DRAFT REMEDIAL ACTION WORK PLAN

PHASE I SOIL CAPPING: PARK PARCEL
FORMER GORHAM MANUFACTURING FACILITY
333 ADELAIDE AVENUE
PROVIDENCE, RHODE ISLAND

JULY 2007

MACTEC

engineering and constructing a better tomorrow

July 5, 2007

Mr. Joe Martella
Rhode Island Department of Environmental Management
Office of Waste Management
235 Promenade Street
Providence, RI 02908-5025

Subject: **"Draft for Discussion" Remedial Action Plan**
Phase I Soil Capping: Parcel D
Former Gorham Manufacturing Property
333 Adelaide Avenue
Providence, Rhode Island
MACTEC Project No. 3650050041.10

Dear Mr. Martella:

Enclosed please find the Draft Remedial Action Plan (RAP) for the Phase I Soil Capping: Parcel D. The Draft RAP contains the drawings and specifications completed to date in appendices A and B, respectively.

MACTEC is continuing to work on preparing the next version of the RAP and appendices as your review this draft. We appreciate very much your reviewing this document at this time.

Please feel free to contact me at (781) 213-5655 for any comments or questions on this Draft RAP.

Sincerely,
MACTEC Engineering and Consulting, Inc.

David E. Heislein
Project Manager

Michael Murphy
Principal Scientist

cc: G. Simpson, Textron Inc.
MACTEC Project File [P:\TEXTRON\GORHAM\PublicRelations\RIDEM Ltr_CIS Mailing List.doc]

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

1,1,1-TCA	1,1,1-trichloroethane
ABB-ES	ABB Environmental Services
ELUR	Environmental Land Use Restriction
GZA	Goldberg Zoino & Associates
HLA	Harding Lawson Associates
LOW	limit of work
MACTEC	MACTEC Engineering and Consulting, Inc.
PCE	tetrachloroethene
RAWP	Remedial Action Work Plan
RDEC	Residential Direct Exposure Criteria
RIDEM	State of Rhode Island Department of Environmental Management
SI	site inspection
SSIR	supplemental site investigation report
SVOCs	semi-volatile organic compounds
TCE	trichloroethene
Textron	Textron, Inc.
the Site	Park Parcel
TPH	total petroleum hydrocarbons
VOCs	volatile organic compounds

1.0 INTRODUCTION

The Former Gorham Manufacturing Facility is located at 333 Adelaide Avenue, Providence, Rhode Island. The focus of this Remedial Action Work Plan (RAWP) is Phase I of the Park Parcel (the Site). Supplemental site investigation activities were conducted between December 2005 and July 2006 to support completion of a human health and ecological risk assessment for the Site, including Mashapaug Cove. Based on the results of 2006 and historical sampling events, soils exhibiting contaminant concentrations exceeding State of Rhode Island Department of Environmental Management (RIDEM) Residential Direct Exposure Criteria (RDEC) require capping as detailed in this RAWP. This RAWP has been prepared pursuant to Section 9.0 (RAWPs) of the RIDEM *Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases* (hereafter referred to as the Remediation Regulations) on behalf of Textron, Inc. (Textron) by MACTEC Engineering and Consulting, Inc. (MACTEC).

A phased approach to capping the Park Parcel was developed such that the area in the immediate vicinity of the new high school and proposed YMCA would be addressed first in 2007, followed by remaining areas of the Site, including Mashapaug Cove in 2008. This RAWP details the work to be performed for the Phase I Cap Construction. Phase II Mashapaug Cove Capping and Phase III Soil Capping will be detailed under separate RAWPs that are anticipated to be developed in spring 2008.

1.1 PROPERTY AND SITE HISTORY

The Former Gorham Manufacturing Facility is a 37-acre parcel of land where Gorham Silver engaged in the manufacture of silverware, both sterling and plated, and bronze castings from approximately 1890 to 1985. Operations included casting, rolling, polishing, lacquering, forging, plating, annealing, soldering, degreasing, machining, and melting. Vapor degreasers reportedly used trichloroethene (TCE), tetrachloroethene (PCE), and 1,1,1-trichloroethane (1,1,1-TCA). More recent conditions are shown in the aerial photograph in Figure 1. In this figure, the Site is located immediately north of Adelaide Avenue and west of the railroad tracks. The former manufacturing facility has been razed, partly remediated, and is in the process of redevelopment. A retail development has been completed on the southeastern portion (Parcel A). A public high school has been constructed on a second parcel (Parcel B).

1.2 PHYSICAL SETTING

The 333 Adelaide Avenue property is bordered to the east by railroad tracks (Figure 1). Adelaide Avenue and a residential neighborhood bound the 333 Adelaide Avenue property to the south. To the north and west, the Site is bounded by Mashapaug Pond. The Park Parcel constitutes the northern portions of the 333 Adelaide Avenue property. On the opposite (northern) shore of Mashapaug Pond is an industrially-zoned area.

The Site uplands can be divided into three areas moving from west to east for the purposes of physical description. Phase I capping will be conducted within the first (western) and second (central) areas. Phase III capping will address contamination in the third (eastern) area of the Site.

The first of these areas is the portion of the parcel extending from the southwestern property boundary to the tip of the western peninsula that bends into Mashapaug Pond. This area is heavily wooded with moderate to steep slopes that descend to the Pond. There is no historic information or current visual evidence that would suggest that this portion of the parcel was subject to industrial uses. There are structures present which we have surmised were used for water extraction.

The second (central) area is the portion that borders the southern shore of Mashapaug Cove. This area includes a steep wooded embankment that leads down to wooded lowland that is adjacent to the cove. A slag pile previously located in the central portion of this area was removed from the property by Textron in July 2006. Post-excavation confirmatory soil sampling has been conducted, and the samples have been submitted for laboratory analysis. MACTEC submitted a September 2006 *Slag Removal Action Summary Report* to the Consent Order parties summarizing analytical results and the excavation activities.

The embankments along the southern end of Mashapaug Cove are underlain by heterogeneous fill, consisting of granular reworked soils with varying amounts of casting sands and construction, demolition, and miscellaneous debris such as fire brick, old wood beams, and metal debris. The fill varies in thickness from one-foot at the northern edge of the former West Parking area (former facility area) to approximately 20-feet along the embankment to the south of the southern shore of

Mashapaug Cove. Several historic groundwater wells used for industrial purposes still exist (but are not in use) near the southwestern shore of the cove.

The third portion of the parcel lies to the northeast. It borders the cove and pond and includes the eastern shore of Mashapaug Cove, a steep hill to the east, and a flat upland area that formerly housed an employee recreational building (known as the 'Casino') and associated parking lots. In addition, in the northeast corner of the Site is a plot of land that is in active use by the Amtrak High Speed railroad. Also in the upland area in the northeast corner is a vacant building that was identified historically as a garage or carriage house. There is an approximately 30-foot difference in elevation between the former manufacturing facility upland parcel and the shoreline of Mashapaug Cove.

A large portion of the Site is currently wooded and heavily vegetated. The Western Peninsula has variable elevation and is a wooded environment. The peninsula is accessible via one or more paths. The tip of the peninsula is relatively open compared to the wooded areas adjacent to it. The Cove shore area is a small, relatively flat area at the bottom of the embankment and is vegetated with brush and saplings. There is a very steep embankment between the developed portion of the property to the south of the Parcel D and the shore of Mashapaug Cove. The Eastern Peninsula has trees and vegetation, but is generally more open and accessible than the areas immediately to the south of Mashapaug Cove. The uplands portion of the Site is currently enclosed by a chain-link fence.

1.3 REGULATORY BACKGROUND AND PREVIOUS INVESTIGATIONS

Environmental investigations have been carried out at the 333 Adelaide Avenue property and Mashapaug Pond since 1985. The Site was not the focus of most of those investigations. Mashapaug Pond water and sediment samples were first collected from several locations by the University of Rhode Island in 1986. A consultant (Goldberg Zoino & Associates (GZA)) also collected a surface water sample from Mashapaug Cove in 1986.

RIDEM completed a United States Environmental Protection Agency Potential Hazardous Waste Site Identification Form in 1987 in response to a complaint by the Providence Police Department. This occurred after the facility ceased operations in 1986. RIDEM completed a Preliminary Assessment of the 333 Adelaide Avenue property in 1989 which designated the property as a

Medium Priority for a Site Inspection (SI). A SI Report was prepared by Camp Dresser & McKee in 1993 under contract to RIDEM. The SI recommended further investigation of the property. ABB Environmental Services (ABB-ES) and, subsequently, Harding Lawson Associates (HLA), both now known as MACTEC, completed several environmental investigations on behalf of Textron since 1993.

In 1995, a Remedial Investigation Report (ABB-ES, 1995a) and a Supplemental Remedial Investigation Report (ABB-ES, 1995b) were prepared to assess site conditions, including portions of the Site. The results of the earlier investigations (circa 1986 to 1995) were summarized in the Remedial Investigation Report.

A Supplemental Investigation Report (HLA, 1998) was prepared in 1998 for the Site. In 1999 a Site Investigation Summary Report and Risk Assessment (HLA, 1999) was prepared and submitted to RIDEM that addressed the entire 333 Adelaide Avenue property, including the Site. This report was formally approved by RIDEM in a June 15, 2001 RIDEM Remedial Decision Letter. In April 2001, Harding ESE (now MACTEC), prepared and submitted to RIDEM on Textron's behalf the *Remedial Action Work Plan, Former Gorham Manufacturing Facility, Providence, Rhode Island.*

In November 2002 MACTEC submitted a Method 3 Risk Assessment Work Plan (MACTEC, 2002) to RIDEM to assess the proposed redevelopment of the undeveloped portion of the 333 Adelaide Avenue property as a park with walking trails. Following review comments from RIDEM in September 2003, MACTEC submitted the *Method 3 Human Health Risk Assessment – Park Parcel* (MACTEC, 2004) to RIDEM in August 2004.

Current soil conditions at selected locations within the Site, material from the slag pile, and sediment conditions at selected locations in Mashapaug Cove were investigated in December 2005 on RIDEM's behalf and are documented in a Site Investigation Report submitted by Fuss & O'Neill, Inc. to RIDEM in April 2006. Surface soil sampling was also conducted by MACTEC in 1994, 1998, 2001 and 2002, including both surface soils and surface sediment found in erosion channels along the bank that leads into the Cove. The 1998 surface soil analytical results for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), and metals are presented in the *Supplemental Site Investigation Report, Proposed Park Subdivision, Former Gorham Manufacturing Facility, 333 Adelaide Avenue,*

Providence, Rhode Island (HLA, 1998). Additional surface soil sampling was conducted along the bank of the Cove in 2001 and 2002 by MACTEC. This soil sampling program is summarized and results are presented in the *Method 3 Human Health Risk Assessment – Park Parcel* (MACTEC, 2004).

The previous environmental investigations have demonstrated that soil at the 333 Adelaide Avenue Property, particularly the former manufacturing facility parcel, has been impacted by historical industrial operations. Constituents of potential concern in soils at the Site include VOCs (principally the chlorinated hydrocarbons TCE, PCE, and 1,1,1-TCA and their degradation products 1,2-dichloroethene and vinyl chloride), SVOCs (principally PAHs), metals (primarily arsenic, copper, and lead), and TPH. The south bank of the Cove is an area of exposed fill material. Variable concentrations of VOCs, PAHs, metals and TPH were reported to be associated with these fill materials.

The available information indicates that limited manufacturing activities (other than withdrawal of groundwater for use in manufacturing operations and the operation of Building V) were conducted within the Site. A portion of Building V, the former smelting building, is within the Park Parcel and the former slag pile is associated with that building. The data suggest that impacted fill from the former manufacturing facility parcel impinges upon the southerly portion of the Site. That fill material generally contains metals and PAHs.

Constituents detected in sediments and surface soils adjacent to the Cove include TPH, SVOCs, VOCs, metals, and dioxins. The 2005 RIDEM sediment samples identified various chlorinated VOCs in cove sediments. Sediment samples from drainage swales and erosion channels that serve as a pathway for the discharge into Mashapaug Cove showed sporadic detections of SVOCs, TPH, and some metals. Surface soil samples from low lying areas adjacent to the Cove also showed some detections of metals.

Based on discussions with RIDEM and comments received on earlier reports and Work Plans, MACTEC prepared a Supplemental SI Work Plan in June 2006. On July 31, 2006 MACTEC submitted a *Supplemental Site Investigation Report* (SSIR) to RIDEM. Section 6.0 of the 2006 SSIR proposed three remedial alternatives to address soil contamination. On June 28, 2007 MACTEC submitted an addendum to the SSIR to RIDEM. The SSIR Addendum detailed compliance sampling performed in February 2007 and the analytical results. These results and

other soil sampling outside the proposed Phase I cap supported the regulatory compliance of the remedial alternative (see Section 4.0). This RAWP details the approach for Phase I soil capping following applicable RIDEM regulations.

1.4 PHASED APPROACH

A phased remediation approach has been developed for Park Parcel such that necessary remedial activities are conducted in a timely manner on the portion of the Site that is closest to the High School and the proposed YMCA. Phase I addresses the western half of the Site, Phase II addresses Mashapaug Cove, and Phase III addresses the remaining eastern half of the Site. Refer to Figure 2 for the phases of remedial action at the Site. By completing Phase I in 2007, the potential contact of students with construction machinery and impacted soils is minimized. Work on the soil cap will proceed from west to east going away from the school. This will limit work near the students by the planned school opening of September 1, 2007. At this time, it is anticipated that in order to complete Phase I capping activities in the vicinity of the school parcel prior to September 1, 2007, all RIDEM approvals must occur by July 23, 2007.

The phased-approach will also allow for the simultaneous additional investigation of the groundwater at the Gorham Site and the Mashapaug Cove sediments, which are required to support future remedial activities. Textron is planning to prepare a work plan for RIDEM review later this summer and conduct the work later this year. This data will be used to complete the SSIR for the remainder of the Site and to develop the remedial alternatives and prepare the selected remedial alternative design for Phases II and III. Completion of the Phase II cove sediment and wetland remediation work is planned for June 2008 after the students are out of school for the summer. The Phase III soil cap will also be performed immediately following Phase II; this area will be used to stage material and equipment necessary to complete Phase II activities. The chain-link fence following the upland (southern) portion of the Site will be maintained through the completion of Phase III when all soils exceeding RIDEM RDEC have been addressed. Both Phase II and Phase III will be described in detail to RIDEM under a separate RAWP. The purpose of this RAWP is to address Phase I only.

2.0 LIMITED DESIGN INVESTIGATION

This task is reserved in the event that the RIDEM requests that a limited design investigation be performed. At this time, the approach for this RAWP includes Engineered Controls and Institutional Controls, in conjunction with limited soil excavation. MACTEC has not received a request from RIDEM for a limited design investigation to expand on the remedial approaches for soil.

3.0 REMEDIAL OBJECTIVE AND REMEDY

3.1 SUPPLEMENTAL SOIL EXCAVATION

Based on RIDEM comments on the Slag Removal Summary Report dated September 2006, Textron has committed to provide additional excavation, test pitting, and sampling within the location of the former slag pile. The detailed scope of work was submitted to RIDEM on January 16, 2007 and MACTEC received comments from RIDEM on February 2, 2007. A final response to comments was submitted to RIDEM by Textron on February 26, 2007 concurring with the additional soil sampling requested. This work at the former slag pile has been incorporated into the Phase I cap.

An existing pile of stone will be removed from the former slag area and staged at the laydown area (Phase III area). Approximately 75 cubic yards of soil will be excavated from two locations (Figure 3) and transported to a disposal facility by Clean Harbors. Approximately 10 test pits will be excavated by the contractor at locations where the lead concentrations exceed the Industrial/Commercial Direct Exposure Criteria to further define the extent of lead contaminated soil; MACTEC will collect confirmatory soil samples from these test pits and the excavated area for total lead and Synthetic Precipitation Leaching Procedure analytical testing. A geotextile liner is proposed for the cap of this former slag pile area to be protective for the recreational use of the Park Parcel. The test pitting activities performed as part of supplemental soil excavation may determine that the proposed liner in this area needs to be extended over a larger area. The cap in this former slag area is described below in Section 3.3.

