be reconstituted to a higher density and retested. Three reconstituted specimens prepared and unconfined compressive strength measured shall constitute one test. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place dry unit weight.
- As an alternative to the unconfined compressive strength test for samples exhibiting cohesive or cementing behavior, vane shear testing may be used according to ASTM D2573. A minimum passing result is 1,500 pounds per square foot. If the strength tests fail to meet the minimum required values, the samples shall be reconstituted to a higher density and retested. Three reconstituted specimens prepared and vane shear tests measured shall constitute one test. The

moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place dry unit weight.

- Direct Shear Strength (for samples exhibiting non-cohesive behavior) according to ASTM D3080. Normal stresses of 2, 10, and 20 pounds per square inch (psi) shall be applied. A minimum passing result of 32 degrees peak friction angle is required. If the strength tests fail to meet the minimum required strength, the samples shall be reconstituted to a higher density and retested. Alternatively, the project-specific soil strength parameters may be evaluated by a qualified geotechnical engineer with respect to the specific berm geometry and anticipated loadings. If this evaluation meets the slope stability criteria from the design slope stability analyses, the test results may be accepted by the CQA Officer. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place unit weight. For granular soils, preconstruction strength testing frequencies may be reduced if the CQA Officer determines that 1) the initial three strength tests show consistent results, 2) the resulting strength parameters exceed minimum requirements, 3) the source material exhibits consistent gradation (+/- 10% passing each sieve by weight) as determined by ASTM D6913, and 4) the strength parameters are insensitive to dry unit weight.

5.2 Testing During Construction

CQA Consultant

During construction, the CQA Consultant will monitor and document the placement and compaction of the soils used for structural fill. The CQA Consultant will determine the in-place moisture content and dry unit weight of the structural fill material following ASTM D6938, latest edition. In-place tests will be performed at a minimum frequency of

one test for each 1,000 cubic yards placed, with a minimum of one test per day of construction or per lift of clay placed to verify compliance with the requirements of Items 1 and 2 below, unless otherwise indicated in the project plans.

1. Verify that structural fill is compacted to at least the minimum acceptable in-place density determined from the strength testing as described above, unless otherwise indicated in the project plans.

2. Verify that the in-place moisture content is between -4 and +0 percentage points of the maximum acceptable in-place moisture content determined from the strength testing as described above, unless otherwise indicated in the project plans.

3. Perform photographic documentation of construction to confirm conformance to project requirements.

Earthwork Contractor

The Earthwork Contractor will perform all the following during construction of structural fill:

1. Place and compact each lift with a general thickness of 9-inches after compaction for cohesive soils and 12-inches after compaction for granular soils, unless otherwise indicated in the project plans. In cases where the first lift of soil material is placed over geosynthetics, it will be placed at a minimum thickness of 18 inches after compaction, unless otherwise indicated in the project plans.

2. Compact each soil lift thoroughly and uniformly to the required density.

3. Protect the structural fill from detrimental climatic effects during construction. Remove all ice, snow, and frozen soil during cold weather construction prior to placing a lift and do not use any frozen soil in any part of the structural fill.

4. Remove observed roots, rocks, rubbish, or soils that do not meet the specifications of the project plans and drawings.

6 ATTENUATION LAYER

Attenuation layer material consists of cohesive materials which are used for the purpose of the attenuation layer. The soil used in the construction of the attenuation layer shall be relatively free of organic material, debris, or other deleterious material such that none of these deleterious materials are visible in the completed layer and do not penetrate the overlying layers. Material used as attenuation layer will meet the classification requirements of SC, CH, CL, CL/ML, or ML per the Unified Soil Classification System, ASTM D2487. Modified proctor moisture-density correlation (ASTM D1557) will also be tested to determine the maximum dry density of the soil.

6.1 Pre-Construction Testing

For every attenuation layer material type, source, or when visual observations indicate that a change has occurred in the soils, a soil sample will be collected, tested and acceptable results obtained prior to utilizing soil in construction.

The CQA Consultant shall perform the following tests:

1. Index Testing

    - Natural Moisture Content according to ASTM D2216. One test per 5,000 cubic yards of material.

    - Grain Size according to ASTM D6913. One test per 5,000 cubic yards of material.

    - Atterberg Limits according to ASTM D4318. One test per 5,000 cubic yards of material.

    - Unified Soil Classification according to ASTM D2487. One test per 5,000 cubic yards of material.

2. Compaction Testing

   - Modified Proctor Compaction Test according to ASTM D1557. One test per 5,000 cubic yards of material.

3. Strength Testing

   Reconstituted test specimens shall be prepared according to the results of the compaction test(s). Initial specimens shall be prepared at 90% of maximum dry unit weight and optimum moisture content according to the results of the ASTM D1557 compaction test(s). Subsequent test specimens may be prepared at different moisture contents to establish the maximum acceptable value for compaction. The laboratory may consider preparing a range of different moisture contents (such as +0, +4, +6% of ASTM D1557 optimum moisture content) for this purpose so that the resulting strength-based compaction criteria are comprehensive. Subsequent test specimens may also be prepared to greater unit weights as needed to achieve the minimum required strength. Reconstituted test specimens shall be subject to one of the following tests, depending on the character of the sample:

   - One test per 10,000 cubic yards of material.
   - Unconfined Compressive Strength (for samples exhibiting cohesive or cementing behavior only) according to ASTM D2166. A minimum passing result is 3,000 pounds per square foot (psf). If the strength tests fail to meet the minimum required strength, the samples shall be reconstituted to a higher density and retested. Three reconstituted specimens prepared and unconfined compressive strength measured shall constitute one test. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place dry unit weight.
   - As an alternative to the unconfined compressive strength test for samples exhibiting cohesive or cementing behavior, vane shear testing may be used

according to ASTM D2573. A minimum passing result is 1,500 pounds per square foot. If the strength tests fail to meet the minimum required values, the samples shall be reconstituted to a higher density and retested. Three reconstituted specimens prepared and vane shear tests measured shall constitute one test. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place dry unit weight.

- Direct Shear Strength (for samples exhibiting non-cohesive behavior) according to ASTM D3080. Normal stresses of 2, 10, and 20 psi shall be applied. A minimum passing result of 32 degrees peak friction angle is required. If the strength tests fail to meet the minimum required strength, the samples shall be reconstituted to a higher density and retested. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place unit weight.

6.2 Testing During Construction

CQA Consultant

During construction, the CQA Consultant will monitor and document the placement and compaction of the soils used for attenuation layer. The CQA Consultant will determine the in-place moisture content and dry unit weight of the attenuation layer material following ASTM D6938, latest edition. In-place tests will be performed at a minimum frequency of one test for each 1,000 cubic yards placed, with a minimum of one test per day of construction or per lift of clay placed to verify compliance with the requirements of Items 1 and 2 below, unless otherwise indicated in the project plans.

1. Verify that attenuation layer is compacted to at least the minimum acceptable in-place density determined from the strength testing as described above, unless otherwise indicated in the project plans.

2. Verify that the in-place moisture content is between -4 and +0 percentage points of the maximum acceptable in-place moisture content determined from the strength testing as described above, unless otherwise indicated in the project plans.

3. Perform photographic documentation of construction to confirm conformance to project requirements.

Earthwork Contractor

The Earthwork Contractor will perform all the following during construction of the attenuation layer:

1. Place and compact each lift, except the first lift of material over geosynthetics, with a general thickness of 6-inches after compaction. The first lift of soil material over geosynthetics will be placed at a minimum thickness of 12-inches after compaction, compacted with a Caterpillar D6 dozer or equivalent to achieve compaction specifications, unless otherwise indicated in the project plans. All required in-place density testing must meet specifications prior to placement of subsequent lifts.

2. Compact each soil lift thoroughly and uniformly to the required density.

3. Protect the attenuation layer material from detrimental climatic effects during construction by doing all the following:

    - Remove all ice, snow, and frozen soil during cold weather construction prior to placing a lift and do not use any frozen soil in any part of the attenuation layer;

- Recompact any soil lift of which its integrity is so adversely affected by weather that it no longer meets the requirements of the CQA Plan or project plans, at the discretion of the Owner and CQA Officer;

- Provide cover to prevent frost penetration during and following placement during winter construction; and

4. Remove observed roots, rocks, rubbish, or soils that do not meet the specifications of the project plans and drawings.

7 SUBGRADE PREPARATION

Surveyor

Prior to installation of geosynthetic material, the Surveyor shall establish a 100-foot survey grid system and survey locations along the cell perimeter to verify proper line and grade in accordance with the drawings. The grade tolerance for the landfill cell subgrade shall be 0.0 to -0.1 feet for the bottom of the structural fill layer and top of the secondary liner grades and 0.0 to +0.1 for the top of the attenuation layer. The final thickness of structural fill and attenuation layers shall not be less than the design thickness at any point.

CQA Consultant

During preparation of the subgrade for the Geosynthetic Clay Liner (GCL) and/or other geosynthetic installation, the CQA Consultant shall verify that:

1. The Surveyor has documented that the subgrade is properly prepared for the installation of geosynthetic materials and complies with the following:
    - The underlying soil has been smooth drum rolled, adequately compacted or hand-worked and is free of irregularities, protrusions, loose soil and abrupt changes in grade.
    - The surface is free of roots, standing water, stones or desiccation cracks which would adversely affect the performance of the soil.
    - Elevations of the subgrade are verified before geosynthetics installation and are within the tolerance specified.
2. Areas that do not meet the requirements of the CQA Plan are properly repaired and documented.

Earthwork Contractor

The Earthwork Contractor shall perform the following during the preparation of subgrade for geosynthetics installation:

1. Prepare the soil to a smooth surface, using a smooth drum roller or other suitable equipment, to grades which meet the project plans and grade tolerances.
2. Remove debris, organic materials, roots, any angular or sharp rocks or other material which may damage the geosynthetics. All protrusions (stone, etc.) greater than 1-inch in size, or more angular than "sub-rounded" in shape will be removed and the remaining cavity will be backfilled with clay.
3. Repair any surface which exhibits significant desiccation cracking as directed by the CQA Consultant. All backfill soils used for repair shall meet the applicable requirements of the CQA Plan.
4. Protect the prepared surface from damage from desiccation, flooding, and freezing.

Geosynthetics Contractor/Installer

The Geosynthetics Contractor/Installer shall perform the following during the preparation of the subgrade for geosynthetics installation:

1. Inspect the subgrade surface.
2. Accept, with the Geosynthetic Installer's signature on a Subgrade Acceptance Certification form, that the soil surface is acceptable for geosynthetics installation prior to deployment of the geosynthetic material.

8 GEOSYNTHETIC CLAY LINER

Geosynthetic Clay Liners (GCLs) consist of low hydraulic conductivity montmorillonite-rich expansive clay (bentonite) core, supported by geotextile and/or geomembranes which are held together by needling, stitching or chemical adhesives.

8.1 Materials

The GCL Manufacturer shall submit copies of the GCL roll Quality Control (QC) Certificates to the CQA Consultant for review and approval. These certificates shall be supplied at the minimum frequency as detailed in the Standard Practice for Quality Control of Geosynthetic Clay Liners (ASTM D5889). The results reported on the GCL roll QC Certificates shall, at a minimum, meet the property values detailed in the project plans.

The GCL Manufacturer shall submit representative samples taken from the proposed product for direct shear interface testing as required by the drawings. The CQA Consultant shall manage the direct shear testing of the GCL samples, as needed, per the direction of the Design Engineer and in accordance with the design requirements of the project. Proposed GCL rolls shall not be accepted for installation until the manufacturer provides GCL samples representative of the rolls proposed for installation with test results satisfactory to the Design Engineer according to the design requirements. The Design Engineer and the CQA Consultant shall reject any proposed GCL rolls and/or products that do not demonstrate the design requirements when subjected to direct shear interface testing.

8.2 Geosynthetic Contractor Submittals

When providing materials, the Geosynthetic Contractor will submit a schedule of GCL delivery and installation to the Owner prior to the start of the GCL installation.

The CQA Consultant shall verify that all submittals required of the Geosynthetic Contractor have been received and meet the requirements of the CQA Plan. The schedule

and any drawings submitted by the Geosynthetic Contractor, once approved by the CQA Consultant, shall be the basis of GCL deployment.

8.3 GCL Delivery and Storage

Geosynthetic Contractor

The Geosynthetic Contractor shall perform the following:

1. Prepare the GCL roll storage area to protect the GCL from dirt, mud, dust, moisture, and damage prior to deployment (i.e. a well-drained area protected from the elements and high traffic areas.) The GCL rolls shall be protected against adverse weather and other hazards. The rolls should be stored per the GCL Manufacturer's recommendations and to allow access for roll identification. The integrity and legibility of roll labels must be maintained during storage. The rolls must be protected from the elements by the application and maintenance of a proper cover.
2. Be responsible for off-loading the GCL rolls when delivered to the Site.
3. Instruct all personnel of the proper handling techniques so as not to damage the GCL rolls. Lifting of rolls shall be performed so as not to cause damage to the GCL or the protective covering.
4. Assure that the GCL rolls are packaged, shipped, and stored on-site in such a manner that the GCL rolls are not subjected to damage or moisture.
5. Identify and separate all damaged rolls from undamaged rolls and store these rolls at a location designated by the Owner until disposition of the damaged roll(s) is determined.

CQA Consultant

The CQA Consultant shall perform the following:

1. Inspect the GCL roll storage area to verify compliance with the CQA Plan.
2. Visually inspect the surface of all GCL rolls for visible defects and/or damage.

3. Compare the roll number against the GCL Manufacturer's QC Certifications for compliance with the project plans and the CQA Plan. Any damage detected shall be documented and the Geosynthetic Contractor shall be notified.

8.4 GCL Installation

The GCL can be deployed on the soil subgrade which has been inspected and accepted by the CQA Consultant and the Geosynthetic Contractor.

8.4.1 Weather Conditions

The Geosynthetic Contractor shall not deploy the GCL material during precipitation events or on areas with frost or precipitation accumulation. The GCL material shall not be deployed on softened or unstable subgrade.

8.4.2 Placement

GCL panels shall be placed in a controlled manner to prevent damage to the GCL materials or other in-place material. Any such damage shall be repaired by the Geosynthetic Contractor.

Personnel working on the GCL shall not smoke, wear damaging shoes, or engage in other activities which could damage the material. Wheeled vehicle traffic on the GCL panels is prohibited. Permission to drive other equipment on the GCL will only be granted in writing by the manufacturer on a case-by-case basis as outlined in the Manufacturer's installation guidelines. Foot traffic on the GCL panels shall be minimized. The Geosynthetic Contractor shall provide protection of the GCL from equipment or concentrated personnel traffic associated with the project.

GCL panels shall be deployed in such a manner as to minimize seams, be in contact with the material directly beneath it, and preclude folds or wrinkles which may become folds, and bridging. Any wrinkle, fold, or bridging that is observed shall be removed through

realignment of the GCL panel or cutting and repairing the panel in accordance with the CQA Plan.

Each adjoining GCL panel shall be overlapped a minimum of 6-inches on each side and a minimum end-to-end overlap of 12- inches or greater if required by the Manufacturer's installation recommendations. GCL panels on perimeter sideslopes shall be overlapped a minimum of 24-inches. The minimum overlap shall be indicated by a line, or series of lines spaced no more than 50-feet on the exposed surface of the GCL panel. The overlap area shall be free of dirt, gravel, and debris. The overlap shall be shingled following the presumed flow direction. The overlap shall be maintained to prevent seam openings during the installation and covering process. The Geosynthetic Contractor is responsible for assuring that the GCL panels remain overlapped throughout the installation process and until the overlying material is placed. Bentonite clay powder, or other approved supplement, shall be applied between the GCL layers in the overlap area as required by the GCL Manufacturer's specifications and the Geosynthetic Contractor's Installation QC Procedures.

Overlapping seams of adjacent GCL panels will be offset between layers of GCL to ensure that each overlap seam in the upper GCL does not vertically coincide with the overlap seam in the lower GCL (see figure below).

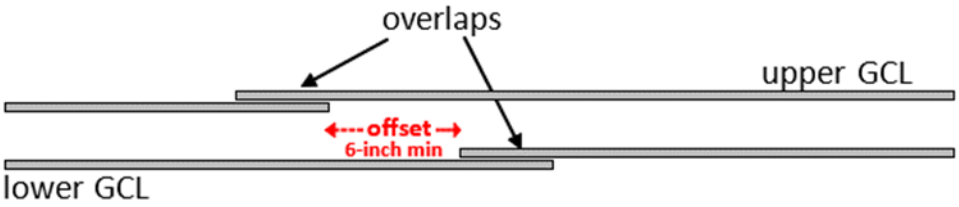

Figure 1. Offset of Overlap Seams between Upper and Lower GCL

Horizontal GCL seams on sideslopes greater than 5 percent shall be minimized. If horizontal seams are required due to the length of the sideslope, horizontal seams shall

be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet. Panels shall be placed such that the up-slope panels overlie those down-slope.

Placement of the GCL shall be in such a manner as to reduce the risk of water infiltration into the bentonite clay portion of the GCL. The GCL shall be covered with geomembrane and/or soil materials as required by the project design, as soon as practical, to provide maximum protection against the elements. The Geosynthetic Contractor shall direct stormwater drainage away from the GCL by construction of temporary stormwater diversion berms or other similar structures.

The Geosynthetic Contractor shall not install more GCL panels than can reasonably be covered with geomembrane that same day. The Geosynthetic Contractor shall also limit the installation of GCL panels during periods of impending bad weather such that the amount of uncovered GCL panels is minimized.

Premature hydration of the GCL prior to completion of the project may be cause for removal of the hydrated material, as directed by the CQA Officer.

If the bentonite clay portion of the GCL becomes prematurely hydrated, the CQA Officer shall inspect the material to ensure the integrity of the GCL has not been compromised. The CQA Officer shall inspect the material to ensure that significant thinning of the GCL has not occurred, that the reinforcing geotextile fibers have not been broken causing the internal strength of the GCL to be reduced, or that other properties of the GCL have not been detrimentally affected. The CQA Officer shall also consult with the Design Engineer to ensure that the stability of the liner has not be affected. If the CQA Officer finds that the integrity and or stability of the GCL has been compromised, the Geosynthetic Contractor shall either install new GCL over the compromised GCL or replace the compromised GCL, as directed by the CQA Officer after consultation with the Design Engineer.

The Geosynthetic Contractor shall clean the work area daily by removing scrap material and other debris associated with geosynthetic activities and dispose of scrap material properly.

The CQA Consultant shall observe and document the GCL deployment to verify that all provisions of the CQA Plan have been followed.

8.4.3 Temporary Anchoring

The Geosynthetic Contractor is responsible for the temporary anchoring of the GCL during construction. The Geosynthetic Contractor shall use sandbags or other means necessary to restrain the GCL without damage and to prevent the material from being pulled from proper alignment. Areas of damage caused by improper or insufficient temporary anchoring shall, as determined by the CQA Consultant and required by the Owner, be repaired or removed, disposed, and replaced by the Geosynthetic Contractor.

8.4.4 Permanent Anchoring

The Earthwork Contractor is responsible for the permanent anchoring of the GCL material. Permanent anchorage shall comply with the project plans and shall be installed as soon as practical following installation of the GCL material and the installation of the overlying materials.

8.4.5 Repairs

Holes, tears, or damage to the GCL material shall be repaired by placing a patch extending a minimum of 1-foot in all directions beyond the edges of the defect. Bentonite clay powder or other approved supplement shall be applied between the GCL panel and the patch as required by the GCL Manufacturer's installation recommendations and the Geosynthetic Contractor's Installation QC Procedures.

GCL panels with holes or tears extending more than 25 percent across the panel width shall be removed and replaced or covered by a single patch. GCL panels, or portions of

panels, which contain excessive patching, as determined by the Owner, shall be removed and replaced or repaired with a single patch.

The CQA Consultant shall verify and document that GCL repairs are performed as required by the CQA Plan.

8.5 GCL Acceptance

The Geosynthetic Contractor shall retain ownership and responsibility of the GCL until acceptance by the Owner or Owner's representative. Acceptance of the GCL will be complete when:

1. All required documentation from the GCL Manufacturer and the Geosynthetic Contractor has been received and accepted.
2. The geosynthetic installation is complete, the GCL material is intact and the GCL is not in a hydrated condition.
3. All repairs have been completed and tested.

9 GEOMEMBRANE

Geomembranes are synthetic membrane liners with very low permeability. They are used in landfill lining, capping and other fluid control systems. This section is applicable to field and factory fabricated panels of smooth and textured linear low density polyethylene (LLDPE) and high density polyethylene (HDPE) materials but is not valid when using geomembranes manufactured with other materials such as polyvinyl chloride (PVC).

9.1 Materials

9.1.1 Resin

The geomembrane manufacturer shall provide the following information prior to delivery of the geomembrane to the Site:

1. The resin supplier's name, resin production facility, resin identification, and production date of the resin.

2. A copy of the quality control certificates issued by the resin supplier.

3. Results of tests conducted by the resin supplier to verify the raw material quality including specific gravity and carbon black content.

4. A certification from the resin supplier that the polymer used in the geomembrane meets the criteria of the specifications.

5. Reports of tests or a certification by the manufacturer verifying the quality of the raw materials including specific gravity and melt flow index. These tests shall be performed at a frequency of at least one per resin batch but not less than once per 180,000 pounds of resin used in the manufacturing of the geomembrane.

6. A certification that reclaimed polymer is not added to the resin and that polymer recycled during the manufacturing process does not exceed 2 percent of the resin.

The CQA Consultant shall review the submittals provided by the manufacturer to verify compliance with the requirements of the specifications.

9.1.2 Geomembrane

Geomembrane Manufacturer

The geomembrane manufacturer shall perform the following:

1. Provide a certification that the geomembrane manufactured for this project meets the following criteria:

    a) The geomembrane contains no more that 1 percent by weight of additives, fillers, or extenders, excluding carbon black.

    b) The geomembrane is without holes, cracks, thin spots, tears, punctures, blisters, undispersed raw materials, roughness other than produced due to texturing, or any other indication of contamination.

    c) HDPE geomembrane must conform to the minimum properties of the project plans and the latest revisions to Geosynthetic Research Institute Test Method GRI-GM13.

2. Provide a copy of the manufacturer's geomembrane properties and quality control requirements, and instructions for geomembrane delivery, storage and handling.

3. Provide QC Certificates which represent each roll of geomembrane to be delivered to the job site. Each QC Certificate shall include:

    a) Roll number, geomembrane type, thickness, manufacturer, date of production, and roll dimensions. Each finished roll shall be identified by a number corresponding to the batch of resin used.

    b) The manufacturer's test results on samples from rolls from the same production lot, which verify that the rolls meet the requirements of the project plans. These

samples shall be tested to confirm that the requirements of the project plans are met, except that testing for environmental stress crack resistance and low temperature impact need not be performed. The test data shall be identified by roll number.

c) Certification that the roll meets the requirements of the project plans.

4. The manufacturer is responsible for the production of extrusion beads and/or welding rod from polyethylene resin which shall meet the requirements of the project plans.

CQA Consultant

The CQA Consultant shall verify that the manufacturer's submittals meet the requirements of the project plans.

The Manufacturer shall also submit representative samples taken from the proposed product for direct shear interface testing as directed by the CQA Consultant. The CQA Consultant shall manage the direct shear testing of the geomembrane samples, as needed, per the direction of the Design Engineer and in accordance with the design requirements. Proposed geomembrane rolls shall not be accepted for installation until the manufacturer provides geomembrane samples representative of the rolls proposed for installation with test results satisfactory to the Design Engineer according to the design requirements. The Design Engineer and the CQA Consultant shall reject any proposed geomembrane rolls and/or products that do not demonstrate the design requirements when subjected to direct shear interface testing.

9.2 Geosynthetics Contractor Submittals

Geosynthetics Contractor

The Geosynthetics Contractor shall submit to the Owner the following information prior to the start of geomembrane installation:

1. Schedule of geomembrane installation.

2. Panel layout drawings.

3. Drawings of construction details for anchor trenches, sumps and other features as required by the CQA Consultant.

4. A resume for the Master Seamer to be assigned to the project. A Master Seamer must be present on-site during all geomembrane seaming operations and shall have completed seaming on at least 1,000,000 square feet of polyethylene geomembrane, using both extrusion and fusion welding methods.

5. A resume for each Seamer to be assigned to the project. Each Seamer shall have completed seaming on a minimum of 100,000 square feet of polyethylene geomembrane.

6. A resume for each Seamer subsequently assigned to the project shall also be submitted. Seamer apprentices or assistants do not need the requisite experience if they are working under the direct supervision of a qualified Seamer.

CQA Consultant

The CQA Consultant shall verify that all submittals required of the Geosynthetics Contractor have been received and meet the requirements of the CQA Plan. The schedule and drawings submitted by the Geosynthetics Contractor, once approved by the CQA Consultant, shall be the basis of geomembrane deployment.

9.3 Geomembrane Delivery and Storage

The Contractor handling the supplied materials shall perform the following:

1. Assure that the geomembrane rolls or panels are packaged, shipped, off-loaded, and stored on-site in such a manner that the rolls are not subjected to damage.

2. Prepare the roll storage area to protect the geomembrane from dirt, mud, dust, and damage at all times prior to deployment. The geomembrane shall be protected against adverse weather, and other hazards.

3. Be responsible for off-loading of the geomembrane rolls when delivered to Site.
4. Instruct all personnel of the proper handling techniques so as not to damage any of the geomembrane rolls.
5. Assure that the geomembrane material is not folded. Folded geomembrane material shall be rejected.
6. Stack the geomembrane rolls per the manufacturer's recommendations but no more than five rolls high.
7. Identify and separate all damaged rolls from undamaged rolls and store these rolls at a location designated by the Owner until disposition of the damaged rolls is determined.

CQA Consultant

The CQA Consultant shall perform the following:

1. Inspect the geomembrane roll storage area to verify compliance with the CQA Plan.
2. Document the following information for all liner material delivered to the Site:
    - Storage location,
    - Name of the manufacturer and fabricator,
    - Name, type and thickness of the liner,
    - Batch code,
    - Roll number or Panel number (if prefabricated),
    - Date of fabrication, and
    - Physical dimensions.
3. Observe the material off-loading and storage of geomembrane rolls to verify compliance with the requirements of the CQA Plan.

4. Visually inspect the surface of all geomembrane rolls for visible defects and/or damage. Any damage observed shall be documented.

9.4 Geomembrane Installation

9.4.1 Anchor Trench

CQA Consultant

The CQA Consultant shall verify that the anchor trench has been constructed according to the requirements of the project plans and drawings. The CQA Consultant shall observe and document the placement of the geomembrane in the anchor trench and the placement of the anchor trench backfill material as required by the project plans and drawings. The anchor trench shall not be backfilled until the destructive and non-destructive testing of the seams to be buried have met requirements of the CQA Plan.

Earthwork Contractor

The Earthwork Contractor shall perform the following:

1. Construct anchor trenches to the nominal dimensions shown on the project plans and drawings plans with rounded edges and maintain trenches until properly backfilled.
2. Provide for adequate drainage of anchor trenches.
3. Backfill the anchor trench according to the drawings and the CQA Plan.

9.4.2 Weather Conditions

The CQA Consultant shall verify and document that geomembrane seaming is performed only during weather conditions which are considered acceptable, as described in the following sections.

All reasonable efforts will be made to install geomembrane when the geomembrane sheet temperature and the ambient temperature (measured 1 to 3 feet above the geomembrane) are above 32 degrees Fahrenheit. Welding performed at temperatures below 32 degrees Fahrenheit will only occur as allowed by the manufacturer's installation

guidelines and with authorization by the Owner or CQA Consultant. If authorized, welding at temperatures below 32 degrees Fahrenheit shall be performed in accordance with Geosynthetic Research Institute Test Method GRI-GM9 and in accordance with the following procedures:

1. CQA Consultant shall continue to monitor and record the ambient temperature and geomembrane sheet temperature hourly during liner installation or field seaming. If seaming is occurring in an enclosed structure, recorded temperatures shall be those in the enclosure. Maximum geomembrane sheet temperatures will be determined based on the geomembrane manufacturer's installation guidelines.
2. Extrusion welding shall be performed only with a hot air pre-heat operating immediately in front of the extrusion nozzle.
3. A specimen will be obtained from the end of each fusion welded seam that exceeds 25 feet in length, exclusive of cross-seams. The specimen will be hand-tested for peel adhesion. The result of peel testing will be recorded as a pass/fail on the CQA Consultant's Panel Seaming Form.
4. Destructive sample test frequency may be increased based on observation and determinations of the CQA Consultant.

Cold weather seaming procedures may be revised or modified with approval of the CQA Consultant.

Geosynthetics Contractor

The Geosynthetics Contractor shall:

1. Not weld during precipitation events, in the presence of excess moisture (i.e. heavy fog or dew, in an area of ponded water), or during conditions of winds which affect the control of the welding temperatures (unless engineering controls are installed).

2. Ensure that field seaming is not performed in adverse weather conditions that could impair the quality of the geomembrane installation unless protective structures or other methods are used to maintain seam integrity during construction.

9.4.3 Deployment Methods

The Geosynthetics Contractor shall install the geomembrane according to the panel layout drawings previously submitted to the Owner. Any changes to the panel layout must be approved by the Owner. The geomembrane shall be deployed so that it is in a loose and relaxed condition at the time of geomembrane seaming.

9.4.4 Prevention of Damage

The Geosynthetics Contractor shall be responsible to assure that:

1. Installation personnel do not use equipment or tools that may damage the geomembrane.
2. No installation personnel shall smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.
3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the underlying materials.
4. The method used to deploy the geomembrane shall minimize wrinkles.
5. Bridging of grade changes by the geomembrane shall be removed as directed by, and at the discretion of, the CQA Consultant.
6. Adequate loading (i.e. sandbags or similar items that will not damage the geomembrane) shall be placed on the geomembrane to prevent uplift and relocation of panels by wind.
7. Direct contact with the geomembrane shall be minimized (i.e. geomembrane in traffic areas shall be protected by geotextiles, additional geomembrane layers, or other materials approved by the CQA Consultant).

8. Use of wheeled vehicles driving on underlying geosynthetic material is prohibited.

9.4.5 Field Panel Identification and Deployment

The CQA Consultant or their representative shall assign each field panel a unique identification number consistent with the panel layout drawings submitted to the Owner. The Geosynthetics Contractor shall deploy field panels according to the panel layout drawing. Deviations from the approved panel layout drawing shall be approved in advance by the CQA Consultant. Each panel deployed shall be recorded by the Geosynthetics Contractor. Identification number, location, and date shall be recorded.

The CQA Consultant shall perform the following activities regarding geomembrane placement:

1. Verify that each panel is clearly identified, and its location noted.
2. Verify and document that the panel deployment proceeds according to the panel layout drawing and that pertinent information including panel overlap is recorded.
3. Visually observe the geomembrane for uniformity, damage and imperfections, including any of the following: holes, cracks, thin spots, tears, punctures, blisters or foreign material.

9.4.6 Geomembrane Panel Thickness Measurements

Panel thickness measurements shall be provided by the geomembrane manufacturer on the material certifications. Panels suspected to not meet the requirements based on field observations may be removed.

9.5 Seaming Specifications

9.5.1 General Procedures

The Geosynthetics Contractor shall perform the following:

1. Overlap (shingle) the geomembrane panels such that any fluid flowing across the seams would flow from the top panel to the underlying panel.
2. Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams on sideslopes greater than 5 percent should be minimized. If horizontal seams are required due to the length of the sideslope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet. Panels shall be placed such that the up-slope panels overlie those down-slope. Geomembrane panels placed on slopes shall extend a minimum 5-feet beyond the toe of the slope.
3. Clean the seam area such that the seam area is free of moisture, dust, dirt, debris, and foreign matter of any kind prior to seaming.
4. Align seams with the least possible number of wrinkles and "fish mouths". Fish mouths are to be cut, removed, and patched.
5. Field seam only in weather conditions which shall not impair the quality of the geomembrane, unless approved by the Owner.

The CQA Consultant shall verify that all geomembrane Seamers meet the experience requirements of the CQA Plan and that a Master Seamer who meets the experience requirements of the CQA Plan is present on-site whenever seaming is conducted. The CQA Consultant shall observe and document the geomembrane seaming activities to verify that the requirements of the CQA Plan are met.

9.5.2 Trial Welds

The Geosynthetic Contractor shall perform the following:

1. Begin geomembrane seaming only after Seamers and their assigned seaming equipment have successfully completed trial welds.
2. Perform trial welds at: (1) at the beginning of each seaming period; (2) at least once each 5-hour period; (3) after extended periods of shutdown; or (3) as directed by the CQA Consultant if materials, equipment or environmental conditions have changed since the last successful trial weld.
3. Perform trial welds using similar materials and in the same surroundings and environmental conditions as the production welds.
4. The trial weld specimen shall be a minimum of 10-feet long for self-propelled seaming(fusion) devices, and a minimum of 3-feet long for hand-held (extrusion) devices.
5. One-inch wide cutouts of the trial weld shall be subject to shear and peel adhesion testing in the field. A minimum of two cutouts shall be tested for bonded seam strength (shear) and an additional three cutouts shall be tested for peel adhesion using a properly calibrated digital readout tensiometer and the testing procedures of ASTM D6392.