3.2 REMEDIAL OBJECTIVE FOR SOIL

The July 31, 2006, SSIR presented contaminant concentrations in surface soils, sediment, and surface water. As part of the phased-approach, Phase I of the remedial action will focus solely on surface soil in the western half of the Park Parcel. Phase II will focus on the Mashapaug Cove sediment and surface water and Phase III will complete the soil capping on the Park Parcel.

The remedial objectives for the Phase I and III work consist of the following:

- contain/consolidate identified areas of solid waste
- prevent direct-contact human exposure to contaminated soil and waste exceeding RIDEM RDEC
- minimize leaching of metals from vadose zone soil to groundwater at the location of the former slag pile. Historical samples that exceed RDEC have been included in the area to be capped. The soil cap work will include confirmatory sampling and possible extension of the cap area if confirmatory sampling exhibit contaminant concentrations exceeding RDEC.

3.3 PROPOSED REMEDY

The Phase I remedial action will consist of installation of a soil cap(s) at the approximate locations shown on Figure 2. Cap construction will be modified to result in a low-permeability cap at the former location of the slag pile. The soil cap will contain solid wastes, prevent direct contact exposure, and restrict the potential migration of contaminants through the action of wind erosion and surface run-off into Mashapaug Pond. The low-permeability section of the cap above the former slag area will restrict water infiltration and reduce potential leaching of metals from vadose zone soil to groundwater.

The Phase I soil cap contains three distinct components. These components are color-coded on Figure 2 and include a waste fill cap, a wetland buffer cap, and a former slag area cap. All components of these caps will be tested and meet RIDEM RDEC. Refer to Figure 4 and Drawing C-503 for cross sections of the cap across Phase I that show the anticipated construction including grading of slopes that exceed a one-to-three slope. Figure 4 depicts the approximate location of the cross sections and Drawing C-503 depicts typical cross sections of the Phase I cap.

During the construction of the Phase I soil cap, soil thickness will be measured following final grading as a quality control (contractor) and quality assurance (Textron/RIDEM) measure to ensure the proper soil cap has been constructed. Storm water management will be included with the construction of the cap to maintain its integrity and recharge storm water runoff into the buffer zone, wetlands, and Cove.

Waste Fill Cap

The waste fill area consists of casting sands, concrete, rubble, and other debris. Waste fill was historically characterized through soil borings and test pits. The waste fill areas will be capped

with two feet of clean fill (18" cover soil and 6" topsoil). The finished surface for the upland waste fill area will be seeded or stabilized with erosion control matting. The top of upland waste fill cap will meet slope at the existing High School and Parcel C.

A small area at the west/southwest corner of the Park Parcel (Figure 2) will either be capped with 2 feet of soil or the soil in these small areas that exceed RIDEM RDEC will be relocated under the main part of the Phase I soil cap. Due to scheduling constraints the western shore capping may be completed after the Phase I cap closest to the school. This would be done to aid in completing activities closest to the High School by the September 1, 2007 opening.

Wetland Buffer Cap

The wetland buffer area consists of the area within 50' of the delineated wetland boundary (approximate cove shoreline). As the Site cap abuts the shore of Mashapaug Cove, special considerations for wetlands have been included as part of Phase I. The wetland delineation was completed in May 2007 and the location of the wetland boundary and high water mark was surveyed. Refer to Appendix A for drawings depicting the location of these site features (note that "delineated" wetlands are typically located 5' to 10' upland from the shoreline). The limit of work (LOW) for Phase I will be conducted outside of this wetland boundary such that all of the remediation work within the freshwater wetlands will be conducted as part of Phase II in June 2008 along with the Cove sediment remediation. This will allow for water access to the wetland area for the capping and construction of a natural transition zone from the wetlands into the Cove.

The contractor will attempt to save as many large trees within the buffer zone as possible as these provide habitat for the Mashapaug Cove wildlife. Clearing and grubbing of the wetland buffer zone scrub material will be conducted to support the installation of the soil cap. One foot of soil at the toe of the LOW will be removed to allow the soil cap to key into the existing grade above the wetland boundary. Twelve inches of clean soil will then be spread throughout the buffer zone to provide the soil cap.

The finished surface for the wetland buffer cap will be stabilized with erosion control matting, and wetland vegetation will be planted. This cap will restrict the contact with the subsurface soils. Please refer to Appendix B for specifications detailing the existing wetland condition and the planned restoration strategy in.

Former Slag Area Cap

In response to RIDEM questions regarding the potential leaching from the soil in contact with the former slag pile, the cap design for the former slag area contains a geotextile membrane to limit infiltration and restrict contact with the underlying soils. Following the grading of the existing soil, the former slag area will be capped with 6" sand, 40-mil geomembrane, drainage composite layer, 12" clean cover soil, and 6" clean fill topsoil. The finished surface for the slag area will be seeded or stabilized with erosion control matting. The haul road access to the former slag area will be improved during construction and removed after construction is complete.

Wetland Restoration within the Phase I Cap

The Site is located along the shoreline of Mashapaug Cove within Mashapaug Pond within the Pawtuxet River watershed. Existing vegetative communities include forested and scrub-shrub wetlands, mixed oak woodland and mid-successional woodland cover types.

Wetlands at the Site occur as fringe features forming a narrow band along the cove shore. Tree species within the wetland areas include, red maple (*Acer rubrum*), silver maple (*A. saccharinum*), and black willow (*Salix nigra*). The shrub layer consists of sweet pepperbush (*Clethra alnifolia*), red osier dogwood (*Cornus stolonifera*), and buttonbush (*Cephalanthus occidentalis*). Sensitive fern (*Onoclea sensibilis*), blue flag iris (*Iris versicolor*), and poison ivy (*Toxicodendron radicans*) occur in the herbaceous understory.

The mixed oak woodland community occurs in the upland areas on the western shore of the cove (west of the slag removal area). Tree species within this area include red oak (*Quercus rubra*), black oak (*Q. velutina*), and to a lesser extent white oak (*Q. alba*). Sweet birch (*Betula lenta*) and black cherry (*Prunus serotina*) are also present within this cover type. The understory includes a mix of low growing shrubs such as low bush blueberry (*Vaccinum angustifolium*), mountain laurel (*Kalmia latifolia*), and huckleberry (*Gaylussacia baccata*). There are few non native invasive species present within this habitat type. In addition, several signs of wildlife usage were observed including a fox den and a painted turtle shell.

The mid-successional community occurs in the perimeter wetland and upland areas along the eastern shore of the cove (east of the slag removal area). Tree species within this area include red maple, red oak, black oak, tree-of-heaven (*Ailanthus altissima*), and gray birch (*Betula populifolia*). The understory within this area is dominated by non native invasive plant species

including, Asiatic bittersweet (*Celastrus orbiculatus*), Morrow's honeysuckle (*Lonicera morrowii*), Japanese honeysuckle (*L. japonica*), and Japanese knotweed (*Fallopia japonica*). The dominance of invasive species in this habitat is likely a result of previous disturbances which allowed these opportunistic species to colonize.

Invasive Species Management

As noted earlier, portions of the Site are typical of disturbed sites in that they harbor numerous invasive plant species. Invasive plants of note at this site include; Japanese knotweed, Morrow's and Japanese honeysuckle, and Asiatic bittersweet. If these populations are not addressed they will undoubtedly compromise the integrity of the restoration project. The aggressive nature and superior competitive ability of these plants in disturbed habitats (i.e., newly planted areas), will negatively affect botanical diversity and survivorship of restorative plantings.

Therefore, potential treatment options include chemical and mechanical approaches. Mechanical removal (i.e., cutting) of above ground plant parts can aid in the management of certain invasive species. Mechanical treatment alone will not control the revegetation of the invasive species. Foliar, or cut stem, application of herbicidal chemicals (i.e., glyphosate (Rodeo)) will transport the herbicide to belowground parts detrimentally affecting the vigor of the belowground root/rhizome system and effect plant death or vigor. These options will be coordinated with the construction schedule as part of the site clearing and restoration activities.

Revegetation

Following Phase I remedial construction, the Site will be revegetated to stabilize soils and enhance species diversity and structural complexity. These activities will be conducted using best management practices and every effort to minimize impacts to the surrounding landscape will be taken.

The restoration planting plan consists of two distinct vegetation zones. The species composition of each zone reflects morphological and physiological adaptations of the species occupying them to their specific habitats. Since remediation activities will strive to preserve mature trees and other desirable native vegetation when possible, an enhancement planting approach has been developed. This approach stresses under-story, and shade tolerant plantings as the primary components of the revegetation activities. Species composition within the mixed oak woodland are proposed to be used as a reference condition to guide restoration and revegetation of upland

portions of the Site. In addition, only woody species have been selected for these plantings in order to enable the anticipated installation between 1 September and 15 November.

The diversity of species outlined in the following zone descriptions is reflective of the inherent uncertainties of restorative planting success. For this reason many of the species are redundant throughout the various zones, these redundancies are also found in nature as certain plant species are tolerant of a wide range of hydrologic and soil saturation scenarios. Due to the uncertainty of post-remediation site hydrology in the restoration area specific elevation boundaries for these zones are not described.

Forested Wetland

This zone will occur in areas along the Cove shoreline that will be subject to wetland hydrology after remediation activities. Revegetation will focus on recreation of extant on-site habitats of good quality (i.e., few invasive). Revegetation for these areas will include species selected from Table A. Selections will be based largely on availability and will only use plant species native to Rhode Island.

TABLE A – FORESTED WETLAND SPECIES

Common Name	Botanical Name	Wetland Indicator Status
Red Maple	*Acer rubrum*	FAC
Silver Maple	*Acer saccharinum*	FACW
Black Willow	*Salix nigra*	FACW+
Red-osier Dogwood	*Cornus sericea*	FACW+
Northern Arrowwood	*Viburnum dentatum*	FACW-
Sweet pepper bush	*Clethra alnifolia*	FAC+
Highbush blueberry	*Vaccinum corymbosum*	FACW
Buttonbush	*Cephalanthus occidentalis*	OBL
Sensitive fern	*Onoclea sensibilis*	FACW
Blue flag iris	*Iris versicolor*	OBL

Mixed Oak Woodland

This zone will occur in areas upland of the cove shoreline that will not be subject to wetland hydrology after remediation activities. Revegetation will focus on recreation of extant on-site habitats of good quality (i.e., few invasive). Revegetation for these areas will include species

selected from Table B. Selections will be based largely on availability and will only use plant species native to Rhode Island.

TABLE B – MIXED OAK WOODLAND SPECIES

Common Name	Botanical Name	Wetland Indicator Status
Red Maple	*Acer rubrum*	FAC
Sweet Birch	*Betula lenta*	FACU
White Pine	*Pinus strobus*	FACU
White Oak	*Quercus alba*	FACU
Northern Red Oak	*Quercus rubra*	FACU-
Black Oak	*Quercus velutina*	UPL
Black Cherry	*Prunus serotina*	FACU
Gray Birch	*Betula populifolia*	FAC
Mountain Laurel	*Kalmia latifolia*	FACU
Lowbush Blueberry	*Vaccinum angustifolium*	FACU-
Black Huckleberry	*Gaylussacia baccata*	FACU

3.4 INSTALLATION OF MONITORING WELLS

As groundwater infiltration and flow from the Site to Mashapaug Pond play a critical role in the Site conceptual model, MACTEC will restore monitoring well GZA-5 and maintain existing monitoring wells within the Phase I Cap. These monitoring wells will provide information about groundwater flow and aid in developing remedial alternatives. Monitoring well GZA-5 was destroyed during the slag excavation activities in the summer of 2006 and will be re-installed. Existing monitoring wells within the cap (e.g., GZA-3) will be secured and maintained during the construction of the soil cap. Additional monitoring wells will be installed adjacent to, but outside the Phase I cap as part of the proposed groundwater investigations.

4.0 POINTS OF COMPLIANCE & COMPLIANCE DETERMINATION

4.1 POINTS OF COMPLIANCE

In accordance with Section 9.06 and 9.18 of the Remediation Regulations, MACTEC has performed confirmatory sampling outside of the cap to determine that remedial objectives have been met. The points of compliance are sample locations outside of the Phase I cap that are detailed in Section 4.2 below.

4.2 COMPLIANCE DETERMINATION

Textron has proposed a "Recreational Use" Cap that will bring the Site into compliance, per the Remediation Regulations, with soil RDEC. The compliance demonstration is accomplished by using Method 1 and Method 2 (dioxin TEQ and several other analytes) soil objectives approach. In the absence of any recreational land use criteria, the RDEC are health protective criteria for recreational land use. The exposure assumptions used to calculate the RDEC clearly overestimate likely recreational exposures and compliance with these criteria will create a health protective environment for use of the Park Parcel for recreational purposes.

Within the MACTEC SSIR Addendum letter to RIDEM dated June 28, 2007, a discussion of the RDEC compliance of the Phase I cap was discussed in detail. Please refer to the SSIR Addendum for a detailed description and tables and figures denoting the RDEC compliance of the proposed remedy. A summary of this discussion is presented below.

The analytical data for soils outside the footprint of the proposed "Recreational Use" Cap have been compiled, summarized, and compared to RDECs and UCLs. Using the criteria contained in Section 8.10 of the Remediation Regulations, the soils in areas outside the proposed "Recreational Use" Cap have arithmetic mean chemical concentrations that are below the RDECs. No single concentration is greater than 5 times the corresponding RDECs, not more than 10% of the samples have concentrations greater than the RDECs, and no concentrations of chemicals in soil are greater than the soil UCLs. Therefore, the soils outside the proposed "Recreational Use" Cap are in compliance with the RDECs. In the absence of any recreational land use criteria, the RDECs are health protective criteria for recreational land use. The exposure assumptions used to calculate the RDECs clearly overestimate likely recreational exposures.

Therefore, the soils outside the proposed "Recreational Use" Cap represent a health protective condition for recreational land use.

In addition, the cap will be constructed with material that also meets RDECs, so overall, the soils both inside and outside the footprint of the "Recreational Use" Cap will be in compliance with the health protective RDECs. Therefore, upon construction of the "Recreational Use" Cap, Park Parcel soils will represent a health protective condition for recreational use by the community.

Procedures for determining compliance with cap construction requirements and specification (e.g., materials, thicknesses, and construction methods) will be detailed in the construction drawings and specifications.

5.0 PROPOSED SCHEDULE FOR REMEDIATION

The following schedule is proposed to minimize conflicts with the proposed redevelopment plans. This schedule is contingent upon the timing of approvals and subcontractor availability.

Description	**Completion Date**
Draft Work Plan to RIDEM	June 29, 2007
Issue Final RAWP	Within two weeks upon receipt of Comments
Distribute Public Notice Materials or RIDEM comment	Within four weeks of Final RAWP
Mobilization	July 23, 2007
Complete Construction	October 30, 2007

Schedules will be provided to the RIDEM as bids are accepted for Site preparation and construction. Follow-up verification and monitoring will also be conducted in a phased approach. Schedules will be provided for the installation of monitoring wells

6.0 CONTRACTORS AND/OR CONSULTANTS

As part of this RAWP, MACTEC will subcontract the surveying, wetland, and construction services. The following names, addresses, and telephone numbers of contractors used to implement the proposed remedy are as follows:

CABCO Consult (Land Surveyor)
P.O. Box 14
Clinton, MA 01510
Telephone: 978-368-1591
Contact: Chuck Budnick

EA Engineering, Science and Technology
15 Loveton Circle
Sparks, MD 21152
Telephone: 401-736-3440
Contact: Jon Petrillo

The construction and earthworks contractor has yet to be determined. Three potential bidders are reviewing the specifications of the project and once the work has been awarded by Textron to the contractor, MACTEC will notify RIDEM.