A trial weld sample shall be considered passing, according to the following table (Table 9.1), for all specimens tested in shear and peel adhesion:

Table 9.1

Smooth or Textured Geomembrane Seam Strength Requirements

Property	Criteria		
	40 mill HDPE	60 mil HDPE	80 mil HDPE
1. Shear Strength (lb./inch)	80	120	160
2. Peel Adhesion (lb./inch) - Fusion	60	91	121
3. Peel Adhesion (lb./inch) - Extrusion	52	78	104

For trial welds, all specimens must meet the seam strength criteria with 0 percent incursion into the welded area.

A failed trial weld shall not be retested. The seaming equipment and the Seamer that produced the failed trial weld shall not be allowed to weld the geomembrane until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

The CQA Consultant shall observe the trial weld preparation and testing and verify that requirements of the CQA Plan are met. The CQA Consultant shall document trial welds, test results, and appropriate responses.

9.5.3 Seaming and Testing Equipment

Approved processes for field seaming are fusion and extrusion welding. Fusion welding shall be the primary (production) seaming method with extrusion welding used for geomembrane repairs unless specified otherwise by the Design Engineer. Proposed alternate processes shall be documented and submitted by the Geosynthetics Contractor to the CQA Consultant for approval prior to use in the field.

The Geosynthetics Contractor shall:

1. Use dual track fusion welders and extrusion welders for field seaming. Extrusion welders shall be equipped with gauges to indicate the temperature in the welder and in the pre-heat nozzle.
2. Provide a properly calibrated field tensiometer for on-site shear and peel adhesion tests. This device shall meet the requirements for testing shear and peel adhesion according to ASTM D6392.
3. Provide an air pressure/vacuum pump, air pressure measuring devices, and vacuum testing viewing boxes with the capabilities for air pressure and vacuum box nondestructive testing as required by the CQA Plan.
4. Provide a coupon die and press to produce test specimens (coupons) in the field for shear and peel adhesion testing.
5. Provide protective lining material and a splash pad large enough to collect spilled fuel under generators if portable gasoline-powered electric generators are used.

9.5.4 Fusion Welding Seam Preparation

The Geosynthetics Contractor shall:

1. Overlap the geomembrane panels a minimum of 4 inches.
2. Clean the geomembrane seam area prior to seaming to assure that the area is clean and free from moisture, dirt, dust, and debris. No grinding is required for fusion geomembrane welding.
3. Use a protective, moveable layer (“rub sheet”) directly below the overlap of geomembrane to be seamed, as required, to prevent build-up of moisture between the panels.
4. The welding technician shall legibly mark the following information on the geomembrane at the start of each seam:

- Date and start time,
- Technician identification, and
- Welding machine identification.

The CQA Consultant shall verify and document that geomembrane overlapping and preparation for fusion seaming is performed as required by the CQA Plan.

9.5.5 Extrusion Welding Seam Preparation

The Geosynthetics Contractor shall:

1. Overlap the geomembrane panels to be welded a minimum of 3-inches. Unless approved by the Engineer, extrusion welding shall not be used as the primary (production) field seaming method.
2. Clean the geomembrane panels prior to seaming to assure that the area is clean and free of moisture, dirt, dust, and debris.
3. For geomembranes greater than 60 mils in thickness, the edge of the upper geomembrane to be extrusion welded shall be beveled with a hand grinder at a 45-degree angle prior to heat tacking into place.
4. Weld the geomembrane within 15 minutes of grinding and cover all abraded areas with extrudate.
5. Purge the extruder prior to beginning the seam to remove all heat degraded extrudate from the barrel of the extrusion machine.
6. Keep the welding rod clean and dry.
7. For the age of geomembrane older than two years at the time of tie-in installation, the extrusion welds serving as a tie-in between two cells will be capped.
8. The welding technician shall legibly mark the following information on the geomembrane at the start of each seam or repair:

- Date and start time,
- Technician identification, and
- Welding machine identification.

The CQA Consultant shall verify and document that geomembrane seam overlapping and preparation for extrusion welding is performed as required by the CQA Plan.

9.6 Non-Destructive Seam Testing

The Geosynthetic Contractor shall perform non-destructive tests on all field seams and repairs over their full length. Test equipment required for non-destructive testing shall be furnished and operated by the Geosynthetics Contractor. Where the seam cannot be non-destructively tested, as determined by the CQA Consultant, the Geosynthetics Contractor shall submit to the CQA Consultant an alternate testing method for approval. Non-destructive testing shall be performed as the seaming work progresses, not at the completion of all field seaming.

The CQA Consultant shall observe and document the results of all non-destructive seam testing. The CQA Consultant shall verify that the test methods meet the requirements of the CQA Plan and document that all seams which fail non-destructive tests are repaired according to the CQA Plan.

9.6.1 Air Pressure Testing

Air pressure testing is applicable to dual track fusion welding which produces a double seam separated by an air channel.

The Geosynthetics Contractor shall perform the following:

1. Conduct air pressure testing wherever determined feasible by the CQA Consultant on dual track fusion seams.

2. Use the following equipment for air pressure testing of dual track fusion seams:

    a) An air pump or pressure tank equipped with a pressure gauge capable of generating and sustaining a minimum pressure of 50 psi and mounted on a cushion to protect the geomembrane. The air pump may be manual or motor driven.

    b) A manometer or other pressure measuring device capable of indicating the air pressure in 1.0 psi increments within the test range and equipped with a sharp needle.

3. Use the following procedures when performing air pressure testing:

    a) Seal the air channel at both ends of the seam area to be tested.

    b) Insert a manometer or other approved pressure gauge directly into the air channel created by the dual track fusion welding. Means of pressurizing must be provided.

    c) Energize the air pump to a minimum pressure of 30 psi. The air pump valve shall be closed and the pressure shall be allowed to stabilize for 2 minutes. After the stabilization period, the pressure must be sustained for an additional 5 minutes.

    d) If there is a loss of pressure exceeding 3 psi, or if the pressure does not stabilize, the reason for failure shall be investigated and the faulty area shall be located, repaired, and the seam retested.

    e) Ensure that the air channel is not obstructed by releasing air from the end of the seam opposite the manometer and observing the resulting pressure drop on the manometer.

    f) Remove the manometer and repair the holes.

9.6.2 Vacuum Box Testing

Vacuum box testing is applicable to extrusion welded seams. Fusion welded seams which cannot otherwise be air pressure tested may be vacuum box tested with prior approval of the CQA Consultant.

The Geosynthetics Contractor shall:

1. Use the following equipment for vacuum pressure testing:
    a) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft gasket attached to the bottom, a valve assembly, and a vacuum gauge.
    b) A vacuum pump assembly equipped with a pressure controller and pipe connections.
    c) Additional fittings and connections as needed to perform the tests.
2. Use the following procedure when performing the vacuum pressure testing:
    a) Trim excess geomembrane sheet overlap, if any.
    b) Apply a soapy solution to a length of the geomembrane approximately 12 inches by 48 inches along the seam (approximately the length of the vacuum box).
    c) Place the vacuum box over the area wetted by the soapy solution and apply pressure to seal the box over the seam. Apply a minimum vacuum pressure of five pounds per square inch gauge (psig) to the interior of the box.
    d) For a period of approximately 10 seconds, examine the geomembrane seam through the viewing window for the indication of soap bubbles.
    e) If no bubbles appear, release the vacuum and move the vacuum box to the next area of the seam, with a minimum 3-inch overlap. Repeat the process.
    f) Mark all areas where soap bubbles formed and repair the marked seam as required. Retest the repaired seam.

9.7 Destructive Seam Testing

The purpose of destructive testing is to evaluate seam strength. Destructive seam testing shall be performed as the seaming work progresses, not at the completion of all field seaming.

9.7.1 Sampling

Geosynthetic Contractor

The Geosynthetic Contractor shall:

1. Obtain at least one destructive test sample per day per seaming crew or machine, or every 500-feet of seam, whichever is greater, from locations specified by the CQA Consultant. Additional destructive test samples shall be taken as directed by the CQA Consultant.
2. Cut the destructive test samples as seaming progresses in the locations designated by the CQA Consultant. The destructive test samples shall be nominally 12-inches wide by 42-inches long, with the seam centered lengthwise. One cutout from each end of the sample shall be field tested prior to destructive testing. The remaining sample shall be cut into thirds (two 15-inch samples, one 12-inch sample), with two pieces given to the CQA Consultant (one 15-inch laboratory sample and one 12-inch archive sample) and the other sample retained by the Geosynthetics Contractor.
3. Label all samples with the location and seam number and record the date, location, panel numbers, seam number, welding machine and welding technician.
4. Repair all holes in the geomembrane resulting from obtaining the destructive test samples. All extrusion welded patches shall be vacuum tested.

CQA Consultant

The CQA Consultant shall:

1. Determine and identify the locations for destructive test sampling.

2. Verify and document that the Geosynthetic Contractor's destructive sampling and testing procedures meet the requirements of the CQA Plan.

3. Send the destructive test samples to an off-site laboratory for testing described below. On-site destructive testing performed in a controlled environment by qualified individuals of the CQA Consultant may be utilized in place of an off-site laboratory, if approved by the CQA Officer.

4. Verify and document that all destructive test results meet the requirements of the CQA Plan. Observe and document all subsequent activities relating to the repair and patching of the destructive test sample location.

5. Locate and document the destructive test sample locations on the panel layout drawing.

9.7.2 Testing

The CQA Consultant shall perform the following:

1. Test destructive samples for bonded seam strength (shear) and for peel adhesion. Samples from dual track welds shall be tested for peel adhesion on both tracks of the seam.

2. Cut out ten, 1-inch wide specimens from the destructive test sample. Test five specimens for shear and five specimens for peel strength in accordance with ASTM D6392. The passing criteria is as follows:

   a) For peel testing, five out of five test specimens must each pass the criteria listed in Table 9.1, with 25 percent or less seam separation as a percentage of the total weld area.

   b) For shear testing, five out of five test specimens must each pass the criteria listed in Table 9.1 with 50 percent seam elongation achieved at break and 25 percent or less seam separation as a percentage of the total weld area

c) Geomembrane destructive sample test results must conform to the minimum requirements of the CQA Plan and the latest revisions to Geosynthetics Research Institute Test Method GRI-GM19a.

9.7.3 Destructive Test Failure

The Geosynthetic Contractor shall ensure that the following procedures are followed if a sample fails a field destructive test:

1. Retrace the welding path to an intermediate location (approximately 10-feet from each side of the failed test), at the CQA Consultant's discretion, and take additional destructive test samples. If the bounding test passes the CQA Plan criteria, then the seam shall be repaired between that location and the original failed test location. If the test fails, the process is repeated. All failed test samples must be bounded by passing test samples or bounded by the point at which the seamer/seaming device was taken out of service.
2. With approval from the CQA Consultant, a laboratory destructive test of a previously performed trial weld may be used as a bounding sample for a failed destructive test.
3. Over the length of seam failure, either cut out the old seam, reposition the panel and re-seam, or install a cap-strip, as required by the CQA Consultant.
4. In lieu of installing a cap-strip over a failed fusion-welded seam, the Geosynthetics Contractor may elect to extrusion weld the upper flap of the fusion seam to the lower geomembrane, provided that the upper flap has a 2-inch minimum extension beyond the fusion weld.
5. Vacuum test all extrusion weld repairs. Additional destructive samples shall be taken at the discretion of the CQA Consultant.

9.8 Destructive Testing of Tie-in Seams to Existing Geomembrane

The following section applies to tie-in seams with existing cells where the existing geomembrane has been in place for more than 2 years.

Trial welds shall be conducted using the same geomembrane material as the actual production seams, e.g. new geomembrane to existing geomembrane, following the requirements of Section 9.5. The production weld shall be destructively and nondestructively tested following the requirements of Sections 9.6 and 9.7. See Figure 2 below for identification of the production weld.

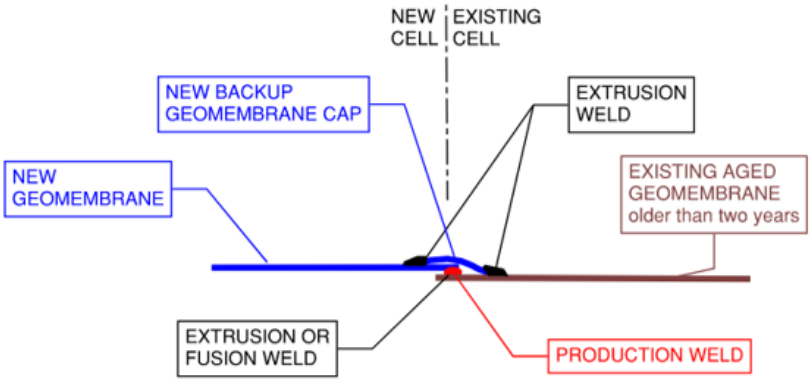

Figure 2. Location of Production Weld in Tie-in Seams to Existing Geomembrane

Based on destructive test results, any failed production weld shall be resampled, tested, and reconstructed per the requirements of Section 9.7. Additional destructive testing may be performed on any production weld geomembrane cap at the discretion of the CQA Consultant (Figure 3 below).

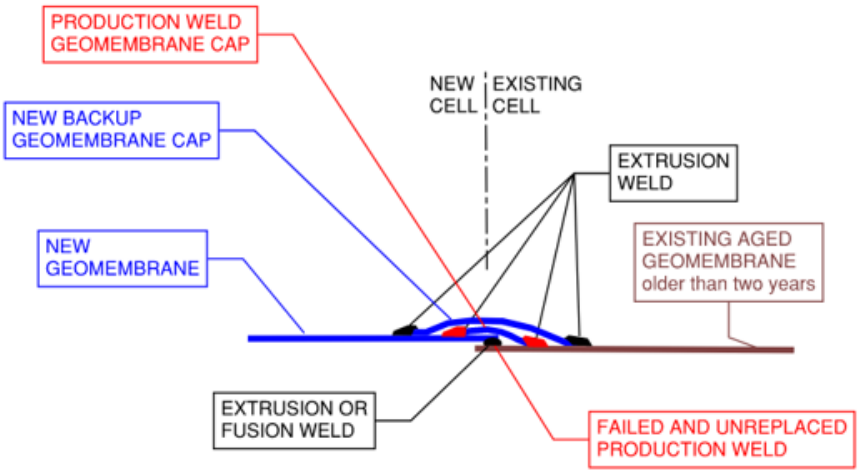

Figure 3. Location of Production Weld Geomembrane Cap

Upon receipt of successfully passing production weld destructive testing results, a final backup geomembrane cap will be extrusion welded over the entire length of the production weld, including over any production weld geomembrane cap. The final backup geomembrane cap shall be nondestructively tested per the requirements of Section 9.6. Destructive testing of the final backup geomembrane cap is not required.

9.9 Defects and Repairs

The CQA Consultant shall perform the following:

1. As each geomembrane panel is deployed, or as soon as possible after deployment, observe the geomembrane surface for damage and imperfections including holes, cracks, thin spots, tears, punctures, blisters, and foreign material. The surface of the geomembrane shall be clean at the time of the CQA Consultant's observations.
2. Identify, mark, and observe non-destructive testing of suspect locations.
3. Verify and document that all defects found as a result of: (1) the inspection and testing of suspected areas;(2) non-destructive tests; (3) destructive tests; and (4) any other inspection or observation, are identified for repair.

4. Verify and document that all identified defects are properly repaired in accordance with the CQA Plan. Repair equipment, materials, and procedures are subject to the approval of the CQA Consultant.
5. Verify and document that all repairs are non-destructively tested and either pass the tests or are again repaired and tested until passing test results are achieved.
6. Record the locations and types of defects and record the repairs and non-destructive testing at these locations.

The Geosynthetic Contractor shall perform the following:

1. Clean the geomembrane surface prior to inspection of the geomembrane by the CQA Consultant. The geomembrane surface shall be brushed, blown, or washed if the amount of dust or mud inhibits observations.
2. Perform non-destructive tests of each suspect location in the presence of the CQA Consultant. Each location that fails the non-destructive tests shall be marked by the CQA Consultant and repaired according to the procedures in the CQA Plan.
3. Repair any portion of the geomembrane which exhibits a flaw or fails a destructive or non-destructive test as follows:
    a) Small holes shall be repaired by extrusion welding. If the hole is larger than 0.25-inches, the hole shall be patched.
    b) Failed seams shall be repaired in accordance with the sections above.
    c) Tears shall be repaired by patching. If the tear is on a slope or an area of stress and has a sharp edge, the tear shall be rounded by cutting prior to patching.
    d) Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by large patches.
    e) Surfaces of the geomembrane which are to be patched shall be abraded and cleaned no more than 15 minutes prior to the repair. All abraded areas shall be

covered by extrudate. No more that 5-10 percent of the thickness shall be removed by abrading.

f) Folded geomembrane that has been creased or otherwise damaged shall be replaced. Patching shall be permitted with the approval of the CQA Consultant.

g) Patches shall be round or oval shaped, made of the same geomembrane, and extend a minimum of 6-inches beyond the edge of the defect. All patches shall be of the same compound and thickness as the geomembrane being repaired.

h) All surfaces must be clean and dry at the time of repairs. All seaming equipment used in the repairs must be approved by the CQA Consultant. All repair procedures, materials, and techniques must be approved by the CQA Consultant.

4. Perform non-destructive tests on each repair location. Repairs that pass the non-destructive test shall be noted as an acceptable repair. Failed tests indicate that the repair shall be repeated and retested until a passing test is achieved. The CQA Consultant may also require a destructive seam test sample to be taken from a repaired seam. Acceptance of the repaired seam shall then also be subject to the sampling, testing, and acceptance criteria of the CQA Plan.

9.10 Geomembrane Acceptance

The Geosynthetic Contractor shall retain ownership and responsibility for the geomembrane until acceptance by the Owner. The Owner shall accept the geomembrane installation when:

1. All required documentation from the geomembrane manufacturer and the Geosynthetics Contractor has been received and accepted.
2. The geomembrane installation is complete.
3. Verification that all field seams and repairs, including associated testing is complete.
4. The geosynthetic installation has been accepted in a final approval notice signed by the Geosynthetics Contractor and the CQA Consultant.

10 GEOGRID, GEONET, GEOTEXTILE, AND GEOCOMPOSITE MATERIALS

The design may include geogrid, geonet, geotextile, and/or geocomposite materials as indicated in the project plans and drawings for drainage and stability purposes in the landfill foundation liner and final cover system. This section of the CQA Plan addresses geogrid, geonet, geotextile, and geocomposite materials for use in the landfill liner system and/or the final cover.

10.1 Submittals

The manufacturer of the geogrid, geonet, geotextile, and geocomposite shall submit the following:

1. Manufacturer's specifications and certification stating that the materials meet or exceed the applicable requirements of the project plans and drawings.
2. Manufacturer's instructions for handling and storage of the geogrid, geonet, geotextile, and/or the geocomposite.
3. Manufacturer's QC test results for geogrid, geonet, geotextile, and/or geocomposite. These test results shall identify each roll of geocomposite with the corresponding roll identifications of the geonet and geotextiles incorporated therein such that the results of the following tests can be positively correlated with the geocomposite roll identification. The testing shall be performed by the manufacturer as follows:
    a) The geogrid shall be sampled at a minimum frequency of one sample for each 100,000 square feet delivered and shall be tested by the manufacturer to verify that the requirements in the project plans and drawings are met.
    b) The geonet shall be sampled at a minimum frequency of one sample for each 100,000 square feet delivered and shall be tested by the manufacturer to verify that the requirements in the project plans and drawings are met.
    c) The geotextile shall be sampled at a minimum frequency of one sample for each 100,000 square feet delivered and shall be tested by the manufacturer to verify

that the requirements in the specifications are met. Testing for UV Resistance is not required. Certification by the manufacturer that the UV Resistance requirement is achieved shall be provided.

d) The geocomposite shall be sampled at a minimum frequency of one sample for each 100,000 square feet delivered. The geonet and the geotextile from the geocomposite samples shall be certified that the requirements of the project plans and drawings are met.

The CQA Consultant shall verify and document that the information submitted by the manufacturer meets the requirements of the project plans and drawings.

The Manufacturer shall also submit samples taken from the proposed product rolls for direct shear interface testing as requested by the CQA Consultant. The CQA Consultant shall manage the direct shear testing of the geosynthetic samples, as needed, per the direction of the Design Engineer. Proposed geosynthetic rolls shall not be accepted for installation until the manufacturer provides geosynthetic samples representative of the rolls proposed for installation with test results satisfactory to the Design Engineer according to the design requirements. The Design Engineer and the CQA Consultant shall reject any proposed geosynthetic rolls and/or products that do not demonstrate the design requirements when subjected to direct shear interface testing.

10.2 Materials

10.2.1 Geogrid

The geogrid shall be comprised of geosynthetic materials and shall meet the minimum average roll values outlined in the project plans and drawings.

10.2.2 Geonet

The geonet shall be comprised of HDPE and shall meet the minimum average roll values outlined in the project plans and construction drawings.

10.2.3 Geotextile

The geotextile shall consist of continuous filament, needle punched, non-woven material and shall meet the minimum average roll values outlined in the project plans and drawings.

10.2.4 Geocomposite

The geocomposite shall be comprised of a geonet heat-bonded to geotextile. The geonet and geotextile shall meet the requirements of the project plans and drawings. Additionally, the geocomposite shall meet the requirements of the project plans and drawings.

10.3 Material Delivery, Handling, and Storage

The Geosynthetics Contractor shall perform the following:

1. Assure that the geogrid, geonet, geotextile, and geocomposite rolls are packed, shipped, off-loaded and stored by appropriate methods to prevent damage. The Geosynthetics Contractor shall be responsible for replacing any damaged or unacceptable material.
2. Protect the materials from mud, dust, dirt, and other damaging conditions. The manufacturer's procedures for shipping, handling, and storage shall be followed.
3. Assure that the geogrid, geonet, geotextile, and the geocomposite rolls are clearly labeled with the manufacturer's name, roll number, lot number, and batch number. Information shall be provided by the manufacturer which clearly identifies the corresponding roll information for the geonet and geotextiles incorporated into the geocomposite.

The CQA Consultant shall observe the off-loading of the geogrid, geonet, geotextile, and geocomposite and shall visually inspect the surface of all rolls for defects and/or damage. The CQA Consultant shall document any observed damage to any of the rolls.

10.4 Material Deployment

The Geosynthetics Contractor shall perform the following:

1. Assure that all geogrid, geonet, geotextile, and geocomposite materials are handled in a manner to prevent damage.
2. Assure that no materials are placed over the geomembrane until all required documentation regarding the geomembrane installation is complete.
3. Assure that the surface on which the materials are to be placed does not contain stones or excessive dust that could cause damage to any geosynthetic component.
4. In periods of high winds, weight all geosynthetic components with sandbags or similar material. The Geosynthetics Contractor shall be responsible for damage to the geosynthetic components resulting from wind damage.
5. Cut the geogrid, geonet, geotextile, and geocomposite materials using an approved tool. Care must be taken to protect the underlying geomembrane when the materials are being cut in-place.
6. Use equipment to deploy the geosynthetic components that shall not cause damage to any material.
7. Assure that no personnel working on the geosynthetic materials shall smoke, wear damaging shoes, or engage in other activities that could damage the materials.
8. Use of wheeled vehicles driving on underlying geosynthetic materials is prohibited.
9. If tri-planar geocomposite is used, the geocomposite roll should be installed in the direction of the slope. Tri-planar geocomposite directs flow predominately in the machine direction (along the roll length) and thus should be installed in the intended direction of flow or as specified by the Design Engineer.

The CQA Consultant shall observe and document the deployment of geogrid, geonet, geotextile, and geocomposite to verify that the provisions of the CQA Plan are met.

10.5 Field Seams

The Geosynthetic Contractor shall perform the following:

1. Field seams for geogrid:
    a) The overlap for seams shall be as specified by the geogrid manufacturer.
    b) Adjacent panels of the geogrid shall be joined as specified by the geogrid manufacturer.
    c) Where more than one layer of geogrid is installed, overlaps must be staggered.
    d) Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams shall be minimized. If horizontal seams are required due to the length of the slope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet.
2. Field seams for geonet:
    a) The overlap for seams shall be 4-inches along panel edges and 6-inches at panel ends.
    b) Adjacent panels of the geonet shall be joined using self-locking nylon straps placed at 5-feet intervals along the seam length on the sides and at one-foot intervals along the seam length at the ends. Only ties which do not damage the underlying geomembrane shall be used. Metal ties shall not be allowed.
    c) Ties shall be white or bright colored for easy identification.
    d) Where more than one layer of geonet is installed, overlaps must be staggered and layers tied together.
    e) Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams shall be minimized. If horizontal seams are required due to the length of the slope,

horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet.

3. Field seams for geotextile:

   a) The initial overlap for seams shall be at least 4-inches, configured into a “prayer” seam for sewing.

   b) The geotextile shall be continuously sewn between panels. Alternate methods of bonding the geotextile must be approved by the CQA Consultant prior to use.

   c) The thread used to sew the geotextile panels together shall meet the manufacturer's requirements.

   d) Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams shall be minimized. If horizontal seams are required due to the length of the slope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet.

4. Field seams for geocomposite:

   a) The overlap for seams shall be 4-inches along panel edges and 12-inches along panel ends.

   b) Adjacent panels of the geonet shall be joined using self-locking nylon ties placed at 5-feet intervals along the seam length on the sides and at 1-foot intervals along the seam length on the ends. End seams shall be covered by a piece of geotextile overlapped 6-inches on each side of the geocomposite seam and heat bonded in place. Only ties which do not damage the underlying geomembrane shall be used. Metal ties shall not be allowed.

   c) Ties shall be white or bright colored for easy identification.

   d) The geotextile shall be continuously sewn between panels. Alternate methods of bonding the geotextile must be approved by the CQA Consultant prior to use.

e) The thread used to sew the geotextile panels together shall meet the manufacturer's requirements and be white or bright colored for easy identification.

f) Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams shall be minimized. If horizontal seams are required due to the length of the slope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet.

The CQA Consultant shall observe and document the seaming of geogrid, geonet, geotextile, and geocomposite to verify that the following requirements of the CQA Plan are met:

1. Observations that all synthetic drainage materials are placed according to project plans.
2. Observations and measurements to ensure that the overlap of all synthetic drainage materials or geotextiles specified in the design and this CQA Plan are achieved.
3. Observations to verify that the synthetic drainage materials and geotextiles are placed free from excessive wrinkles or folds.
4. Observations to verify that weather conditions are appropriate for the placement of the synthetic drainage layer or geotextile materials and that exposure to rain, wind, and direct sunlight during and after installation follows the manufacturer’s recommendations.

10.6 Defects and Repairs

The Geosynthetic Contractor shall repair any holes or tears in the geosynthetic materials as follows, using patches made from the same material:

1. Damaged areas of geotextile shall be repaired by sewing or heat-bonding a patch in place with a 12-inch overlap in all directions.

2. Damaged areas of geogrid shall be repaired by placing a patch overlapping 2-feet beyond the edges of the hole or tear in all directions or according to the procedures recommended by the manufacture.

3. Damaged areas of geonet shall be repaired by placing a patch overlapping 2-feet beyond the edges of the hole or tear in all directions.

4. A geogrid or geonet patch shall be secured to the original geonet every 6-inches using nylon ties. If the damaged area comprises over 50 percent or more of the geonet roll width, the damaged area shall be cut out and the two portions of the geonet shall be joined.

5. Damage to the geocomposite shall be repaired as noted for geonets and the upper geotextile of the patch shall be sewn or heat-bonded to the upper geotextile of the geocomposite.

6. Use of equipment producing an open flame is prohibited when combustible gas including methane may be present.

The CQA Consultant shall observe and document the repairs made to the geogrid, geonet, geotextile, and geocomposite to verify that repairs are made according to the requirements of the CQA Plan.

10.7 Material Acceptance

The Geosynthetics Contractor retains ownership and responsibility for the geogrid, geonet, geotextile, and geocomposite materials until accepted by the Owner.

The Owner shall accept the geosynthetic components installation when:

1. All required documentation from the manufacturer and the Geosynthetics Contractor has been received and accepted.

2. The installation is complete.

3. The completion of field seams and repairs, including associated testing, is verified.

4. Written certification documents, including drawings, sealed by the CQA Consultant have been received by the Owner.

11 LEAK DETECTION AND LEACHATE COLLECTION SYSTEM

11.1 Leak Detection System

The leak detection system is comprised of geosynthetic materials installed by the Geosynthetics Contractor and may also include sumps and sampling pipes. Geosynthetic materials will be handled and installed in accordance with Section 10 of this Plan. Leak detection system materials will meet the specifications listed in the project plans and drawings.

11.2 Leachate Collection System

The leachate collection system is comprised of geosynthetic materials, granular soils, aggregate materials, and piping as shown on the project plans and drawings. Materials will be handled and installed in accordance with corresponding sections of this CQA Plan. Leachate collection system materials will meet the specifications listed in the project plans and drawings.

12 GRANULAR SOILS AND SELECT AGGREGATE

All granular materials and select aggregates used in landfill cell and final cover construction shall meet the requirements of the project plans and this section of the CQA Plan.

12.1 Materials

The granular soils and select aggregates used in the leachate collection and removal system and drainage layer components of the final cover shall meet the following requirements:

1. The granular soil and drainage aggregate shall be free of organic material, debris, trash, clay clods, or other deleterious material. No sharp-edged rocks or hard objects shall be allowed.
2. The granular soil drainage layer shall have maximum particle size as required by the drawings and project plans. The granular soil drainage layer shall be comprised of clean, subangular material of durable non-carbonate origin and shall be free of any materials capable of damaging the liner material.
3. Granular drainage soils shall have a minimum permeability shown in the project plans.
4. The drainage aggregate used around the leachate collection system piping and in sumps shall meet the requirements shown on the drawings and project plans.
5. In no instance shall the drainage aggregate be place directly on the geomembrane.
6. Granular soil samples shall be obtained on a frequency of at least one per every 5,000 cubic yards placed and tested for grain size distribution using a sieve analysis in accordance with ASTM D6913.
7. Granular soil samples shall be obtained on a frequency of at least one per every 5,000 cubic yards placed and tested for permeability in accordance with ASTM D2434.

8. The granular soil samples shall be collected and tested by the CQA Consultant. The CQA Consultant shall verify that the test results meet the requirements of the project plans and CQA Plan.

12.2 Construction Methods / Placement

Earthwork Contractor

The Earthwork Contractor shall install the granular soils in accordance with the following:

1. Low ground-pressure tire or track equipment shall be utilized for work on the granular soil materials whenever the thickness of the granular soil material is less than 24-inches. The granular soil beneath roadways for transporting material over the cell floor and sideslopes shall always be at least 3-feet thick. Excessive rutting shall be prevented. No portion of any earthmoving equipment shall be allowed to contact the underlying geomembrane material at any time.
2. Granular soil material shall be placed to minimize stresses on the underlying geomembrane. Placement of granular soil shall generally proceed by pushing the granular soil up the sideslope. No granular soil shall be allowed to fall or slide into place down the sideslopes.
3. During granular soil material placement, wrinkle propagation of geosynthetic materials shall be minimized.

CQA Consultant

The CQA Consultant shall perform the following:

1. Observe the placement of the granular soil and document soil material uniformity and the presence or absence of foreign materials.
2. Observe for potential and actual damage to the geomembrane during granular soil placement. When damage is suspected, the geomembrane surface shall be exposed to verify its condition. Actual damage to the geomembrane shall be documented and

corrective action shall be taken in accordance with procedures outlined in the CQA Plan.

3. Observe construction procedures to prevent the transport of fine soil particles by surface water run-off into the leachate collection system.

4. Observe and document that the granular soil material meets the material specifications, placement procedures, and thickness requirements of the project plans and the CQA Plan.

12.3 Survey

The Surveyor shall survey the granular soil layer on a 100-foot grid system to verify thickness. Alternately, direct depth checks may be performed by the CQA Consultant to determine the granular soil layer thickness. Locations where the granular soil layer thickness is less than required shall be corrected. The CQA Consultant shall document the placement of additional granular soil material to meet the requirements of the project plans and drawings.

13 PIPING

All piping used in the landfill cell construction or final cover shall meet the requirements of the project plans.

13.1 Pipe Materials

The pipe manufacturer shall provide the CQA Consultant documentation that the pipe provided meets the project plans and drawings.

The CQA Consultant shall review the manufacturer's information to verify that the project plans and CQA Plan requirements are met.

13.2 Delivery and Storage

The CQA Consultant shall obtain the following information when the pipe is delivered to the Site:

1. Name of manufacturer;
2. Product type and identification number;
3. Pipe diameter; and
4. Pipe wall thickness schedule or Standard Dimension Ratio.

The pipe shall be protected during shipment from excessive heat or cold, puncture, or other damage. The pipe shall be stored on-site in a manner to protect it from damage.

The CQA Consultant shall inspect the pipe delivery paperwork to ensure that the information is correct. The CQA Consultant shall also document the pipe material delivery in the daily summary report.

13.3 Pipe Installation

The pipe shall be joined by methods as defined by the pipe manufacturer and the project plans and drawings.