7.0 DESIGN STANDARDS AND TECHNICAL SPECIFICATIONS

Technical specifications (Division 2) are included as Appendix B to this RAWP. The specifications outline the required standards, products, and execution to implement the remedial action. The drawings provide supplemental design information including quantities of materials, limits of work, and construction components and dimensions.

In some cases, the construction is defined by performance based requirements as noted in the specifications and drawings. In other cases, products are specified by fabricator/vendor/manufacturer and model.

Actual material and products to be incorporated into the work will be based on the proposal of the remediation subcontractor. The subcontractor will propose a material/product for the project and submit requisite product information and literature to MACTEC for review and approval. If the submittal satisfactorily meets the requirements of the construction documents (specification and drawings), MACTEC will approve the product/material.

8.0 SET UP PLANS

Set-up Plans as defined by the Rhode Island Remedial Regulations describe pre-operational staging or construction requirements that must be in place prior to implementation of the remedial action. A Subcontractor Work Plan is required by the subcontractor selected to implement the remedial action. This Plan is required to include descriptions and information as outlined in Specification Section 01110 "Summary of Work". The measures and controls required are shown on the Construction Drawings and are described in Specification Section 01500 "Temporary Facilities and Controls. The purpose of these measures and controls include the following:

1 To maintain a healthy and safe work environment for remediation construction and oversight personnel;

2 To minimize erosion of soil and downgradient migration of sediment;

3 To minimize waste generation and migration outside of the Exclusion Zone; and

4 To provide proper collection and storage of generated wastes until characterization and off-site disposal can occur.

9.0 EFFLUENT DISPOSAL

Effluents as defined by the Rhode Island Remedial Regulations are any products or by-products from the proposed remedial action. Waste or waste by-products that will be produced as a result of the remedial action include the following:

1 Clearing and miscellaneous debris;
2 Grubbings;
3 Liquid waste (decontamination water, stormwater management water, etc.);
4 Site trash; and
5 Remediation waste (PPE, plastic sheeting, sampling equipment, etc.);

Waste handling and disposal will be in accordance with the requirements of Specification Sections 02110 "Waste Excavation, Removal, and Handling" and 02120 "Off-Site Transportation and Disposal". The remediation subcontractor is required to submit a Work Plan to MACTEC for review and approval prior to commencing construction. The required plan will contain project specific proposals for waste handling, transportation, and disposal. Characterization of the waste will occur in accordance with the requirements of the Treatment Storage and/or Disposal Facility. Disposal will occur at licensed facilities approved by MACTEC.

10.0 CONTINGENCY PLAN/ HEALTH AND SAFETY PLAN

MACTEC's Contingency Plans are documented within the MACTEC Health and Safety Plan for Phase I Soil Capping. This document contains the names and phone numbers of emergency coordinators and the emergency response procedures and arrangements for the Site. The Health and Safety Plan with contingency procedures will be available on site at all times during the implementation and operations of the Phase I remedial action.

Specification Section 01350 Safety, Health, and Emergency Response requires the selected remediation subcontractor to prepare and follow a site-specific health and safety plan for the work described and referred to in this RAWP.

11.0 OPERATING LOG

All on-site activities will be recorded in an operating logbook to document progress associated with remedial activities at the Site. The logbook will include, at a minimum, detailed information on the following:

1 Personnel on-site and their time of arrival and departure.

2 Time of system (if applicable) operation, including startup time, time of shutdown due to equipment malfunction or failure, and time of completion for the remedial activity.

3 Records of materials transported off-site, and materials brought on-site.

4 Instances during remedial activities where a Contingency Plan may be implemented.

5 Records of any accidents or injuries incurred on the Site.

6 Documentation of inspections and any instances where remedial activity procedures must be changed and/or equipment must be repaired or replaced. An inspection plan will be designed for all remedial activities to ensure that all equipment or activities are operating properly.

7 Details of the work stages and activities, as will records of sampling and any field screening (e.g., dust monitoring) that is performed.

In addition to documentation of field activities, quality assurance procedures for cap construction as described in Specifications Sections 02072, 02073, and 02300 will be recorded in the operating log.

The operating log will be readily available at the Site during all activities outlined in this RAWP.

12.0 SECURITY PROCEDURES

Access to the Phase I work area will be at three locations. One access point is the existing gate on Adelaide Avenue, west of Parcel C. The gate at this access point will be repaired or replaced, and it will be used after Phase I Construction. In addition, an access road will be constructed in the northwestern corner of the Parcel C down to the western end of the Phase I cap (near Mashapaug Cove). The other two access points will be the existing gate at the slag area and at the laydown area in the northeast of the Site (behind the retention basin).

An 8' high security fence and gate will be installed along the LOW at the north end of the Parcel C and it will tie into the existing fence at the school property for vehicular access to the western end of the cap near Mashapaug Cove. It is assumed that plantings along the new fence will not be required with the installation of the fence around the High School restricting access to the Park Parcel and planned remedial activities in support of a recreational use. This fence will be maintained through the completion of the Phase III remediation.

Only authorized personnel (e.g., engineer, construction personnel, and approved visitors) will be permitted to access the work zone. All visitors required to check in with the Site Superintendent upon entering.

Fencing and gates will be secured at the close of each working day. Areas where fencing is removed will be gated and/or properly secured with temporary fencing and signage.

13.0 SHUT-DOWN, CLOSURE AND POST-CLOSURE REQUIREMENTS

Shutdown will consist of final cleanup, removal of temporary facilities and controls, and equipment demobilization from the Site. Points of compliance and compliance determination for capping activities are discussed in Section 4.0. Security and siltation fencing will not be removed before construction is complete, specified erosion control measures (e.g. rock dams, erosion control mats, etc.) have been installed, and specified erosion control vegetation is established.

14.0 INSTITUTIONAL CONTROLS AND NOTICES

An Environmental Land Use Restriction (ELUR) in accordance with Rule 8.09 of the Remediation Regulations will be developed for the Site at the close of Phase III soil capping. The specific ELUR for the Site will be included with the report summarizing the Phase III soil capping activities.

15.0 CERTIFICATION REQUIREMENTS

The following certifications are provided pursuant to Rule 9.19 of the Remediation Regulations.

The undersigned hereby certifies that to the best of their knowledge the information contained in this report is complete and accurate based on the information available at the time of its preparation. Furthermore, the undersigned certifies that to the best of their knowledge the report is as complete and accurate of a representation of the Site and the release based on the available information, and contains the known facts surrounding the release.

MACTEC Engineering and Consulting, Inc.

_____ _____

David E. Heislein — Date

Senior Principal

Textron, Inc.

_____ _____

Gregory Simpson — Date

Senior Project Manager, Site Remediation

FIGURES

Remedial Action Work Plan
333 Adelaide Avenue Site
Providence, Rhode Island

MACTEC

Site Plan

Project 3650-05-0041

Figure 1

Document: P:\TEXTRON\GORHAM\GIS\MapDocuments\SI_Report_11x17P.mxd PDF: P:\TEXTRON\GORHAM\GIS\Figures\Phase I RAWP\Figure 1.pdf 07/03/2007 3:51 PM bjroden

Mashapaug Pond

Abandoned Garage

Railroad Tracks

Phase III

Mashapaug Cove

Phase II

Retail

Phase I

Parking Lot

Phase I

Planned Development 2006 / 2007

Adelaide Avenue

N

0 75 150 Feet

Legend

- Area to be capped
- Division of Phase I and III and access roads to cap and cove
- Approximate Waste Fill Area
- Wetland Buffer 12" Soil, Limited Clearing of Brush
- 12" Soil Cap with Geofabric
- 24" Soil Cap without Geofabric
- Former Slag Area 12'' Soil Cap with Liner
- Delineation of Inner and Outer Cove
- Approximate Park Parcel Boundary
- Elevation

Prepared/Date: BJR 07/03/07
Checked/Date: MJM 07/03/07

Former Gorham Maufacturing Site
333 Adelaide Avenue
Providence, RI

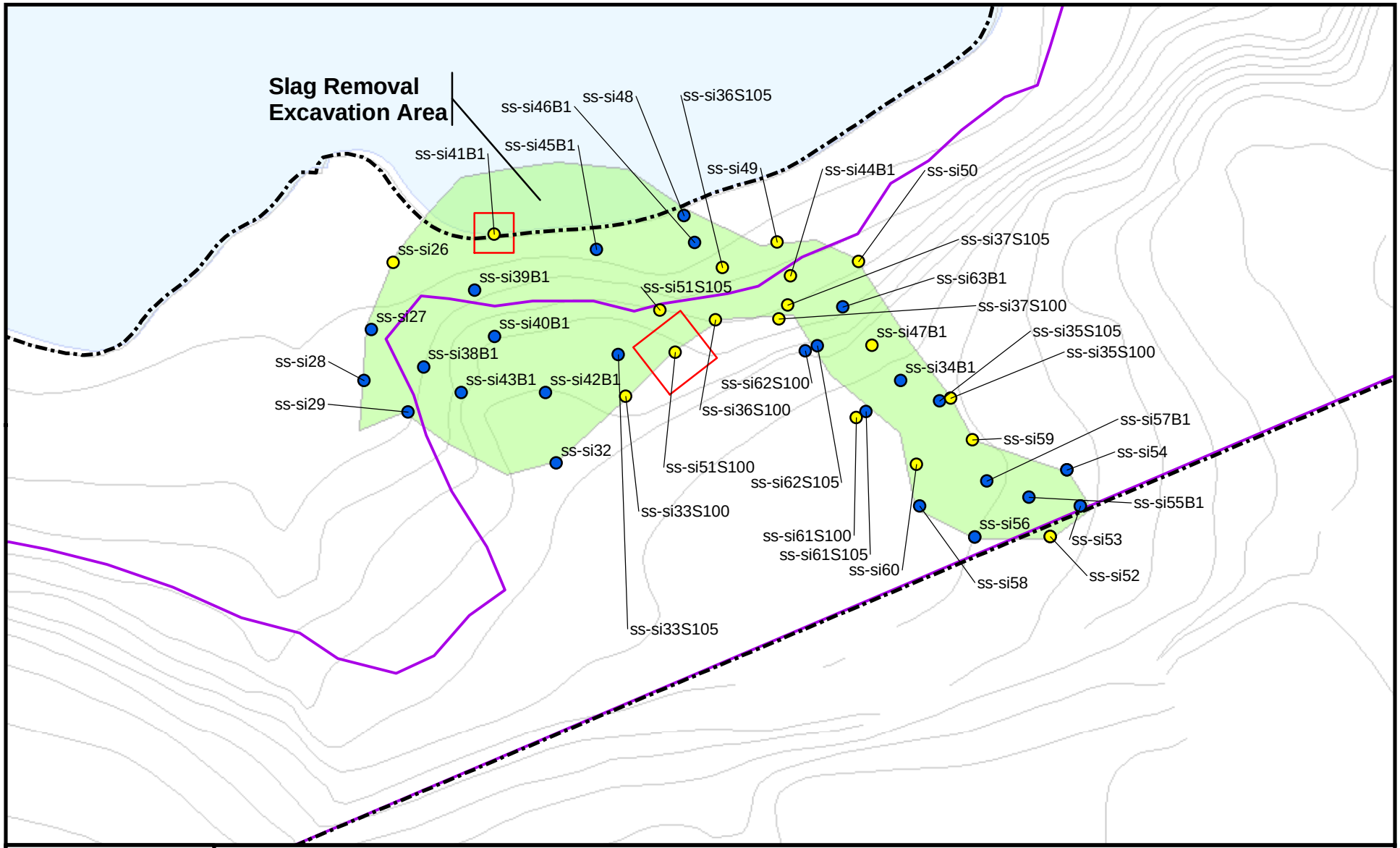
MACTEC

Park Parcel Three Phased Remediation
Gorham Site

Project 3650-05-0041

Figure 2

Document: P:\TEXTRON\GORHAM\GIS\MapDocuments\ParkParcelRemediationOptions.mxd PDF: P:\TEXTRON\GORHAM\GIS\Figures\Phase I RAWP\Figure 2.pdf 07/03/2007 3:40 PM bjroden



MACTEC

N

0 17.5 35 Feet

Prepared by BJR | Checked by DEH

Legend

- Lead > 500 mg/kg
- Lead < 500 mg/kg
- Approximate Site Boundary
- Mashapaug Cove
- Approximate Fill Area
- Additional Soil Removal Area
- Former Slag Pile Area
- Elevation

Figure 3
Supplemental Soil Excavation
Former Slag Pile, Park Pacel

Former Gorham Site
333 Adelaide Avenue
Providence, Rhode Island

Document: P:\TEXTRON\GORHAM\GIS\MapDocuments\ExcavatedArea_Revised.mxd PDF: P:\TEXTRON\GORHAM\GIS\Figures\Addendum Supplemental SIR\Figure 4 - Confirmatory Soil Sample Locations.pdf 06/28/2007 10:31 AM bjroden

Phase III

Mashapaug Cove

Phase II

Former Slag Area

Phase I

Retail

Parking Area

School

Undeveloped Parcel C

N

0 50 100 Feet

Legend

- Division of Phase I
- Approximate Park Parcel Boundary
- Location of Cross Sections
- Delineation of Inner and Outer Cove
- Wetland Buffer 12" Soil, Limited Clearing of Brush
- 12" Soil Cap with Geofabric
- 24" Soil Cap without Geofabric
- Former Slag Area 12" Soil Cap with Liner
- Existing Structures
- Elevation

Prepared/Date: BJR 07/03/07
Checked/Date: DGK 07/03/07

Former Gorham Maufacturing Site
333 Adelaide Avenue
Providence, RI

MACTEC

Approximate Location of Cap Cross Section Details
Park Parcel, Former Gorham Site

Project 3650-05-0041

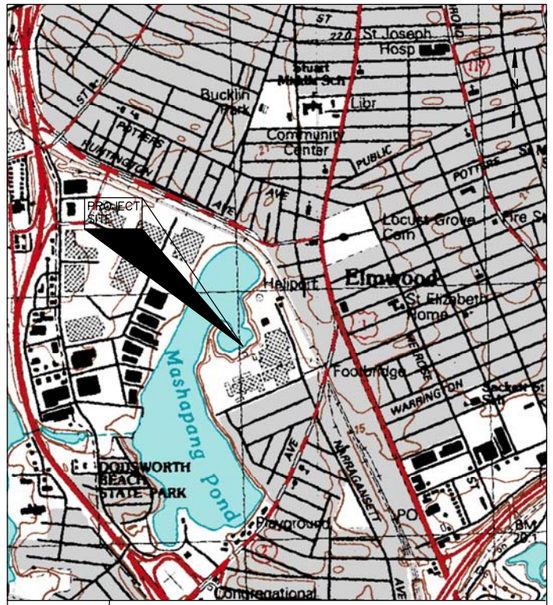
Figure 4

Document: P:\TEXTRON\GORHAM\GIS\MapDocuments\ParkParcelRemediationOptions.mxd PDF: P:\TEXTRON\GORHAM\GIS\Figures\Phase I RAWP\Figure 4.pdf 07/03/2007 3:56 PM bjroden

APPENDIX A

DRAWINGS

REMEDIAL DESIGN
PHASE I RECREATIONAL CAP
FORMER GORHAM MANUFACTURING SITE
PROVIDENCE, RHODE ISLAND
JUNE 2007



LOCUS MAP

0 500 1000 2000
SCALE IN FEET

KEY

0 100 200 400
SCALE IN FEET

MAP SOURCE: GIS COLOR ORTHO IMAGE OF PROVIDENCE COUNTY R.I.
FILE: 3426 AND 3428

DRAWING INDEX

INCLUDED IN THIS SUBMITTAL	SHEET NUMBER	DRAWING TITLE	DISCIPLINE NUMBER
•	1	COVER SHEET	G-001
•	2	GENERAL NOTES, ABBREVIATIONS, AND LEGEND	G-002
•	3	EXISTING CONDITION PLAN	C-101
•	4	EROSION CONTROL AND SUBGRADE PLAN 1	C-102
•	5	EROSION CONTROL AND SUBGRADE PLAN 2	C-103
•	6	FINAL GRADE PLAN 1	C-104
•	7	FINAL GRADE PLAN 2	C-105
•	8	SOLID WASTE AREA REMEDIATION	C-106
•	9	PLANTING PLAN 1	L-101
•	10	PLANTING PLAN 2	L-102
•	11	CROSS SECTIONS	C-301
•	12	EROSION AND SEDIMENTATION CONTROL NOTES	C-501
•	13	EROSION AND SEDIMENTATION CONTROL NOTES	C-502
•	14	CIVIL DETAILS 1	C-503
•	15	CIVIL DETAILS 2	C-504
•	16	LANDSCAPING DETAILS	L-501

NO.	DATE	REVISION	BY	APVD

DSGN Karle L. Henning | DR Richard H. Holman | CHK Jeff P. McCrady | APVD William J. Weber

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

MACTEC Engineering and Consulting, Inc.
P.O. Box 1076, 511 Congress Street
Portland, Maine 04112-7050
(207) 775-5401

MACTEC

General
COVER SHEET

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	06/18/07
PROJ	3650050041
DWG	G-001
SHEET	1 OF 1

FILE NAME: M:\Projects\TEXTRON\GORHAM SITE - PHASE I\RSC-G-001.DWG PLOT DATE: Wed, 27 Jun 2007 PLOT TIME: 2:57 PM

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CIVIL
EXISTING CONDITION PLAN

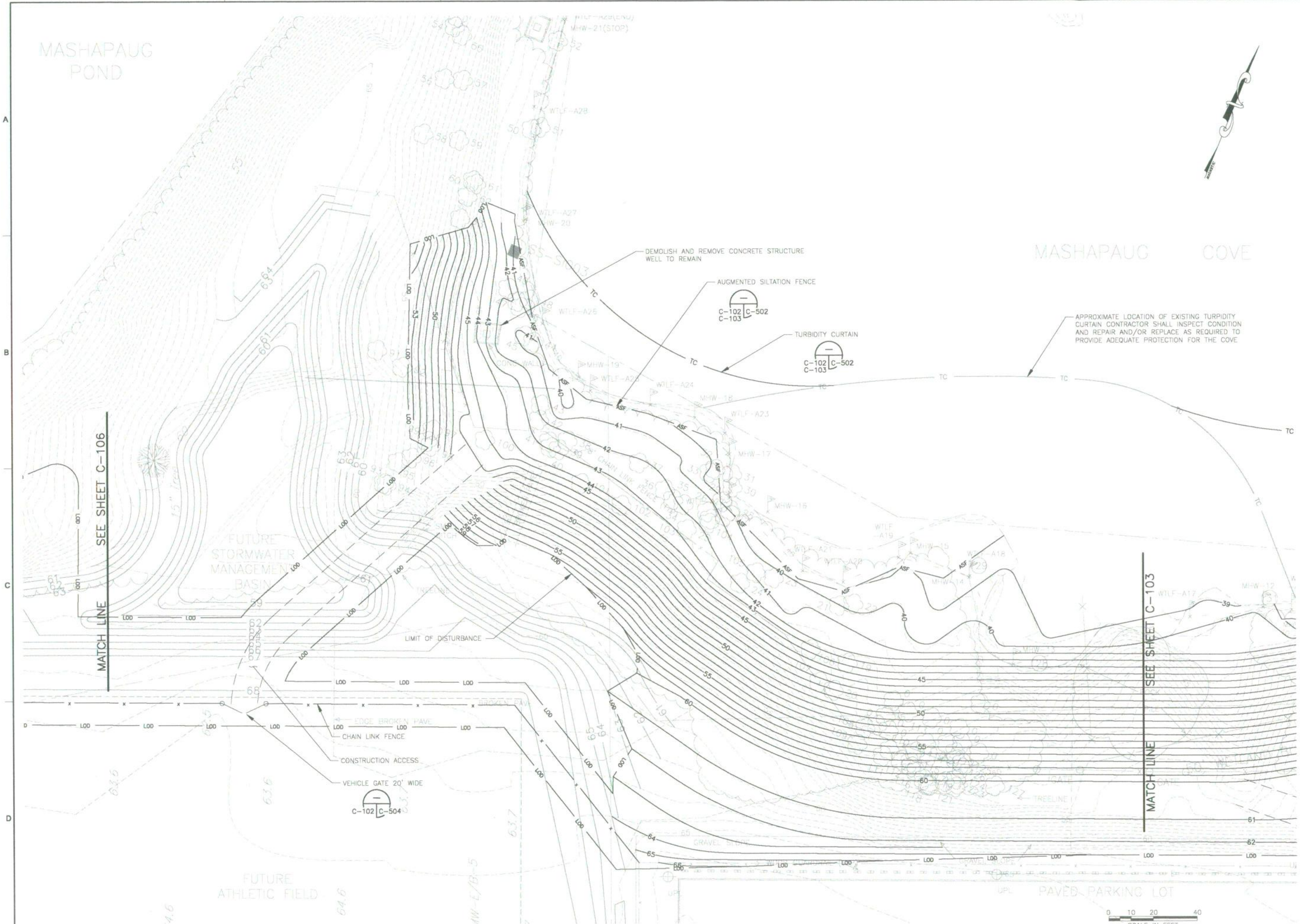
Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

NO.	DATE	REVISION	BY	APVD
A	6/29/07	DRAFT SUBMITTAL TO RIDEM	JPM	DEH

DSGN	DR	CHK	APVD
JPM		RHH	DEH	WJW

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	C-101
SHEET	3 OF 16



NO.	DATE	REVISION	BY	APVD
A	6/29/07	DRAFT SUBMITTAL TO RIDEM	JPM	DEH

DSGN	DR	CHK	APVD
JPM	RHH	DEH	WJW

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

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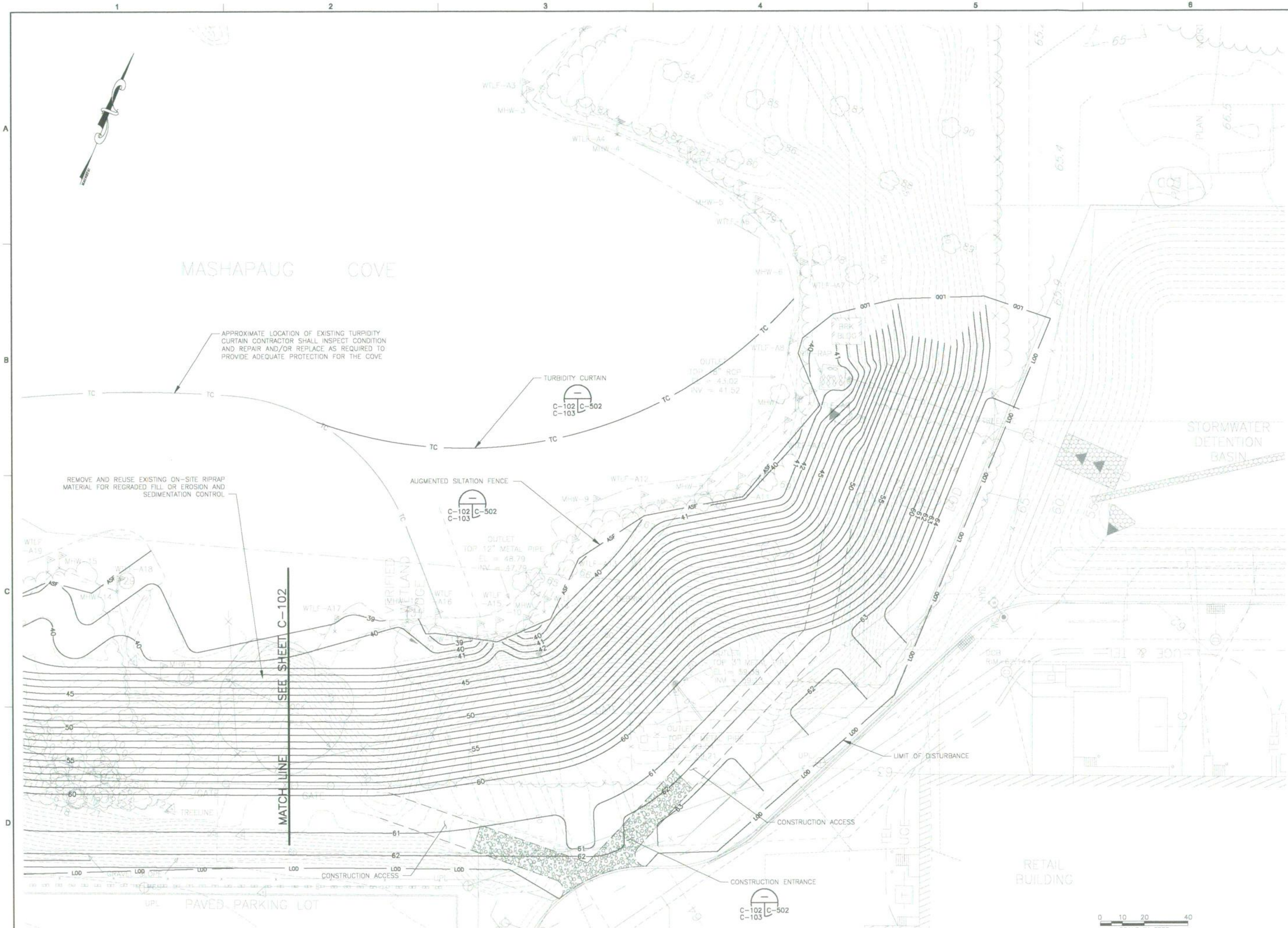
CIVIL

EROSION CONTROL AND SUBGRADE PLAN 1

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	C-102
SHEET	4 OF 16



Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

NO.	DATE	REVISION	BY	APVD
A	6/29/07	DRAFT SUBMITTAL TO RIDEM	JPM	DEH

DSGN	DR	CHK	APVD
JPM		RHH	DEH WJW

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CIVIL
EROSION CONTROL AND SUBGRADE PLAN 2

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	C-103
SHEET	5 OF 16

MASHAPAUG POND

MASHAPAUG COVE

LEGEND:

- WETLAND BUFFER CAP
- UPLAND CAP
- SLAG AREA CAP
- RIPRAP

TYPICAL WETLAND BUFFER CAP
C-104 | C-503

TYPICAL UPLAND CAP
C-104 | C-503

WETLAND BUFFER CAP TOE DETAIL
C-104 | C-503

TYPICAL TRANSITION DETAIL: SLAG AREA CAP TO WETLAND BUFFER CAP
C-104 | C-503

TYPICAL SLAG AREA CAP
C-104 | C-503

SLAG AREA CAP TOE DETAIL
C-104 | C-503

TYPICAL TRANSITION DETAIL: UPLAND CAP TO WETLAND BUFFER CAP
C-104 | C-503

TYPICAL TRANSITION DETAIL: SLAG AREA CAP TO UPLAND CAP
C-104 | C-503

SLAG AREA CAP ANCHOR DETAIL
C-104 | C-503

SLAG AREA CAP ANCHOR TRENCH
C-104 | C-503

SEE SHEET C-106

MATCH LINE

SEE SHEET C-105

MATCH LINE

FUTURE STORMWATER MANAGEMENT BASIN

FUTURE ATHLETIC FIELD

PAVED PARKING LOT

EDGE BROKEN PAVE

0 10 20 40
SCALE IN FEET

NO.	DATE	DSGN	DR	CHK	APVD
A	8/29/07	JPM	JPM	RHH	DEH

REVISION BY APVD

DRAFT SUBMITTAL TO RIDEM JPM DEH

WJW

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

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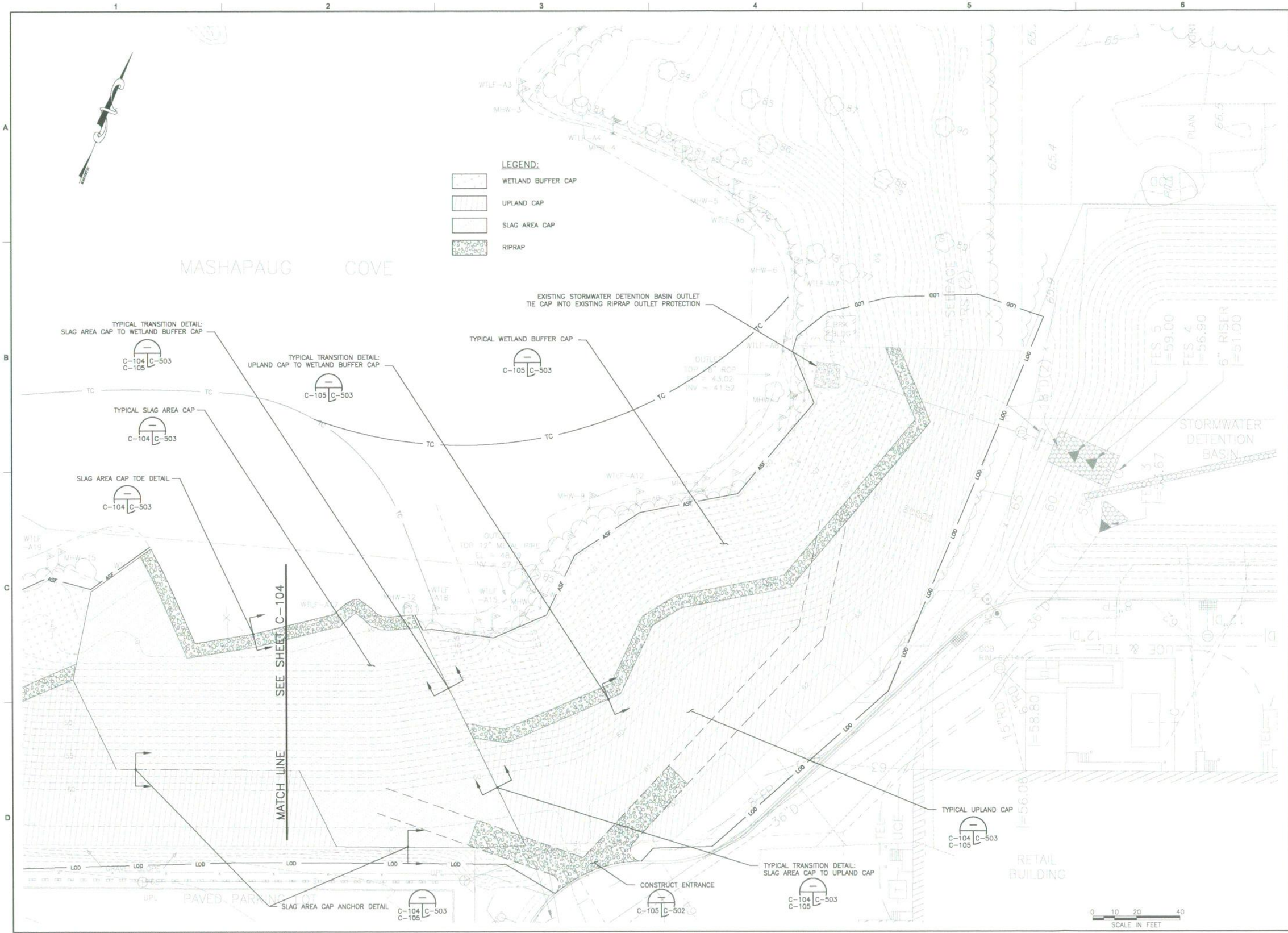
Portland, Maine 04112-7050
(207) 775-5401

CIVIL
FINAL GRADE PLAN 1

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	C-104
SHEET	6 OF 16



NO.	DATE	DSGN	DR	CHK	APV'D
A	6/29/07	JPM	JPM	RHH	DEH

DRAFT SUBMITTAL TO RIDEM

REVISION BY APV'D

JPM DEH

W.NW

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

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MACTEC

CIVIL

FINAL GRADE PLAN 2

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	C-105
SHEET	7 OF 16

MATCH LINE SEE VIEW RIGHT

MASHAPAUG POND

FUTURE DEVELOPMENT

LIMIT OF DISTURBANCE

APPROXIMATE SURFICIAL SOLID WASTE BOUNDARY

TYPICAL UPLAND CAP
C-106 | C-502

STONE CHECK DAM
C-106 | C-502

CONSTRUCT ENTRANCE
C-106 | C-502

SEED AND EROSION CONTROL MATTING

EXISTING GATE

TYPICAL DRAINAGE AREA CAP
C-106 | C-502

CHAIN LINK GATE
C-106 | C-502

Adelaide Avenue

NOTES:

1. CONSOLIDATE AND GRADE SOLID WASTE AREAS AS REQUIRED TO BLEND WITH SURROUNDING TOPOGRAPHY AND TO PROTECT EXISTING TREES.
2. SLOPE OF CAP AREAS SHALL BE BETWEEN 5% MINIMUM AND 33% MAXIMUM.