CQA Consultant

The CQA Consultant shall perform the following:

1. Inspect the pipe material for compliance with the project plans.
2. Observe and document the placement and joining of the pipe for compliance with the pipe manufacturer's specifications and the project plans and drawings.
3. Observe and document the backfill of the pipe for compliance with the project plans.
4. Observe and document the placement of filter materials, if used, around the pipe for compliance with project plans.

Earthwork Contractor

The Earthwork Contractor shall perform the following:

1. Pipe placement shall not be performed in the presence of excessive moisture.
2. Prepare the pipe subgrade condition and slope according to the project plans.
3. Join the pipe sections according to the pipe manufacturer's specifications and the project plans and drawings.
4. After joining, de-bead the pipe as required by the Owner.
5. Backfill the pipe according to the project plans.

The Surveyor shall survey the installed pipe every 100-feet and at appurtenances to verify that the pipe grade is in conformance with the project plans and drawings.

14 FINAL COVER SYSTEM

The final cover system may contain geosynthetic, granular, aggregate, piping, soil components, and Engineered Artificial Turf Landfill Cover (EATLC). EATLC, geosynthetic, granular, aggregate, and piping components of the final cover system will be installed per the project plans and drawings and according to corresponding sections of this CQA Plan. Soil components will be installed per the project plans and drawings and according to the installation guidelines of the following subsections. EATLC components will be installed per the latest manufacturers installation guidelines, for the EATLC product selected unless otherwise specifically stated on the project drawings.

14.1 Soil Material

The protective soil layer and topsoil layer of the final cover will meet the specifications of the approved project plans, drawings, and this section of the CQA Plan. Protective soil and topsoil will meet the following requirements:

1. The protective soil layer shall be free of debris, trash, stumps, or other deleterious materials. No sharp-edged rocks or other hard objects which could damage the geosynthetics shall be allowed.
2. The topsoil layer shall be capable of supporting shallow rooted vegetation and shall conform to the specifications of the project plans and drawings.

14.2 Soil Material Construction and Placement

CQA Consultant

The CQA Consultant shall perform the following:

1. Observe and document the placement of the soil layers. Visually inspect for material uniformity and the presence or absence of foreign materials.
2. Monitor the placement of the soil layers for potential or actual damage to the underlying components of the final cover system. Where damage of underlying

geosynthetic material is suspected, the geosynthetic material surface shall be exposed to verify its condition. If damage of geosynthetic material is found, the damage shall be documented, and corrective actions and repairs shall be made according to the CQA Plan.

3. Conduct field and laboratory testing at the frequency specified by project plans and drawings.
4. Certify that the soil layers have been placed and tested in accordance with the specifications of the project plans and drawings.

Earthwork Contractor

The Earthwork Contractor shall perform the following:

1. Place and compact each lift, except the first lift of material over geosynthetics, with a general thickness of 6-inches after compaction. The first lift of soil material over geosynthetics will be placed at a minimum thickness of 1 foot after compaction, unless otherwise indicated in the project plans.
2. Monitor the placement of the soil layers for potential or actual damage to the underlying components of the final cover system. Where damage of underlying geosynthetic material is suspected, the geosynthetic material surface shall be exposed to verify its condition. If damage of geosynthetic material is found, the damage shall be documented, and corrective actions and repairs shall be made according to the CQA Plan.
3. Soil placement shall be accomplished to minimize stresses on the underlying geosynthetic components of the final cover system.

Surveyor

The Surveyor shall survey the final cover soil components on a 100-foot grid system to verify thickness. Alternately, direct depth checks may be performed by the CQA Consultant to determine soil thickness. Locations where soil thickness is less than

required shall be corrected. The CQA Consultant shall document placement of additional soil material to meet the requirements of the project plans and drawings.

14.3 Engineered Artificial Turf Landfill Cover

An Engineered Artificial Turf Landfill Cover may be selected as part of the final cover system. EATLC components will be installed per the latest manufacturers installation guidelines for the EATLC product selected, unless otherwise specifically stated on the project drawings.

CQA Consultant

The CQA Consultant shall perform the following:

1. Materials submittals and certifications per the manufacturer's installation guidelines.
2. Observe and document the placement of the EATLC. Visually inspect for material uniformity and the presence or absence of foreign materials.
3. Monitor the placement of the EATLC layers for potential or actual damage to the underlying components of the final cover system. Where damage of underlying geosynthetic material is suspected, the geosynthetic material surface shall be exposed to verify its condition. If damage of geosynthetic material is found, the damage shall be assessed and any correction actions or repairs deemed necessary shall be documented and made according to the CQA Plan.
4. Conduct field and laboratory testing at the frequency specified by the EATLC manufacturer's installation guidelines and project drawings.
5. Certify that the EATLC has placed and tested in accordance with the specifications of the project plans and drawings.

Engineered Turf Installer

The Engineered Turf Installer shall conform to the following:

1. Inspect the subgrade and observe the following:
    a. The protective cover soil is substantially free of surface irregularities and protrusions including stones or other objects that could damage and of the EATLC components
    b. The anchor trench dimensions have been checked and the trenches are free of sharp objects and other deleterious materials.
    c. Accept, with the Installer's signature on a Subgrade Acceptance Certification form, that the soil surface is acceptable for EATLC installation prior to deployment of the material.
    d. Survey shots and as-built drawings will be carefully reviewed and evaluated to verify the surface grades will drain as intended on the drawings.
2. Installation of the geomembrane liner component of the EATLC must be completed by a geosynthetics contractor meeting the minimum qualifications stated in the manufacturer's installation guidelines. Installation shall follow the EATLC manufacturer's installation guidelines.
3. Construction equipment on the EATLC geomembrane component will be limited to reduce the potential for geosynthetics damage. Manufacturer's installation guidelines regarding construction equipment on the geomembrane component will be followed.
4. Anchor trench backfill will be completed as required by the manufacturer's installation guidelines.
5. Installation of the Engineered Turf component of the EATLC must be completed by a contractor meeting the minimum qualifications stated in the manufacturer's installation guidelines. Installation shall follow the EATLC manufacturer's installation guidelines.

6. The infill components of the EATLC must meet the requirements of the project drawings and manufacturer's installation guidelines. Installation shall follow the EATLC manufacturer's installation guidelines.

Surveyor

The Surveyor shall survey the EATLC on a 100-foot grid system.

WIND SPEED MONITORING PROGRAM

1.0 The Primary Wind Speed Sensor (PWSS) continually records and displays the Average Hourly Wind Speed (AHWS) and the Instantaneous Wind Speed (IWS) at the elevation corresponding to the Primary Active Face (PAF).

2.0 The PWSS is required to be positioned as follows:

2.1 The MMD/EGLE requires the PWSS be positioned along the southwest slope of Master Cell VI.

2.2 The MMD/EGLE requires the PWSS must be positioned at an elevation above mean sea level that is no lower than ten feet below the elevation at which waste is being placed. The PWSS may always be higher than this but never lower. The height of the sensor above its base must be taken into account when locating the appropriate position for the base. The elevation of the sensor, not the base, must be no lower than ten feet below the elevation of the location at which waste is being placed.

2.3 Coastal Environmental, the manufacturer of the current PWSS, requires the WeatherPak field sensor be maintained in an approximately vertical position to achieve maximum measurement accuracy.

3.0 If the PWSS indicates a Wind Speed Exceedance Level 1 (WSE1) at the PAF elevation:

3.1 WDI will conduct water application in accordance with SOP LOM-OP-009-BEL Standard Operating Procedure for Fugitive Dust Management.

4.0 If the PWSS indicates a Wind Speed Exceedance Level 2 (WSE2) at the PAF elevation:

4.1 All WDI Waste Placement Operations will stop immediately.

4.2 The PWSS may be moved to a lower elevation along the southwest slope of Master Cell VI corresponding to the elevation of an Alternate Active Face (AAF).

4.2.1. If there is not a WSE at the elevation of the AAF, waste placement operations may resume at the AAF and the Transfer Box. Waste placement may not occur at the PAF until the WSE at the elevation of the PAF has stopped.

4.2.2. If there is a WSE at the PAF and AAF or if there is not an AAF available, waste placement may not occur at the PAF or AAF until the WSE at those elevations has stopped; and the PWSS may be moved down the southwest slope of Master Cell VI to an elevation corresponding to the Transfer Box, which means an elevation not lower than ten feet below the elevation of the top edge of the wall of the WDI Transfer Box.

4.3 If there is a WSE at the PAF and the AAF, the PWSS may be moved to a lower elevation along the southwest slope of Master Cell VI corresponding to the elevation of the Transfer Box.

4.3.1. If there is not a WSE at the elevation of the Transfer Box, and if authorized by the Landfill Manager or designee, waste may be deposited into the Transfer Box; and waste may be pushed into piles in the Transfer Box to create as much temporary capacity in the Transfer Box as possible. However, normal waste segregation practices must continue to be observed in the Transfer Box, and waste may not be piled above the rim of the transfer box, until the WSE at the PAF or AAF has stopped.

4.3.2. If there is a WSE at the elevation of the Transfer Box:

4.3.2.1. None of the aforementioned waste placement operations may occur at the Transfer Box. However, if approved by the Landfill Manager or designee, non-bulk waste (e.g., containers, transformers, etc.) may be staged for inspection and sampling at the staging area adjacent to the WDI Transfer Box. Waste may not be placed into the Transfer Box or moved beyond the limits of the staging area until the WSE at the elevation of the Transfer Box stops and only if approved by the Landfill Manager or designee. Before authorizing non-bulk waste to be offloaded to the staging area, the Landfill Manager or designee must take into consideration the risk that non-bulk waste will have to be placed back on the delivery vehicle and rejected if the WSE preventing waste placement does not stop by the end of the operating day or if it is not desirable or possible to leave the waste in the Transfer Box in the event that only Restricted Waste Placement Operations are possible.

4.3.2.2. A handheld wind speed monitor may be used to check wind speed at the Transfer Box. The handheld monitor will be positioned at or above the top of the wall of the Transfer Box and within 20 feet laterally from the edge. IWS will be measured at least once per minute and the WSO will record IWS and calculated AHWS on the Handheld Wind Speed Monitor Log. If there is not a WSE, and if authorized by the Landfill Manager or designee, waste may be deposited into the Transfer Box and waste may be

pushed into piles in the Transfer Box to create as much temporary capacity in the Transfer Box as possible. However, normal waste segregation practices must continue to be observed in the Transfer Box and waste may not be piled above the rim of the transfer box.

5.0 In the event the PWSS is offline, switch to the Secondary Wind Speed Sensor (SWSS). At present the SWSS is located on the roof of the Receiving Department building because it is not a wireless system and there must be a direct connection between the sensor and the Receiver.

5.1 Because of the location of the SWSS, the MMD/EGLE requires that when using the SWSS the definition for a WSE be reduced 5 miles per hour lower than the definition of a PWSS WSE as defined in the Definitions section of this SOP.

5.2 The SWSS may be used as a substitute for the PWSS for up to two weeks unless a request for extension is approved by the MMD/EGLE.

5.3 WDI voluntarily operates a SWSS so that it is immediately available in the event the PWSS goes offline. Although WDI voluntarily operates a SWSS, WDI is not obligated to operate the SWSS, or record and store data output from the SWSS, until such time that the PWSS is offline and waste placement operations are occurring.

5.4 If the PWSS is offline and the SWSS indicates a WSE:

5.4.1. All WDI waste placement operations will stop immediately and may not resume until the WSE has stopped.

5.4.2. A handheld wind speed monitor may be used instead of the SWSS. The handheld monitor must be positioned at the same location and elevation that would otherwise have been required for the PWSS; all the same procedures described for PWSS monitoring followed; the definition of a PWSS WSE will apply; IWS will be measured once per minute; and the WSO will record IWS and calculated AHWS (calculated every 10 minutes) on the Handheld Wind Speed Monitor Log.

6.0 If the PWSS and SWSS are both offline:

6.1 A handheld wind speed monitor may be used. The handheld monitor must be positioned at the same location and elevation that would otherwise have been required for the PWSS; all the same procedures described for PWSS monitoring followed; the definition of a PWSS WSE will apply; IWS will be measured once per minute; and the WSO will record IWS and calculated AHWS (calculated every 10 minutes) on the Handheld Wind Speed Monitor Log.

6.2 The hand held wind speed monitor may be used as a substitute for the PWSS and SWSS for up to two weeks unless a request for extension is approved by the MMD/EGLE.

7.0 Whenever Waste Placement Operations are occurring at WDI, someone trained on the applicable parts of this procedure must perform the responsibilities of the Wind Speed Observer (WSO). This is required whether during normal receiving hours or outside of normal receiving hours including during waste transfer from MDWTP to WDI. Normally the WSO will be a Receiving Coordinator. If someone other than a Receiving Coordinator is acting as the WSO, that person will be responsible for performing all of the WSO duties described below.

7.1 Depending on the method of wind speed monitoring, the WSO may or may not need to be present in the Receiving building to access wind speed data.

7.1.1. The PWSS may be remotely monitored through the internet or by being present in the Receiving building.

7.1.1.1. If present in the Receiving building it is not necessary for the WSO to observe the wind speed display because an audible alarm will sound for the duration of any WSE.

7.1.1.2. If the WSO is remotely monitoring the PWSS through the internet, the WSO must observe the wind speed display at least once per 10 minutes to visually verify there is not a WSE.

7.1.2. The SWSS can only be monitored from the Receiving building. However, it is not necessary for the WSO to observe the wind speed display because an audible alarm will sound for the duration of any WSE.

7.1.3. When a handheld wind speed monitor is being used, the WSO may either be the person directly collecting wind speed measurements or may be remotely available to receive the data from the person performing the measurements. But in any case, someone must be present to perform and record the wind speed measurements and to calculate and record the AHWS.

7.2 The WSO will notify the Landfill Operators at the start and finish of each WSE. If the WSE occurs during an after hours waste transfer from MDWTP, the only notification by the WSO is to the MDWTP Shift Supervisor who will notify the MDWTP Waste Transfer Operator at the start and finish of each WSE.

7.3 The WSO will complete the Wind Speed Monitoring Equipment Downtime Log when the PWSS is offline. It is not required to document when the SWSS is offline unless both the PWSS and SWSS are offline.

7.4 During any after hours waste transfer from MDWTP to WDI, it is the responsibility of the MDWTP Shift Supervisor to act as the WSO or to designate an alternate WSO that has been trained on all the applicable parts of this procedure.

8.0 If directed by the Landfill Manager or designee, dust control operations may occur within the active area of the landfill during a WSE if necessary to manage dust emissions. However, during such activities, vehicle speeds will be minimized to reduce dust generation.

9.0 Daily cover will be placed at the end of each operating day whether or not there is an on-going WSE. However, if daily cover is placed during a WSE, dust generation will be managed by minimizing the speeds of vehicles used in the application of daily cover.

10.0 Only the Landfill Manager or designee may authorize PWSS power to be disconnected. Any employee that disconnects the power supply to the PWSS or is aware that the PWSS is offline for any reason must immediately notify the WSO so that a notation can be made to the Wind Speed Monitoring Equipment Downtime Log. If the Coastal Environmental WeatherPak is unplugged from its power source or loses power, it takes exactly one hour from the time power is restored before the AHWS will be displayed because it takes one hour to accumulate enough data to calculate AHWS (other data will be displayed in ten minutes). Until the AHWS display resumes, the SWSS must be temporarily used as the PWSS and the loss of power must be documented on the Wind Speed Monitoring Equipment Downtime Log. If the cause of the power loss is that someone has unplugged the sensor, even if unintentionally, that must be noted in the log.

11.0 Each day the Receiving Supervisor or designee will check wind speed forecasts for the next three business days and communicate forecasted WSEs to all of the following: WDI Director of Operations; WDI Landfill Manager; MDWTP General Manager; Customer Service Manager; Scheduling Coordinator; Transportation Manager; Rail Manager.

12.0 Whenever a WSE or series of WSEs causes time on site for any waste delivery vehicle to exceed three hours, the Receiving Supervisor will contact the appropriate USE Customer Service representatives to discuss whether trucks should be diverted to other facilities (e.g., WDI to MDWTP if possible) or scheduled to return on a different day.

CALIBRATION, MAINTENANCE AND DATA MANAGEMENT

1.0 Calibration/Service

1.1 PWSS: The Coastal Environmental WeatherPak does not require calibration per the owner's manual. However, preventive maintenance is recommended by the manufacturer every 12 months.

It is the responsibility of the Landfill Manager or designee to send the WeatherPak to Coastal Environmental for preventive maintenance every 12 months. The preventive maintenance schedule will be documented in the Compliance Calendar. Further, the alarm within receiving can be tested manually by blowing air across the sensor with an air compressor. This will be done annually as well or if it appears the alarm has malfunctioned.

1.2 SWSS: This sensor does not require calibration unless the propeller or propeller shaft have been damaged or distorted. WDI will send the sensor to the manufacturer every 2 years for evaluation of all bearings and preventive maintenance as needed to assure it is operating within factory standards. This preventive maintenance will be scheduled on the Compliance Calendar.

1.3 Handheld wind speed monitor: This sensor does not require calibration. Maintenance involves battery replacement as needed, and impeller replacement if it has become damaged or worn. The impeller must be totally intact and rotate freely without excessive play. in any case, WDI will replace the impeller every 2 years to assure the sensor is operating within standards. This preventive maintenance will be scheduled on the Compliance Calendar.

2.0 Data Storage

2.1 Only wind speed data collected during landfill waste transfer and placement operations is required to be stored however nothing in this procedure precludes WDI from storing more data.

2.2 PWSS:

2.2.1. Data must be stored electronically.

2.2.2. The Coastal Environmental PWSS generates one electronic data file per 24-hour day.

2.2.3. Coastal Environmental PWSS electronic data is stored at K:\Intercept Data\.

2.2.4. Electronic data files will be saved in the designated electronic folder at least once per week for any week in which the PWSS was the active wind speed sensor.

2.3 SWSS:

2.3.1. Data collected by the SWSS is not required to be stored unless the SWSS is the active wind speed sensor but if it is stored it should also be stored electronically.

2.3.2. R.M. Young SWSS electronic data is stored at: K:\RMY\.

2.3.3. Electronic data files will be saved in the designated electronic folder at least once per week for any week in which the SWSS was the active wind speed sensor.

2.4 Handheld wind speed monitor: Data collected by the hand held wind speed monitor, if any, must be documented on the Handheld Wind Speed Monitor Log which is stored in the Receiving building.

3.0 Time Settings

3.1 The Coastal PWSS receiver displays Coordinated Universal Time (abbreviated UTC, not CUT, consistent with international standards). The time setting on the Coastal receiver does not change throughout the year between Standard Time and Daylight Savings Time so the time setting should not need to be adjusted. UTC is 5 hours ahead of local time during Standard Time (first Sunday in November to the second Sunday in March) and 4 hours ahead of local time during Daylight Savings Time (second Sunday in March to first Sunday in November). UTC is often referred to as Greenwich Mean Time (GMT) although strictly speaking UTC's atomic time scale is only approximately the same as GMT. Time zones around the world are expressed as positive or negative offsets from UTC. In this role as the zero-point reference, UTC is also referred to as Zulu time (Z).

3.2 The R.M. Young SWSS time must be changed the first Sunday in November (Standard Time – back one hour) and the second Sunday in March (Daylight Savings Time – forward one hour) to stay current with local time. This is the responsibility of the Receiving Supervisor or designee.

INSPECTIONS

1.0 Once per operating day PWSS is verified to meet the following requirements

1.1 In accordance with MMD/EGLE requirements, the PWSS is positioned along the southwest slope of Master Cell VI.

1.2 In accordance with MMD/EGLE requirements, the PWSS is positioned at an elevation above mean sea level that is no lower than ten feet below the elevation at which waste is being placed. The PWSS may always be higher than this but never lower. The height of the sensor above its base must be taken into account when locating the appropriate position for the base. The elevation of the sensor, not the base, must be no lower than ten feet below the elevation of the location at which waste is being placed.

1.3 In accordance with Coastal Environmental requirements, the manufacturer of the current PWSS, the WeatherPak field sensor is maintained in an approximately vertical position to achieve maximum measurement accuracy.

2.0 Once per operating day verify that the Wind Speed Monitoring Equipment Downtime Log is up to date.

3.0 Once per week:

3.1 Verify that wind speed electronic data files have been stored in the designated electronic folders. This check will be documented on the Wind Speed Data Storage Verification Log. If corrective action is necessary, it will be noted on the Wind Speed Data Storage Verification Log.

3.2 Verify whether a Handheld Wind Speed Monitoring Log was generated since the previous inspection and, if so, whether the Log was properly filed. This check will be documented on the Wind Speed Data Storage Verification Log.

DEFINITIONS:

Alternate Active Face: An alternative location within the active area of the landfill that is at a lower elevation, and presumably experiencing a lower wind speed, compared to the Primary Active Face.

After Hours Waste Transfer: The transfer of waste from MDWTP into the WDI Transfer Box when no WDI Landfill Operators are present.

Average Hourly Wind Speed (AHWS): AHWS is the average of all wind speed data recorded in the most recent 60-minute interval. This number is a "rolling average" re-calculated every ten minutes using the most recent 60-minutes' data. So, for example, at 9:10 am the wind speed data collected from 8:10 am to 9:10 am is used to calculate AHWS. The PWSS and SWSS AHWS appears on the display screens from 9:10 am until 9:20 am at which time the AHWS is re-calculated using all wind speed data collected from 8:20 am to 9:20 am. The Coastal Environmental, R.M. Young, and Kestrel wind speed sensors calculate AHWS slightly differently:

1. Coastal Environmental PWSS: Measures wind speed once per second (60 readings per minute, 3,600 readings per hour) and then every 10 minutes it calculates the average of the most recent 3,600 measurements. The average of the most recent 3,600 measurements is the AHWS. This calculation is performed in the Weatherpak field sensor and then the calculated result is transmitted to the receiver once every 10 minutes.
2. R.M. Young SWSS: Measures the number of sensor revolutions that occur in each minute to calculate a one-minute average wind speed. Then, once

every ten minutes, it calculates the average of the 60 most recent one-minute average speeds.

3. Kestrel handled wind speed monitor: The WSO monitors the IWS and records it into the Handheld Wind Speed Monitor Log at least every minute. From these entries the WSO calculates and records the AHWS at least every 10 minutes.

Coastal Environmental: Manufacturer of the current PWSS. The component that is located in the field and measures wind speed is referred to by Coastal Environmental as the "WeatherPak." The Receiver is located in the Receiving building. The WeatherPak is not directly wired to the Receiver. Wind speed data is transmitted wirelessly from the WeatherPak to the Receiver. For help, contact Technical Support, Coastal Environmental, Seattle, WA, 206-682-6048 ext 138 or 800-488-8291 ext 138. See WeatherPak 2000 User Manual for additional details. Other information is available at www.coastalenvironmental.com.

Instantaneous Wind Speed (IWS): The Coastal Environmental, R.M. Young, and Kestrel wind speed sensors calculate IWS slightly differently:

1. Coastal PWSS: Measures a true instantaneous wind speed every second and then once a minute calculates the average of the most recent 60 readings. This average is reported as the IWS. This calculation is performed in the Weatherpak field sensor and then the calculated result is transmitted to the receiver once every minute.
2. R.M. Young SWSS: Measures the number of sensor revolutions that occur within each minute and converts number of sensor revolutions to an average wind speed for that minute.
3. Kestrel handheld wind speed monitor: The IWS is actually the average wind speed over the preceding 3-second observation period. The IWS is updated on the display every second. The WSO observes IWS and records it into the Handheld Wind Speed Monitor Log at least every minute."

Kestrel: Manufacturer of the current hand held wind speed monitor. See Kestrel 1000 Pocket Weather Meter Instruction Manual for further details. This sensor and instruction manual are retained in the office of the Landfill Manager.

Primary Active Face: The location within the active area of the landfill where waste is normally being placed at any given time.

Primary Wind Speed Sensor (PWSS): The device normally used to measure wind speed at WDI.

R.M. Young: Manufacturer of the current SWSS. Model number 05103. Web site is www.youngusa.com. See the MODEL 05103 WIND MONITOR MANUAL PN 05103-90 for further details. The sensor is located on the roof of the Receiving building. The receiver is located in the Receiving office. The sensor is connected to the receiver.

Secondary Wind Speed Sensor (SWSS): The device normally used as backup to the Primary Wind Speed Sensor to measure wind speed at WDI.

Waste Placement Operations: Unloading waste into the WDI Transfer Box; hauling waste from the Transfer Box to the Primary Active Face; spreading and compacting waste at the Primary Active Face.

WeatherPak: The component of the Coastal Environmental PWSS that is located outside and measures wind speed.

Wind Speed Exceedance Level 1 (WSE1):

1. If the PWSS is active or if a handheld wind speed monitor is being used: AHWS reaches or exceeds 20 miles per hour or IWS reaches or exceeds 25 miles per hour.
2. If the SWSS is active: AHWS reaches or exceeds 15 miles per hour or IWS reaches or exceeds 20 miles per hour.

Wind Speed Exceedance Level 2 (WSE2):

1. If the PWSS is active or if a handheld wind speed monitor is being used: AHWS reaches or exceeds 30 miles per hour or IWS reaches or exceeds 35 miles per hour.
2. If the SWSS is active: AHWS reaches or exceeds 25 miles per hour or IWS reaches or exceeds 30 miles per hour.

FUGITIVE DUST MANAGEMENT

1. **Engineering Controls** - Engineering controls refer to physical features and equipment within the Active Area (Figure 1) that are used for management of fugitive dust.

   1.1. **Mobile Wind Screens -** WDI uses mobile wind screens at or near the active waste face to reduce wind speed, and to thereby reduce suspension and transport of dust, from the area of the active face. The number and location of screens deployed depend upon wind conditions and the size and location of the active face. WDI's objective is to maximize the number of mobile wind screens placed upwind of the active face; however, WDI's ability to place mobile wind screens may be limited by the size, surface and location of the active face. Mobile wind screens may occasionally need to be removed from the hazardous waste landfill for repairs which will temporarily limit availability for use.

   1.2. **Stationary Wind Screens -** WDI uses stationary wind screens around the waste transfer box to reduce wind speed, and thereby suspension and transport of dust, from waste transfer operations.

2. **Operational Controls -** Operational controls refer to activities that are used to manage fugitive dust. WDI shall take the following precautions to manage fugitive dust:

   2.1. **Size of the Active Face -** WDI will minimize the size of the active face to minimize the surface area exposed to wind erosion.

   2.2. **Daily Cover** - WDI applies ConCover™ daily cover products (ProGuard IIB Plus and SB) or an equivalent product or geotextile (GSE and/or Propex or an equivalent product) or six inches of soil to the active waste face at the end of each working day or other product approved by the OWMRP/MDEQ. If the working day ends early due to excessive wind speeds the daily cover will be applied at that time.

   2.3. **Speed Limit -** Vehicle speeds on paved areas are limited by posted signs to 6 mph with the exception of the road located between the WDI wheel wash facility and the WDI transfer box which has a posted limit of 16 mph. Speeds are limited for all non-paved areas of the site by posted signs at 16 mph. Employees are trained to observe vehicle speed limits. When a vehicle is observed exceeding the speed limit, the driver will be issued a warning. Warnings for non-USE employees are recorded in the Receiving Department and repeated

offenses may result in being banned from the site. Speeding by USE employees is handled by USE conduct policies. Within the active landfill, operators are trained to drive slowly to control dust emissions.

2.4. **Street Sweeping and Water Application** - All paved areas are swept or wetted at least once every operating day weather permitting. The application of water to paved areas is done on an as-needed basis to supplement sweeping. If the application of water is used as a substitute for sweeping due to sweeper maintenance, water will be applied as-needed to control dust for no longer than two (2) weeks unless DEQ approves a request for extension. Within the Active Area, water is applied to roads as soon as possible, weather permitting, following the observation of visible dust emissions from the roads.

2.5. **Snow Removal** - Snow removed from paved areas will either be stockpiled on pavement that drains to the lined pond or placed within the Active Area. Snow removed from paved areas will not be stockpiled on unpaved surfaces.

2.6 **Truck Tarps** - All trucks are to remain tarped unless they are being sampled/inspected or are being off-loaded. Signs posting this policy are present along the waste transport route and drivers are reminded at the waste acceptance area.

2.7 **Wind Speed Monitoring** - Wind speeds are continually monitored in accordance with the SOP LOM-OP-013-BEL Standard Operating Procedure for Wind Speed Monitoring. If wind speed limits are reached or exceeded during operating hours, alarms sound within the Receiving Building and the landfill operations staff are immediately instructed to act as follows:

- Wind Speed Exceedance Level 1 (WSE1): Conduct water application per Section 2.8 below.

- Wind Speed Exceedance Level 2 (WSE2): Immediately stop all waste placement operations. Follow the requirements of SOP LOM-OP-013-BEL for restart of operations.

2.8 **Water Application** - During times when wind speeds reach or exceed WSE1 but are below WSE2, WDI will apply water to the waste at the primary active waste face as follows:

Water Source and Application Equipment:

- 5000 gallon insert tank on articulated off-road truck, or 2500 gallon tank on daily cover machine on trailer.

- Hydraulically driven water pump.

- Conical or fan-pattern spray nozzle.
- Application Spray Options:
    - Spray nozzles on the rear of the insert tank assembly (one man operation and preferred method for personnel safety).
    - 50’ (minimum), 1” (minimum) diameter water hose (two man operations and secondary method as necessary during waste unloading).

Water Source and Application Equipment:

- The water source, application equipment and operating personnel will be deployed sufficiently near the location of unloading and waste placement to reach the waste.
- The operating personnel will continually observe unloading and placement operations at the active face. If water source and application equipment are not present or functional, or if operating personnel are not present to continually observe and apply water as needed, waste unloading and placement activities at the active face will stop.
- The operating personnel will use the water source and application equipment to apply water to the waste as necessary to prevent visible dust generation at all times during waste unloading and placement operations at the active face.

DEFINITIONS:

Active Area: Refers to any part of the landfill that has not yet been closed by construction of a final cover barrier or interim closed with two feet of clay or other interim barrier approved by the Michigan Department of Environmental Quality Waste and Hazardous Materials Division. The boundary of the Active Area is identified as the edge of final cover or interim final cover barriers.

Affected Employees: Any employee that has to work in, or in close proximity to, the Active Area.

US ECOLOGY
WAYNE DISPOSAL, INC.

STORM WATER MANAGEMENT SYSTEM EVALUATION REPORT

Prepared for:

US Ecology
Wayne Disposal, Inc.
49350 North I-94 Service Drive
Belleville, Michigan 48111

Original: June 2019
Revised: May 2023

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US ECOLOGY WAYNE DISPOSAL, INC.

STORM WATER MANAGEMENT SYSTEM

EVALUATION REPORT

Revised May 2023

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STORM WATER MANAGEMENT SYSTEM

EVALUATION REPORT

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1.0 Introduction

Wayne Disposal, Inc. (WDI, Site) is a licensed Type I hazardous waste disposal facility located at 49350 North I-94 Service Drive, Van Buren Township, Wayne County, Michigan. This Storm Water Management System Evaluation Report was prepared by CTI and Associates, Inc. (CTI), on behalf of WDI, to present an updated evaluation of the current storm water management system at the Site.

The storm water management system at the Site has been evaluated by NTH Consultants, Ltd. (NTH) (NTH, 2009), the Mannik & Smith Group, Inc. (M&S) (M&S, 2016), and CTI and Associates (CTI, 2019) in the past. However, Site conditions have changed along with the construction of new cells and storm water conveyance structures after completion of previous evaluations. As such, this report was prepared as an update on the storm water management system evaluation based on the readily available information related to site conditions and system updates since last report.

The current stormwater management system has been modified to safely manage conservative future conditions. In this report, the storm water management system was evaluated pursuant to the provisions of R299.9604 of the Michigan Administrative Code to determine: (1) if the storm water collection structures can accommodate the water volume resulting from a 24-hour, 100-year storm; and (2) if the storm water conveyance structures can divert surface water run-on during peak discharge from a 24-hour, 25-year storm.

2.0 Methodology

Initial site conditions include various storm water management features (Drawing 2A). The Site consists of three (3) major watersheds (**Drawing 2B**) which are denoted as the North Sedimentation Basin (NSB) (**Drawing 2B-1**), the South Sedimentation Basin (SSB) (**Drawing 2B-2**) and the Lined Pond (LP) (**Drawing 2B-3**). In each watershed, the storm water runoff is conveyed by a network of conveyance structures (ditches, culverts, storm sewers, etc.) prior to discharge to the NSB, SSB, and LP.

The total runoff volume was calculated in accordance with the TR-55 methodology published by United States Department of Agriculture (USDA) in Urban Hydrology for Small Watersheds (USDA, 1986). The current storage capacity of each sediment basin and pond is determined based on as-built survey data.

The peak flow rates in the conveyance structures and peak storage levels in the storage ponds were calculated using two computer programs: 1) SEDCAD (University of Kentucky), and 2) Storm Water Management Model (SWMM, USEPA).

SEDCAD is used to evaluate the required flow capacities (peak flow rates) of existing conveyance structures (ditches, diversion berms, and culverts) in the NSB watershed. SEDCAD, which stands for Sediment, Erosion, Discharge by Computer Aided Design, is a program developed at the University of Kentucky to assist in the design and evaluation of storm water, erosion, and sediment control management. This computer program utilizes widely accepted methods that are developed by the Soil Conservation Service (SCS) of USDA to generate the hydrographs and compute the peak discharge rates and runoff volumes based on site conditions. SEDCAD also allows the sizing of channels, culverts, and basins based on the calculated flow rates and volumes.

This program allows the user to divide watershed areas into relatively homogenous sub-watersheds with respect to the expected hydrologic response. The sub-watersheds are linked with drainage structures (e.g., diversion channels, culverts) to establish a complete network. Hydrographs developed for each sub-watershed based on a design storm event. The time of concentration and hydrograph are calculated with drainage areas and SCS

curve numbers as input. The hydrograph is then routed through each storm water control structure, and peak flows and runoff volumes are calculated.

Due to a limited capacity of SEDCAD to evaluate storm sewers, SWMM was used to evaluate the peak flow rates of conveyance structures in the SSB and LP watersheds. SWMM is a dynamic rainfall-runoff simulation model developed by USEPA used for single event or long-term simulation of runoff quantity and quality from primarily urban areas. SWMM contains a flexible set of hydraulic modeling capabilities used to route runoff and external inflows through a drainage system network of pipes, channels, storage/treatment units and diversion structures. It has been widely used throughout the world for planning, analysis, and design related to storm water runoff, combined and sanitary sewers, and other drainage systems.

3.0 Input Parameters

3.1 Curve Numbers

In the TR-55 methodology, the runoff curve number (CN) method is used to represent the hydrologic soil group, cover type, treatment, and hydrologic condition in a watershed. In the runoff volume and peak discharge rate evaluation, CNs were determined for different types of watersheds as follows:

- 100 for Exposed Geomembrane Cover (EGC) areas, paved roads, paved parking lots, and building roofs (100% impervious area);
- 100 for sedimentation basins (100% runoff area); and
- 84 for grass covered areas (fair condition, grass cover 50%-70%); and
- 74 for MC I area, grass covered (good condition, grass cover over 75%).

3.2 Design Storm

A 100-year, 24-hour storm event with a Type II storm distribution was used to analyze the storm water storage ability of each pond. This storm event corresponds to 5.12 inches of rainfall in 24 hours according to National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Vol.8, Ver.2 (**Appendix A**).

A 25-year, 24-hour storm event with a Type II storm distribution (3.95 inches rainfall in 24 hours) was used to calculate the required hydraulic capacities of the conveyance structures.

4.0 System Changes and Updates

4.1 NSB Watershed

- The 2009 design prepared by NTH includes a sedimentation basin located near the northwest corner of the Site named Northwest Sediment Basin (NWSB). NWSB was deemed a detention pond for the SSB watershed and designed to temporarily hold storm water which was intended to eventually drain to SSB via a lift station. In order to improve its capacity to accommodate the increasing rainfall volumes in the storm water containment system during a 100-year storm event, the June 2019 storm water management plan removed the lift station and routed the storm water to the east. Since the water in the NWSB will be discharged to the N-MC VII Ditch by gravity, we renamed it as NW Ditch (NWD) (**Drawing 2B**).
- To conservatively accommodate future conditions, various areas of MC VI and MC V are modeled with future EGC in place or as future active area. This increases the total runoff and peak flows at downstream structures.
- The conservative future conditions include removal of the ditch east of MC IV. The ditch is scheduled for removal in Spring of 2023.
- The construction of the northwest portion of MC VI eliminates the temporary culverts. The conservative future conditions consider filling complete in this area.
- Diversion Berm S-MC XI DV has been removed allowing portions of MC XI to drain directly to the SSB.
- Runoff from portions of MC I will drain to the SSB subwatershed.
- Runoff from the entirety of MC VII will drain to the NSB watershed.
- The area providing direct runoff to the NSB increased due to completed construction activities and conservative future conditions.
- The NSB pond volume was increased to the south.

4.2 SSB Watershed

- To conservatively accommodate future conditions, various areas of MC VI are modeled with EGC in place or as future active area. This increased the total runoff and peak flows at downstream structures.
- Diversion Berm S-MC XI DV has been removed allowing an additional area of MC XI to drain directly to the SSB (also discussed in Section 4.1).
- Runoff from portions of MC I will drain to the SSB subwatershed (also discussed in Section 4.1).
- S3 inlet containment berm improvement.
- The Wastewater Treatment Plant (WWTP) area is removed from the SSB watershed. The runoff from the WWTP is collected and treated within the WWTP.
- The Lined Pond area is increased which reduces the SSB watershed.

4.3 Lined Pond Watershed

The lined pond area and volume has been increased due to 2021 construction activities.

4.4 Drawing Updates

All above-described changes are incorporated into the revised drawings (2B, 2B-1, 2B-2, and 2B-3). CTI updated the drawings in this report to accurately reflect the current watersheds and conveyance structures.

5.0 Runoff Storage Capacity Analysis

The total storm water runoff to NSB, SSB, and LP was calculated based on the updated Site conditions and the design rainfall intensity for a 100-year storm (i.e., 5.12 inches for 24 hours). To be conservative and consider variations in future EGC placement, some areas of MC VI are simultaneously included in both the NSB and SSB water sheds. The conditions considered in the calculation conservatively include future drainage areas that are larger than current conditions. Larger drainage areas result in more stormwater run-off. Therefore, the storage capacity meeting design conditions will also meet current conditions. The calculation sheets are included in **Appendix B**. The estimated runoff volume to each storage basin/pond (i.e., the required storage capacity of the basin/pond) is lower than the current storage capacity calculated based on as-built survey data (**Table 1**), indicating that those storage structures have adequate capacity to manage the runoff generated in a 100-year, 24-hour storm. The detailed watershed information for each basin/pond is provided in **Appendix B** and **Drawings 2B-1, 2B-2, and 2B-3.**

5.1 NSB Watershed

The NWD receives runoff from a portion of MC I, MC IV, MC VIG, the proposed EGC areas in MC VI, and the existing EGC areas at the north end of the MC VIE (Areas 6 and 10), consisting of a total watershed area of approximately 94.2 acres (**Drawing 2B-1**). In addition to the NWD described above, the NSB watershed also includes MC VII, and portions of MC X and MC XI, and the entire MC IX (**Drawing 2B-1**). The total area of NSB watershed is approximately 246.3 acres.

For a conservative evaluation, the potential detention of water in the NWD is not considered when calculating the total runoff volume to NSB (i.e., required storage capacity of NSB). The NSB, including the existing expansion pond to the south (total storage capacity of 147.8 ac-ft), has adequate capacity to manage the runoff generated in a 100-year, 24-hour storm (79.8 ac-ft) (**Table 1**).

5.2 SSB Watershed

The SSB receives the runoff from portions of EGC areas in the eastern portion of MC VI; soil cover area in the southern portion of MC VI; portions of MC I, MC X, and MC XI; and portions of the entrance area, and the wastewater treatment plant. The area of the SSB watershed is approximately 133.4 acres.

The current storage capacity of the SSB with approved expansion sections is 66.8 ac-ft (**Drawing 2B-2**) and is anticipated to have adequate capacity to manage the runoff generated in a 100-year, 24-hour storm (39.8 ac-ft) (**Table 1**).

5.3 LP Watershed

The LP receives the runoff from approximately 15.2 acres of paved areas (**Drawing 2B-3**). With the revised storage capacity of 14.8 ac-ft, the lined pond is anticipated to provide adequate capacity to manage the runoff generated in a 100-year, 24-hour storm (i.e., 6.5 ac-ft) (**Table 1**).

Table 1. Storm Storage Capacities of Basin/Pond

Storage Structures	Pond Capacities (ac-ft)	Required Storage Capacities (ac-ft)	Adequate Capacity (Y/N)
NSB	147.8	79.8	Y
SSB	66.8	39.8	Y
LP	14.8	6.5	Y

6.0 Existing Storm Water Conveyance Structure Capacity Analysis

The flow capacities of existing storm water conveyance structures were evaluated for the design 25-year, 24-hour storm event. The conditions considered in the calculation conservatively include future drainage areas that are larger than current conditions which results in larger peak flows at each downstream structure. Therefore, the storm water conveyance structures meeting design conditions will also meet current conditions. Peak flow rates for each conveyance structure were calculated using either SEDCAD model (NSB watershed) or SWMM model (for SSB and LP watersheds). For some features the minimum dimension (for example, the height for ditches; the diameter for culverts or storm sewers) required for each structure to convey the runoff from the design storm event was estimated based on site conditions, and then compared with existing dimensions to determine whether the structure has adequate capacity to manage the design storm event.

6.1 NSB Watershed

The conveyance structures in the NSB watershed include a detention pond, ditches, diversion berms and culverts. The required flow capacity of each conveyance structure was analyzed using SEDCAD.

For the design 25-year, 24-hour storm event, the peak flow rate into the NWD is estimated to be 325.35 cubic feet per second (cfs) and runoff in NWD is estimated to be discharged at the rate of 16.73 cfs (**Appendix C**). The peak water elevation in NWD is 710.08 ft above mean sea level (amsl), which is below the elevation of the top of the berm (712 ft amsl). Therefore, the simulation results demonstrate that the NWD is adequately sized. The NWD and ditches modeled as temporary retention structures to determine peak water levels upstream of the culvert are summarized in **Table 2A**.

Tables 2 and **3** present details on the existing ditches and culverts in the NSB watershed.

Table 2A. Capacity of Ditches Modeled as Temporary Retention Structures in the NSB Watershed						
Ditches	**Peak Ditch Inflow (cfs)**	**Peak Ditch Discharge (cfs)**	**Peak Flow Elev.**	**Existing Containment Berm Elev.**	**Min. Containment Elev.***	**Adequate Flow Capacity (Y/N)**
NWD*	325.35	16.73	710.08	712	710.5	Y
W MC VII/XI & E MC VII/XI	45.91	26.48	706.76	707	707.0	Y
MC VII/IX	202.06	32.18	702.78	704	703.0	Y

*Notes:

1. Minimum containment berm elevation is the required minimum top of berm elevation required to contain the design storm event.
2. NWD values include the entirety of all NWD configurations.

Table 2. Capacity of Ditches and Diversion Berms in the NSB Watershed					
Ditches	**Slope**	**Minimum Ditch Height (ft)**	**Peak Flow Depth (ft)**	**Peak Flow Rate (cfs)**	**Adequate Flow Capacity (Y/N)**
N-MC VII Ditch	0.20%	2.0	1.32	32.97	Y
N-MC IX Ditch	0.05%	3.0	2.65	60.73	Y
NE-MC IX Ditch	0.1%	2.6	1.66	63.15	Y
E-MC IX Ditch	0.96%	2.5	1.37	38.69	Y
MC X/XI Ditch	0.10%	7.0	1.67	85.24	Y
W-MC X DV	1.10%	2.5	1.84	26.95	Y
E-MC X DV	1.00%	2.5	1.67	31.55	Y
MC VI DV	0.3%	2.0	1.50	52.42	Y

*Notes:

1. For diversion berms, the “minimum ditch height” column refers to the required minimum crest of berm height to contain storm water flows.

Table 3. Capacity of Culverts in the NSB Watershed						
Culverts	**Diameter (in.)**	**Roughness Coefficient**	**Slope**	**Available Capacity* (cfs)**	**Peak Flow Rate (cfs)**	**Local Storage Required (Y/N)**
W-G1S Culvert	Three 24	0.012	0.59%	56.63	37.57	N
N-MC VII Culvert	One 36 One 54	0.016	0.04%	42.91	32.97	N
N-MC VII/IX Culvert	24	0.013	0.14%	36.52 (See Note 2)	32.18	N
NSB Culvert	One 54 Three 30	0.016 0.024	0.14%	84.95	80.88	N
MC X/XI Culvert	48	0.016	0.90%	111.02	85.24	N
E-MC VII/XI Culvert	24	0.013	0.50%	27.70 (See Note 2)	26.48	N
E-MC IX Culvert	36	0.016	3.60%	103.10	31.55	N
NW Ditch /MC VII Culvert	Three 12	One- 0.012 Two- 0.024	4.20%	18.64 (See Note 2)	16.73	N
G1 EGC Culvert	18	0.014	0.50%	20.46 (See Note 2)	15.45	N

*Notes:

1. Except as otherwise noted, full pipe flow (Available Capacity) was calculated using Manning equation under open channel conditions (gravity flow) which does not consider the headwater backup and tailwater depth. Increasing tailwater depth decreases the culvert capacity while increasing headwater backup increases the culvert capacity. For the culverts considered in the full pipe flow calculation, the headwater is larger than the tailwater. Therefore, the available capacities calculated using the Manning equation are conservative and representative values for these culverts and provide an appropriate estimate of flow capacity. The SEDCAD model assumes that the culverts will transmit the design flow, therefore, the Manning equation estimate does not affect downstream features in the model. The available capacity is calculated and included in this table for reference.
2. Culverts N-MC VII/IX, E-MC VII/XI, and NW Ditch/MC VII are modeled as temporary retention structures. Culvert G1 EGC is modeled as a pond. Therefore, the available capacity of these culverts is evaluated using SEDCAD.SEDCAD takes into account the headwater and tailwater to calculate the capacity of the culverts. The culvert available capacity is set for the maximum headwater level.

6.2 SSB Watershed

The storm water conveyance structures in the SSB watershed include a detention pond, ditches, culverts, catch basins, and storm sewers. The peak flow rates for each conveyance structure in SSB watershed were simulated using the SWMM model.

Table 4 provides details on the ditches in the SSB watershed. All ditches have adequate capacity to manage a 25-year, 24-hour storm (**Appendix D**).

Table 4. Capacity of Ditches in the SSB Watershed								
Ditches	**Roughness Coefficient**	**Slope**	**Maximum Capacity (cfs)**	**Existing Ditch Height (ft)**	**Peak Flow Rate (cfs)**	**Peak Flow Depth (ft)**	**Min. Ditch Height (ft)**	**Adequate Flow Capacity (Y/N)**
E-MC I Ditch	0.025	0.02%	158.65	5.20	30.11	1.61	2.0	Y
MC VI/XI Ditch	0.025	0.13%	509.66	4.60	68.52	3.40	3.75	Y
E MC X Ditch	0.025	0.13%	139.26	3.00	11.61	1.53	1.75	Y
S MC X Ditch	0.025	0.30%	246.72	5.00	13.72	1.45	1.75	Y
W MC X Ditch	0.025	0.22%	835.47	6.00	17.00	1.80	2.0	Y
S-MC I DV	0.025	0.14%	169.11	3.00	20.43	2.24	2.5*	Y

*Notes:

1. For diversion berms, the required minimum ditch height refers to the minimum crest of berm height to contain surface water flow.

Details on four culverts in the SSB watershed are summarized in **Table 5**. For the Denton RD culvert (**Drawing 2B**), the current capacity is close to the peak flow rate, but the estimated head water elevation (704.30 ft amsl) is lower than the top of ditch elevation (706.92 ft amsl, E-MC I Ditch) and the tail water elevation (698.59 ft amsl) is lower than the rim elevation of catch basin (700.50 ft amsl). As such, the culvert is expected to provide adequate capacity to convey the runoff generated in a 25-year, 24-hour storm.

The E MC VI culvert is located within MC VI/IX Ditch and allows an adjacent remaining portion of the ditch to contain overflow from the culvert. The E MC VI culvert when combined with adjacent overflow channel capacity will safely convey the runoff generated in a 25-year, 24-hour storm.

Table 5. Capacity of Culverts in the SSB Watershed						
Culverts	**Diameter (in.)**	**Roughness Coefficient**	**Slope**	**Full Pipe Flow* (cfs)**	**Peak Flow Rate (cfs)**	**Local Storage Required (Y/N)**
MC I NE Culvert	Two 12	0.013	2.17%	5.24	2.63	N
Denton RD Culvert	18	0.013	8.25%	30.17	30.11	N
W MC X Culvert	30	0.013	5.84%	99.15	16.67	N
E MC VI Culvert	30	0.013	0.13%	143.27 (See Note 2)	67.81	N
S-MC VI Culvert	24	0.013	1.73	29.79	21.29	N

*Notes:

1. Full pipe flow was calculated using Manning equation under open channel conditions (gravity flow) which does not consider the headwater backup and tailwater depth. The Peak Flow Rate calculated by SWMM takes headwater and tailwater depths into consideration. Therefore, the peak flow rate is accurate and representative for these culverts. The Manning equation estimate does not affect the model. The available capacity is calculated and included in this table for reference.
2. E MC VI Culvert full pipe flow includes the culvert and adjacent remaining channel capacity.

Table 6 presents details on the storm sewers in the SSB watershed. One existing storm sewer segment in the SSB watershed does not have adequate capacity to convey the runoff generated by the design 25-year, 24-hour storm event. This results in surface water backup at the S3 inlet. The S3 inlet consists of two HDPE pipes connected to the storm sewer system. The area in which S3 is located was designed to provide temporary storm water storage. Local storage required for S3 is estimated to be a maximum of 599,000 gallons based on conservative future conditions for a 25-year, 24-hour storm (**Appendix D, 12 of 16**). The maximum water level in this temporary storage area is 710.8, which is below the top of the berm at 713.5 (**Appendix E**). Existing topography and the S3 Inlet Containment berm provide a minimum of 2.7 ft of freeboard to contain the design storm event. Water will be retained in the area and gradually drained into the storm sewer system after the storm event. The water will occupy a maximum of 26,930 sf of area and will drain within approximately 10 hours (**Figure 2B-2**).

Existing conditions within the SSB watershed safely manage all surface water and flooding from the design worst-case scenario. Additional engineering controls are not needed.

Table 6. Capacity of Storm Sewers in the SSB Watershed								
Storm Sewer	**From**	**to**	**Pipe Diameter (in.)**	**Slope**	**Upstream Catch Basin Rim Elevation (ft amsl)**	**Full Pipe Flow (cfs) (Note 2)**	**Peak Flow Rate (cfs)**	**Local Storage Required (Y/N) (Note 3)**
3	S3	S4	8	1.64%	700.98	1.57	4.84	Y
2	S2	S9	36	0.02%	699.45	9.68	20.43	N
7	S7	S9	12	2.16%	698.74	5.24	4.90	N
9	S9	S11	36	0.20%	697.57	30.19	22.73	N
8	S8	S10	12	1.36%	698.73	4.15	2.36	N
10	S10	S11	12	0.68%	696.70	2.95	4.65	N
11	S11	S12	36	-0.48%	701.32	46.05	25.80	N
16	S16	S15	24	2.98%	704.20	39.04	43.41	N
15	S15	S14	24	0.77%	701.61	19.87	43.44	N
17	S17	S18	18	0.02%	700.16	1.50	11.56	N
18	S18	S19	18	0.36%	700.00	6.28	11.56	N
19	S19	BT	18	12.59%	700.24	37.27	12.62	N
1	S1	S4	36	3.96%	700.50	132.74	30.11	N
4	S4	S5	36	0.18%	700.64	28.30	34.83	N
5	S5	S5E	42	0.64%	699.51	80.45	34.86	N
121	S5E	S12.1	54	0.64%	695.57	157.32	34.90	N
122	S12.1	S12.2	36	0.33%	705.67	41.34	34.91	N
123	S12.2	S12.3	36	0.17%	706.45	29.79	34.92	N
124	S12.3	S12.3SE	48	0.25%	703.23	77.81	34.93	N
125	S12.3SE	S12	36	0.27%	692.00	34.61	34.95	N
12	S12	S13	42	0.37%	702.43	61.17	59.20	N
13	S13	S14	42	-0.30%	701.47	55.19	59.20	N
14	S14	BT	42	0.06%	702.22	24.69	95.75	N
38	BT	S20	42	0.07%	See Note 2	27.08	103.58	N

Notes:

1. Structure BT is blind tap between two pipes and does not have surface access.
2. Full pipe flow was calculated using Manning equation under open channel conditions (gravity flow) which does not consider the headwater pressure and tailwater depth. In most cases in this table, the "Full Pipe Flow" is not reflecting actual flow capacities of the storm sewers. The full pipe flow values are provided in this table for reference. When stormwater backups occur within the storm sewer system, the pressure increases the peak flow rate above the full pipe flow. The Peak Flow Rate calculated by SWMM takes headwater and tailwater depths into consideration. Therefore, the peak flow rate is accurate and representative of site conditions.
3. Local Storage Required is determined by the SWMM model. Areas where surface water backup flows out of the storm sewer system onto surrounding topography are identified in the model output and are the locations requiring local storage. Locations where headwater building up does not extend above the catch basin rim do not require local storage.
4. Structures S5E and S12.3SE represent locations where the existing storm sewer pipe changes diameter with no manhole. These two structures are included for modeling purposes.

6.3 LP Watershed

The conveyance structures in the LP watershed consist of a storage basin, catch basins and storm sewers. Based on the results of SWMM model (**Appendix F**), storm sewers are undersized for runoff conveyance for the 25-year, 24-hour design storm event (**Table 7**). This finding is consistent with the 2009 evaluation conducted by NTH, even with a lower design storm intensity (i.e, 3.60 inches rainfall). WDI has constructed curbs as recommended in the 2009 evaluation (NTH, 2009) to a minimum elevation of 701.5 ft amsl to provide a storage capacity of 525,000 gallons. SWMM model results indicated that in a 25-year, 24-hour storm, approximately 263,000 gallons is anticipated to overtop the storm sewers. The overtopped runoff will be temporarily retained in curbed area (**Drawing 2B-3**) to allow a gradual drainage back into the storm sewer system after the storm event.

Also, surface water along the haul road north of the curbed area that does not enter a catch basin will flow along the curb to adjacent catch basins. The model shows that catch basins L3R, L4R, L5, L6 and L7 overflow during the design storm for less than 20 minutes (0.33 hrs), resulting in water flowing along the existing curb to the next catch basin. This occurs for a limited time period during the storm event and the storm water sewer continues to collect and manage all run-off. Therefore, all surface water is collected and the storm water management system functions as designed.

In the area south of the Michigan Disposal Facility, for the most conservative storm, a maximum of 21,000 gallons of surface water at the catch basin L23 backs up approximately 3 inches (0.25 feet) for 0.54 hours. A maximum of 1,000 gallons of surface water backs up at catch basin L26 approximately 0.1 inches (0.01 ft) for 0.19 hours. Due to accuracy limitations of the current topography, and small flooding volumes, determining the limits of flooding at L23 and L26 is difficult. An estimate of maximum flooding limits is shown on Drawing 2B-3. The flooding at L23 and L26 is incidental surface water that will be contained on the paved surface in the vicinity of the catch basin inlets. No additional measures are needed to control flooding.

Existing conditions within the LP watershed safely manage all surface water and flooding from the design worst-case scenario. Additional engineering controls are not needed.

Table 7. Capacity of Storm Sewers in the Lined Pond Watershed								
Storm Sewer	**From**	**To**	**Pipe Diameter (in.)**	**Slope**	**Upstream Catch Basin Rim Elevation (ft amsl)**	**Full Pipe Flow(cfs) (Note 1)**	**Peak Flow Rate (cfs)**	**Local Storage Required (Y/N) (Note 2)**
1	L1R	L2R	12	1.16%	718.20	3.83	3.41	N
2	L2R	L3R	12	2.61%	716.76	5.76	6.14	N
3	L3R	L4R	12	4.11%	711.54	7.22	6.17	N
4	L4R	L5	12	0.22%	704.26	1.68	3.36	Y
5	L6	L5	12	8.57%	704.80	10.43	0.86	N
6	L5	L7	12	0.31%	704.60	1.99	3.47	Y
7	L8	L7	12	5.65%	702.29	8.47	0.86	N
8	L7	L9	12	0.26%	701.98	1.80	2.97	Y
12	L9	L9.5	12	0.34%	700.94	2.09	3.95	Y
13	L9.5	L10	18	0.20%	700.29	4.64	3.95	Y
14	L12	L11	18	0.20%	699.84	4.71	3.55	Y
15	L11	L10	18	1.07%	699.87	10.87	5.52	Y
16	L10	L14	18	0.08%	702.29	2.93	6.88	N
17	L13	L14	12	7.21%	699.23	9.56	2.35	Y
18	L14	L15	18	-0.14%	699.90	3.97	7.95	N
19	L17	L16	12	0.69%	699.29	2.96	2.26	Y
21	L22	L16	12	0.83%	698.60	3.25	2.32	Y
20	L16	L15	12	3.89%	699.49	7.02	2.51	N
22	L15	L20	18	-1.00%	699.53	10.50	7.82	N
23	L21	L20	12	2.55%	701.11	5.69	0.76	N
25	L19	L20	12	0.27%	700.05	1.84	4.37	Y
26	L20	BT	18	0.30%	699.25	5.76	6.02	Y
27	L23	L24	12	0.80%	703.98	3.19	5.25	Y
31	L26	L25	12	2.28%	704.00	5.38	3.35	Y
32	L25	L24	18	0.26%	703.80	5.31	3.88	N
28	L24	L28	12	-0.47%	704.35	2.45	7.64	N
29	L28	BT	12	12.72%	705.41	12.71	8.01	N
33	BT	L29	18	0.27%	-	5.42	8.24	N
34	L29	L32	18	0.04%	700.03	2.09	10.97	N
35	L30	L31	18	0.44%	699.65	6.97	4.47	N
36	L31	L32	12	2.99%	700.61	6.16	8.03	N
37	L32	L34	18	0.52%	700.65	7.61	18.64	N
38	L34	L33	18	0.12%	701.96	3.69	14.54	N
39	L33	L36	48	0.24%	702.01	70.20	17.82	N
40	L36	L39	48	0.09%	702.98	44.23	17.62	N
41	L39	L41	48	-0.03%	700.04	22.78	17.63	N
42	L41	L42	48	0.21%	697.39	66.49	23.65	N

Notes:

1. Full pipe flow was calculated using Manning equation under open channel conditions (gravity flow) which does not consider the headwater pressure and tailwater depth. In most cases in this table, the "Full Pipe Flow" is not reflecting actual flow capacities of the storm sewers. The full pipe flow values are provided in this table for reference. When stormwater backups occur within the storm sewer system, the pressure increases the peak flow rate above the full pipe flow. The Peak Flow Rate calculated by SWMM takes headwater and tailwater depths into consideration. Therefore, the peak flow rate is accurate and representative of site conditions.
2. Local Storage Required is determined by the SWMM model. Areas where surface water backup flows out of the storm sewer system onto surrounding topography are identified in the model output. Locations where headwater building up does not extend above the catch basin rim do not require local storage.

7.0 Conveyance System Improvements

All structure improvements discussed in this report have been completed to manage conservative future conditions. The current improved storm water management conveyance structures have sufficient capacity to divert storm water runoff from the 25-year, 24-hour design storm event to the storage basins under the designed conditions presented on Drawing 2B.

8.0 Conclusion

- All existing storage basins/ponds at the Site provide adequate storage capacity to manage storm water runoff from the design 100-year, 24-hour storm event.
- All existing conveyance structures in the NSB watershed provide adequate flow capacity for the storm water runoff from the design 25-year, 24-hour storm event.
- Existing ditches and culverts in the SSB watershed have adequate capacity for the updated 25-year, 24-hour storm. The storm sewer system provides adequate capacity to convey runoff generated from the 25-year, 24-hour design storm.
- The existing storm sewer system in the LP watershed with constructed curbs (temporary local storage) provide adequate capacity to manage the runoff from the 25-year, 24-hour design storm.

9.0 References

CTI and Associates, Inc. 2021. Storm Water Management System Evaluation Report, US Ecology, Wayne Disposal, Inc., June 2019.

NTH Consultants, Ltd., 2009. Storm Water Management System Evaluation, Wayne Disposal Inc., Site No. 2. April 20, 2009.

The Mannik & Smith Group, Inc., 2016. South Sedimentation and Northwest Sedimentation Basins Capacity Evaluation, Wayne Disposal, Inc., Site No. 2. December 12, 2016.

United States Department of Agriculture, 1986. Urban Hydrology for Small Watersheds Technical Release 55, June 1986.

Appendices

Appendix A
Point Precipitation Frequency Estimates

NOAA Atlas 14, Volume 8, Version 2
Location name: Van Buren Twp, Michigan, USA*
Latitude: 42.223°, Longitude: -83.5226°
Elevation: 699.8 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.321 (0.267-0.392)	0.379 (0.314-0.464)	0.475 (0.393-0.582)	0.556 (0.457-0.684)	0.670 (0.532-0.844)	0.759 (0.589-0.965)	0.850 (0.637-1.10)	0.943 (0.677-1.24)	1.07 (0.738-1.44)	1.17 (0.783-1.59)
10-min	0.470 (0.390-0.575)	0.555 (0.460-0.679)	0.696 (0.575-0.853)	0.814 (0.670-1.00)	0.981 (0.779-1.24)	1.11 (0.863-1.41)	1.24 (0.932-1.61)	1.38 (0.992-1.82)	1.57 (1.08-2.11)	1.71 (1.15-2.32)
15-min	0.573 (0.476-0.701)	0.676 (0.561-0.828)	0.848 (0.702-1.04)	0.993 (0.817-1.22)	1.20 (0.951-1.51)	1.36 (1.05-1.72)	1.52 (1.14-1.96)	1.68 (1.21-2.22)	1.91 (1.32-2.57)	2.08 (1.40-2.83)
30-min	0.767 (0.638-0.938)	0.907 (0.752-1.11)	1.14 (0.942-1.40)	1.34 (1.10-1.64)	1.61 (1.28-2.04)	1.83 (1.42-2.33)	2.06 (1.54-2.66)	2.29 (1.64-3.02)	2.60 (1.80-3.50)	2.84 (1.91-3.87)
60-min	0.970 (0.806-1.19)	1.15 (0.950-1.40)	1.44 (1.19-1.77)	1.70 (1.40-2.09)	2.07 (1.65-2.61)	2.36 (1.83-3.01)	2.66 (2.00-3.46)	2.98 (2.15-3.94)	3.42 (2.36-4.61)	3.76 (2.53-5.12)
2-hr	1.17 (0.980-1.42)	1.38 (1.16-1.68)	1.75 (1.45-2.12)	2.06 (1.70-2.52)	2.52 (2.02-3.17)	2.89 (2.26-3.66)	3.27 (2.47-4.22)	3.68 (2.66-4.84)	4.24 (2.95-5.69)	4.68 (3.17-6.33)
3-hr	1.30 (1.09-1.58)	1.53 (1.28-1.85)	1.93 (1.61-2.34)	2.28 (1.89-2.77)	2.79 (2.25-3.51)	3.21 (2.53-4.06)	3.66 (2.78-4.70)	4.13 (3.00-5.41)	4.79 (3.35-6.40)	5.31 (3.61-7.14)
6-hr	1.55 (1.30-1.85)	1.79 (1.51-2.15)	2.23 (1.87-2.68)	2.62 (2.19-3.16)	3.21 (2.61-4.01)	3.70 (2.93-4.66)	4.22 (3.23-5.41)	4.79 (3.52-6.25)	5.59 (3.94-7.44)	6.24 (4.27-8.33)
12-hr	1.81 (1.53-2.15)	2.06 (1.74-2.45)	2.51 (2.12-2.99)	2.92 (2.45-3.50)	3.55 (2.91-4.41)	4.08 (3.26-5.11)	4.66 (3.59-5.93)	5.28 (3.90-6.85)	6.17 (4.39-8.16)	6.89 (4.75-9.15)
24-hr	2.07 (1.77-2.45)	2.35 (2.00-2.77)	2.83 (2.41-3.36)	3.28 (2.77-3.90)	3.95 (3.26-4.87)	4.52 (3.63-5.60)	5.12 (3.97-6.47)	5.78 (4.30-7.43)	6.71 (4.80-8.80)	7.46 (5.18-9.83)
2-day	2.35 (2.02-2.76)	2.68 (2.30-3.15)	3.25 (2.78-3.82)	3.75 (3.19-4.43)	4.49 (3.71-5.46)	5.09 (4.11-6.25)	5.73 (4.46-7.15)	6.40 (4.79-8.15)	7.34 (5.28-9.54)	8.09 (5.65-10.6)
3-day	2.58 (2.22-3.01)	2.92 (2.51-3.41)	3.51 (3.01-4.11)	4.03 (3.43-4.73)	4.78 (3.97-5.79)	5.40 (4.37-6.59)	6.05 (4.73-7.51)	6.73 (5.05-8.53)	7.68 (5.55-9.94)	8.44 (5.92-11.0)
4-day	2.78 (2.40-3.23)	3.13 (2.70-3.64)	3.73 (3.21-4.35)	4.26 (3.64-4.99)	5.03 (4.18-6.07)	5.66 (4.59-6.88)	6.31 (4.95-7.82)	7.01 (5.27-8.86)	7.97 (5.77-10.3)	8.74 (6.15-11.4)
7-day	3.29 (2.85-3.80)	3.68 (3.19-4.26)	4.34 (3.75-5.03)	4.92 (4.22-5.72)	5.74 (4.79-6.87)	6.41 (5.22-7.74)	7.10 (5.60-8.74)	7.83 (5.92-9.83)	8.84 (6.43-11.3)	9.63 (6.82-12.4)
10-day	3.75 (3.26-4.32)	4.17 (3.63-4.81)	4.89 (4.23-5.64)	5.50 (4.74-6.38)	6.38 (5.34-7.59)	7.08 (5.79-8.51)	7.81 (6.17-9.55)	8.56 (6.50-10.7)	9.60 (7.01-12.2)	10.4 (7.40-13.4)
20-day	5.09 (4.46-5.82)	5.61 (4.90-6.41)	6.46 (5.63-7.40)	7.17 (6.22-8.24)	8.17 (6.86-9.61)	8.95 (7.35-10.6)	9.74 (7.74-11.8)	10.6 (8.06-13.1)	11.7 (8.56-14.7)	12.5 (8.94-16.0)
30-day	6.26 (5.50-7.12)	6.87 (6.03-7.82)	7.86 (6.87-8.96)	8.67 (7.54-9.92)	9.77 (8.23-11.4)	10.6 (8.75-12.5)	11.5 (9.13-13.8)	12.3 (9.42-15.1)	13.4 (9.88-16.8)	14.2 (10.2-18.1)
45-day	7.79 (6.87-8.83)	8.55 (7.53-9.69)	9.75 (8.56-11.1)	10.7 (9.35-12.2)	12.0 (10.1-13.9)	12.9 (10.7-15.1)	13.8 (11.0-16.5)	14.7 (11.3-17.9)	15.8 (11.6-19.7)	16.5 (11.9-21.0)
60-day	9.14 (8.08-10.3)	10.0 (8.87-11.3)	11.5 (10.1-13.0)	12.6 (11.0-14.3)	14.0 (11.8-16.1)	15.0 (12.4-17.5)	15.9 (12.7-18.9)	16.8 (12.9-20.4)	17.9 (13.2-22.2)	18.6 (13.5-23.5)

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

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

Please refer to NOAA Atlas 14 document for more information.