MASHAPAUG POND

MATCH LINE SEE SHEET C-104

CHAIN LINK FENCE

LIMIT OF DISTURBANCE

APPROXIMATE SURFICIAL SOLID WASTE BOUNDARY

FUTURE DEVELOPMENT

TYPICAL UPLAND CAP
C-106 | C-502

REMOVE AND RE-INSTALL EXISTING CHAIN LINK FENCE AS REQUIRED

MATCH LINE SEE VIEW LEFT

NOTES:

1. CONSOLIDATE AND GRADE SOLID WASTE AREAS AS REQUIRED TO BLEND WITH SURROUNDING TOPOGRAPHY AND TO PROTECT EXISTING TREES.
2. SLOPE OF CAP AREAS SHALL BE BETWEEN 5% MINIMUM AND 33% MAXIMUM.

0 10 20 40
SCALE IN FEET

NO.	DATE	DSGN	BY	APVD
A	6/29/07	JPM	DEH	WJW

DRAFT SUBMITTAL TO RIDEM

REVISION | CHK | APVD
DR | JPM | DEH
RHH

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

MACTEC Engineering and Consulting, Inc
P.O. Box 7050, 511 Congress Street
Portland, Maine 04112-7050
(207) 775-5401

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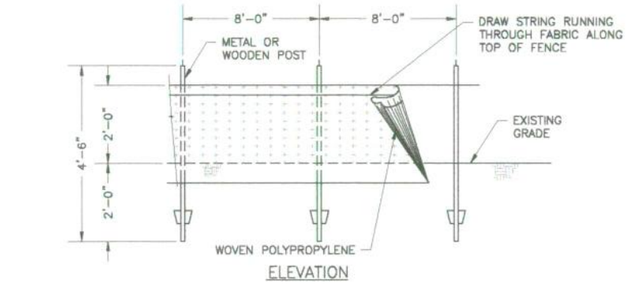
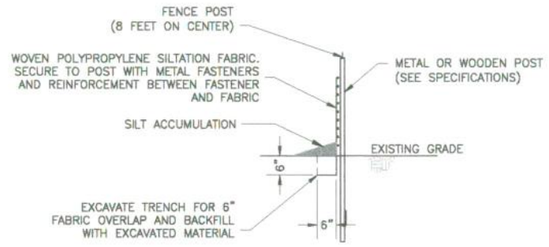
CIVIL
SOLID WASTE AREA REMEDIATION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	C-106
SHEET	8 OF 16



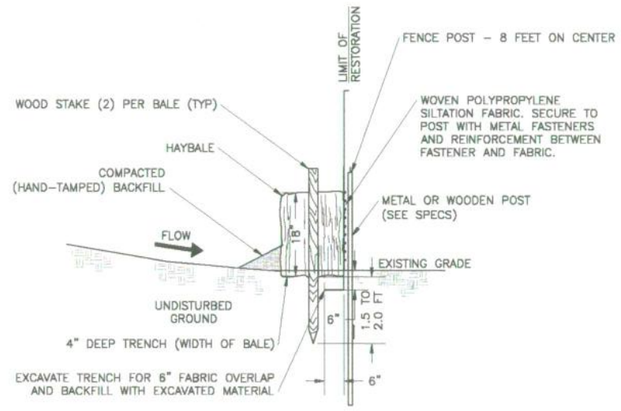
ELEVATION



SECTION

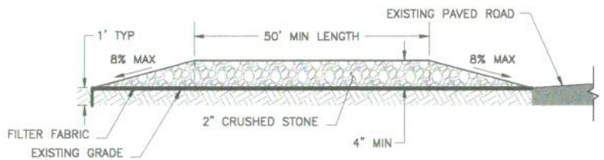
NOTE:
WHERE REQUIRED AT CRITICAL LOCATIONS, SILTATION FENCE REINFORCED WITH HOG OR CHICKEN WIRE OR INTEGRAL PLASTIC MESH REINFORCING MAY BE USED.

SILT FENCE
NTS
C-102 | C-502



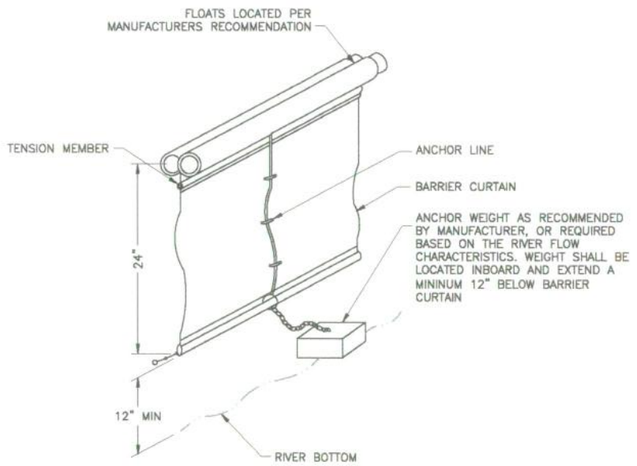
NOTE:
AT CRITICAL LOCATIONS, AUGMENTED SILTATION FENCE MAY BE USED.

AUGMENTED SILTATION FENCE
NTS
C-102 | C-502



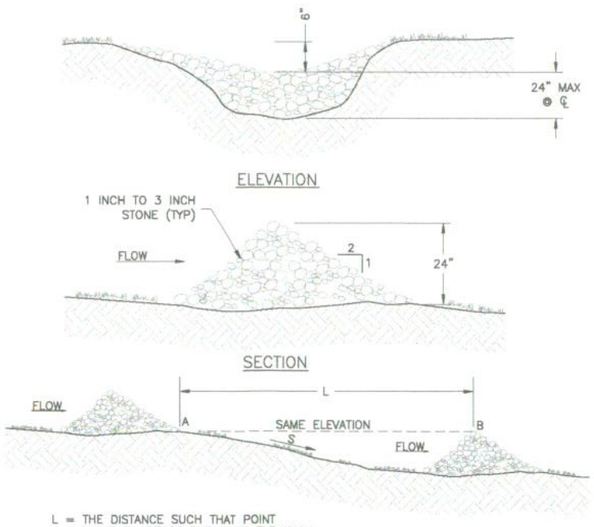
PROFILE

CONSTRUCTION ENTRANCE
NTS
C-102 | C-502



NOTES:
1. THE TURBIDY CURTAIN SHALL BE DEPLOYED PRIOR TO DISTURBING THE RIVER BANK SOILS.
2. THE TURBIDITY CURTAIN SHALL WITHSTAND A RIVER VELOCITY OF UP TO 6 FT/SEC.

TURBIDITY CURTAIN DETAIL
NTS
C-102 | C-502



L = THE DISTANCE SUCH THAT POINT A AND B ARE OF THE SAME ELEVATION

S = SLOPE

TEMPORARY STONE CHECK DAM (TYP)
NTS
C-101 | C-502
C-102
C-103
C-104
C-105

NO.	DATE	DSGN	BY	APVD
A	6/29/07	JPM	DEH	WJW

DRAFT SUBMITTAL TO RIDEM

REVISION | CHK: DEH | APVD: DEH | DR: JPM | CHK: RHH

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

MACTEC Engineering and Consulting, Inc.
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(207) 775-5401

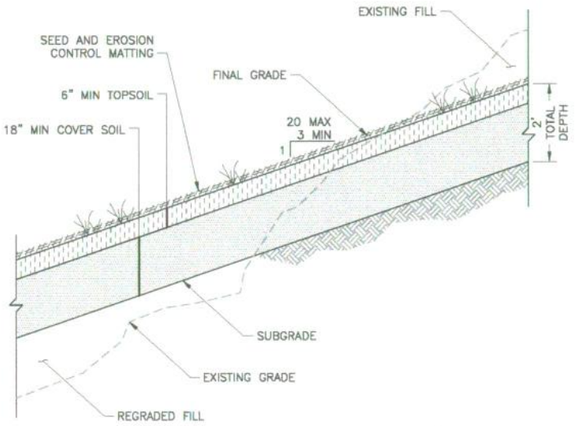
MACTEC

CIVIL
EROSION AND SEDIMENTATION CONTROL DETAILS

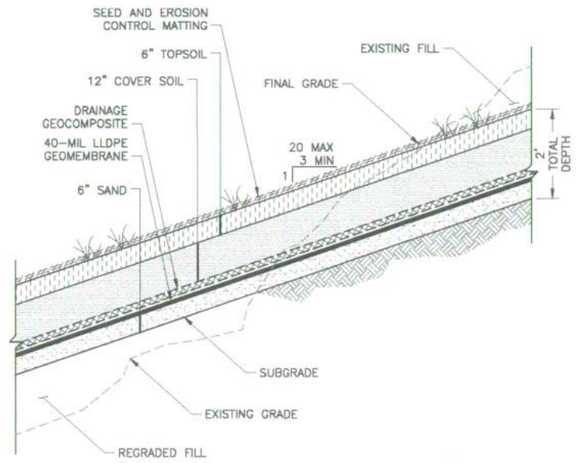
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	C-502
SHEET	13 OF 16

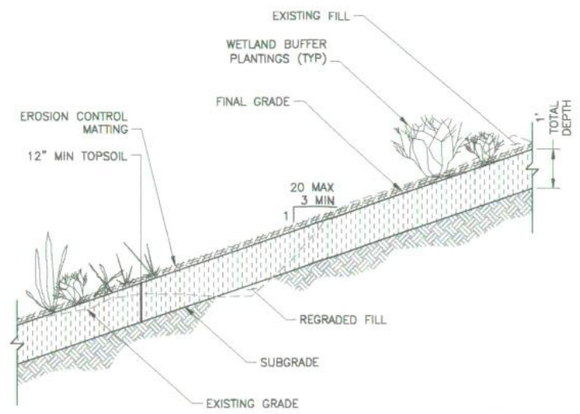
FILE NAME: M:\Projects\TEXTRON\GORHAM SITE_PHASE I\DSG C-502.dwg PLOT DATE: Fri, 29 Jun 2007 PLOT TIME: 3:45 PM



TYPICAL UPLAND CAP
NTS
C-104 C-105 C-503



TYPICAL SLAG AREA CAP
NTS
C-104 C-105 C-503



TYPICAL WETLAND BUFFER CAP
NTS
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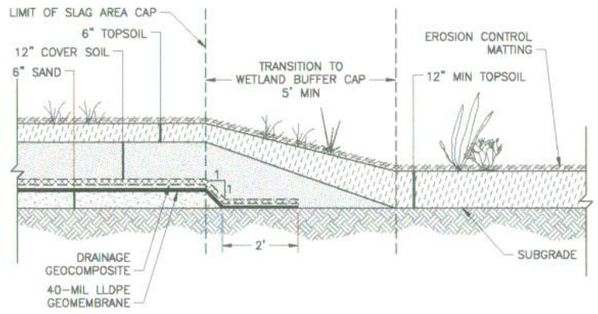
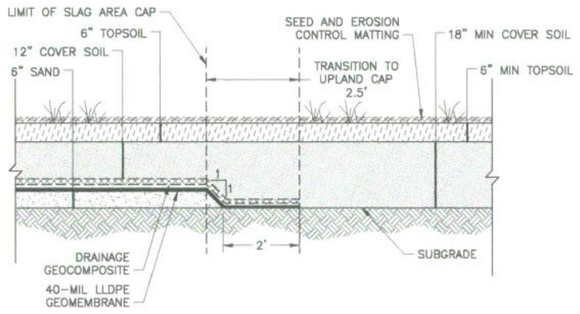
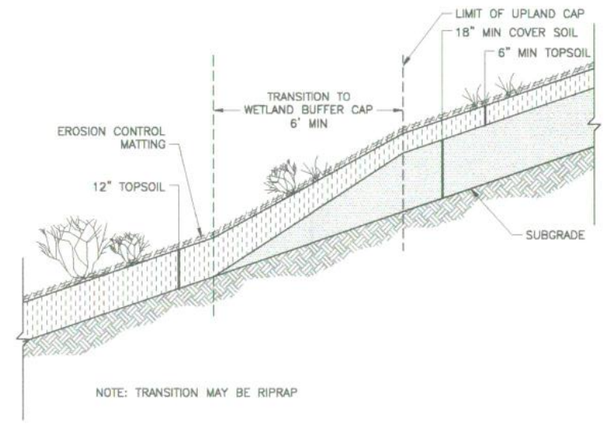


TYPICAL TRANSITION DETAIL:
SLAG AREA CAP TO WETLAND BUFFER CAP
NTS
C-104 C-105 C-503

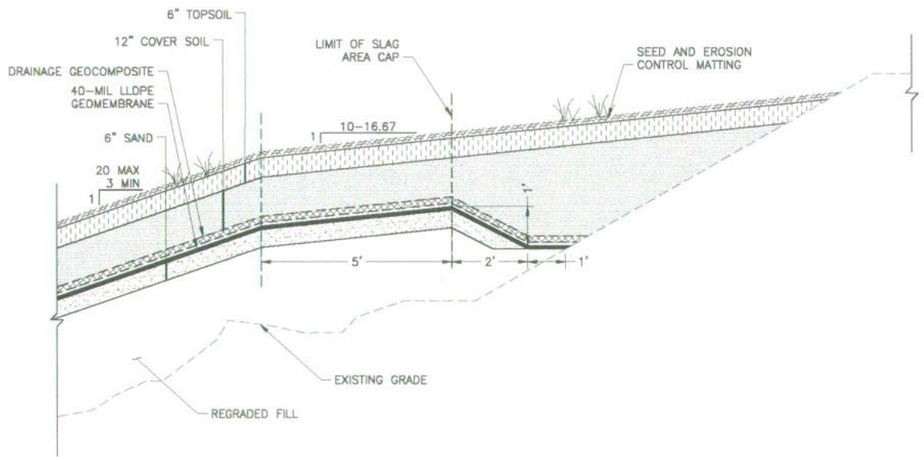


TYPICAL TRANSITION DETAIL:
SLAG AREA CAP TO UPLAND CAP
NTS
C-104 C-105 C-503

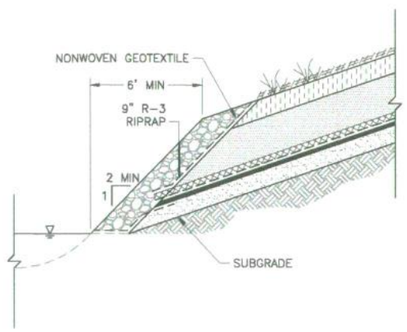


NOTE: TRANSITION MAY BE RIPRAP

TYPICAL TRANSITION DETAIL:
UPLAND CAP TO WETLAND BUFFER CAP
NTS
C-104 C-105 C-503



SLAG AREA CAP ANCHOR DETAIL
NTS
C-104 C-105 C-503



SLAG AREA CAP TOE DETAIL
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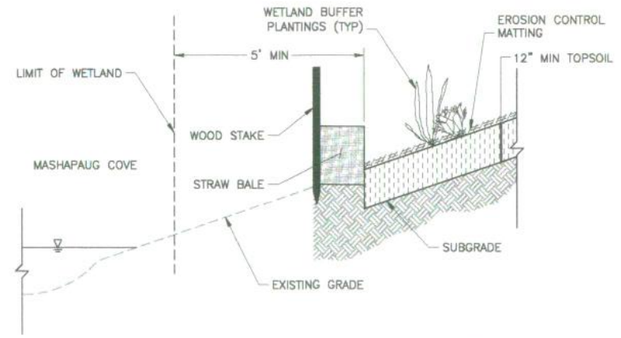
C-104 C-105 C-503