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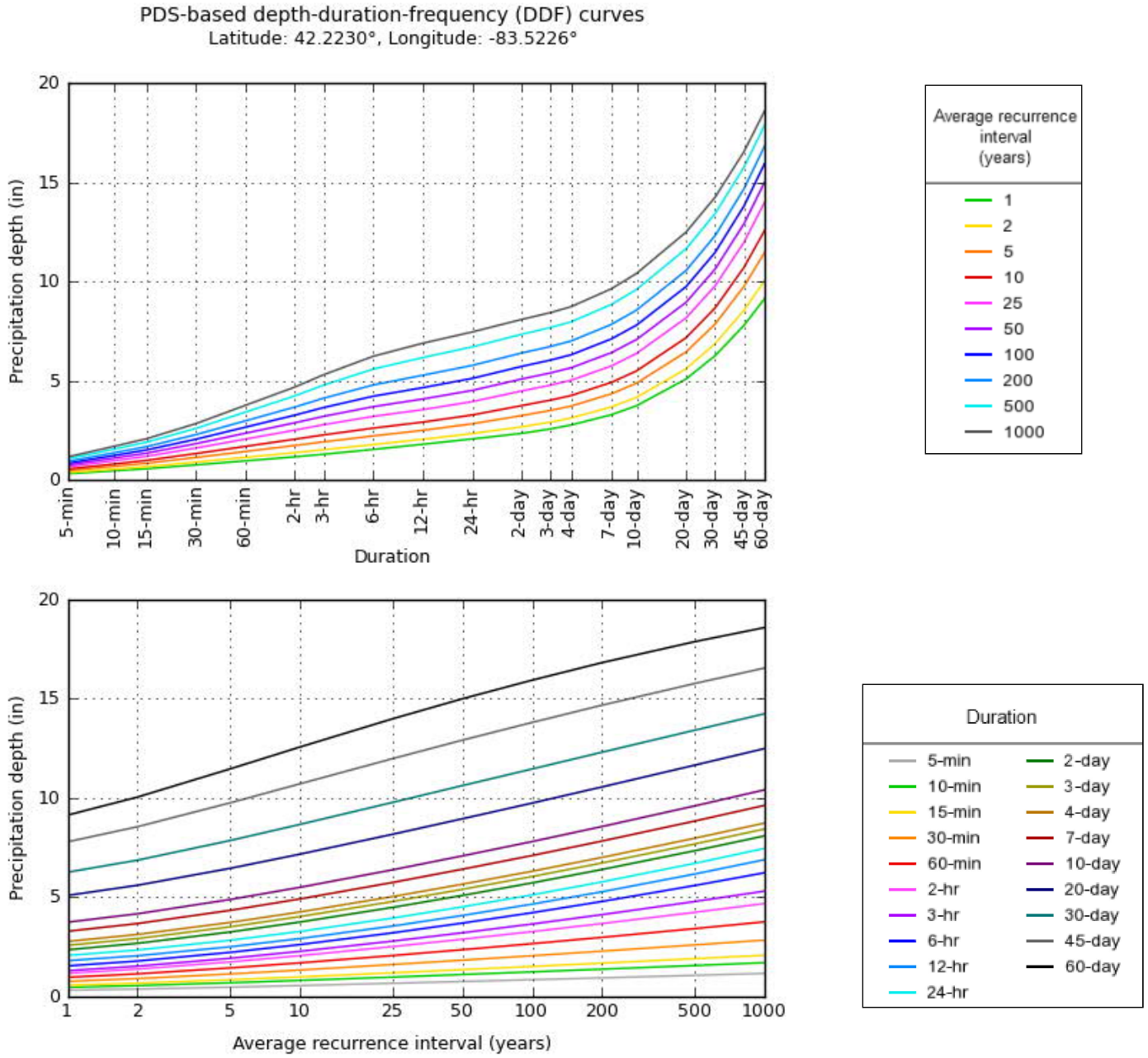
PF graphical



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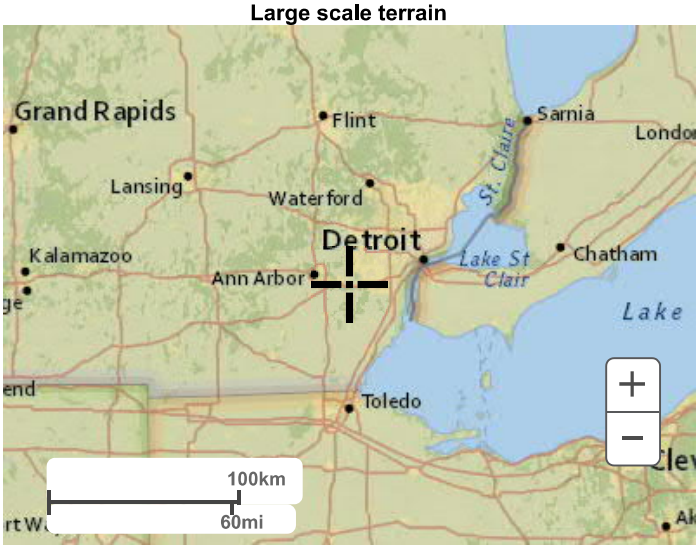
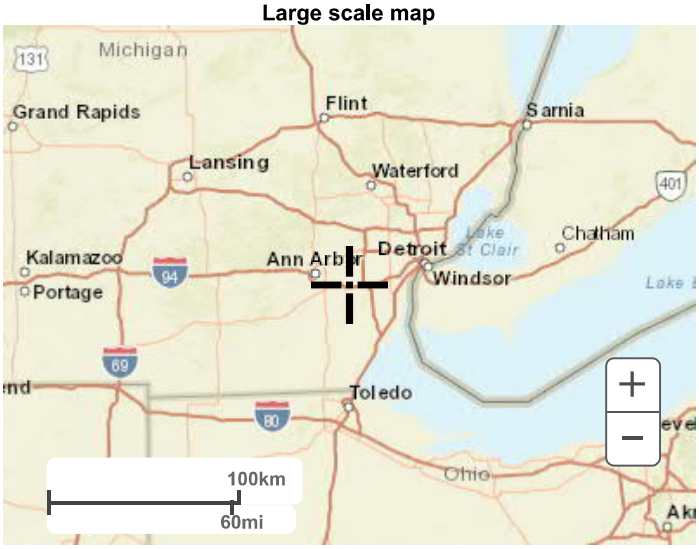
Maps & aerials

Small scale terrain

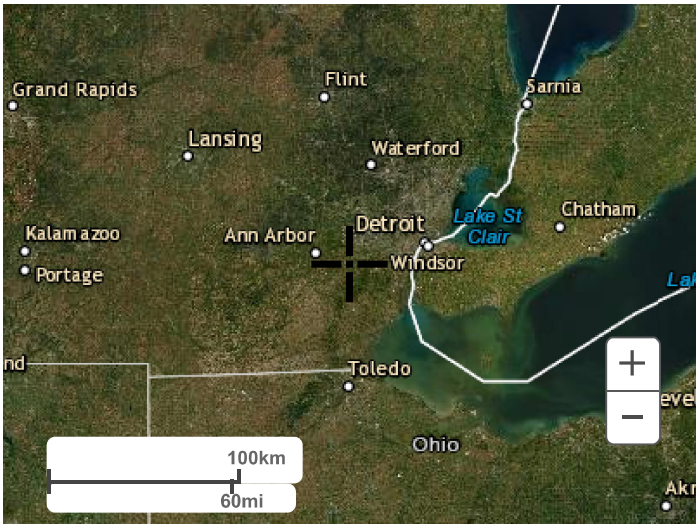
Large scale terrain



Large scale map



Large scale aerial



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National Water Center
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Appendix B

Runoff Storage Capacity Calculation Sheet

RUNOFF CURVE NUMBER AND RUNOFF CALCULATION

Source: USDA TR-55 Urban Hydrology for Small Watersheds

Project WDI Stormwater -NSB
Project Number 1218070050
Site Location Van Buren Township (Belleville), Michigan
Prepared by TR Date 2/3/2022
Checked by Date

RUNOFF CURVE NUMBER					
AREA ID	SOIL NAME AND HYDROLOGIC GROUP (APP A)	COVER DESCRIPTION	CN Tab. 2-2 Fig. 2-3, 4	AREA (ACRES)	CN X A
EGC Area	N/A	100% impervious Area	100	68.22	6822
MC4 & MC6G	Hydrologic Soil Group D	Fair Condition (grass cover 50%~70%)	84	21.02	1765.68
NWD	N/A	100% Runoff Area	100	4.99	499
MC6, 7, 10, & 11	Hydrologic Soil Group D	Fair Condition (grass cover 50%~70%)	84	141.6	11894.4
NSB	N/A	100% Runoff Area	100	10.47	1047
		TOTAL		**246.3**	**22028.08**
		WEIGHTED CN	**89**	*S*	*1.236*

RUNOFF			
	STORM #1	STORM #2	STORM #3
FREQUENCY, yr	100		
RAINFALL, P (24-HOUR), in	5.12		
RUNOFF, Q, in	3.89		
TOTAL RUNOFF, Q, FT-AC	79.78		
TOTAL RUNOFF, Q, FT3	3,475,173		

RUNOFF CURVE NUMBER AND RUNOFF CALCULATION

Source: USDA TR-55 Urban Hydrology for Small Watersheds

Project	WDI Stormwater -SSB		
Project Number	1218070050		
Site Location	Van Buren Township (Belleville), Michigan		
Prepared by	TR	Date	9/30/2022
Checked by		Date	

RUNOFF CURVE NUMBER					
AREA ID	SOIL NAME AND HYDROLOGIC GROUP (APP A)	COVER DESCRIPTION	CN Tab. 2-2 Fig. 2-3, 4	AREA (ACRES)	CN X A
EGC Area	N/A	100% impervious Area	100	34.91	3491
MC1	Hydrologic Soil Group D	Fair Condition (grass cover 50%~70%)	74	33.78	2499.72
MC6, MC10, & MC11	Hydrologic Soil Group D	Fair Condition (grass cover 50%~70%)	84	56.74	4766.16
Entrance Area	Hydrologic Soil Group D	Fair Condition (grass cover 50%~70%)	100	2.63	263
SSB	N/A	100% Runoff Area	100	5.36	536
		TOTAL		**133.42**	**11555.88**
		WEIGHTED CN	**86**	*S*	*1.628*

RUNOFF			
	STORM #1	STORM #2	STORM #3
FREQUENCY, yr	100		
RAINFALL, P (24-HOUR), in	5.12		
RUNOFF, Q, in	3.58		
TOTAL RUNOFF, Q, FT-AC	39.79		
TOTAL RUNOFF, Q, FT3	1,733,433		

RUNOFF CURVE NUMBER AND RUNOFF CALCULATION

Source: USDA TR-55 Urban Hydrology for Small Watersheds

Project: WDI MTE Calculation -Lined Pond
Project Number: 1218070050
Site Location: Van Buren Township (Belleville), Michigan
Prepared by: TR Date: 2/3/2022
Checked by: Date:

RUNOFF CURVE NUMBER					
AREA ID	SOIL NAME AND HYDROLOGIC SOIL GROUP	COVER DESCRIPTION	CN	AREA (ACRES)	CN X A
Paved Area	N/A	100% Impervious Area	100	13.79	1379
Lined Pond	N/A	100% Runoff	100	1.39	139
		TOTAL		**15.18**	**1518**
		WEIGHTED CN	**100**	*S*	*0.000*

RUNOFF			
	STORM #1 (100-yr, 24-hr)	STORM #2	STORM #3
FREQUENCY, yr	100		
RAINFALL, P (24-HOUR), in	5.12		
RUNOFF, Q, in	5.12		
TOTAL RUNOFF, Q, FT-AC	6.48		
TOTAL RUNOFF, Q, FT3	282,129		
TOTAL RUNOFF, Q, GAL	2,110,328		

Appendix C

Improved Conveyance Structure Capacity Report for NSB Watershed (SEDCAD)

WDI Stormwater MOD.

M4 and M6 to NSB

Future MC4 & MC6 EGC

Travis Rutta

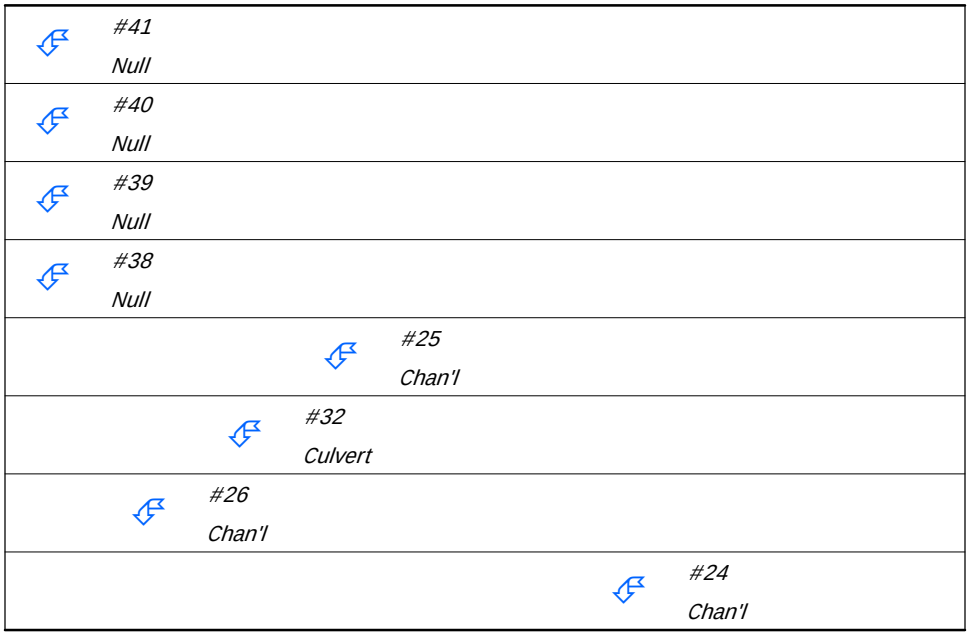
General Information

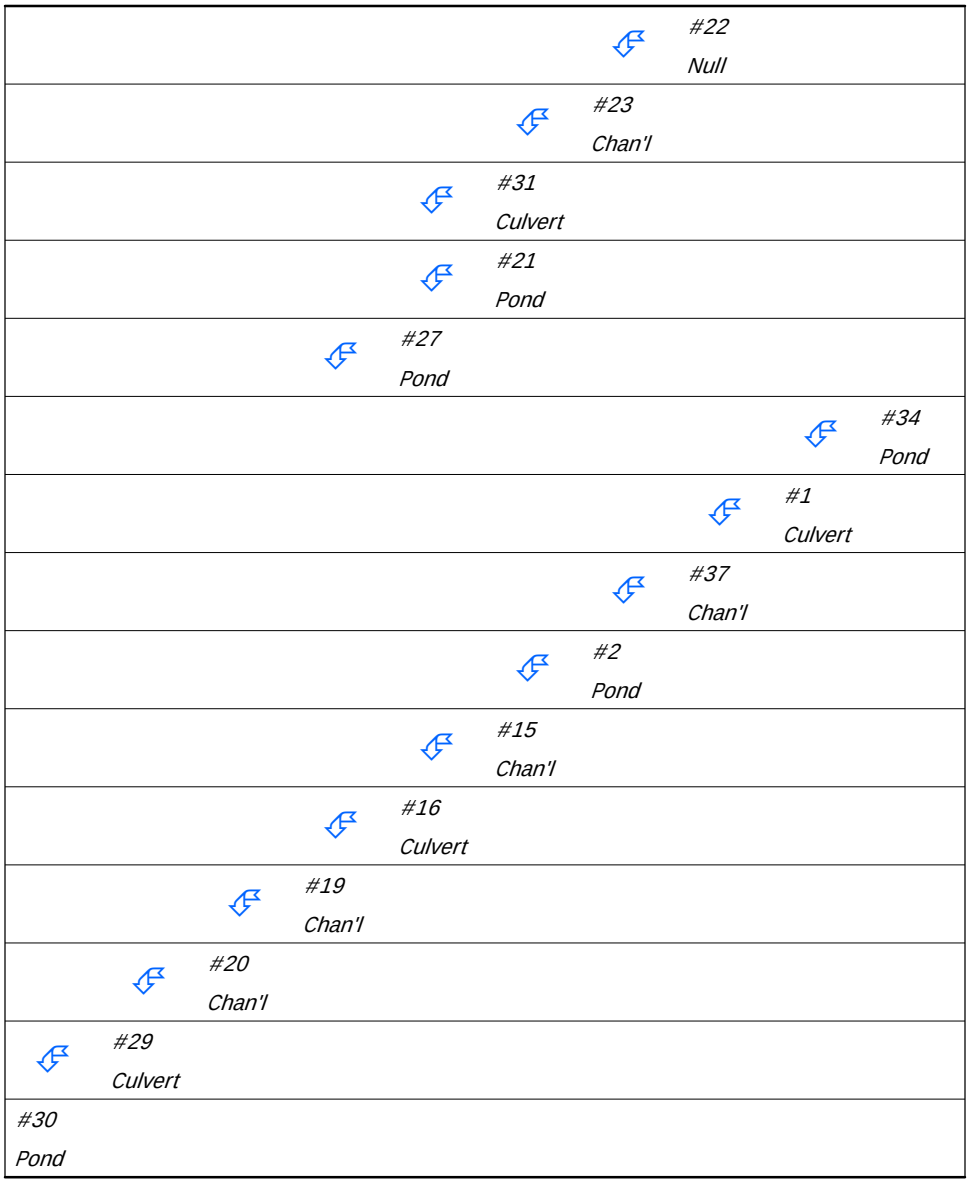
Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	3.950 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Culvert	#1	==>	#37	0.000	0.000	W-G1S-CULVERT
Pond	#2	==>	#15	0.315	0.163	NWD
Channel	#15	==>	#16	0.000	0.000	N-MC VII DITCH
Culvert	#16	==>	#19	0.715	0.081	N-MC VII CULVERT
Channel	#19	==>	#20	0.372	0.163	N-MC IX DITCH
Channel	#20	==>	#29	0.000	0.000	NE-MC IX DITCH
Pond	#21	==>	#27	0.000	0.000	E-MC VII/XI CULVERT
Null	#22	==>	#23	0.000	0.000	Reserved
Channel	#23	==>	#31	0.000	0.000	MC X/XI DITCH
Channel	#24	==>	#23	0.000	0.000	W-MC X DV
Channel	#25	==>	#32	0.000	0.000	E-MC X DV
Channel	#26	==>	#29	0.000	0.000	E-MC IX DITCH
Pond	#27	==>	#19	0.000	0.000	N-MC VII/IX CULVERT
Culvert	#29	==>	#30	0.000	0.000	NSB CULVERT
Pond	#30	==>	End	0.000	0.000	NSB
Culvert	#31	==>	#27	0.000	0.000	MC X/XI CULVERT
Culvert	#32	==>	#26	0.114	0.231	E-MC IX CULVERT
Pond	#34	==>	#1	0.000	0.000	G1 EGC Culvert
Channel	#37	==>	#2	0.000	0.000	MC VI DV
Null	#38	==>	#30	0.000	0.000	Reserved
Null	#39	==>	#30	0.000	0.000	Reserved
Null	#40	==>	#30	0.000	0.000	Reserved
Null	#41	==>	#30	0.000	0.000	Reserved





Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	6. Grassed waterway	0.30	2.79	930.00	0.82	0.315
#2	Muskingum K:					0.315
#16	6. Grassed waterway	0.05	0.42	850.00	0.33	0.715
#16	Muskingum K:					0.715
#19	6. Grassed waterway	0.30	3.30	1,100.00	0.82	0.372
#19	Muskingum K:					0.372
#32	6. Grassed waterway	0.96	5.76	600.00	1.46	0.114
#32	Muskingum K:					0.114

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#41		0.000	0.000	0.00	0.00
#40		0.000	0.000	0.00	0.00
#39		0.000	0.000	0.00	0.00
#38		0.000	0.000	0.00	0.00
#25		13.100	13.100	31.55	2.53
#32		0.000	13.100	31.55	2.53
#26		8.450	21.550	38.69	4.17
#24		11.177	11.177	26.95	2.16
#22		0.000	0.000	0.00	0.00
#23		23.100	34.277	85.24	6.68
#31		0.000	34.277	85.24	6.68
#21	In	19.490	19.490	45.91	3.75
	Out			26.48	3.75
#27	In	34.315	88.082	202.06	17.12
	Out			32.18	17.12
#34	In	14.570	14.570	79.50	4.79
	Out			15.45	4.79
#1		6.800	21.370	37.57	6.13
#37		5.320	26.690	52.42	7.13
#2	In	67.537	94.227	325.35	27.46
	Out			16.73	27.45
#15		7.330	101.557	32.97	28.87
#16		0.000	101.557	32.97	28.87
#19		5.450	195.089	60.73	47.04
#20		10.840	205.929	63.15	49.14
#29		0.000	227.479	80.88	53.30
#30	In	18.820	246.299	146.11	58.39
	Out			0.02	0.06

Structure Detail:

Structure #41 (Null)

Reserved

Structure #40 (Null)

Reserved

Structure #39 (Null)

Reserved

Structure #38 (Null)

Reserved

Structure #25 (Vegetated Channel)

E-MC X DV

Triangular Vegetated Channel Inputs:

Material: Grass mixture

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	9.1:1	1.0	C, C	0.50			5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	31.55 cfs		31.55 cfs	
Depth:	1.67 ft	2.17 ft	1.67 ft	2.17 ft
Top Width:	20.18 ft	26.23 ft	20.18 ft	26.23 ft
Velocity:	1.87 fps		1.87 fps	
X-Section Area:	16.83 sq ft		16.83 sq ft	
Hydraulic Radius:	0.823 ft		0.823 ft	
Froude Number:	0.36		0.36	
Roughness Coefficient:	0.0697		0.0697	

Structure #32 (Culvert)

E-MC IX CULVERT

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
72.00	3.60	0.0160	3.00	2.00	0.90

Culvert Results:

Design Discharge = 31.55 cfs

Minimum pipe diameter: 1 - 36 inch pipe(s) required

Structure #26 (Vegetated Channel)

E-MC IX DITCH

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	2.6:1	20.0:1	1.0	C, C	0.50			5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	38.69 cfs		38.69 cfs	
Depth:	1.37 ft	1.87 ft	1.37 ft	1.87 ft
Top Width:	34.01 ft	45.31 ft	34.01 ft	45.31 ft
Velocity:	1.52 fps		1.52 fps	
X-Section Area:	25.39 sq ft		25.39 sq ft	
Hydraulic Radius:	0.744 ft		0.744 ft	
Froude Number:	0.31		0.31	
Roughness Coefficient:	0.0785		0.0785	

Structure #24 (Vegetated Channel)

W-MC X DV

Triangular Vegetated Channel Inputs:

Material: Grass mixture

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	4.0:1	1.1	C, C	0.50			5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	26.95 cfs		26.95 cfs	
Depth:	1.84 ft	2.34 ft	1.84 ft	2.34 ft
Top Width:	12.85 ft	16.35 ft	12.85 ft	16.35 ft
Velocity:	2.28 fps		2.28 fps	
X-Section Area:	11.80 sq ft		11.80 sq ft	
Hydraulic Radius:	0.883 ft		0.883 ft	
Froude Number:	0.42		0.42	
Roughness Coefficient:	0.0629		0.0629	

Structure #22 (Null)

Reserved

Structure #23 (Vegetated Channel)

MC X/XI DITCH

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
56.00	3.5:1	2.8:1	0.1	C, C	0.50			5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	85.24 cfs		85.24 cfs	
Depth:	1.67 ft	2.17 ft	1.67 ft	2.17 ft
Top Width:	66.54 ft	69.69 ft	66.54 ft	69.69 ft
Velocity:	0.83 fps		0.83 fps	
X-Section Area:	102.51 sq ft		102.51 sq ft	
Hydraulic Radius:	1.529 ft		1.529 ft	
Froude Number:	0.12		0.12	
Roughness Coefficient:	0.0751		0.0751	

Structure #31 (Culvert)

MC X/XI CULVERT

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
75.00	0.90	0.0160	4.00	3.00	0.90

Culvert Results:

Design Discharge = 85.24 cfs

Minimum pipe diameter: 1 - 66 inch pipe(s) required

Structure #21 (Pond)

E-MC VII/XI CULVERT

Pond Inputs:

Initial Pool Elev:	704.00 ft
Initial Pool:	0.15 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
24.00	40.00	0.50	0.0130	700.30	0.90	4.00

Pond Results:

Peak Elevation:	706.76 ft
Dewater Time:	0.51 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
700.00	0.000	0.000	0.000		
700.30	0.001	0.000	0.000		Spillway #1
700.50	0.003	0.000	0.000		
701.00	0.008	0.003	0.000		
701.50	0.016	0.009	0.000		
702.00	0.027	0.019	0.000		
702.01	0.027	0.020	0.000		
702.50	0.044	0.037	0.000		
703.00	0.064	0.064	0.000		
703.50	0.089	0.102	0.000		
704.00	0.117	0.153	0.000		
704.50	0.153	0.220	10.284	11.75	
705.00	0.193	0.306	15.410	0.10	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
705.50	0.239	0.414	19.236	0.15	
706.00	0.289	0.546	22.429	0.10	
706.50	0.375	0.712	25.199	0.15	
706.76	0.428	0.820	26.484	0.10	Peak Stage
707.00	0.473	0.923	27.700		

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
700.00	0.000	0.000
700.30	0.000	0.000
700.50	0.000	0.000
701.00	0.000	0.000
701.50	0.000	0.000
702.00	0.000	0.000
702.01	0.000	0.000
702.50	0.000	0.000
703.00	0.000	0.000
703.50	0.000	0.000
704.00	0.000	0.000
704.50	(7)>10.284	10.284
705.00	(7)>15.410	15.410
705.50	(7)>19.236	19.236
706.00	(7)>22.429	22.429
706.50	(7)>25.199	25.199
707.00	(7)>27.700	27.700

Structure #27 (Pond)

N-MC VII/IX CULVERT

Pond Inputs:

Initial Pool Elev:	697.10 ft
Initial Pool:	0.06 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
24.00	30.00	0.14	0.0130	697.10	0.90	0.00

Pond Results:

Peak Elevation:	702.78 ft
Dewater Time:	0.68 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
696.00	0.000	0.000	0.000		
696.50	0.032	0.005	0.000		
697.00	0.127	0.043	0.000		
697.10	0.153	0.057	0.000		Spillway #1
697.50	0.280	0.142	1.432	4.05	
698.00	0.488	0.331	4.058	1.45	
698.50	0.756	0.640	6.236	3.10	
698.90	1.012	0.992	8.852	1.35	
699.00	1.190	1.102	9.681	0.30	
699.01	1.192	1.114	9.767		
699.50	1.313	1.728	14.292	1.20	
700.00	1.441	2.416	18.627	0.80	
700.50	1.576	3.170	21.862	0.65	
701.00	1.716	3.993	24.513	0.65	
701.50	1.863	4.887	26.884	0.65	
702.00	2.015	5.857	29.063	0.65	
702.50	2.101	6.885	31.093	0.75	
702.78	2.151	7.496	32.180	0.60	Peak Stage
703.00	2.189	7.958	33.001		
703.50	2.279	9.075	34.806		
704.00	2.370	10.237	36.522		

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
696.00	0.000	0.000
696.50	0.000	0.000
697.00	0.000	0.000
697.10	0.000	0.000
697.50	(1)>1.432	1.432
698.00	(1)>4.058	4.058
698.50	(1)>6.236	6.236

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
698.90	(1)>8.852	8.852
699.00	(1)>9.681	9.681
699.01	(1)>9.767	9.767
699.50	(4)>14.292	14.292
700.00	(6)>18.627	18.627
700.50	(5)>21.862	21.862
701.00	(5)>24.513	24.513
701.50	(5)>26.884	26.884
702.00	(5)>29.063	29.063
702.50	(5)>31.093	31.093
703.00	(5)>33.001	33.001
703.50	(5)>34.806	34.806
704.00	(5)>36.522	36.522

Structure #34 (Pond)

G1 EGC Culvert

Pond Inputs:

Initial Pool Elev:	714.50 ft
Initial Pool:	2.29 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
18.00	26.00	0.50	0.0140	714.50	0.90	0.00

Pond Results:

Peak Elevation:	718.68 ft
Dewater Time:	0.76 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
698.00	0.007	0.000	0.000	
698.50	0.011	0.004	0.000	
699.00	0.015	0.011	0.000	
699.50	0.021	0.020	0.000	
700.00	0.027	0.032	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
700.50	0.031	0.046	0.000		
701.00	0.035	0.063	0.000		
701.50	0.039	0.081	0.000		
702.00	0.043	0.101	0.000		
702.50	0.050	0.124	0.000		
703.00	0.057	0.151	0.000		
703.50	0.065	0.181	0.000		
704.00	0.073	0.216	0.000		
704.50	0.082	0.255	0.000		
705.00	0.091	0.298	0.000		
705.50	0.100	0.345	0.000		
706.00	0.110	0.398	0.000		
706.50	0.121	0.455	0.000		
707.00	0.132	0.519	0.000		
707.50	0.144	0.588	0.000		
708.00	0.157	0.663	0.000		
708.50	0.170	0.745	0.000		
709.00	0.183	0.833	0.000		
709.50	0.196	0.927	0.000		
710.00	0.210	1.029	0.000		
710.50	0.225	1.138	0.000		
711.00	0.240	1.254	0.000		
711.50	0.255	1.377	0.000		
712.00	0.271	1.509	0.000		
712.50	0.288	1.648	0.000		
713.00	0.305	1.796	0.000		
713.50	0.322	1.953	0.000		
714.00	0.340	2.118	0.000		
714.50	0.358	2.293	0.000		Spillway #1
715.00	0.377	2.477	1.694	12.70	
715.50	0.396	2.670	3.081	2.20	
716.00	0.416	2.873	4.973	1.20	
716.50	0.436	3.086	8.363	0.60	
717.00	0.457	3.309	10.472	0.40	
717.50	0.478	3.543	12.173	0.35	
718.00	0.500	3.788	13.675	0.35	
718.50	0.522	4.043	15.003	0.35	
718.68	0.530	4.139	15.450	0.20	Peak Stage
719.00	0.545	4.310	16.242		
719.50	0.568	4.588	17.381		
720.00	0.591	4.878	18.479		
720.50	0.615	5.179	19.477		
721.00	0.640	5.493	20.463		

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
698.00	0.000	0.000
698.50	0.000	0.000
699.00	0.000	0.000
699.50	0.000	0.000
700.00	0.000	0.000
700.50	0.000	0.000
701.00	0.000	0.000
701.50	0.000	0.000
702.00	0.000	0.000
702.50	0.000	0.000
703.00	0.000	0.000
703.50	0.000	0.000
704.00	0.000	0.000
704.50	0.000	0.000
705.00	0.000	0.000
705.50	0.000	0.000
706.00	0.000	0.000
706.50	0.000	0.000
707.00	0.000	0.000
707.50	0.000	0.000
708.00	0.000	0.000
708.50	0.000	0.000
709.00	0.000	0.000
709.50	0.000	0.000
710.00	0.000	0.000
710.50	0.000	0.000
711.00	0.000	0.000
711.50	0.000	0.000
712.00	0.000	0.000
712.50	0.000	0.000
713.00	0.000	0.000
713.50	0.000	0.000
714.00	0.000	0.000
714.50	0.000	0.000
715.00	(1)>1.694	1.694
715.50	(1)>3.081	3.081
716.00	(1)>4.973	4.973
716.50	(6)>8.363	8.363
717.00	(5)>10.472	10.472
717.50	(5)>12.173	12.173
718.00	(5)>13.675	13.675