WETLAND BUFFER CAP TOE DETAIL
NTS
C-104 C-105 C-503

NO.	DATE	DSGN	DR	CHK	APVD
A	6/29/07	JPM	JPM	KLH	DEH

DRAFT SUBMITTAL TO RIDEM

BY	APVD
JPM	DEH
DEH	WJW

REVISION

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
333 Adelaide Avenue
Providence, Rhode Island

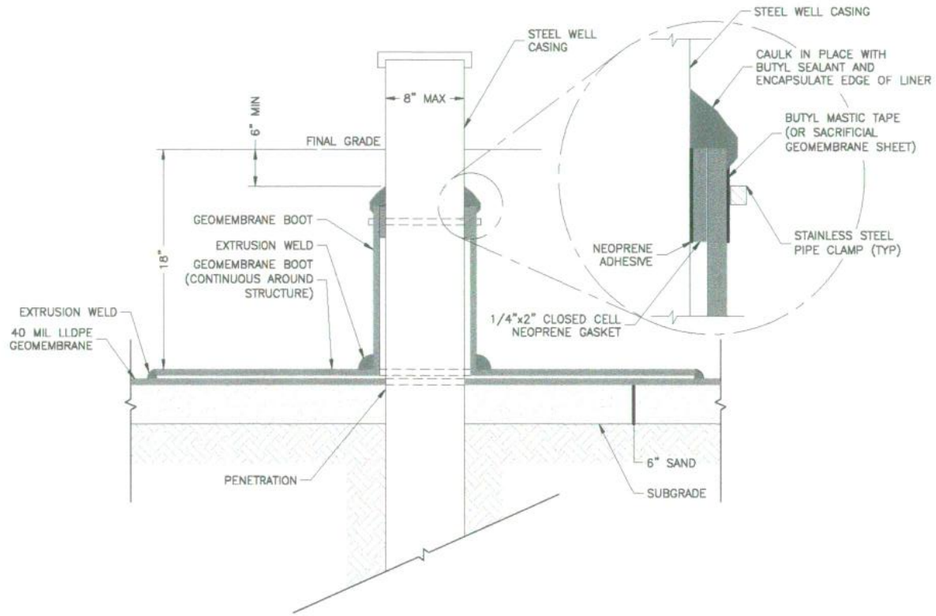
MACTEC Engineering and Consulting, Inc.
P.O. Box 7050, 511 Congress Street
Portland, Maine 04112-7050
(207) 775-5401

MACTEC

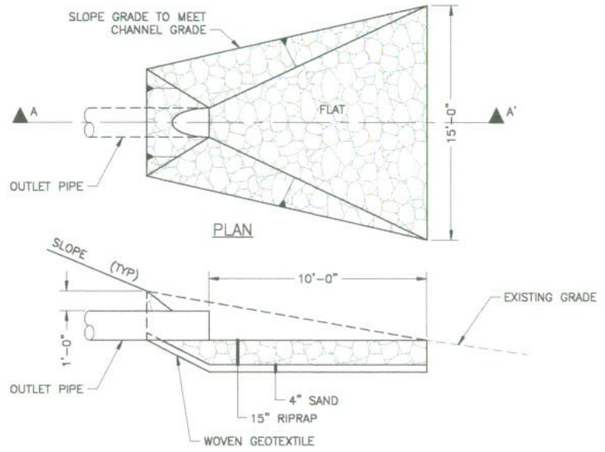
CIVIL
CIVIL DETAILS 1

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

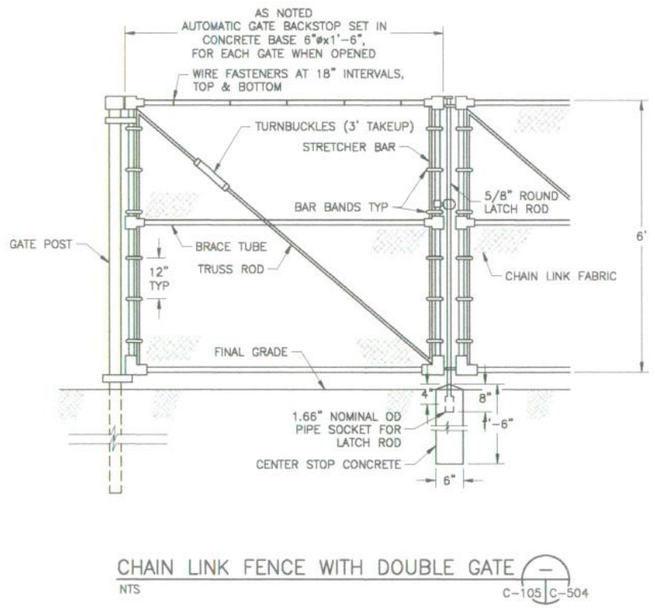
DATE	6/29/07
PROJ	3650050041
DWG	C-503
SHEET	14 OF 16



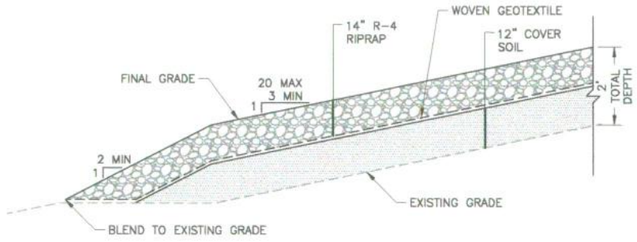
MONITORING WELL PENETRATION DETAIL
NTS
C-102 | C-504



RIPRAP APRON DETAIL
NTS
C-105 | C-504



CHAIN LINK FENCE WITH DOUBLE GATE
NTS
C-105 | C-504



TYPICAL DRAINAGE AREA CAP
NTS
C-106 | C-502

NO.	DATE	DSGN
A	6/29/07	JPM

DRAFT SUBMITTAL TO RIDEM

BY	APVD
JPM	DEH
DR	APVD
JPM	DEH
CHK	
RHH	

REVISION

WJW

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
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Providence, Rhode Island

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Portland, Maine 04112-7050
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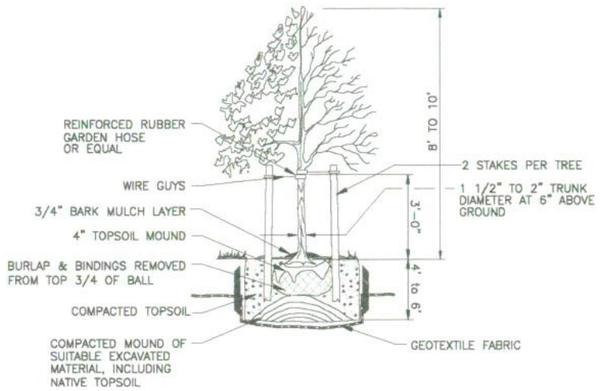
MACTEC

CIVIL
CIVIL DETAILS 2

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	C-504
SHEET	15 OF 16

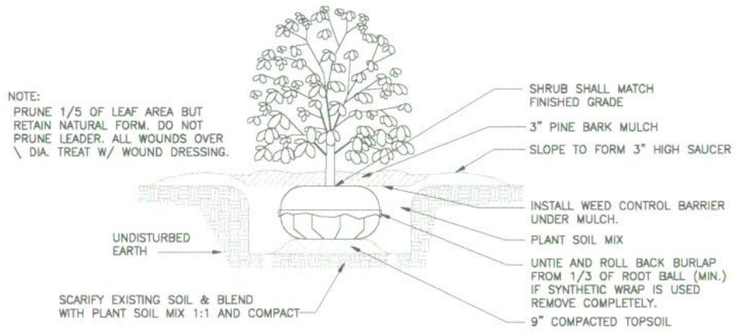


PROVIDE TREES WITH ABOVE MINIMUM DIMENSIONS OR LARGER

TYPICAL DECIDUOUS TREE PLANTING DETAIL

NTS

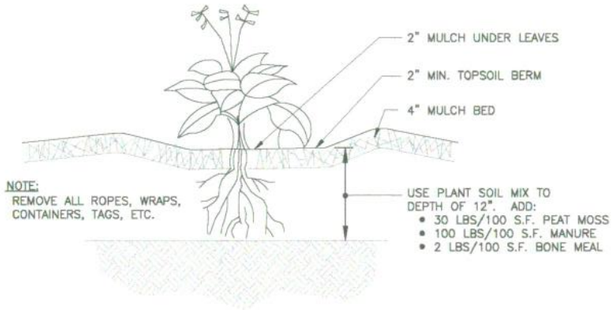
L-501



TYPICAL SHRUB PLANTING DETAIL

NTS

L-501



PLANTING DETAIL FOR PERENNIAL BEDS

NTS

L-501

NO.	DATE	DSGN	DR	CHK	APVD	BY
A	6/29/07	JPM	JPM	RHH	DEH	APVD
						DEH
						JPM

DRAFT SUBMITTAL TO RIDEM

REVISION

WJW

Remedial Design - Phase 1 Recreational Cap
FORMER GORHAM MANUFACTURING SITE
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Providence, Rhode Island

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Portland, Maine 04112-7050
(207) 775-5401

MACTEC

LANDSCAPE
LANDSCAPING DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	6/29/07
PROJ	3650050041
DWG	L-501
SHEET	16 OF 16

APPENDIX B

SPECIFICATIONS

SECTION 02072

GEOMEMBRANE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work provided in this Section includes furnishing labor, equipment, materials, testing, and incidentals required to install a 40-mil textured (both sides) Linear Low Density Polyethylene (LLDPE) geomembrane as shown on the Drawings and as specified herein as part of the multi-layer cap construction in the former Slag Area.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02300: Earthwork
Section 02373: Geocomposite Drainage Net

1.03 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are reffered to in the text by the basic designation only.

A. American Society for Testing and Materials (ASTM):
1. ASTM D 638, Standard Test Method for Tensile Properties of Plastics
2. ASTM D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
3. ASTM D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
4. ASTM D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
5. ASTM D 1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
6. ASTM D 1603 Standard Test Method for Carbon Black in Olefin Plastics
7. ASTM D 4437 Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
8. ASTM D 5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
9. ASTM D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
10. ASTM D 5994 Standard Test Method for Measuring the Core Thickness of Textured Geomembrane

B. Geosynthetic Research Institute (GRI):
1. GM11 Accelerated Weathering of Geomembranes Using a Fluorescent UVA-Condensation Exposure Devise
2. GM12 Asperity Measurement of Textured Geomembranes Using a Depth Gage

1.04 SUBMITTALS

Submit the following in accordance with Section 01330 – Submittal Procedures.

A Submittals relating to liner Manufacturer and liner material:

1. List of material properties and samples of liner meeting the requirements herein with attached certified test results.
2. Manufacturer's quality control program and manual including description of in-house laboratory facilities.
3. A list of ten completed facilities totaling a minimum of five million square feet, for which the Manufacturer has manufactured LLDPE geomembrane. The following information shall be provided for each facility.
   a. Name and purpose of facility, its location and date of installation.
   b. Name of Owner, Project Manager, Design Engineer and Installer.
   c. Geomembrane thickness and surface area.
4. Qualifications statement in accordance with Sub-Part 1.07.

B. The origin of the resin to be used in the manufacturing of geomembrane used on-site including the suppliers name and production plant, as well as brand name and tracking number.

C. Copy of quality control certificates in conformance with Sub-Parts 2.1 and 2.2. Certification that the LLDPE geomembrane and extrudate produced for this project have compatible properties. Quality control reports for the time period materials were produced for this project.

D. A "Sample Warranty" in accordance with Sub-Part 1.09.

E. Prior to shipment of liner material to the site, provide samples from rolls to be provided. Only ship to site material that is approved by the Engineer.

F. Submittals relating to the Installer:
1. Information on equipment and personnel.
2. Anticipated average daily production.
3. Number of crews employed and number available for this work.
4. Qualifications in accordance with Sub-Part 1.07
5. A list of five completed facilities totaling 2 million square feet for which the Installer has installed 40 mil LLDPE geomembrane with GCL underlayment. The following information shall be provided for each facility:
   a. Name and purpose of facility, its location and date of installation.
   b. Name of Owner, Design Engineer, Manufacturer and name and telephone number of Manufacturer's Representative at the facility who can discuss the project.
   c. Surface area of the installed 40 mil LLDPE geomembrane.
   d. Type of seaming, patching and tacking equipment.
   e. A copy of the Manufacturer's certification or approval letter.

G. Within 60 days prior to liner installation submit the following:
1. Shop Drawings:
   a. Proposed panel layout showing the installation layout identifying field seams as well as any variance or additional details which deviate from the Drawings.
   b. Details of seaming the geomembrane, anchoring, connections, penetrations and other construction details, which deviate from these specifications.

H. Installation Quality Control:
1. A quality control manual that specifically defines the quality control program during installation for this project. The manual shall include daily procedures, welding techniques, field testing procedures, lab testing procedures, specific

steps that are to be taken in the event of a failure or defect, personnel requirements, levels of authority and other information necessary to ensure a high quality geomembrane installation.

2. Resume of the Installation Supervisor to be assigned to and on-site during the project.
3. Resume of the Master Seamer to be assigned to the project.
4. A list of personnel performing field seaming operations along with pertinent experience information.

I. Quality Control

1. In addition to Manufacturer and Installer requirements for qualifications and certification specified in Sub-Part 1.6, Quality Control consists of conformance testing of the material delivered to the site and field quality control during installation.
2. Conformance testing requirements are specified in Sub-Part 2.2. The purpose of conformance testing is to verify that the supplied material conforms to the Specifications and to the Manufacturer's quality control certificates.
3. Field quality control requirements are specified in Sub-Part 3.6. The purpose of field quality control procedures is to verify that the geomembrane has been installed in accordance with the specifications and Manufacturer's recommendations.
4. Quality Control Forms:
   The forms in attached Appendix A, forms for geomembrane quality control documentation, shall be used for field installation documentation. Alternative forms may be used for documentation as submitted and approved by the Engineer.

J. Geomembrane Quality Control Documentation:

1. Project Files:
   a. Two duplicate project files shall be maintained. One shall be maintained by the Engineer's Field Representative and the other shall be maintained by the Contractor. The Contractor shall provide the Engineer's Field Representative with daily documentation by the end of the following work day. At the end of each work week, the Engineer and Contractor will update and check the files to assure that copies of pertinent project information are included in each file.
   b. Blank copies of the following project forms shall be available onsite throughout the duration of the project and are included in attached Appendix A:

Form No.	Title
1	Material Delivery Inventory
2	Installation and Seaming Report
3	Field Seaming Destructive Testing Report
4	Non-Destructive Seam Testing Report

1.05 JOB CONDITIONS

A. Site information: See Section 00330 – Existing Conditions for additional information.
B. Existing Utilities: See Section 00330 – Existing Conditions for additional information.

1.06 DEFINITIONS

A. Geonet:

A net-like polymeric material formed from intersecting ribs integrally joined at the junctions manufactured for use as drainage media with foundation, soil, rock, earth, or any other geotechnical-related material as an integral part of a human-made project, structure, or system.

B. Geotextile:

A woven or nonwoven permeable man-made textile used with geotechnical engineering-related materials.

C. Composite Drainage Net (CDN):

The CDN shall be composed of one layer of ribbed polyethylene geonet with a nonwoven polypropylene or polyester geotextile, thermally bonded to each side of the geonet.

D. Minimum Average Roll Value (MinARV):

Minimum of a series of average roll values representative of the product furnished.

E. Maximum Average Roll Value (MaxARV):

Maximum of a series of average roll values representative of the product furnished.

F. Overlap:

Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

1.07 QUALIFICATIONS

A. Manufacturer:

The Manufacturer of the lining material described hereunder shall have previously demonstrated its ability to produce this geomembrane by having at least 5 years continuous experience in the manufacturing of LLDPE geomembrane and successfully manufactured a minimum of 50 million square feet of similar material for hydraulic liner installations.

B. Installer:

The Installer shall be the Manufacturer or an approved Installer trained and certified to install the Manufacturer's geomembrane. Installation shall be performed under the constant direction of a single Installation Supervisor who shall remain on site and be in responsible charge, through the geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs and other site activities required by the Installer. The Installer shall also provide a Master Seamer (who may also be the Installation Supervisor). The Installation Supervisor/Master Seamer shall have installed or supervised the installation and seaming of a minimum of two million square feet of 40 mil LLDPE and/or HDPE geomembrane liner.

1.08 DELIVERY, STORAGE AND HANDLING

A. The geomembrane rolls shall be packaged and shipped by appropriate means to prevent damage of the geomembrane rolls. Off-loading and storage of the geomembrane is the responsibility of the Installer. The Installer shall be responsible for replacing any damaged or unacceptable material at no additional cost to the Owner.

B. Roll Identification:

The Manufacturer shall provide geomembrane rolls marked or tagged with the following information:

1. Manufacturer's name,

2. Product identification;
3. Thickness;
4. Roll dimensions;
5. Manufacturer's roll and lot number; and
6. Date of manufacture.

C. Damage during off-loading shall be documented by the Engineer's Field Representative. Damaged rolls must be separated from the undamaged rolls until the proper disposition of that material has been determined by the Engineer's Field Representative.

D. The geomembrane rolls shall be stored so as to be protected from puncture, dirt, grease, water, mud, mechanical abrasions and excessive heat that may damage the geomembrane material. The rolls shall be stored on a prepared surface (not wooden pallets or hard abrasive surfaces) and shall not be stacked more than two rolls high.

1.09 MATERIAL WARRANTY

The LLDPE geomembrane Manufacturer shall warrant the geomembrane against manufacturing defects and material degradation under outdoor or radiological exposure for a period of 20 years on a prorated basis from the date of final payment and acceptance. The Manufacturer shall repair or replace, at no expense to the Owner, any material which fails from the above causes within the warranty period. The Manufacturer shall furnish a written warranty covering the requirements of this Sub-Part.

1.10 GUARANTEE

The Installer shall guarantee the LLDPE geomembrane against defects in installation and workmanship for the period of 1 year commencing with the date of final payment and acceptance by the Engineer. The guarantee shall include the services of qualified personnel, all materials required for the repairs and testing at no expense to the Owner.

1.11 DEFINITIONS AND RESPONSIBILITIES

A. Contractor:

The Contractor is the firm or corporation with whom the Owner has entered into agreement to construct the project. The Contractor is responsible for submittals by the Manufacturer and the Installer as required by the Specifications. The Contractor is also responsible for scheduling and coordination of the required work with the Manufacturer and the Installer to complete the project.

B. Engineer's Field Representative:

The Engineer's field representative shall oversee the installation of the geomembrane by the Installer. The Engineer's field representative will be responsible for inspections and reviewing testing results for conformance with the specified requirements. The Engineer's field representative will compile QC test results daily and document all QC activities in weekly reports submitted to the Engineer.

C. Manufacturer:

The Manufacturer is the firm or corporation contracted by the Contractor for production of the geomembrane material to be used in the project. The Manufacturer shall produce a consistent product meeting the project specifications and shall provide quality control documentation for the product specified herein.

D. Installer:

The Installer is the firm or corporation contracted by the Contractor for installation of the geomembrane. The Installer shall be the Manufacturer or an approved Installer trained

and certified to install the Manufacturer's geomembrane. The Installer shall be responsible for field handling, storing, placing, seaming, sampling, testing and other aspects of the geomembrane installation.

E. Quality Control Laboratory:
An independent Quality Control Laboratory (QCL) hired by the Engineer to perform conformance testing of the liner material. The QCL shall have GRI certification.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General

1. The resin from which the geomembrane is made shall be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min. Formulated sheet density shall be 0.939 g/ml or higher.
2. The blended resin shall contain two to three percent carbon black, anti-oxidants and heat stabilizer, but no fillers or extenders. The resin shall be virgin material, with no more than two percent rework. If rework is used, it must be of the same formulation as the parent material. No post-consumer resin of any type shall be added to the formulation.
3. The geomembrane material shall be so produced as to be free of holes, blisters, thin areas, inconsistent texturing, undispersed raw materials, or any sign of contamination by foreign matter.
4. The sheets shall be manufactured in a minimum 15-ft seamless width.

B. Properties:

1. The geomembrane rolls shall be 40-mil textured LLDPE and shall meet the specified physical, mechanical, and chemical property requirements listed in attached Table 02072-1.
2. Interface Strength Requirements: In addition to the general material properties requirements, the Manufacturer shall provide geomembrane material meeting the minimum project-specific interface strength requirements listed in Table 02072-2:

Table 02072-2: Interface Strength Requirements

Interface	Peak Shear Strength[1]	Residual Shear Strength[1]
Geocomposite/Geomembrane	25 degrees	22 degrees
Geocomposite/ Cover Soil	25 degrees	22 degrees
Geomembrane/Sand	25 degrees	22 degrees

Notes:
1. Cohesion = 0 conditions.
2. Site-specific soils taken from samples used for borrow source testing in Specification 02300 will be provided to the QAL along with the Manufacturer provided geomembrane material.

C. Other Materials:

1. Extrudate welding rods (for fusion welds) shall be compatible and similar to the geomembrane and supplied by the Manufacturer and shall be delivered in the

original sealed containers. Each container shall have a label bearing the brand name, Manufacturer's lot number and complete directions as to proper storage.

2. Boots and shrouds for pipe penetration shall fit snugly around the pipe. Prefabricated material shall be designed to fit site specific conditions for the intended slope and size of pipe and be made of compatible and similar materials as the geomembrane.

2.02 CONFORMANCE TESTING

A. Tests:

Conformance testing shall be performed by the independent Quality Control Laboratory (QCL) provided and paid for by the Engineer. The Manufacturer shall obtain the samples from the roll, mark the machine direction and identification number and ship the samples to the QCL. The following conformance tests shall be conducted at the laboratory prior to shipment to the site:

1. Thickness
2. Density
3. Tensile properties
4. Tear resistance
5. Carbon black content
6. Carbon black dispersion
7. Asperity height

B. Frequency:

These conformance tests shall be performed in accordance with Table 02372-1, at a frequency of one sample per lot or one sample per 100,000 square feet, whichever provides the largest number of tests.

C. Acceptance or Rejection:

Conformance test results shall be reviewed by the Engineer and accepted or rejected, prior to shipment of the geomembrane. Test results shall meet, or exceed, the property values listed in Table 02072-1. The course of action implemented for retesting failing tests shall be approved by the Engineer. In case of failing test results, the Manufacturer may request that another sample be retested by the independent laboratory with Manufacturer's technical representative present during the testing procedures. This retesting shall be paid for by the Manufacturer. The Manufacturer may also have the sample retested at two different laboratories approved by the Engineer, paid for by the Manufacturer. If both laboratories report passing results, the material shall be accepted. If both laboratories do not report passing results, geomembrane material from the lot or bracketed square footage representing the failing sample will be considered out of specification and rejected.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. Preparation of the subgrade shall be as specified in Sections 02300 - Earthwork

B. The surface of the subgrade shall be smooth, uniform, relatively free from abrupt changes in grade, rocks and stones greater than 1-inch, sharp objects, debris and deleterious materials. During actual placing and seaming of the geomembrane, the subgrade surface shall be kept free of standing water. If the subgrade below the geomembrane becomes wet and unstable, it shall be recompacted in accordance with

Section 02300 - Earthwork. Before the GCN and geomembrane installation begins, the Engineer and Installer shall verify and sign off that the surface area to be lined has been properly prepared.

3.02 ANCHOR TRENCH

A. The anchor trench shall be constructed as shown on the Drawings and/or as specified herein.

B. The anchor trench shall be adequately drained to prevent water ponding and softening of adjacent soils. The anchor trench shall be backfilled and compacted.

C. Geosynthetic material in the anchor trench shall be temporarily anchored with sandbags or other suitable materials until final approvals are obtained.

D. Backfilling of the anchor trench shall be conducted when the geomembrane is in its most contracted (taut) state.

E. Care shall be taken when backfilling and compacting the trenches to prevent any damage to the lining materials.

3.03 GEOMEMBRANE PLACEMENT

A. Weather Conditions:

Geomembrane placement shall not proceed at an ambient temperature below 32 degrees F or above 104 degrees F unless otherwise authorized, in writing, by the Engineer. Geomembrane placement shall not be performed during precipitation, excessive moisture, in an area of ponded water, or excessive winds that adversely affect the geomembrane placement.

B. Method of Placement

1. Each panel of the geomembrane shall be rolled out and installed in accordance with the approved shop drawings prepared by the Installer. The layout shall be designed to keep field seams of the LLDPE geomembrane liner to a minimum and consistent with proper methods of LLDPE geomembrane installation. Panel layout and deployment shall be such that seams run down slope (i.e., perpendicular to top of slope). End seams across slopes greater than 25 percent shall be avoided. See additional seam requirements in Sub-Part 3.4.
2. Geomembrane rolls shall be placed in a manner to prevent the material from being stretched during deployment and disturbing the underlying sand cushion layer. If a sheet must be placed a distance greater than its width over the sand, a slip sheet shall be used.
3. The Engineer's field representative shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Also, inspect geomembrane prior to geocomposite drainage layer installation. Defective or damaged panels shall be replaced or repaired, in accordance with Sub-Part 3.7.7 of the specifications.
4. The Installer shall avoid dragging the geomembrane sheets on rough soil subgrade.
5. Geomembrane shall be anchored as shown on the Drawings and/or consistent with Manufacturer's recommendations.
6. Personnel working on the geomembrane shall not smoke, wear damaging shoes or involve themselves in any activity that may damage the geomembrane.
7. Edges and large exposed areas of the geomembrane shall be properly weighted to avoid uplift due to wind.

8. Vehicular traffic except for proper installation vehicles (ATVs) across the geomembrane shall not be allowed. Any vehicle used prior to or after liner placement shall be first approved by the Engineer's field representative.
9. Repaired areas and destructive sample locations shall be recorded and indicated on the as-built drawings.
10. When tying into previously installed geomembrane, excavation, if required, adjacent to installed liner shall be performed by hand to prevent damage.
11. The geomembrane shall be kept free of debris, unnecessary tools and materials. In general, the geomembrane area shall remain neat in appearance.
12. Equipment necessary to perform the installation (generators, compressors, etc) at a minimum shall have a scrap geomembrane sheet placed underneath to protect the installed geomembrane from possible damage.
13. No welder or testing equipment shall be allowed to remain on top of the installed geomembrane overnight. Equipment must be removed and stored off the installed geomembrane.
14. No fueling of equipment will be allowed on top of the installed geomembrane. No fuel containers shall be allowed on the geomembrane.

3.04 FIELD SEAMS

A. Individual panels of geomembrane shall be laid out and overlapped by a minimum of 4-inches prior to welding. The area to be welded shall be cleaned and prepared in accordance with the quality control welding procedures approved by the Engineer's field representative.

B. Double track hot wedge fusion welds shall be used for straight long seams to the maximum extent possible.

C. Extrusion welds shall be used in areas inaccessible for double track hot wedge fusion welding, including patches, repairs and penetration boots.

D. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the geomembrane material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.

E. No "fish mouths" or wrinkles will be allowed within the seam area. Where "fish mouths" or wrinkles occur, the material shall be cut, overlapped and an extrusion weld patch shall be applied. Welds upon completion of the work shall be tightly bonded. Any geomembrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of geomembrane. The number of patches per 100-ft length of seam length shall not exceed five. If more than five patches per 100-ft length are necessary, then the entire 100-ft length of seam shall be removed. Further welding will cease at this time and the Engineer's field representative shall be notified.

F. Seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the as-built drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be welded together. Patches, boots and repairs shall be numbered using a system that includes the panel number where the patch, boot or repair is located.

G. Fusion welded "T" seams (i.e., the result of the geomembrane panels placed perpendicular to each other) shall be double welded where possible. The extrusion process shall be used for the second weld.

H. Extrudate shall be free of dirt, dry and protected from damage.

I. If an extrusion welder is stopped for longer than one minute, it shall be purged to remove heat degraded extrudate. Purged extrudate shall not be placed on the installed geomembrane.

J. Seams constructed on sloped surfaces shall be perpendicular to the top and toe of the slope (vertical seams).

K. Panels placed on sloped surfaces (steeper than 25%) shall extend a minimum of 5-ft inward (on the flat) from the top of slope or edge of trench.

L. End seams shall be staggered a minimum of 5-ft in length between contiguous panels. No end seams are allowed on slopes 25 percent (4 horizontal and 1 vertical) or greater, unless otherwise approved by the Engineer's field representative.

M. To prevent moisture buildup during fusion welding, it may be necessary to place a movable protective layer of plastic (skid sheet) directly below each overlap of geomembrane that is to be seamed.

N. Seam welds shall extend the full extent into the anchor trench.

O. Factory seams, field seams and repair welds shall meet seam strength requirements specified in Table 02072-3.

Table 02372-3: Seam Properties of LLDPE Geomembrane, Textured on Both Sides

Property	Unit	Test Method	Value
Shear Strength (min. avg.)	lb/in	ASTM D 4437	44
Peel Strength (min. avg.)	lb/in	ASTM D 4437	40 & FTB

P. Seams shall be "shingled" or "rain-lapped."

3.05 SEAMING WEATHER CONDITIONS

A. Normal Weather Conditions

1. The normal required weather conditions for seaming are:
   a. Ambient temperature higher than 32 degrees F and lower than 104 degrees F.
   b. No precipitation or other excessive moisture, such as fog or dew.
   c. No excessive winds.
2. These weather conditions shall be fulfilled during seaming process.

B. Cold Weather Conditions

1. If the ambient air temperature is below 32 degrees F, the following procedures shall be implemented:
   a. Preheating the surface of the geomembrane to achieve normal temperature range.
   b. Preheating may be waived by the Engineer's field representative if the Installer demonstrates that satisfactory welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
   c. Preheating devices shall be approved by the Manufacturer.
   d. Care shall be taken to assure that surface temperatures are not lowered below the minimum required surface temperature for welding due to winds.

e. Additional destructive test samples shall be taken at the discretion of the Engineer's field representative.

f. Test seams, as described in Sub-Part 3.6.1, shall be performed under similar ambient temperature conditions as the actual seams.

C. Warm Weather Conditions

1. If the ambient air temperature is above 104 degrees F, no seaming of geomembrane shall be permitted unless the Installer can demonstrate, to the satisfaction of the Engineer's field representative that geomembrane seam quality is not adversely impacted.
2. Test seams shall be performed under similar ambient air temperature conditions as the actual seams.
3. Additional destructive tests shall be taken at the discretion of the Engineer's field representative.