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
718.50	(5)>15.003	15.003
719.00	(5)>16.242	16.242
719.50	(5)>17.381	17.381
720.00	(5)>18.479	18.479
720.50	(5)>19.477	19.477
721.00	(5)>20.463	20.463

Structure #1 (Culvert)

W-G1S-CULVERT

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
170.00	0.59	0.0120	2.50	1.00	0.90

Culvert Results:

Design Discharge = 37.57 cfs

Minimum pipe diameter: 1 - 60 inch pipe(s) required

Structure #37 (Vegetated Channel)

MC VI DV

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
20.00	2.0:1	3.0:1	0.3	C, C				5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	52.42 cfs		52.42 cfs	
Depth:	1.50 ft		1.50 ft	
Top Width:	27.49 ft		27.49 ft	
Velocity:	1.47 fps		1.47 fps	
X-Section Area:	35.54 sq ft		35.54 sq ft	
Hydraulic Radius:	1.267 ft		1.267 ft	
Froude Number:	0.23		0.23	
Roughness Coefficient:	0.0648		0.0648	

Structure #2 (Pond)

NWD

Pond Inputs:

Initial Pool Elev:	704.50 ft
Initial Pool:	0.57 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	125.00	4.20	0.0120	704.50	0.90	3.00

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	125.00	4.20	0.0240	704.50	0.90	3.00

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
12.00	125.00	4.20	0.0240	704.50	0.90	3.00

Pond Results:

Peak Elevation:	710.08 ft
Dewater Time:	0.95 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
704.00	1.030	0.000	0.000		
704.50	1.241	0.567	0.000		Spillway #1 Spillway #2 Spillway #3
705.00	1.471	1.244	2.253	3.64*	
705.50	1.721	2.041	6.282	2.45	
706.00	1.990	2.968	9.693	1.45	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
706.50	2.238	4.024	11.054	1.25	
707.00	2.501	5.208	12.219	1.20	
707.50	2.778	6.527	13.272	1.30	
708.00	3.070	7.989	14.237	1.30	
708.50	3.284	9.577	14.905	1.75	
709.00	3.506	11.274	15.500	1.95	
709.50	3.734	13.084	16.079	2.15	
710.00	3.970	15.010	16.645	2.95	
710.08	4.012	15.333	16.728	1.30	Peak Stage
710.50	4.214	17.055	17.167		
711.00	4.465	19.225	17.657		
711.50	4.724	21.522	18.147		
712.00	4.990	23.950	18.636		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Straight Pipe (cfs)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
704.00	0.000	0.000	0.000	0.000
704.50	0.000	0.000	0.000	0.000
705.00	(4)>0.751	(4)>0.751	(4)>0.751	2.253
705.50	(4)>2.094	(4)>2.094	(4)>2.094	6.282
706.00	(8)>3.443	(7)>3.125	(7)>3.125	9.693
706.50	(8)>4.414	(7)>3.320	(7)>3.320	11.054
707.00	(8)>5.190	(7)>3.514	(7)>3.514	12.219
707.50	(8)>5.883	(7)>3.695	(7)>3.695	13.272
708.00	(8)>6.509	(7)>3.864	(7)>3.864	14.237
708.50	(8)>6.839	(7)>4.033	(7)>4.033	14.905
709.00	(7)>7.118	(7)>4.191	(7)>4.191	15.500
709.50	(7)>7.397	(7)>4.341	(7)>4.341	16.079
710.00	(7)>7.664	(7)>4.490	(7)>4.490	16.645
710.50	(7)>7.898	(7)>4.634	(7)>4.634	17.167
711.00	(7)>8.133	(7)>4.762	(7)>4.762	17.657
711.50	(7)>8.367	(7)>4.890	(7)>4.890	18.147
712.00	(7)>8.601	(7)>5.018	(7)>5.018	18.636

Structure #15 (Vegetated Channel)

N-MC VII DITCH

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
24.00	2.0:1	2.0:1	0.2	C, C	0.50			5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	32.97 cfs		32.97 cfs	
Depth:	1.32 ft	1.82 ft	1.32 ft	1.82 ft
Top Width:	29.29 ft	31.29 ft	29.29 ft	31.29 ft
Velocity:	0.94 fps		0.94 fps	
X-Section Area:	35.22 sq ft		35.22 sq ft	
Hydraulic Radius:	1.178 ft		1.178 ft	
Froude Number:	0.15		0.15	
Roughness Coefficient:	0.0794		0.0794	

Structure #16 (Culvert)

N-MC VII CULVERT

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
42.00	0.00	0.0160	3.00	0.00	0.90

Culvert Results:

Design Discharge = 32.97 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Structure #19 (Vegetated Channel)

N-MC IX DITCH

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
22.00	2.0:1	2.0:1	0.1	C, C	0.50			5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	60.73 cfs		60.73 cfs	
Depth:	2.65 ft	3.15 ft	2.65 ft	3.15 ft
Top Width:	32.60 ft	34.60 ft	32.60 ft	34.60 ft
Velocity:	0.84 fps		0.84 fps	
X-Section Area:	72.31 sq ft		72.31 sq ft	
Hydraulic Radius:	2.136 ft		2.136 ft	
Froude Number:	0.10		0.10	
Roughness Coefficient:	0.0658		0.0658	

Structure #20 (Vegetated Channel)

NE-MC IX DITCH

Trapezoidal Vegetated Channel Inputs:

Material: Grass mixture

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
33.00	2.0:1	2.0:1	0.1	C, C	0.50			5.0

Vegetated Channel Results:

	Stability Class C w/o Freeboard	Stability Class C w/ Freeboard	Capacity Class C w/o Freeboard	Capacity Class C w/ Freeboard
Design Discharge:	63.15 cfs		63.15 cfs	
Depth:	1.66 ft	2.16 ft	1.66 ft	2.16 ft
Top Width:	39.64 ft	41.64 ft	39.64 ft	41.64 ft
Velocity:	1.05 fps		1.05 fps	
X-Section Area:	60.25 sq ft		60.25 sq ft	
Hydraulic Radius:	1.491 ft		1.491 ft	
Froude Number:	0.15		0.15	
Roughness Coefficient:	0.0694		0.0694	

Structure #29 (Culvert)

NSB CULVERT

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
110.00	0.14	0.0110	4.00	2.00	0.90

Culvert Results:

Design Discharge = 80.88 cfs

Minimum pipe diameter: 1 - 66 inch pipe(s) required

Structure #30 (Pond)

NSB

Pond Inputs:

Initial Pool Elev:	688.00 ft
Initial Pool:	56.27 ac-ft

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev (ft)	Entrance Loss Coefficient	Tailwater Depth (ft)
2.00	100.00	1.00	0.0240	688.00	0.90	0.00

Pond Results:

Peak Elevation:	695.75 ft
Dewater Time:	0.00 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
670.00	0.999	0.000	0.000	
670.50	1.050	0.512	0.000	
671.00	1.102	1.050	0.000	
671.50	1.155	1.614	0.000	
672.00	1.210	2.206	0.000	
672.50	1.261	2.823	0.000	
673.00	1.313	3.467	0.000	
673.50	1.366	4.136	0.000	
674.00	1.420	4.833	0.000	
674.50	1.471	5.556	0.000	
675.00	1.524	6.304	0.000	
675.50	1.577	7.079	0.000	
676.00	1.631	7.881	0.000	
676.50	1.682	8.710	0.000	
677.00	1.734	9.564	0.000	
677.50	1.787	10.444	0.000	
678.00	1.841	11.351	0.000	
678.50	1.893	12.285	0.000	
679.00	1.945	13.244	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
679.50	1.998	14.230	0.000		
680.00	2.052	15.242	0.000		
680.50	2.664	16.418	0.000		
681.00	3.356	17.920	0.000		
681.50	4.128	19.788	0.000		
682.00	4.980	22.062	0.000		
682.50	5.096	24.580	0.000		
683.00	5.213	27.157	0.000		
683.50	5.331	29.793	0.000		
684.00	5.451	32.489	0.000		
684.50	5.572	35.244	0.000		
685.00	5.694	38.061	0.000		
685.50	5.817	40.938	0.000		
686.00	5.942	43.878	0.000		
686.50	6.069	46.881	0.000		
687.00	6.196	49.947	0.000		
687.50	6.325	53.078	0.000		
688.00	6.456	56.273	0.000		Spillway #1
688.50	6.587	59.533	0.001		
689.00	6.720	62.860	0.003		
689.50	6.854	66.253	0.004		
690.00	6.990	69.714	0.005		
690.50	7.127	73.243	0.007		
691.00	7.265	76.841	0.008		
691.50	7.404	80.509	0.009		
692.00	7.545	84.246	0.011		
692.50	7.687	88.054	0.012		
693.00	7.831	91.934	0.013		
693.50	7.976	95.885	0.015		
694.00	8.122	99.910	0.016		
694.50	8.270	104.008	0.017		
695.00	8.418	108.180	0.019		
695.50	8.569	112.426	0.020		
695.75	8.643	114.548	0.021	0.00	Peak Stage
696.00	8.720	116.748	0.021		

Detailed Discharge Table

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
670.00	0.000	0.000
670.50	0.000	0.000
671.00	0.000	0.000
671.50	0.000	0.000
672.00	0.000	0.000
672.50	0.000	0.000
673.00	0.000	0.000
673.50	0.000	0.000
674.00	0.000	0.000
674.50	0.000	0.000
675.00	0.000	0.000
675.50	0.000	0.000
676.00	0.000	0.000
676.50	0.000	0.000
677.00	0.000	0.000
677.50	0.000	0.000
678.00	0.000	0.000
678.50	0.000	0.000
679.00	0.000	0.000
679.50	0.000	0.000
680.00	0.000	0.000
680.50	0.000	0.000
681.00	0.000	0.000
681.50	0.000	0.000
682.00	0.000	0.000
682.50	0.000	0.000
683.00	0.000	0.000
683.50	0.000	0.000
684.00	0.000	0.000
684.50	0.000	0.000
685.00	0.000	0.000
685.50	0.000	0.000
686.00	0.000	0.000
686.50	0.000	0.000
687.00	0.000	0.000
687.50	0.000	0.000
688.00	0.000	0.000
688.50	0.001	0.001
689.00	0.003	0.003
689.50	0.004	0.004
690.00	0.005	0.005
690.50	0.007	0.007

Elevation (ft)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
691.00	0.008	0.008
691.50	(1)>0.009	0.009
692.00	(1)>0.011	0.011
692.50	(1)>0.012	0.012
693.00	(1)>0.013	0.013
693.50	(1)>0.015	0.015
694.00	(1)>0.016	0.016
694.50	(1)>0.017	0.017
695.00	(1)>0.019	0.019
695.50	(1)>0.020	0.020
696.00	(1)>0.021	0.021

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#41	Σ	0.000						0.00	0.000
#40	Σ	0.000						0.00	0.000
#39	Σ	0.000						0.00	0.000
#38	Σ	0.000						0.00	0.000
#25	1	13.100	0.369	0.000	0.000	84.000	TR55	31.55	2.529
	Σ	13.100						31.55	2.529
#32	Σ	13.100						31.55	2.529
#26	1	6.280	0.049	0.114	0.231	84.000	TR55	24.83	1.217
	2	2.170	0.116	0.000	0.000	84.000	TR55	8.58	0.420
	Σ	21.550						38.69	4.166
#24	1	11.177	0.368	0.000	0.000	84.000	TR55	26.95	2.158
	Σ	11.177						26.95	2.158
#22	Σ	0.000						0.00	0.000
#23	1	8.550	0.097	0.000	0.000	84.000	TR55	33.80	1.657
	2	14.550	0.147	0.000	0.000	84.000	TR55	47.32	2.865
	Σ	34.277						85.24	6.680
#31	Σ	34.277						85.24	6.680
#21	1	2.860	0.097	0.000	0.000	84.000	TR55	11.31	0.554
	2	16.630	0.296	0.000	0.000	84.000	TR55	44.36	3.198
	Σ	19.490						45.91	3.752
#27	1	20.620	0.177	0.000	0.000	84.000	TR55	65.95	4.029
	2	7.730	0.075	0.000	0.000	84.000	TR55	30.56	1.498
	3	0.595	0.034	0.000	0.000	84.000	TR55	2.35	0.115
	4	5.370	0.177	0.000	0.000	84.000	TR55	17.18	1.049
	Σ	88.082						202.06	17.122
#34	1	9.930	0.094	0.000	0.000	100.000	TR55	54.18	3.267
	2	4.640	0.108	0.000	0.000	100.000	TR55	25.32	1.527
	Σ	14.570						79.50	4.794
#1	1	6.800	0.138	0.000	0.000	84.000	TR55	22.12	1.339
	Σ	21.370						37.57	6.133
#37	1	5.320	0.211	0.000	0.000	84.000	TR55	15.98	0.999
	Σ	26.690						52.42	7.132

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	4.160	0.121	0.000	0.000	84.000	TR55	16.45	0.806
	2	1.270	0.006	0.000	0.000	84.000	TR55	5.02	0.246
	3	9.690	0.020	0.000	0.000	100.000	TR55	52.87	3.188
	4	2.170	0.006	0.000	0.000	84.000	TR55	8.58	0.420
	5	14.010	0.025	0.000	0.000	100.000	TR55	76.45	4.609
	6	2.690	0.006	0.000	0.000	84.000	TR55	10.63	0.521
	7	1.780	0.055	0.000	0.000	84.000	TR55	7.04	0.345
	8	0.152	0.001	0.008	0.379	100.000	TR55	0.83	0.046
	9	0.985	0.055	0.005	0.395	100.000	TR55	5.37	0.324
	10	1.876	0.003	0.003	0.415	100.000	TR55	10.24	0.617
	11	1.801	0.003	0.129	0.228	100.000	TR55	9.83	0.593
	12	0.072	0.001	0.006	0.417	100.000	TR55	0.39	0.016
	13	1.414	0.003	0.006	0.410	100.000	TR55	7.72	0.465
	14	1.013	0.001	0.006	0.422	100.000	TR55	5.53	0.333
	15	1.593	0.004	0.132	0.315	100.000	TR55	8.69	0.524
	16	0.186	0.004	0.008	0.417	100.000	TR55	1.01	0.056
	17	3.475	0.004	0.009	0.424	100.000	TR55	18.96	1.143
	18	1.430	0.012	0.000	0.000	84.000	TR55	5.65	0.277
	19	0.390	0.021	0.000	0.000	84.000	TR55	1.54	0.075
	20	1.870	0.000	0.000	0.000	100.000	TR55	10.20	0.615
	21	15.510	0.206	0.008	0.379	100.000	TR55	67.58	5.107
	Σ	94.227						325.35	27.458
#15	1	1.900	0.546	0.000	0.000	84.000	TR55	3.69	0.363
	2	5.430	0.099	0.000	0.000	84.000	TR55	21.47	1.052
	Σ	101.557						32.97	28.867
#16	Σ	101.557						32.97	28.867
#19	1	3.530	0.538	0.000	0.000	84.000	TR55	6.91	0.680
	2	1.920	0.514	0.000	0.000	84.000	TR55	3.86	0.370
	Σ	195.089						60.73	47.039
#20	1	7.690	0.056	0.000	0.000	84.000	TR55	30.40	1.490
	2	3.150	0.661	0.000	0.000	84.000	TR55	5.44	0.607
	Σ	205.929						63.15	49.136
#29	Σ	227.479						80.88	53.302
#30	1	8.350	0.133	0.000	0.000	84.000	TR55	27.16	1.644
	2	10.470	0.000	0.000	0.000	100.000	TR55	57.13	3.445
	Σ	246.299						146.11	58.391

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	1.60	5.92	370.00	1.010	0.101
		6. Grassed waterway	1.30	2.98	230.00	1.710	0.037
#1	1	Time of Concentration:					0.138
#2	1	3. Short grass pasture	3.50	22.75	650.00	1.490	0.121
#2	1	Time of Concentration:					0.121
#2	2	3. Short grass pasture	25.00	25.00	100.00	4.000	0.006
#2	2	Time of Concentration:					0.006
#2	3	7. Paved area and small upland gullies	25.00	190.00	760.00	10.060	0.020
#2	3	Time of Concentration:					0.020
#2	4	3. Short grass pasture	33.00	33.00	100.00	4.590	0.006
#2	4	Time of Concentration:					0.006
#2	5	7. Paved area and small upland gullies	25.00	227.50	910.00	10.060	0.025
#2	5	Time of Concentration:					0.025
#2	6	3. Short grass pasture	33.00	37.95	115.00	4.590	0.006
#2	6	Time of Concentration:					0.006
#2	7	3. Short grass pasture	10.00	20.00	200.00	2.520	0.022
#2	7	Time of Concentration:					0.055
#2	8	3. Short grass pasture	1.60	3.20	200.00	1.010	0.055
#2	8	Time of Concentration:					0.001
#2	9	3. Short grass pasture	1.60	3.20	200.00	1.010	0.055
#2	9	Time of Concentration:					0.055
#2	10	7. Paved area and small upland gullies	33.00	16.50	49.99	11.560	0.001
#2	10	Time of Concentration:					0.003
#2	11	7. Paved area and small upland gullies	33.00	39.60	120.00	11.560	0.002
#2	11	Time of Concentration:					0.003
#2	12	7. Paved area and small upland gullies	33.00	42.90	130.00	11.560	0.003
#2	12	Time of Concentration:					0.001
#2	13	7. Paved area and small upland gullies	33.00	42.90	130.00	11.560	0.003
#2	13	Time of Concentration:					0.003
#2	14	7. Paved area and small upland gullies	20.00	12.00	60.00	9.000	0.001
#2	14	Time of Concentration:					0.001
#2	15	7. Paved area and small upland gullies	25.00	37.50	150.00	10.060	0.004
#2	15	Time of Concentration:					0.004
#2	16	7. Paved area and small upland gullies	25.00	37.50	150.00	10.060	0.004
#2	16	Time of Concentration:					0.004
#2	17	7. Paved area and small upland gullies	25.00	37.50	150.00	10.060	0.004
#2	17	Time of Concentration:					0.004
#2	18	3. Short grass pasture	10.00	11.50	115.00	2.520	0.012

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	18	Time of Concentration:					0.012
#2	19	3. Short grass pasture	7.00	11.62	166.00	2.110	0.021
#2	19	Time of Concentration:					0.021
#2	21	7. Paved area and small upland gullies	25.00	118.75	475.00	10.060	0.013
		7. Paved area and small upland gullies	0.50	4.94	988.00	1.420	0.193
#2	21	Time of Concentration:					0.206
#15	1	3. Short grass pasture	20.00	9.00	45.00	3.570	0.003
		6. Grassed waterway	0.10	0.92	920.00	0.470	0.543
#15	1	Time of Concentration:					0.546
#15	2	3. Short grass pasture	3.60	19.43	539.72	1.510	0.099
#15	2	Time of Concentration:					0.099
#19	1	3. Short grass pasture	9.00	23.40	260.00	2.400	0.030
		6. Grassed waterway	0.10	0.86	860.00	0.470	0.508
#19	1	Time of Concentration:					0.538
#19	2	3. Short grass pasture	20.00	17.00	85.00	3.570	0.006
		6. Grassed waterway	0.10	0.86	860.00	0.470	0.508
#19	2	Time of Concentration:					0.514
#20	1	3. Short grass pasture	6.00	24.00	400.00	1.950	0.056
		6. Grassed waterway	0.10	1.10	1,100.00	0.470	0.650
#20	1	Time of Concentration:					0.056
#20	2	3. Short grass pasture	10.00	10.00	100.00	2.520	0.011
		6. Grassed waterway	0.10	1.10	1,100.00	0.470	0.650
#20	2	Time of Concentration:					0.661
#21	1	3. Short grass pasture	4.30	24.94	580.00	1.650	0.097
#21	1	Time of Concentration:					0.097
#21	2	3. Short grass pasture	2.80	11.90	425.00	1.330	0.088
		6. Grassed waterway	1.40	9.66	690.00	1.770	0.108
		6. Grassed waterway	0.70	3.15	450.00	1.250	0.100
#21	2	Time of Concentration:					0.296
#23	1	3. Short grass pasture	4.10	18.03	439.75	1.610	0.075
		3. Short grass pasture	10.00	20.00	200.00	2.520	0.022
#23	1	Time of Concentration:					0.097
#23	2	3. Short grass pasture	4.00	34.00	850.00	1.600	0.147
#23	2	Time of Concentration:					0.147
#24	1	3. Short grass pasture	4.00	28.00	700.00	1.600	0.121
		6. Grassed waterway	1.10	15.40	1,400.00	1.570	0.247
#24	1	Time of Concentration:					0.368
#25	1	3. Short grass pasture	11.00	38.50	350.00	2.650	0.036
		6. Grassed waterway	1.00	18.00	1,800.00	1.500	0.333
#25	1	Time of Concentration:					0.369
#26	1	3. Short grass pasture	8.00	32.00	400.00	2.260	0.049
#26	1	Time of Concentration:					0.049
#26	2	3. Short grass pasture	33.00	11.55	35.00	4.590	0.002

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		6. Grassed waterway	0.96	5.76	600.00	1.460	0.114
#26	2	Time of Concentration:					0.116
#27	1	3. Short grass pasture	3.00	26.40	880.00	1.380	0.177
#27	1	Time of Concentration:					0.177
#27	2	3. Short grass pasture	5.40	27.00	500.00	1.850	0.075
#27	2	Time of Concentration:					0.075
#27	3	3. Short grass pasture	4.00	8.00	200.00	1.600	0.034
#27	3	Time of Concentration:					0.034
#27	4	3. Short grass pasture	3.00	26.40	880.00	1.380	0.177
#27	4	Time of Concentration:					0.177
#30	1	6. Grassed waterway	1.00	7.20	720.00	1.500	0.133
#30	1	Time of Concentration:					0.133
#34	1	7. Paved area and small upland gullies	25.00	87.50	350.00	10.060	0.009
		7. Paved area and small upland gullies	2.00	17.40	870.00	2.840	0.085
#34	1	Time of Concentration:					0.094
#34	2	7. Paved area and small upland gullies	25.00	65.00	260.00	10.060	0.007
		7. Paved area and small upland gullies	0.50	2.60	520.00	1.420	0.101
#34	2	Time of Concentration:					0.108
#37	1	3. Short grass pasture	3.00	12.90	430.00	1.380	0.086
		6. Grassed waterway	1.10	7.81	710.00	1.570	0.125
#37	1	Time of Concentration:					0.211

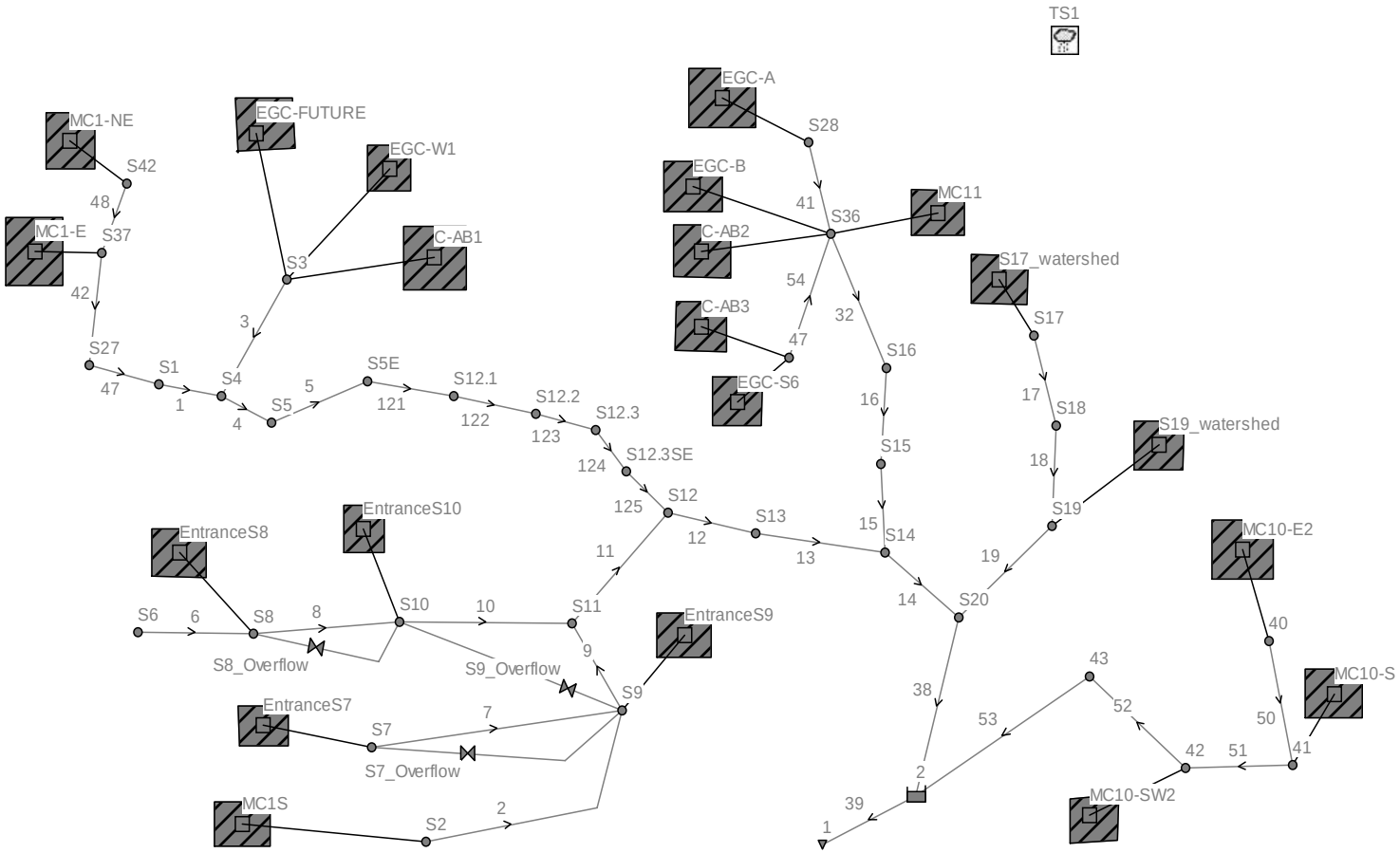
Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	8	7. Paved area and small upland gullies	7.00	11.62	166.00	5.320	0.008
#2	8	Muskingum K:					0.008
#2	9	7. Paved area and small upland gullies	10.00	11.50	115.00	6.360	0.005
#2	9	Muskingum K:					0.005
#2	10	7. Paved area and small upland gullies	17.00	19.55	115.00	8.290	0.003
#2	10	Muskingum K:					0.003
#2	11	7. Paved area and small upland gullies	0.50	3.30	660.00	1.420	0.129
#2	11	Muskingum K:					0.129
#2	12	7. Paved area and small upland gullies	25.00	17.50	70.00	10.060	0.001
		8. Large gullies, diversions, and low flowing streams	7.00	11.62	166.00	7.930	0.005
#2	12	Muskingum K:					0.006

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	13	7. Paved area and small upland gullies	25.00	16.75	67.00	10.060	0.001
		7. Paved area and small upland gullies	10.00	11.50	115.00	6.360	0.005
#2	13	Muskingum K:					0.006
#2	14	7. Paved area and small upland gullies	25.00	29.00	116.00	10.060	0.003
		7. Paved area and small upland gullies	17.00	19.55	115.00	8.290	0.003
#2	14	Muskingum K:					0.006
#2	15	7. Paved area and small upland gullies	25.00	33.75	135.00	10.060	0.003
		7. Paved area and small upland gullies	0.50	3.30	660.00	1.420	0.129
#2	15	Muskingum K:					0.132
#2	16	7. Paved area and small upland gullies	25.00	22.50	90.00	10.060	0.002
		7. Paved area and small upland gullies	25.00	16.75	67.00	10.060	0.001
		7. Paved area and small upland gullies	10.00	11.50	115.00	6.360	0.005
#2	16	Muskingum K:					0.008
#2	17	7. Paved area and small upland gullies	25.00	60.00	240.00	10.060	0.006
		7. Paved area and small upland gullies	17.00	19.55	115.00	8.290	0.003
#2	17	Muskingum K:					0.009
#2	18	7. Paved area and small upland gullies	6.00	4.79	79.83	4.930	0.004
#2	18	Muskingum K:					0.000
#2	19	3. Short grass pasture	33.00	19.80	60.00	4.590	0.003
#2	19	Muskingum K:					0.000
#2	21	7. Paved area and small upland gullies	7.00	11.62	166.00	5.320	0.008
#2	21	Muskingum K:					0.008
#26	1	6. Grassed waterway	0.96	5.76	600.00	1.460	0.114
#26	1	Muskingum K:					0.114

Appendix D

Existing Conveyance Structure Capacity Report for SSB Watershed (SWMM)


TS1
EGC-A
S28
EGC-B
MC11
41
S36
C-AB2
S17_watershed
54
32
C-AB3
47
S17
S16
EGC-S6
16
17
S18
MC1-NE
EGC-FUTURE
EGC-W1
S42
48
MC1-E
S37
C-AB1
S3
42
3
S27
47
S1
1
S4
4
S5
5
S5E
121
S12.1
122
S12.2
123
S12.3
124
S12.3SE
125
S12
12
S13
13
15
S15
S14
18
S19_watershed
S19
19
MC10-E2
EntranceS10
EntranceS8
11
14
S20
40
S6
6
S8
8
S10
10
S11
EntranceS9
9
S8_Overflow
S9_Overflow
S9
MC10-S
38
43
EntranceS7
7
S7
53
52
50
S7_Overflow
42
51
41
2
MC1S
S2
2
39
MC10-SW2
1

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.1)

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 21
Number of nodes 37
Number of links 39
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
TS1	TS11	INTENSITY	6 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
MC1-E	14.27	2800.00	0.00	2.5000	TS1	S37
MC1S	18.43	1730.00	0.00	0.5000	TS1	S2
C-AB1	4.24	460.00	0.00	20.0000	TS1	S3
EntranceS7	1.09	40.00	100.00	2.0000	TS1	S7
EntranceS8	0.51	115.00	100.00	0.0700	TS1	S8
EntranceS9	0.32	13.00	100.00	1.6000	TS1	S9
EntranceS10	0.50	17.00	100.00	2.6000	TS1	S10
S17_watershed	3.80	450.00	0.00	12.0000	TS1	S17
S19_watershed	0.29	60.00	0.00	5.0000	TS1	S19
EGC-B	13.30	1500.00	100.00	20.0000	TS1	S36
MC11	17.25	920.00	0.00	2.2700	TS1	S36

MC1-NE	0.98	120.00	0.00	3.4000	TS1	S42
MC10-E2	4.57	500.00	0.00	20.0000	TS1	40
MC10-S	4.90	100.00	0.00	20.0000	TS1	41
MC10-SW2	2.74	100.00	0.00	20.0000	TS1	42
EGC-A	8.96	700.00	100.00	20.0000	TS1	S28
C-AB2	2.69	300.00	0.00	25.0000	TS1	S36
EGC-W1	1.19	300.00	100.00	20.0000	TS1	S3
EGC-FUTURE	10.00	800.00	100.00	25.0000	TS1	S3
EGC-S6	1.50	480.00	100.00	33.0000	TS1	47
C-AB3	3.50	630.00	0.00	33.0000	TS1	47

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
S2	JUNCTION	686.25	13.20	0.0	
S3	JUNCTION	696.18	7.96	12000.0	
S4	JUNCTION	693.34	7.00	0.0	
S5	JUNCTION	692.01	7.50	0.0	
S6	JUNCTION	695.71	3.20	0.0	
S7	JUNCTION	694.09	5.45	0.0	
S8	JUNCTION	694.73	5.00	0.0	
S9	JUNCTION	684.57	14.00	0.0	
S10	JUNCTION	691.90	4.80	100.0	
S11	JUNCTION	685.67	15.65	0.0	
S12	JUNCTION	686.18	16.25	0.0	
S13	JUNCTION	685.57	15.90	0.0	
S14	JUNCTION	685.88	16.34	0.0	
S15	JUNCTION	687.52	14.09	0.0	
S16	JUNCTION	697.26	6.94	0.0	
S17	JUNCTION	695.46	4.70	0.0	
S18	JUNCTION	694.60	5.40	0.0	
S19	JUNCTION	690.98	9.26	0.0	
S20	JUNCTION	685.98	10.00	0.0	
S1	JUNCTION	697.50	3.00	0.0	
S28	JUNCTION	698.80	16.17	0.0	
S36	JUNCTION	697.90	6.88	0.0	
S37	JUNCTION	702.20	5.20	0.0	
S27	JUNCTION	700.92	6.20	0.0	

S42	JUNCTION	703.50	3.00	4000.0
40	JUNCTION	697.00	3.00	0.0
41	JUNCTION	695.00	5.00	0.0
42	JUNCTION	692.00	6.00	0.0
43	JUNCTION	690.00	6.00	0.0
S5E	JUNCTION	691.07	11.00	0.0
S12.1	JUNCTION	688.83	16.84	0.0
S12.2	JUNCTION	688.47	17.98	0.0
S12.3	JUNCTION	688.30	14.93	0.0
S12.3SE	JUNCTION	688.00	15.00	0.0
47	JUNCTION	703.82	4.10	0.0
1	OUTFALL	690.00	1.00	0.0
2	STORAGE	671.00	25.00	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
2	S2	S9	CONDUIT	855.0	0.0211	0.0130
3	S3	S4	CONDUIT	91.0	1.6376	0.0130
4	S4	S5	CONDUIT	100.0	0.1800	0.0130
5	S5	S5E	CONDUIT	147.0	0.6395	0.0130
6	S6	S8	CONDUIT	275.0	0.3564	0.0130
7	S7	S9	CONDUIT	163.0	2.1600	0.0130
8	S8	S10	CONDUIT	205.0	1.3562	0.0130
9	S9	S11	CONDUIT	122.0	0.2049	0.0130
10	S10	S11	CONDUIT	19.0	0.6842	0.0130
11	S11	S12	CONDUIT	107.0	-0.4766	0.0130
12	S12	S13	CONDUIT	165.0	0.3697	0.0130
13	S13	S14	CONDUIT	226.0	-0.3009	0.0130
14	S14	S20	CONDUIT	166.0	0.0602	0.0130
15	S15	S14	CONDUIT	35.0	0.7715	0.0130
16	S16	S15	CONDUIT	210.0	2.9775	0.0130
17	S17	S18	CONDUIT	49.0	0.0204	0.0130
18	S18	S19	CONDUIT	14.0	0.3571	0.0130
19	S19	S20	CONDUIT	43.0	12.5869	0.0130
1	S1	S4	CONDUIT	95.0	3.9610	0.0130
32	S36	S16	CONDUIT	500.0	0.1280	0.0250
38	S20	2	CONDUIT	414.0	0.0725	0.0130
39	2	1	CONDUIT	400.0	0.1250	0.0130

41	S28	S36	CONDUIT	708.0	0.1271	0.0250
42	S37	S27	CONDUIT	1314.0	0.0228	0.0250
47	S27	S1	CONDUIT	41.6	8.2491	0.0130
48	S42	S37	CONDUIT	60.0	2.1672	0.0130
50	40	41	CONDUIT	1500.0	0.1333	0.0250
51	41	42	CONDUIT	1000.0	0.3000	0.0250
52	42	43	CONDUIT	900.0	0.2222	0.0250
53	43	2	CONDUIT	120.0	5.8433	0.0130
121	S5E	S12.1	CONDUIT	350.0	0.6400	0.0130
122	S12.1	S12.2	CONDUIT	110.0	0.3273	0.0120
123	S12.2	S12.3	CONDUIT	100.0	0.1700	0.0120
124	S12.3	S12.3SE	CONDUIT	120.0	0.2500	0.0120
125	S12.3SE	S12	CONDUIT	26.0	0.2692	0.0130
54	47	S36	CONDUIT	60.0	1.7336	0.0130
S8_Overflow	S8	S10	WEIR			
S9_Overflow	S9	S10	WEIR			
S7_Overflow	S7	S9	WEIR			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
2	CIRCULAR	3.00	7.07	0.75	3.00	1	9.68
3	CIRCULAR	0.67	0.35	0.17	0.67	1	1.57
4	CIRCULAR	3.00	7.07	0.75	3.00	1	28.30
5	CIRCULAR	3.50	9.62	0.88	3.50	1	80.45
6	CIRCULAR	1.00	0.79	0.25	1.00	1	2.13
7	CIRCULAR	1.00	0.79	0.25	1.00	1	5.24
8	CIRCULAR	1.00	0.79	0.25	1.00	1	4.15
9	CIRCULAR	3.00	7.07	0.75	3.00	1	30.19
10	CIRCULAR	1.00	0.79	0.25	1.00	1	2.95
11	CIRCULAR	3.00	7.07	0.75	3.00	1	46.05
12	CIRCULAR	3.50	9.62	0.88	3.50	1	61.17
13	CIRCULAR	3.50	9.62	0.88	3.50	1	55.19
14	CIRCULAR	3.50	9.62	0.88	3.50	1	24.69
15	CIRCULAR	2.00	3.14	0.50	2.00	1	19.87
16	CIRCULAR	2.00	3.14	0.50	2.00	1	39.04
17	CIRCULAR	1.50	1.77	0.38	1.50	1	1.50
18	CIRCULAR	1.50	1.77	0.38	1.50	1	6.28

19	CIRCULAR	1.50	1.77	0.38	1.50	1	37.27
1	CIRCULAR	3.00	7.07	0.75	3.00	1	132.74
32	TRAPEZOIDAL	4.60	129.17	2.53	50.16	1	509.66
38	CIRCULAR	3.50	9.62	0.88	3.50	1	27.08
39	CIRCULAR	1.00	0.79	0.25	1.00	1	1.26
41	TRAPEZOIDAL	4.60	129.17	2.53	50.16	3	507.90
42	TRAPEZOIDAL	5.20	88.19	2.83	28.92	1	158.65
47	CIRCULAR	1.50	1.77	0.38	1.50	1	30.17
48	CIRCULAR	1.00	0.79	0.25	1.00	2	5.24
50	TRIANGULAR	3.00	49.50	1.48	33.00	1	139.26
51	TRIANGULAR	5.00	45.00	2.19	18.00	1	246.72
52	TRAPEZOIDAL	6.00	135.00	3.28	39.00	1	835.47
53	CIRCULAR	2.50	4.91	0.62	2.50	1	99.15
121	CIRCULAR	4.50	15.90	1.12	4.50	1	157.32
122	CIRCULAR	3.00	7.07	0.75	3.00	1	41.34
123	CIRCULAR	3.00	7.07	0.75	3.00	1	29.79
124	CIRCULAR	4.00	12.57	1.00	4.00	1	77.81
125	CIRCULAR	3.00	7.07	0.75	3.00	1	34.61
54	CIRCULAR	2.00	3.14	0.50	2.00	1	29.79

****
Analysis Options
****
Flow Units ..... CFS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... YES
  Water Quality ..... NO
Infiltration Method ..... CURVE_NUMBER
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 06/14/2019 00:00:00
Ending Date 06/16/2019 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:02:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00

```
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


*********************
Control Actions Taken
*********************


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......        37.864         3.950
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         9.398         0.980
Surface Runoff ...........        28.184         2.940
Final Storage ............         0.322         0.034
Continuity Error (%) .....        -0.107


**************************        Volume        Volume
Flow Routing Continuity        acre-feet     10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......        28.200         9.189
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.000         0.000
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......        28.238         9.202
Continuity Error (%) .....        -0.135


************************
Highest Continuity Errors
```

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*************************
Node 43 (8.33%)
Node 41 (1.23%)


**************************
Time-Step Critical Elements
**************************
None


*******************************
Highest Flow Instability Indexes
*******************************
All links are stable.


*********************************
Most Frequent Nonconverging Nodes
*********************************
Node 1 (0.15%)
Node S12.2 (0.08%)
Node S12.3 (0.08%)
Node S12.1 (0.08%)
Node S12.3SE (0.06%)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
% of Time in Steady State   :     0.21
Average Iterations per Step :     2.01
% of Steps Not Converging   :     0.15
Time Step Frequencies       :
    1.000 -  0.871 sec      :    99.29 %
    0.871 -  0.758 sec      :     0.20 %
    0.758 -  0.660 sec      :     0.39 %
    0.660 -  0.574 sec      :     0.03 %
    0.574 -  0.500 sec      :     0.09 %
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
MC1-E	3.95	0.00	0.00	1.30	0.00	2.60	2.60	1.01	41.61	0.659
MC1S	3.95	0.00	0.00	1.91	0.00	1.99	1.99	0.99	20.43	0.503
C-AB1	3.95	0.00	0.00	1.30	0.00	2.61	2.61	0.30	13.45	0.660
EntranceS7	3.95	0.00	0.00	0.00	3.96	0.00	3.96	0.12	4.98	1.002
EntranceS8	3.95	0.00	0.00	0.00	3.96	0.00	3.96	0.05	2.40	1.002
EntranceS9	3.95	0.00	0.00	0.00	3.96	0.00	3.96	0.03	1.46	1.002
EntranceS10	3.95	0.00	0.00	0.00	3.96	0.00	3.96	0.05	2.31	1.002
S17_watershed	3.95	0.00	0.00	1.30	0.00	2.60	2.60	0.27	11.57	0.659
S19_watershed	3.95	0.00	0.00	1.30	0.00	2.61	2.61	0.02	0.91	0.660
EGC-B	3.95	0.00	0.00	0.00	3.96	0.00	3.96	1.43	72.48	1.002
MC11	3.95	0.00	0.00	1.32	0.00	2.58	2.58	1.21	31.03	0.653
MC1-NE	3.95	0.00	0.00	1.31	0.00	2.60	2.60	0.07	2.66	0.658
MC10-E2	3.95	0.00	0.00	1.30	0.00	2.61	2.61	0.32	14.53	0.660

MC10-S		3.95	0.00	0.00	1.32	0.00	2.58	2.58
0.34	9.41	0.654						
MC10-SW2		3.95	0.00	0.00	1.31	0.00	2.59	2.59
0.19	6.73	0.656						
EGC-A		3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.96	48.65	1.003						
C-AB2		3.95	0.00	0.00	1.30	0.00	2.61	2.61
0.19	8.87	0.660						
EGC-W1		3.95	0.00	0.00	0.00	3.95	0.00	3.95
0.13	6.50	1.001						
EGC-FUTURE		3.95	0.00	0.00	0.00	3.96	0.00	3.96
1.08	54.39	1.002						
EGC-S6		3.95	0.00	0.00	0.00	3.95	0.00	3.95
0.16	8.19	1.000						
C-AB3		3.95	0.00	0.00	1.29	0.00	2.61	2.61
0.25	13.11	0.662						

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
S2	JUNCTION	0.79	10.74	696.99	0 11:53	10.60
S3	JUNCTION	3.58	14.62	710.80	0 12:51	14.62
S4	JUNCTION	0.36	5.24	698.58	0 12:07	3.84
S5	JUNCTION	0.28	6.17	698.18	0 12:07	4.89
S6	JUNCTION	0.00	0.59	696.30	0 12:11	0.55
S7	JUNCTION	0.22	3.23	697.32	0 12:06	3.18
S8	JUNCTION	0.05	1.49	696.22	0 12:12	1.48
S9	JUNCTION	2.41	11.62	696.19	0 12:10	11.62
S10	JUNCTION	0.10	4.22	696.12	0 12:09	4.22
S11	JUNCTION	1.32	10.41	696.08	0 12:09	10.39
S12	JUNCTION	0.81	9.92	696.10	0 12:09	9.75
S13	JUNCTION	1.40	9.91	695.48	0 12:09	9.78
S14	JUNCTION	1.02	8.76	694.64	0 12:09	8.68
S15	JUNCTION	0.96	8.01	695.53	0 12:09	7.95
S16	JUNCTION	0.32	3.72	700.98	0 12:19	3.72

S17	JUNCTION	0.69	2.56	698.02	0	12:00	2.56
S18	JUNCTION	1.25	2.77	697.37	0	12:06	2.77
S19	JUNCTION	0.37	2.46	693.44	0	12:08	2.46
S20	JUNCTION	0.78	7.13	693.11	0	12:09	7.09
S1	JUNCTION	0.09	0.97	698.47	0	12:10	0.97
S28	JUNCTION	0.11	2.19	700.99	0	12:22	2.19
S36	JUNCTION	0.30	3.09	700.99	0	12:19	3.09
S37	JUNCTION	0.25	2.33	704.53	0	12:10	2.33
S27	JUNCTION	0.10	1.26	702.18	0	12:10	1.25
S42	JUNCTION	0.03	1.07	704.57	0	12:09	1.07
40	JUNCTION	0.15	1.18	698.18	0	12:08	1.18
41	JUNCTION	0.43	1.97	696.97	0	12:19	1.96
42	JUNCTION	0.09	0.92	692.92	0	12:20	0.92
43	JUNCTION	1.61	2.69	692.69	0	12:24	2.69
S5E	JUNCTION	0.27	6.77	697.84	0	12:07	5.64
S12.1	JUNCTION	0.39	11.71	700.54	0	12:03	7.75
S12.2	JUNCTION	0.44	9.54	698.01	0	12:03	7.84
S12.3	JUNCTION	0.40	8.08	696.38	0	12:07	7.77
S12.3SE	JUNCTION	0.43	8.22	696.22	0	12:09	8.00
47	JUNCTION	0.08	1.25	705.07	0	12:00	1.25
1	OUTFALL	0.00	0.00	690.00	0	00:00	0.00
2	STORAGE	10.94	14.86	685.86	2	00:00	14.86

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
S2	JUNCTION	20.43	20.43	0	12:06	0.994	0.999	0.010
S3	JUNCTION	74.34	74.34	0	12:00	1.5	1.5	0.004
S4	JUNCTION	0.00	34.73	0	12:10	0	2.58	-0.010
S5	JUNCTION	0.00	34.83	0	12:10	0	2.58	-0.005
S6	JUNCTION	0.00	0.59	0	12:09	0	0.000533	2.559
S7	JUNCTION	4.98	4.98	0	12:00	0.117	0.117	0.281
S8	JUNCTION	2.40	2.40	0	12:00	0.0549	0.0554	-0.010
S9	JUNCTION	1.46	25.86	0	12:06	0.0344	1.15	-0.015

S10	JUNCTION	2.31	4.65	0	12:00	0.0538	0.109	-0.023	
S11	JUNCTION	0.00	25.88	0	12:02	0	1.26	0.051	
S12	JUNCTION	0.00	59.19	0	12:11	0	3.84	-0.006	
S13	JUNCTION	0.00	59.20	0	12:11	0	3.84	0.037	
S14	JUNCTION	0.00	95.75	0	12:11	0	8.04	-0.002	
S15	JUNCTION	0.00	43.41	0	12:45	0	4.2	0.000	
S16	JUNCTION	0.00	68.52	0	11:58	0	4.2	0.037	
S17	JUNCTION	11.57	11.57	0	12:06	0.269	0.269	0.023	
S18	JUNCTION	0.00	11.56	0	12:06	0	0.269	0.047	
S19	JUNCTION	0.91	12.46	0	12:06	0.0206	0.29	0.012	
S20	JUNCTION	0.00	103.58	0	12:10	0	8.33	0.001	
S1	JUNCTION	0.00	30.11	0	12:10	0	1.08	-0.002	
S28	JUNCTION	48.65	48.65	0	12:00	0.963	0.973	-0.091	
S36	JUNCTION	105.00	132.20	0	11:59	2.83	4.21	-0.021	
S37	JUNCTION	41.61	44.24	0	12:06	1.01	1.08	0.063	
S27	JUNCTION	0.00	30.11	0	12:10	0	1.08	-0.001	
S42	JUNCTION	2.66	2.66	0	12:06	0.0692	0.0692	-0.009	
40	JUNCTION	14.53	14.53	0	12:00	0.324	0.324	-2.458	
41	JUNCTION	9.41	20.64	0	12:06	0.344	0.676	1.246	
42	JUNCTION	6.73	17.52	0	12:15	0.193	0.861	-0.382	
43	JUNCTION	0.00	17.00	0	12:20	0	0.864	9.084	
S5E	JUNCTION	0.00	34.86	0	12:10	0	2.58	-0.013	
S12.1	JUNCTION	0.00	34.90	0	12:10	0	2.58	-0.017	
S12.2	JUNCTION	0.00	34.91	0	12:10	0	2.58	-0.004	
S12.3	JUNCTION	0.00	34.92	0	12:10	0	2.58	-0.005	
S12.3SE	JUNCTION	0.00	34.93	0	12:10	0	2.58	-0.009	
47	JUNCTION	21.30	21.30	0	12:00	0.41	0.41	-0.000	
1	OUTFALL	0.00	0.00	0	00:00	0	0	0.000	gal
2	STORAGE	0.00	113.02	0	12:15	0	9.12	0.007	

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
S2	JUNCTION	2.02	7.691	2.459

S3	JUNCTION	11.37	12.700	0.000
S4	JUNCTION	0.08	1.836	1.764
S5	JUNCTION	0.13	2.019	1.331
S11	JUNCTION	0.59	3.310	5.240
S12	JUNCTION	1.15	5.170	6.330
S13	JUNCTION	2.06	6.408	5.992
S14	JUNCTION	1.88	4.889	7.581
S15	JUNCTION	0.75	2.524	6.076
S17	JUNCTION	0.21	0.408	2.142
S20	JUNCTION	1.84	3.627	2.873
S42	JUNCTION	0.14	0.074	1.926
S5E	JUNCTION	0.19	2.274	4.226
S12.1	JUNCTION	0.50	7.214	5.126
S12.2	JUNCTION	0.93	6.539	8.441
S12.3	JUNCTION	0.70	4.084	6.846
S12.3SE	JUNCTION	0.78	4.216	6.784

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CFS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 gal	Maximum Ponded Depth Feet
S3	10.07	70.11	0 12:00	0.599	6.660

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
2	856.309	28	0	0	1219.006	40	2 00:00	0.00

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
1	0.00	0.00	0.00	0.000
System	0.00	0.00	0.00	0.000

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
2	CONDUIT	20.43	0	12:06	2.89	2.11	1.00
3	CONDUIT	4.84	0	12:51	13.72	3.09	1.00
4	CONDUIT	34.83	0	12:10	6.34	1.23	1.00
5	CONDUIT	34.86	0	12:10	7.24	0.43	1.00
6	CONDUIT	0.59	0	12:09	1.12	0.28	0.80
7	CONDUIT	4.90	0	12:00	7.41	0.94	1.00
8	CONDUIT	2.36	0	12:00	3.64	0.57	1.00
9	CONDUIT	22.73	0	12:10	3.22	0.75	1.00
10	CONDUIT	4.65	0	12:00	6.04	1.58	1.00
11	CONDUIT	25.80	0	12:01	3.65	0.56	1.00
12	CONDUIT	59.20	0	12:11	6.15	0.97	1.00
13	CONDUIT	59.20	0	12:11	6.15	1.07	1.00
14	CONDUIT	95.75	0	12:11	9.95	3.88	1.00
15	CONDUIT	43.44	0	12:45	13.83	2.19	1.00
16	CONDUIT	43.41	0	12:45	14.30	1.11	1.00
17	CONDUIT	11.56	0	12:06	6.75	7.71	0.93
18	CONDUIT	11.56	0	12:06	6.89	1.84	0.90

19	CONDUIT	12.62	0	12:03	8.33	0.34	1.00
1	CONDUIT	30.11	0	12:10	9.18	0.23	0.66
32	CONDUIT	68.52	0	11:58	2.18	0.13	0.74
38	CONDUIT	103.58	0	12:10	11.01	3.82	0.94
39	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
41	CONDUIT	13.10	0	11:56	0.42	0.01	0.57
42	CONDUIT	30.11	0	12:10	2.14	0.19	0.31
47	CONDUIT	30.11	0	12:10	21.41	1.00	0.74
48	CONDUIT	2.63	0	12:06	1.99	0.25	1.00
50	CONDUIT	11.61	0	12:08	1.00	0.08	0.51
51	CONDUIT	13.72	0	12:18	3.68	0.06	0.29
52	CONDUIT	17.00	0	12:20	0.86	0.02	0.30
53	CONDUIT	16.67	0	12:24	15.00	0.17	0.28
121	CONDUIT	34.90	0	12:10	4.37	0.22	1.00
122	CONDUIT	34.91	0	12:10	4.94	0.84	1.00
123	CONDUIT	34.92	0	12:10	4.94	1.17	1.00
124	CONDUIT	34.93	0	12:10	3.82	0.45	1.00
125	CONDUIT	34.95	0	12:10	4.94	1.01	1.00
54	CONDUIT	21.29	0	12:00	10.32	0.71	0.63
S8_Overflow	WEIR	0.00	0	00:00			0.00
S9_Overflow	WEIR	0.00	0	00:00			0.00
S7_Overflow	WEIR	0.00	0	00:00			0.00

****
Flow Classification Summary
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	Adjusted	Fraction of Time in Flow Class								
Conduit	/Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
2	1.00	0.01	0.09	0.00	0.90	0.00	0.00	0.00	0.43	0.00
3	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
4	1.00	0.00	0.00	0.00	0.01	0.00	0.00	0.99	0.00	0.00
5	1.00	0.00	0.00	0.00	0.41	0.59	0.00	0.00	0.05	0.00
6	1.00	0.00	0.93	0.00	0.06	0.00	0.00	0.00	0.74	0.00
7	1.00	0.01	0.00	0.00	0.02	0.00	0.00	0.97	0.02	0.00
8	1.00	0.00	0.00	0.00	0.02	0.13	0.00	0.85	0.14	0.00
9	1.00	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.00	0.00
10	1.00	0.00	0.00	0.00	0.02	0.00	0.00	0.98	0.00	0.00

11	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.01	0.00
12	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.01	0.00
13	1.00	0.01	0.01	0.00	0.57	0.00	0.41	0.00	0.00	0.00
14	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.01	0.00
15	1.00	0.01	0.00	0.00	0.04	0.00	0.00	0.95	0.00	0.00
16	1.00	0.01	0.00	0.00	0.02	0.00	0.00	0.98	0.00	0.00
17	1.00	0.14	0.00	0.00	0.00	0.00	0.00	0.86	0.00	0.00
18	1.00	0.15	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.00
19	1.00	0.01	0.53	0.00	0.45	0.00	0.00	0.00	0.84	0.00
1	1.00	0.14	0.00	0.00	0.00	0.25	0.00	0.61	0.25	0.00
32	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.61	0.00
38	1.00	0.01	0.00	0.00	0.41	0.00	0.00	0.57	0.38	0.00
39	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.96	0.00
42	1.00	0.13	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.00
47	1.00	0.13	0.00	0.00	0.00	0.86	0.00	0.00	0.10	0.00
48	1.00	0.13	0.41	0.00	0.44	0.02	0.00	0.00	0.83	0.00
50	1.00	0.13	0.00	0.00	0.87	0.00	0.00	0.00	0.84	0.00
51	1.00	0.13	0.00	0.00	0.87	0.00	0.00	0.00	0.00	0.00
52	1.00	0.13	0.00	0.00	0.87	0.00	0.00	0.00	0.20	0.00
53	1.00	0.25	0.00	0.00	0.54	0.02	0.00	0.18	0.57	0.00
121	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.98	0.00
122	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.76	0.00
123	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
124	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.75	0.00
125	1.00	0.01	0.00	0.00	0.05	0.00	0.00	0.95	0.00	0.00
54	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00

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Conduit Surcharge Summary
****

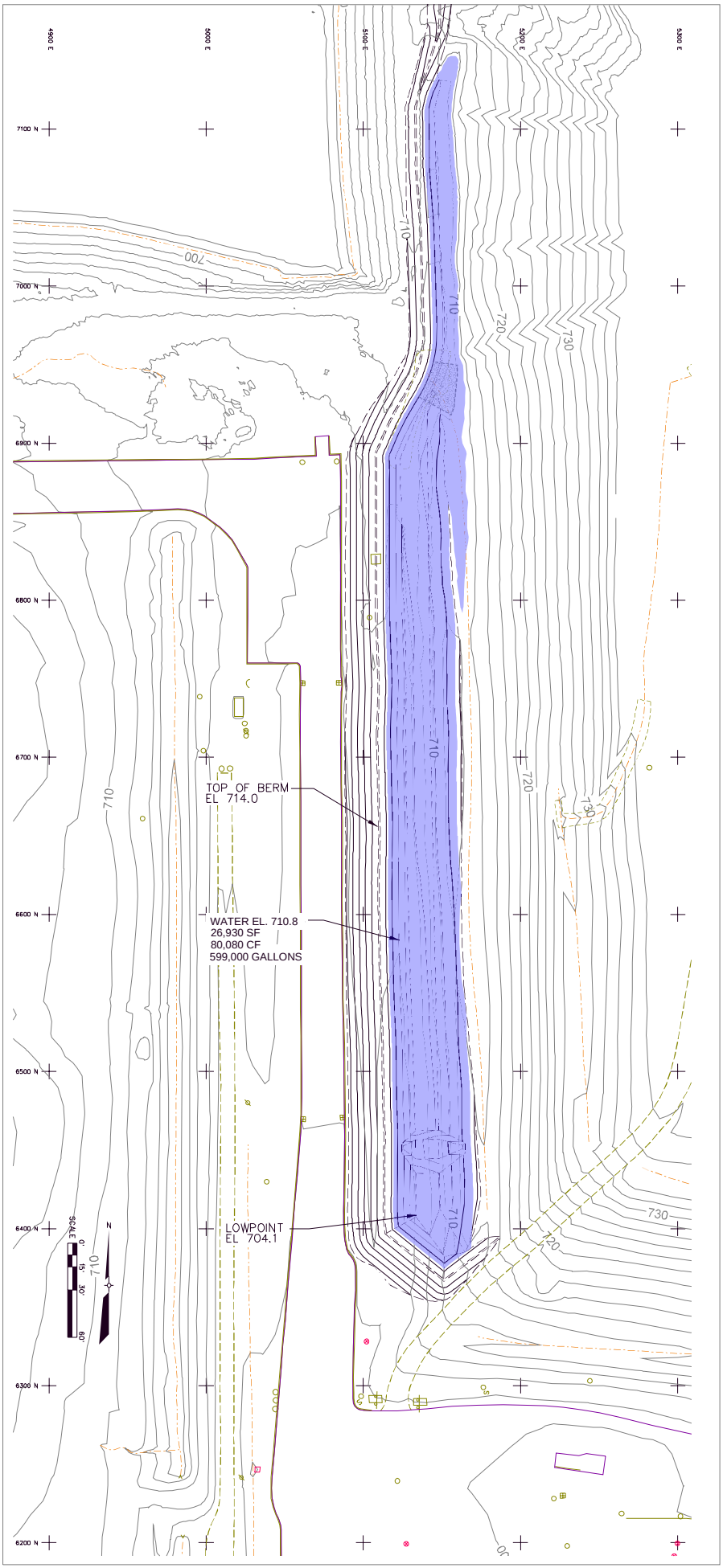
	Hours Full			Hours Above Full	Hours Capacity
Conduit	Both Ends	Upstream	Dnstream	Normal Flow	Limited
2	2.02	2.02	2.05	0.85	0.86
3	10.77	11.37	10.78	12.01	10.77
4	0.13	0.14	0.13	0.28	0.13
5	0.21	0.21	0.32	0.01	0.01

6	0.01	0.01	0.13	0.01	0.01
7	0.30	0.30	0.86	0.01	0.01
8	0.13	0.13	0.59	0.01	0.01
9	2.12	2.12	2.25	0.01	0.01
10	0.56	0.60	0.59	0.18	0.09
11	2.03	2.03	2.25	0.01	0.01
12	1.92	1.92	2.06	0.01	0.01
13	1.88	1.88	2.06	0.15	0.01
14	1.84	1.92	1.84	2.41	1.84
15	1.90	2.02	1.90	2.15	1.90
16	1.69	1.69	1.82	1.56	1.43
17	0.01	0.21	0.01	1.03	0.01
18	0.01	0.01	0.01	0.28	0.01
19	0.17	0.17	6.01	0.01	0.01
1	0.01	0.01	0.08	0.01	0.01
38	0.01	1.84	0.01	2.35	0.01
48	0.14	0.14	1.75	0.01	0.01
121	0.19	0.19	0.50	0.01	0.01
122	0.84	0.84	0.93	0.01	0.01
123	0.93	0.93	0.98	0.27	0.27
124	0.70	0.70	0.78	0.01	0.01
125	1.11	1.11	1.15	0.04	0.03

Analysis begun on: Sun Oct 2 22:10:57 2022
Analysis ended on: Sun Oct 2 22:11:03 2022
Total elapsed time: 00:00:06

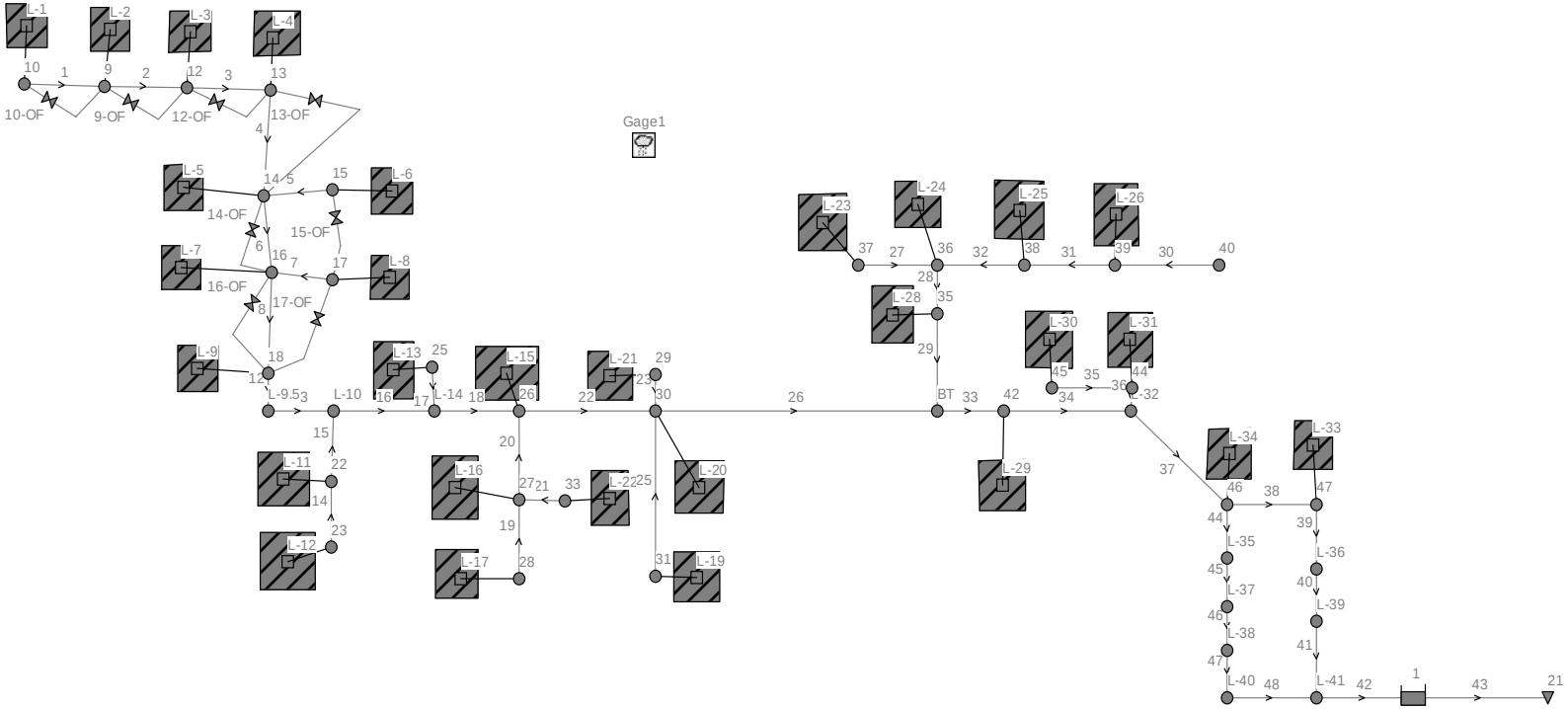
Appendix E

Storage Capacity Calculation Sheet for S3 Area in SSB Watershed (InRoads)


TOP OF BERM
EL 714.0
WATER EL. 710.8
26,930 SF
80,080 CF
599,000 GALLONS
LOWPOINT
EL 704.1
SCALE
0
15
30
60
N

Appendix F

Existing Conveyance Structure Capacity Report for LP Watershed (SWMM)


L-1
L-2
L-3
L-4
10
9
12
13
1
2
3
10-OF
9-OF
12-OF
13-OF
4
Gage1
L-5
L-6
14
5
15
14-OF
15-OF
6
16
7
17
L-7
L-8
16-OF
17-OF
8
L-9
18
12
L-9.5
3
L-10
L-13
25
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17
L-14
L-15
18
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L-21
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22
23
30
26
BT
33
42
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L-30
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L-31
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L-32
L-23
L-24
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L-26
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L-20
L-34
L-33
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38
47
44
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L-35
L-36
45
40
L-37
L-39
46
L-38
41
47
L-40
48
L-41
42
1
43
21

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.1)

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 29
Number of nodes 44
Number of links 52
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Gage1	TS11	INTENSITY	6 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
L-5	0.06	4.00	100.00	0.5000	Gage1	14
L-6	0.19	13.00	100.00	0.5000	Gage1	15
L-7	0.06	4.00	100.00	0.5000	Gage1	16
L-8	0.19	13.00	100.00	0.5000	Gage1	17
L-9	0.19	13.00	100.00	0.5000	Gage1	18
L-11	0.58	38.00	100.00	0.5000	Gage1	22
L-12	1.09	75.00	100.00	0.5000	Gage1	23
L-13	0.32	21.00	100.00	0.5000	Gage1	25
L-15	0.19	13.00	100.00	0.5000	Gage1	26
L-16	0.05	5.00	100.00	0.5000	Gage1	27
L-17	0.26	17.00	100.00	0.5000	Gage1	28
L-19	1.41	95.00	100.00	0.5000	Gage1	31

L-20	0.05	5.00	100.00	0.5000	Gage1	30
L-21	0.13	9.00	100.00	0.5000	Gage1	29
L-23	1.60	105.00	100.00	0.5000	Gage1	37
L-24	0.26	17.00	100.00	0.5000	Gage1	36
L-25	0.19	13.00	100.00	0.5000	Gage1	38
L-26	0.77	53.00	100.00	0.5000	Gage1	39
L-28	0.13	9.00	100.00	0.5000	Gage1	35
L-29	1.34	90.00	100.00	0.5000	Gage1	42
L-30	1.02	70.00	100.00	0.5000	Gage1	45
L-31	0.83	55.00	100.00	0.5000	Gage1	44
L-33	0.77	50.00	100.00	0.5000	Gage1	47
L-34	0.45	30.00	100.00	0.5000	Gage1	46
L-22	0.13	9.00	100.00	0.5000	Gage1	33
L-4	0.13	20.00	100.00	0.5000	Gage1	13
L-3	0.15	20.00	100.00	1.0000	Gage1	12
L-2	0.61	140.00	100.00	1.0000	Gage1	9
L-1	0.72	100.00	100.00	1.0000	Gage1	10

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
13	JUNCTION	697.76	7.10	1800.0	
14	JUNCTION	697.45	7.25	0.0	
15	JUNCTION	699.50	5.40	0.0	
16	JUNCTION	696.59	5.49	0.0	
17	JUNCTION	698.00	4.39	0.0	
18	JUNCTION	692.99	7.95	0.0	
L-9.5	JUNCTION	694.84	5.37	0.0	
L-10	JUNCTION	693.20	9.09	0.0	
22	JUNCTION	695.74	4.13	2600.0	
23	JUNCTION	692.84	7.00	2785.0	
L-14	JUNCTION	694.42	5.48	0.0	
25	JUNCTION	696.88	2.35	1500.0	
26	JUNCTION	694.07	5.53	0.0	
27	JUNCTION	690.73	8.90	0.0	
33	JUNCTION	691.80	6.80	2250.0	
28	JUNCTION	695.99	3.30	0.0	
29	JUNCTION	693.89	7.22	0.0	
30	JUNCTION	692.40	6.85	0.0	

31	JUNCTION	694.92	5.13	2100.0
BT	JUNCTION	693.82	8.50	0.0
35	JUNCTION	695.81	9.60	0.0
37	JUNCTION	698.13	5.85	11571.0
36	JUNCTION	695.43	8.92	11571.0
38	JUNCTION	697.67	6.13	11571.0
39	JUNCTION	698.65	5.35	11571.0
40	JUNCTION	699.74	5.23	0.0
42	JUNCTION	690.03	10.00	24950.0
L-32	JUNCTION	692.31	8.34	0.0
45	JUNCTION	694.65	5.00	24950.0
12	JUNCTION	705.54	6.10	0.0
44	JUNCTION	694.36	6.25	0.0
46	JUNCTION	691.14	10.82	0.0
47	JUNCTION	690.85	11.16	0.0
L-35	JUNCTION	690.78	10.92	0.0
L-37	JUNCTION	690.41	12.10	0.0
L-38	JUNCTION	689.88	12.25	0.0
L-40	JUNCTION	689.45	7.65	0.0
L-36	JUNCTION	689.38	13.60	0.0
L-39	JUNCTION	689.16	10.88	0.0
L-41	JUNCTION	687.70	9.69	0.0
9	JUNCTION	711.26	5.60	0.0
10	JUNCTION	710.90	7.40	0.0
21	OUTFALL	695.00	1.00	0.0
1	STORAGE	686.00	10.00	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
4	13	14	CONDUIT	140.0	0.2214	0.0130
5	15	14	CONDUIT	24.0	8.5730	0.0130
6	14	16	CONDUIT	277.0	0.3105	0.0130
7	17	16	CONDUIT	25.0	5.6490	0.0130
8	16	18	CONDUIT	195.0	0.2564	0.0130
12	18	L-9.5	CONDUIT	61.0	0.3443	0.0130
13	L-9.5	L-10	CONDUIT	82.0	0.1951	0.0130
14	23	22	CONDUIT	139.0	0.2014	0.0130
15	22	L-10	CONDUIT	14.0	1.0715	0.0130
16	L-10	L-14	CONDUIT	103.0	0.0777	0.0130

17	25	L-14	CONDUIT	32.0	7.2061	0.0130
18	L-14	26	CONDUIT	70.0	0.1429	0.0130
19	28	27	CONDUIT	42.0	0.6905	0.0130
21	33	27	CONDUIT	133.0	0.8346	0.0130
20	27	26	CONDUIT	8.5	3.8853	0.0130
22	26	30	CONDUIT	20.0	-1.0001	0.0130
25	31	30	CONDUIT	94.0	0.2660	0.0130
23	29	30	CONDUIT	22.0	2.5463	0.0130
26	30	BT	CONDUIT	309.0	0.3010	0.0130
27	37	36	CONDUIT	97.0	0.8041	0.0130
30	40	39	CONDUIT	26.0	4.3117	0.0130
31	39	38	CONDUIT	43.0	2.2797	0.0130
32	38	36	CONDUIT	86.0	0.2558	0.0130
28	36	35	CONDUIT	55.0	-0.4727	0.0130
29	35	BT	CONDUIT	34.0	12.7193	0.0130
33	BT	42	CONDUIT	559.0	0.2665	0.0130
34	42	L-32	CONDUIT	202.0	0.0396	0.0130
35	45	44	CONDUIT	191.0	0.4398	0.0130
36	44	L-32	CONDUIT	23.4	2.9928	0.0130
37	L-32	46	CONDUIT	61.0	0.5246	0.0130
38	46	47	CONDUIT	73.0	0.1233	0.0130
39	47	L-36	CONDUIT	536.0	0.2388	0.0130
40	L-36	L-39	CONDUIT	327.0	0.0948	0.0130
41	L-39	L-41	CONDUIT	159.0	-0.0252	0.0130
44	46	L-35	CONDUIT	250.0	0.4080	0.0130
45	L-35	L-37	CONDUIT	284.0	0.1092	0.0130
46	L-37	L-38	CONDUIT	282.0	0.2021	0.0130
47	L-38	L-40	CONDUIT	167.0	0.1317	0.0130
48	L-40	L-41	CONDUIT	68.0	-0.5441	0.0130
42	L-41	1	CONDUIT	140.0	0.2143	0.0130
43	1	21	CONDUIT	400.0	0.2500	0.0130
1	10	9	CONDUIT	116.0	1.1552	0.0130
2	9	12	CONDUIT	150.0	2.6142	0.0130
3	12	13	CONDUIT	220.0	4.1080	0.0130
10-OF	10	9	WEIR			
9-OF	9	12	WEIR			
12-OF	12	13	WEIR			
13-OF	13	14	WEIR			
14-OF	14	16	WEIR			
16-OF	16	18	WEIR			
17-OF	17	18	WEIR			
15-OF	15	17	WEIR			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
4	CIRCULAR	1.00	0.79	0.25	1.00	1	1.68
5	CIRCULAR	1.00	0.79	0.25	1.00	1	10.43
6	CIRCULAR	1.00	0.79	0.25	1.00	1	1.99
7	CIRCULAR	1.00	0.79	0.25	1.00	1	8.47
8	CIRCULAR	1.00	0.79	0.25	1.00	1	1.80
12	CIRCULAR	1.00	0.79	0.25	1.00	1	2.09
13	CIRCULAR	1.50	1.77	0.38	1.50	1	4.64
14	CIRCULAR	1.50	1.77	0.38	1.50	1	4.71
15	CIRCULAR	1.50	1.77	0.38	1.50	1	10.87
16	CIRCULAR	1.50	1.77	0.38	1.50	1	2.93
17	CIRCULAR	1.00	0.79	0.25	1.00	1	9.56
18	CIRCULAR	1.50	1.77	0.38	1.50	1	3.97
19	CIRCULAR	1.00	0.79	0.25	1.00	1	2.96
21	CIRCULAR	1.00	0.79	0.25	1.00	1	3.25
20	CIRCULAR	1.00	0.79	0.25	1.00	1	7.02
22	CIRCULAR	1.50	1.77	0.38	1.50	1	10.50
25	CIRCULAR	1.00	0.79	0.25	1.00	1	1.84
23	CIRCULAR	1.00	0.79	0.25	1.00	1	5.69
26	CIRCULAR	1.50	1.77	0.38	1.50	1	5.76
27	CIRCULAR	1.00	0.79	0.25	1.00	1	3.19
30	CIRCULAR	0.13	0.01	0.03	0.13	1	0.03
31	CIRCULAR	1.00	0.79	0.25	1.00	1	5.38
32	CIRCULAR	1.50	1.77	0.38	1.50	1	5.31
28	CIRCULAR	1.00	0.79	0.25	1.00	1	2.45
29	CIRCULAR	1.00	0.79	0.25	1.00	1	12.71
33	CIRCULAR	1.50	1.77	0.38	1.50	1	5.42
34	CIRCULAR	1.50	1.77	0.38	1.50	1	2.09
35	CIRCULAR	1.50	1.77	0.38	1.50	1	6.97
36	CIRCULAR	1.00	0.79	0.25	1.00	1	6.16
37	CIRCULAR	1.50	1.77	0.38	1.50	1	7.61
38	CIRCULAR	1.50	1.77	0.38	1.50	1	3.69
39	CIRCULAR	4.00	12.57	1.00	4.00	1	70.20
40	CIRCULAR	4.00	12.57	1.00	4.00	1	44.23
41	CIRCULAR	4.00	12.57	1.00	4.00	1	22.78
44	CIRCULAR	1.50	1.77	0.38	1.50	1	6.71
45	CIRCULAR	1.50	1.77	0.38	1.50	1	3.47

46	CIRCULAR	1.50	1.77	0.38	1.50	1	4.72
47	CIRCULAR	1.50	1.77	0.38	1.50	1	3.81
48	CIRCULAR	1.50	1.77	0.38	1.50	1	7.75
42	CIRCULAR	4.00	12.57	1.00	4.00	1	66.49
43	CIRCULAR	1.00	0.79	0.25	1.00	1	1.78
1	CIRCULAR	1.00	0.79	0.25	1.00	1	3.83
2	CIRCULAR	1.00	0.79	0.25	1.00	1	5.76
3	CIRCULAR	1.00	0.79	0.25	1.00	1	7.22

****
Analysis Options
****
Flow Units ..... CFS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... YES
  Water Quality ..... NO
Infiltration Method ..... CURVE_NUMBER
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 06/08/2019 00:00:00
Ending Date 06/10/2019 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:02:00
Wet Time Step 00:05:00
Dry Time Step 00:15:00
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.005000 ft

****
Control Actions Taken
****

Runoff Quantity Continuity	Volume acre-feet	Depth inches
Total Precipitation	4.565	3.950
Evaporation Loss	0.000	0.000
Infiltration Loss	0.000	0.000
Surface Runoff	4.575	3.958
Final Storage	0.000	0.000
Continuity Error (%)	-0.214	

Flow Routing Continuity	Volume acre-feet	Volume 10^6 gal
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	4.577	1.492
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Flooding Loss	0.768	0.250
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	3.807	1.240
Continuity Error (%)	0.067	

Highest Continuity Errors

Node 27 (1.42%)

Time-Step Critical Elements

None

Highest Flow Instability Indexes

All links are stable.

****
Most Frequent Nonconverging Nodes
****
Node 21 (0.27%)
Node 33 (0.08%)
Node L-9.5 (0.06%)
Node L-10 (0.06%)
Node 22 (0.05%)

****
Routing Time Step Summary
****
Minimum Time Step : 0.50 sec
Average Time Step : 1.00 sec
Maximum Time Step : 1.00 sec
% of Time in Steady State : 0.21
Average Iterations per Step : 2.02
% of Steps Not Converging : 0.27
Time Step Frequencies :
1.000 - 0.871 sec : 99.92 %
0.871 - 0.758 sec : 0.02 %
0.758 - 0.660 sec : 0.02 %
0.660 - 0.574 sec : 0.01 %
0.574 - 0.500 sec : 0.03 %

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff

```
  ------------------------------------------------------------------------------------------------------------
---------------------
  L-5                        3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.01     0.27   1.002
  L-6                        3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.02     0.86   1.002
  L-7                        3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.01     0.27   1.002
  L-8                        3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.02     0.86   1.002
  L-9                        3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.02     0.86   1.002
  L-11                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.06     2.59   1.002
  L-12                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.12     4.91   1.002
  L-13                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.03     1.43   1.002
  L-15                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.02     0.86   1.002
  L-16                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.01     0.24   1.002
  L-17                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.03     1.16   1.002
  L-19                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.15     6.33   1.002
  L-20                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.01     0.24   1.002
  L-21                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.01     0.59   1.002
  L-23                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.17     7.14   1.002
  L-24                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.03     1.16   1.002
  L-25                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.02     0.86   1.002
  L-26                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.08     3.47   1.002
  L-28                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.01     0.59   1.002
  L-29                       3.95       0.00       0.00       0.00       3.96       0.00       3.96
0.14     6.01   1.002
```

L-30			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.11	4.60	1.002							
L-31			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.09	3.71	1.002							
L-33			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.08	3.43	1.002							
L-34			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.05	2.01	1.002							
L-22			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.01	0.59	1.002							
L-4			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.01	0.67	1.003							
L-3			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.02	0.77	1.003							
L-2			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.07	3.26	1.003							
L-1			3.95	0.00	0.00	0.00	3.96	0.00	3.96
0.08	3.79	1.003							

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
13	JUNCTION	0.20	7.33	705.09	0 12:05	7.33
14	JUNCTION	0.20	7.25	704.70	0 11:55	7.25
15	JUNCTION	0.07	5.28	704.78	0 11:55	5.22
16	JUNCTION	0.21	5.49	702.08	0 11:55	5.49
17	JUNCTION	0.08	4.12	702.12	0 11:55	4.10
18	JUNCTION	2.31	7.95	700.94	0 11:48	7.94
L-9.5	JUNCTION	0.26	5.37	700.21	0 12:01	5.37
L-10	JUNCTION	1.84	7.02	700.22	0 12:09	7.00
22	JUNCTION	0.80	4.50	700.24	0 12:07	4.50
23	JUNCTION	4.22	7.56	700.40	0 12:08	7.56
L-14	JUNCTION	0.63	5.37	699.79	0 12:09	5.34
25	JUNCTION	0.07	2.91	699.79	0 12:07	2.91
26	JUNCTION	0.97	5.32	699.39	0 12:09	5.29
27	JUNCTION	4.46	8.63	699.36	0 12:31	8.63

33	JUNCTION	3.45	7.59	699.39	0	12:07	7.58
28	JUNCTION	1.92	3.30	699.29	0	11:48	3.30
29	JUNCTION	1.67	5.38	699.27	0	12:31	5.37
30	JUNCTION	2.57	6.85	699.25	0	11:49	6.85
31	JUNCTION	0.47	5.74	700.66	0	12:08	5.74
BT	JUNCTION	0.31	6.08	699.90	0	11:44	5.73
35	JUNCTION	2.34	5.54	701.35	0	12:09	5.44
37	JUNCTION	0.16	6.10	704.23	0	12:09	6.10
36	JUNCTION	2.79	8.20	703.63	0	12:09	8.18
38	JUNCTION	0.57	6.13	703.80	0	12:09	6.05
39	JUNCTION	0.10	5.36	704.01	0	12:06	5.36
40	JUNCTION	2.00	2.66	702.40	0	12:13	2.66
42	JUNCTION	2.98	8.59	698.62	0	11:59	8.38
L-32	JUNCTION	0.44	4.21	696.52	0	11:59	3.97
45	JUNCTION	1.80	3.12	697.77	0	12:01	3.11
12	JUNCTION	1.85	6.10	711.64	0	12:01	6.10
44	JUNCTION	1.08	3.38	697.74	0	11:59	3.10
46	JUNCTION	0.80	3.37	694.51	0	11:59	3.22
47	JUNCTION	0.82	2.03	692.88	0	12:01	2.03
L-35	JUNCTION	0.52	2.86	693.64	0	11:59	2.75
L-37	JUNCTION	0.43	2.27	692.68	0	11:59	2.18
L-38	JUNCTION	0.44	1.81	691.69	0	11:59	1.77
L-40	JUNCTION	0.73	1.70	691.15	0	11:59	1.69
L-36	JUNCTION	1.02	2.55	691.93	0	12:03	2.55
L-39	JUNCTION	1.08	2.40	691.56	0	12:04	2.40
L-41	JUNCTION	1.86	2.49	690.19	1	23:03	2.49
9	JUNCTION	0.07	4.84	716.10	0	12:02	4.78
10	JUNCTION	1.84	6.21	717.11	0	12:02	6.17
21	OUTFALL	0.00	0.00	695.00	0	00:00	0.00
1	STORAGE	3.28	4.19	690.19	1	23:58	4.19

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Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
13	JUNCTION	0.67	7.11	0 12:01	0.014	0.173	-0.286

14	JUNCTION	0.27	7.82	0	12:05	0.00645	0.2	-0.001	
15	JUNCTION	0.86	0.86	0	12:00	0.0204	0.0204	-0.000	
16	JUNCTION	0.27	4.91	0	12:00	0.00645	0.204	-0.021	
17	JUNCTION	0.86	0.86	0	12:00	0.0204	0.0204	0.000	
18	JUNCTION	0.86	3.95	0	11:59	0.0204	0.212	0.076	
L-9.5	JUNCTION	0.00	3.95	0	11:59	0	0.212	-0.003	
L-10	JUNCTION	0.00	6.88	0	12:13	0	0.381	0.033	
22	JUNCTION	2.59	5.59	0	12:06	0.0624	0.179	-0.036	
23	JUNCTION	4.91	4.91	0	12:00	0.117	0.117	0.382	
L-14	JUNCTION	0.00	7.95	0	12:08	0	0.417	0.030	
25	JUNCTION	1.43	1.86	0	11:50	0.0344	0.0363	-0.030	
26	JUNCTION	0.86	8.66	0	12:06	0.0204	0.474	0.020	
27	JUNCTION	0.24	2.46	0	12:48	0.00538	0.0672	1.445	
33	JUNCTION	0.59	2.51	0	11:49	0.014	0.0245	2.540	
28	JUNCTION	1.16	2.59	0	11:48	0.028	0.0443	0.353	
29	JUNCTION	0.59	0.89	0	11:45	0.014	0.014	0.980	
30	JUNCTION	0.24	15.60	0	12:06	0.00538	0.642	0.019	
31	JUNCTION	6.33	6.33	0	12:00	0.152	0.152	0.010	
BT	JUNCTION	0.00	8.24	0	12:26	0	0.78	-0.015	
35	JUNCTION	0.59	8.01	0	12:06	0.014	0.316	0.070	
37	JUNCTION	7.14	7.14	0	12:00	0.172	0.172	-0.019	
36	JUNCTION	1.16	7.64	0	12:09	0.028	0.303	0.236	
38	JUNCTION	0.86	3.88	0	11:58	0.0204	0.103	0.199	
39	JUNCTION	3.47	3.47	0	12:00	0.0828	0.0828	-0.046	
40	JUNCTION	0.00	0.04	0	12:06	0	0.00025	250.352	gal
42	JUNCTION	6.01	10.97	0	11:59	0.144	0.907	0.057	
L-32	JUNCTION	0.00	18.64	0	12:01	0	1.11	0.005	
45	JUNCTION	4.60	4.60	0	12:00	0.11	0.11	0.217	
12	JUNCTION	0.77	6.81	0	12:02	0.0158	0.159	-0.021	
44	JUNCTION	3.71	8.02	0	12:01	0.0893	0.199	-0.006	
46	JUNCTION	2.01	20.60	0	12:01	0.0484	1.15	0.005	
47	JUNCTION	3.43	17.90	0	12:00	0.0828	0.722	0.009	
L-35	JUNCTION	0.00	6.06	0	12:01	0	0.515	0.040	
L-37	JUNCTION	0.00	6.06	0	12:01	0	0.515	0.034	
L-38	JUNCTION	0.00	6.06	0	12:01	0	0.515	0.033	
L-40	JUNCTION	0.00	6.09	0	12:00	0	0.515	0.082	
L-36	JUNCTION	0.00	17.82	0	12:01	0	0.722	0.011	
L-39	JUNCTION	0.00	17.62	0	12:03	0	0.722	-0.078	
L-41	JUNCTION	0.00	23.64	0	12:04	0	1.24	0.502	
9	JUNCTION	3.26	6.65	0	12:00	0.0653	0.143	0.007	
10	JUNCTION	3.79	3.79	0	12:00	0.078	0.078	0.339	
21	OUTFALL	0.00	0.00	0	00:00	0	0	0.000	gal
1	STORAGE	0.00	23.65	0	12:04	0	1.23	0.259	

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Node Surcharge Summary
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Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
13	JUNCTION	0.30	0.226	0.000
14	JUNCTION	0.29	0.000	0.000
18	JUNCTION	0.94	2.460	0.000
L-9.5	JUNCTION	1.14	3.870	0.000
L-10	JUNCTION	1.04	2.453	2.067
22	JUNCTION	0.98	2.027	0.000
23	JUNCTION	0.91	1.905	0.000
L-14	JUNCTION	1.16	3.687	0.113
25	JUNCTION	1.03	1.912	0.000
26	JUNCTION	1.16	3.294	0.206
27	JUNCTION	0.88	0.760	0.270
33	JUNCTION	43.98	4.265	0.000
28	JUNCTION	0.82	0.400	0.000
29	JUNCTION	1.12	2.760	1.840
30	JUNCTION	1.13	2.950	0.000
31	JUNCTION	1.15	4.461	0.000
BT	JUNCTION	1.23	4.585	2.415
35	JUNCTION	0.63	2.239	4.061
37	JUNCTION	0.70	5.097	0.000
36	JUNCTION	0.71	4.677	0.723
38	JUNCTION	0.68	4.630	0.000
39	JUNCTION	0.58	2.431	0.000
42	JUNCTION	1.29	4.494	1.406
L-32	JUNCTION	0.17	0.844	4.126
12	JUNCTION	0.05	0.000	0.000
44	JUNCTION	0.12	0.679	2.871
46	JUNCTION	0.24	0.816	7.454
L-35	JUNCTION	0.58	1.093	8.057
L-37	JUNCTION	0.23	0.438	9.832
L-38	JUNCTION	0.17	0.105	10.445

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Node Flooding Summary
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Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CFS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Total Flood Volume 10^6 gal	Maximum Ponded Depth Feet
13	0.30	1.12	0	11:56	0.003	0.226
14	0.29	4.04	0	12:05	0.023	0.000
16	0.33	1.83	0	12:01	0.012	0.000
18	0.01	1.44	0	11:48	0.000	0.000
L-9.5	0.27	2.39	0	12:07	0.010	0.000
22	0.58	2.24	0	12:00	0.007	0.367
23	0.66	2.75	0	12:00	0.012	0.555
25	0.81	1.86	0	11:50	0.006	0.562
33	1.02	2.51	0	11:49	0.014	0.785
28	0.67	2.43	0	12:06	0.026	0.000
30	0.72	15.60	0	12:06	0.178	0.000
31	0.46	2.58	0	12:00	0.010	0.611
37	0.54	4.70	0	12:00	0.021	0.247
38	0.01	0.08	0	12:09	0.000	0.000
39	0.19	0.50	0	12:00	0.001	0.011
12	0.05	0.34	0	12:02	0.000	0.000

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Storage Volume Summary
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Storage Unit	Average Volume 1000 ft|	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft|	Max Pcnt Full	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum Outflow CFS
1	120.092	13	0	0	164.020	17	1	23:58	0.00

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Outfall Loading Summary
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Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
21	0.00	0.00	0.00	0.000
System	0.00	0.00	0.00	0.000

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Link Flow Summary
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Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
4	CONDUIT	3.36	0	11:54	4.28	2.01	1.00
5	CONDUIT	0.86	0	12:00	1.10	0.08	1.00
6	CONDUIT	3.47	0	12:09	4.41	1.75	1.00
7	CONDUIT	0.86	0	12:00	1.09	0.10	1.00
8	CONDUIT	2.97	0	11:56	3.79	1.65	1.00
12	CONDUIT	3.95	0	11:59	5.02	1.89	1.00
13	CONDUIT	3.95	0	11:59	2.23	0.85	1.00
14	CONDUIT	3.55	0	12:08	2.50	0.75	1.00
15	CONDUIT	5.52	0	12:08	4.42	0.51	1.00
16	CONDUIT	6.88	0	12:13	3.89	2.35	1.00
17	CONDUIT	2.35	0	12:31	2.99	0.25	1.00
18	CONDUIT	7.95	0	12:08	4.50	2.00	1.00
19	CONDUIT	2.26	0	11:48	3.01	0.76	1.00
21	CONDUIT	2.32	0	12:48	2.95	0.71	1.00
20	CONDUIT	2.51	0	12:48	3.20	0.36	1.00
22	CONDUIT	7.82	0	12:07	4.43	0.74	1.00
25	CONDUIT	4.37	0	12:08	5.56	2.38	1.00
23	CONDUIT	0.76	0	11:45	1.18	0.13	1.00
26	CONDUIT	6.02	0	12:37	3.41	1.04	1.00
27	CONDUIT	5.25	0	12:26	6.68	1.64	1.00
30	CONDUIT	0.04	0	12:06	2.79	1.15	0.98

31	CONDUIT	3.35	0	12:09	4.26	0.62	1.00
32	CONDUIT	3.88	0	11:58	2.19	0.73	1.00
28	CONDUIT	7.64	0	12:09	9.72	3.12	1.00
29	CONDUIT	8.01	0	12:06	10.19	0.63	1.00
33	CONDUIT	8.24	0	12:26	4.66	1.52	1.00
34	CONDUIT	10.97	0	11:59	6.21	5.25	1.00
35	CONDUIT	4.47	0	12:02	4.00	0.64	0.96
36	CONDUIT	8.03	0	12:01	10.22	1.30	1.00
37	CONDUIT	18.64	0	12:01	10.55	2.45	1.00
38	CONDUIT	14.54	0	12:01	8.32	3.94	0.96
39	CONDUIT	17.82	0	12:01	4.08	0.25	0.38
40	CONDUIT	17.62	0	12:03	3.49	0.40	0.42
41	CONDUIT	17.63	0	12:04	4.23	0.77	0.37
44	CONDUIT	6.06	0	12:01	3.43	0.90	1.00
45	CONDUIT	6.06	0	12:01	3.43	1.75	1.00
46	CONDUIT	6.06	0	12:01	3.43	1.28	1.00
47	CONDUIT	6.09	0	12:00	3.54	1.60	0.94
48	CONDUIT	6.06	0	12:01	3.92	0.78	0.82
42	CONDUIT	23.65	0	12:04	5.53	0.36	0.66
43	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
1	CONDUIT	3.41	0	12:00	5.26	0.89	1.00
2	CONDUIT	6.14	0	12:02	7.82	1.07	1.00
3	CONDUIT	6.17	0	12:01	7.86	0.85	1.00
10-OF	WEIR	0.00	0	00:00			0.00
9-OF	WEIR	0.00	0	00:00			0.00
12-OF	WEIR	0.32	0	12:01			1.00
13-OF	WEIR	4.95	0	12:05			1.00
14-OF	WEIR	0.32	0	11:55			1.00
16-OF	WEIR	0.32	0	11:55			1.00
17-OF	WEIR	0.00	0	00:00			0.00
15-OF	WEIR	0.00	0	00:00			0.00

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Flow Classification Summary
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	Adjusted	Fraction of Time in Flow Class								
Conduit	/Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
4	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.49	0.00

5	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.98	0.00
6	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.96	0.00
7	1.00	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.97	0.00
8	1.00	0.00	0.00	0.00	0.02	0.00	0.00	0.97	0.00	0.00
12	1.00	0.02	0.00	0.00	0.46	0.00	0.00	0.52	0.29	0.00
13	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.49	0.00
14	1.00	0.02	0.00	0.00	0.02	0.00	0.00	0.95	0.00	0.00
15	1.00	0.01	0.00	0.00	0.02	0.00	0.00	0.96	0.00	0.00
16	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
17	1.00	0.00	0.00	0.00	0.98	0.00	0.00	0.02	0.96	0.00
18	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.01	0.00	0.00
19	1.00	0.03	0.00	0.00	0.02	0.00	0.00	0.95	0.00	0.00
21	1.00	0.04	0.01	0.00	0.95	0.00	0.00	0.00	0.01	0.00
20	1.00	0.03	0.06	0.00	0.31	0.11	0.00	0.49	0.38	0.00
22	1.00	0.02	0.00	0.00	0.50	0.00	0.48	0.00	0.00	0.00
25	1.00	0.01	0.00	0.00	0.14	0.00	0.00	0.86	0.05	0.00
23	1.00	0.03	0.01	0.00	0.38	0.07	0.00	0.51	0.43	0.00
26	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.95	0.00
27	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.01	0.88	0.00
30	1.00	0.99	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
31	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.98	0.00
32	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.01	0.00	0.00
28	1.00	0.02	0.00	0.00	0.91	0.00	0.07	0.00	0.00	0.00
29	1.00	0.02	0.01	0.00	0.97	0.00	0.00	0.00	0.96	0.00
33	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.95	0.00
34	1.00	0.02	0.01	0.00	0.07	0.00	0.00	0.91	0.00	0.00
35	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
36	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
37	1.00	0.02	0.00	0.00	0.01	0.00	0.00	0.98	0.00	0.00
38	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
39	1.00	0.01	0.00	0.00	0.71	0.00	0.00	0.28	0.54	0.00
40	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.01	0.94	0.00
41	1.00	0.02	0.00	0.00	0.55	0.00	0.43	0.00	0.00	0.00
44	1.00	0.02	0.42	0.00	0.57	0.00	0.00	0.00	0.96	0.00
45	1.00	0.03	0.00	0.00	0.10	0.00	0.00	0.87	0.00	0.00
46	1.00	0.03	0.11	0.00	0.85	0.00	0.00	0.00	0.86	0.00
47	1.00	0.03	0.00	0.00	0.96	0.00	0.00	0.00	0.07	0.00
48	1.00	0.03	0.00	0.00	0.57	0.00	0.39	0.00	0.00	0.00
42	1.00	0.02	0.00	0.00	0.75	0.00	0.00	0.22	0.00	0.00
43	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
2	1.00	0.00	0.00	0.00	0.41	0.07	0.00	0.51	0.47	0.00
3	1.00	0.01	0.00	0.00	0.02	0.00	0.00	0.96	0.02	0.00

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Conduit Surcharge Summary
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Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
4	1.02	1.02	1.05	0.44	0.39
5	0.72	0.72	1.05	0.01	0.01
6	1.05	1.05	1.10	0.54	0.53
7	0.90	0.90	1.10	0.01	0.01
8	1.10	1.10	1.11	0.73	0.70
12	1.18	1.18	1.21	0.67	0.68
13	1.14	1.14	1.16	0.01	0.01
14	0.91	0.91	0.98	0.01	0.01
15	1.03	1.03	1.04	0.01	0.01
16	1.16	1.16	1.16	0.81	0.81
17	1.03	1.03	1.35	0.01	0.01
18	1.19	1.19	1.21	0.77	0.76
19	0.82	0.82	0.88	0.01	0.01
21	43.98	43.98	45.17	0.01	0.01
20	1.14	1.14	1.18	0.01	0.01
22	1.13	1.13	1.16	0.01	0.01
25	1.15	1.15	1.18	0.56	0.57
23	1.12	1.12	1.18	0.01	0.01
26	1.14	1.14	1.23	0.20	0.19
27	0.70	0.70	3.65	0.37	0.37
30	0.01	0.01	36.10	0.21	0.01
31	0.64	0.64	1.02	0.01	0.01
32	0.67	0.67	0.71	0.01	0.01
28	0.64	0.64	0.97	0.71	0.01
29	0.63	0.63	1.37	0.01	0.01
33	1.23	1.23	1.61	1.00	1.00
34	0.67	1.29	0.67	3.13	0.67
35	0.01	0.01	0.12	0.01	0.01
36	0.18	0.18	0.20	0.20	0.18
37	0.24	0.71	0.24	1.10	0.24
38	0.01	0.44	0.01	1.12	0.01
44	0.39	0.39	1.11	0.01	0.01

45	0.23	0.58	0.23	1.19	0.23
46	0.17	0.30	0.17	0.71	0.17
47	0.01	0.21	0.01	1.13	0.01
48	0.01	0.01	0.80	0.01	0.01
1	0.18	0.18	0.20	0.01	0.01
2	0.20	0.20	0.26	0.09	0.09
3	0.26	0.26	0.91	0.01	0.01

Analysis begun on: Wed Sep 28 16:19:01 2022
Analysis ended on: Wed Sep 28 16:19:12 2022
Total elapsed time: 00:00:11