3.06 FIELD QUALITY CONTROL

A. Start-up Testing

1. A test weld 3-ft long from each welding machine shall be run upon the beginning of each shift and every four hours thereafter, under the same conditions as exist for the geomembrane welding. The test weld shall be marked with date, time of day, Seamer's initials, temperature and speed settings (for fusion welds) or temperature and preheat settings (for extrusion welds), and machine number. The Installer shall provide a calibrated tensiometer, on-site before and during geomembrane installation for the purpose of testing samples. Six 1-in wide specimens shall be cut from each test weld and tested on-site in the presence of the Engineer's field representative (three for peel and three for shear strength) in accordance with Table 02072-3.
2. Test seams shall be performed under the same conditions as the actual seams and shall be at least 3-ft long and 1-ft wide after seaming. Material for test seams shall be cut out of the approved geomembrane rolls.

B. Nondestructive Seam Testing

1. The Installer shall perform a nondestructive test on field seams over their full length. The purpose of this test is to assure continuity and integrity of the seams. Vacuum and air pressure tests shall be used for nondestructive testing. The vacuum test shall be used for extrusion welds. The air pressure test shall be used for double track fusion welds.
2. Vacuum Testing
   a. Equipment for testing single wedge fusion seams and extrusion seams shall be comprised of the following:
      1) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly and a vacuum gauge.
      2) A vacuum tank and pump assembly equipped with a pressure controller and pipe connections.
      3) A rubber pressure/vacuum hose with fittings and connections.
      4) A plastic bucket and wide paint brush or mop.
      5) A soapy solution.
   b. The following procedures shall be followed by the Installer:
      1) Excess sheet overlap shall be trimmed away.

2) Clean the window, gasket surfaces and check for leaks.
3) Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.
4) Wet a strip of geomembrane approximately 12-in by 48-in (length of box) with the soapy solution.
5) Place the box over the wetted area and compress.
6) Close the bleed valve and open the vacuum valve.
7) Ensure that a leak-tight seal is created.
8) For a minimum period of 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
9) If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum of 3-in overlap and repeat the process.
10) Areas where soap bubbles appear shall be marked and repaired in accordance with Sub-Part 3.7.7 and then retested.

c. If the seam is not accessible to vacuum box equipment and cannot be tested prior to final installation, the seaming operations shall be observed by the Engineer's field representative for uniformity and completeness.

3. Air Pressure Testing (for double track fusion seams only).

a. The following procedures are applicable to those processes which produce a double seam with an enclosed space.

b. Equipment for testing double fusion seams shall be comprised of the following:
1) An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.
2) A manometer equipped with a sharp hollow needle, or other approved pressure feed device.

c. The following procedures shall be followed by the Installer:
1) Seal both ends of the seam to be tested. The length of seam shall not exceed 500-ft without approval by the Engineer's field representative.
2) Insert needle or other approved pressure feed device into the tunnel created by the double wedge fusion weld.
3) Energize the air pump to a pressure between 25 and 30 psi. After allowing two minutes for relaxation, the pressure shall be monitored over a test period not less than five minutes.
4) If the loss of pressure exceeds 4-psi or the pressure does not stabilize, the weld shall be considered faulty (unless the Installer can demonstrate that monitoring for an additional five minutes does not cause an additional loss in pressure in excess of 1 psi, and that the pressure stabilizes within the second monitoring period). Locate the faulty area, repair in accordance with Sub-Part 3.7.7 and retest.
5) If the pressure loss is less than 4 psi after five minutes, cut the air channel on the opposite end the pressure device to confirm there is no blockage and verify the length of the seam tested. Remove needle of other approved pressured feed device and seal

both ends with an extrusion weld. Remove needle or other approved pressure feed device and seal.

3.07 DESTRUCTIVE SEAM TESTING

A. Purpose

The purpose of the destructive testing is to evaluate seam strength properties. A minimum of one test sample shall be obtained per 500-ft of performed seam length. The location of samples shall be determined by the Engineer's field representative. Selection of such locations may be prompted by suspicion of overheating, contamination, or other potential cause that may adversely impact the welds. Location of samples shall not be revealed to Installer in advance. Sampling shall be performed by the Installer. Testing of field samples shall be performed by the Engineer's Quality Control Laboratory (QCL).

B. Sampling Procedures

1. Samples shall be cut by the Installer at locations chosen by the Engineer's field representative as the seaming progresses.
2. The seams shall not be covered by another material before they have been tested and accepted by Engineer's field representative.
3. Upon obtaining each sample, assign a number to the sample and mark it accordingly.
4. Record sample location on layout drawing.
5. Record purpose of the sample, statistical routine or suspicious weld area.
6. Holes in the geomembrane resulting from destructive seam testing shall be immediately repaired in accordance with Sub-Part 3.7.7.

C. Size and Disposition of Samples

1. Two samples, 12-inch wide by 18-inch shall be taken for field testing. Each of these samples shall be cut with a 1-in wide die, with the seam centered parallel to the width. The distance between these two samples shall be 36-in. If all samples pass the field test described in Sub-Part 3.7.4, a sample for laboratory testing shall be taken from the 36-inch portion.
2. The laboratory sample shall be cut into three parts and distributed as follows:
   a. One portion to the Installer for optional laboratory testing, 12-in by 12-in.
   b. One portion for QCL testing, 12-in by 12-in.
   c. One portion to the Engineer for archive storage, 12-in by 12-in.

D. Field Testing

The following shall be performed by the Installer in the presence of the Engineer's field representative:

1. The Installer shall cut six 1-in wide replicate specimens from the field testing samples to be tested for shear and peel strength, in accordance with the criteria set in Table 02072-2.
2. The Installer shall test three specimens for shear seam strength and three for peel strength. Replicate test specimens shall pass for the seam to be acceptable.
3. Samples shall be tested with a tensiometer equipped with a drive/pull apparatus adjusted to a pull rate of 2-in per minute for both peel and sheer testing. Each sample shall be tested until film tearing bond (FTB) is achieved. At a minimum, the required pass criteria for peel shall be as specified in Appendix A.

4. Any specimen that fails through the weld or through the fusion at the weld sheet interface is a non-FTB break and shall be considered a failure even if it achieves the acceptable strengths.
5. A specimen that does not break at the full extent of the test apparatus will be considered a passing test.
6. Alternate testing to evaluate both sides of dual wedge welds.

E. Quality Control Laboratory Testing
1. The Installer shall package and ship destructive test samples to the Engineer's independent Quality Control Laboratory (QCL) as directed by the Engineer's field representative by overnight delivery service. Shipping costs and destructive tests are to be paid by the Contractor.
2. Laboratory testing shall include shear and peel strength tests performed in accordance with ASTM D 4437. The minimum acceptable values obtained in these tests shall be in accordance with Table 020723-3.
3. At least five specimens shall be tested each for shear and peel strength. A passing test shall meet the minimum required values in the five specimens tested for each method.
4. The QCL shall provide verbal test results to the Engineer's field representative no more than 24 hours after they receive the samples. The Engineer's field representative shall review the laboratory results as soon as they become available.

F. Procedures for Destructive Test Failure
1. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted in the field or by the QCL. The Installer has two options.
   a. The Installer can repair the seam between (1/2 distance or as directed by the Engineer's field representative) any two passing test locations in accordance with Sub-Part 3.7.7
   b. The Installer can retrace the welding path to an intermediate location a minimum of 10 feet on each side of the failed sample. The sample shall be tested in the field. Subsequent failure of test samples shall cause the testing to move further down the seam until the extent of faulty seam has been determined.
2. Acceptable repaired seams shall be bound by two passing locations on each side of the original sample. In cases where repaired seam exceeds 150-ft, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Sub-Part 3.7.7.
3. The Engineer's field representative shall document all actions taken in conjunction with destructive test failures.

G. Repair Procedures
1. Any portion of the geomembrane exhibiting signs of any kind of defect, or failing a destructive or a nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the Engineer's field representative.
2. The repair procedures available include:
   a. Patching, used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

b. Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized defects.
c. Capping, is used to repair large lengths of failed seams.
d. Removing bad seam and replacing with a strip of new material welded in place.

3. For any repair method, the following provisions shall be satisfied:
a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.
b. Surfaces shall be clean and dry at the time of the repair.
c. Seaming equipment used in repairing procedures shall be qualified.
d. Patches and caps shall extend at least 4-inches beyond the edge of the defect.
e. Patches shall have rounded corners.

H. Repair Verification

Each repair shall be numbered and logged by the Installer. Each repair shall be nondestructively tested using the methods described in Sub-Part 3.6.2 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150-ft long may be of sufficient length to require destructive test sampling, at the discretion of the Engineer's field representative. A failed test of the repaired section indicates that the repair shall be redone and retested until passing test results are achieved. The Engineer's field representative shall observe nondestructive testing of repairs. The Installer shall record the number of each repair, date and test outcome.

I. Wrinkles

Large wrinkles that remain in the sheet as result of temperature expansion or uneven surface preparation may need removal as determined by the Engineer's field representative in consideration of applied loads on the wrinkle. Should the wrinkle need removing, the lower down-slope edge of the wrinkle shall be cut, overlapped and repaired as described in 3.7.6. Both ends of the wrinkle repair shall be patched. Caution must be taken in removing any wrinkles. Wrinkles are needed to allow for future contraction of the geomembrane liner, especially in cold weather.

3.08 DISPOSAL OF WASTE MATERIAL

Upon completion of installation, the Installer shall properly remove and dispose of all trash, waste material, tools, and equipment used in connection with the performed work and shall leave the premises in a neat and acceptable condition.

3.09 AS-BUILT DRAWINGS

The Installer shall prepare and submit to the Engineer an as-built drawing reflecting the actual installation of geomembrane liner, including the location of seams, the location of destructive samples, and the location of repair work. The as-built drawing shall be submitted to the Engineer within seven days of the completion of the geomembrane. In addition, a copy of the complete documentation package will accompany the as-built drawing.

Table 02072-2: Material Properties, LLDPE Geomembrane, Textured Both Sides

Property	Unit	Test Method	Value
Thickness – specified	mil	ASTM D 5994	40
Thickness – min. average	mil	ASTM D 5994	38
Asperity height (min. avg.)	mil	GRI GM12	10
Tensile Properties (min. avg.)		ASTM D 638(Type IV @ 2 in/min)	
1. Break Strength	lb/in		60
2. Break Elongation	%		150
Tear Resistance (min. avg.)	lb	ASTM D 1004	22
Puncture Resistance (min. avg.)	lb	FTMS 101 Method 2065	48
Density	g/cc	ASTM D 792 or ASTM D 1505	< 0.939
Carbon Black Content (range)	%	ASTM D 1603	2.0 to 3.0
Carbon Black Dispersion (10 different views, all 10 in Cat-1 or Cat-2)	N/A	ASTM D 5596	Cat-1 or Cat-2
Interface Friction		ASTM D 5321[1,2,3]	25 degrees peak 22 degrees residual

(Interface Friction - Textured Geomembrane to Geocomposite, Geocomposite to Cover Soil; and Geomembrane to Sand)

1. For textured LLDPE only; perform test at normal stresses of 1.5, 3, and 4.5 psi with a displacement rate of at least 0.2 in/min, under inundated conditions, report peak and residual values.
2. The interface friction testing between the Textured Geomembrane to Geocomposite Drainage Material and the Textured Geomembrane to Sand used at the site shall be performed in accordance with the requirements of this Section. Both interfaces shall demonstrate adequate interface friction and cohesion to provide an acceptable factor of safety. The interface friction and cohesion values obtained by the Contractor from quality control testing, as described in this Section, shall be evaluated by the Engineer. Any materials that have been placed and do not provide an acceptable factor of safety shall be removed or reworked by the Installer at no additional cost to the Owner.
3. Sand/Cover Soil shall be compacted to 90% of density, as percentage of the maximum dry density as determined by ASTM D 698 with the moisture content a maximum of 3% wet of optimum
4. The above tests shall be performed by the manufacturer of the LLDPE geomembrane for identification of the manufacturer's product. The above test results shall be submitted to the Engineer for approval of the product. The geomembrane to be supplied for the project shall meet these properties.

END OF SECTION

SECTION 02073

GEOCOMPOSITE DRAINAGE NET (GCN)

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work provided in this Section includes furnishing labor, equipment, materials, testing, and incidentals required to install a Geocomposite Drainage Net as shown on the Drawings and as specified herein as part of the multi-layer cap construction in the former Slag Area.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02072: Geomembrane

B. Section 02300: Earthwork

1.03 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic definition only.

A. American Society for Testing Materials (ASTM):

1. ASTM D 1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique (R 1990).
2. ASTM D 1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics (R 1979).
3. ASTM D 3776, Standard Test Methods for Mass Per Unit Area Weight of Woven Fabric (R 1990).
4. ASTM D 3786, Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method.
5. ASTM D 4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
6. ASTM D 4595, Standard Test Method for Tensile Properties of Geotextiles by Wide-Width Strip Method.
7. ASTM D 4632, Standard Method for Grab Breaking Load and Elongation of Geotextiles.
8. ASTM D 4716, Standard Test Methods for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
9. ASTM D 1593, Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
10. ASTM F 904, Standard Test Method for Comparison of Bond Strength of Ply Adhesion of Similar Laminates Made from Flexible Materials.
12. ASTM G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

B. Geosynthetic Research Institute (GRI):

1. GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite.

1.04 SUBMITTALS

Submit to the engineer for approval the following in accordance with Section 1330 – Submittal

Procedures.

A. Shop Drawings
   1. Material specifications, descriptive drawings, and literature.
   2. Description of method of tying or joining GCN materials.
   3. Layout and installation drawings.
   4. The manufacturer of the GCN shall submit documents to the Engineer for review that the GCN to be supplied to the project site has proven installation. As a minimum, the manufacturer shall certify that
      (a) The proposed GCN has been installed at least 10 million square feet. The proposed GCN has been installed at least 10 projects that are in operations for a minimum two years.
      (b) The proposed GCN has been installed at least 5 superfund projects.

B. Samples: Sewn or heat seamed joints of geotextile.

C. Quality Control Submittals:
   1. Manufacturer's Certificate of Compliance.
   2. Installation Procedures.
   3. Interface Friction: Perform direct shear tests (ASTM D5321) on a sample of GCN and Cover Soils and GCN and Type 1 Geomembrane material specified. Run the tests at confining stresses of 1, 2, and 4 psi and displacement rate of 0.02 in/min. The GCN/Geomembrane interface shall be saturated. The vegetative support material shall be prepared at a moisture content and compacted as specified in Section 02300 – Earthwork. Demonstrate a minimum interface friction angle of 25 degrees. Other combinations of shear strength parameters which can be shown by standard analytical techniques to provide adequate static and dynamic factors of safety against slope failure may be acceptable if approved by the Engineer.
   4. Report of geocomposite transmissivity testing results in accordance with ASTM D4716. Testing shall be performed at gradients of 0.1 and 0.3 and at a normal load of 1,000 psf using vegetative support layer soil as the upper contact surface.
   5. Mill Certificate or Affidavit:
      a. Signed by a legally authorized official from the company manufacturing the materials.
      b. Attest that the geosynthetic materials for the project meet the chemical, physical, and manufacturing requirements stated in this Specification.
      c. Provide certification and quantity of any patches applied in the manufacturing facility resulting from lamination burn through.

1.05 JOB CONDITIONS:

A. Site Information: See Section 00330 – Existing Conditions for additional information.

B. Existing Utilities: See Section 00330 – Existing Conditions for additional information.

1.06 DEFINITIONS

A. Geonet:

Geonets are a net-like polymeric material formed from intersecting ribs integrally joined at the junctions manufactured for use as drainage media with foundation, soil, rock, earth, or any other geotechnical-related material as an integral part of a human-made project, structure, or system.

B. Geotextiles:
Geotextiles are woven or nonwoven permeable man-made textile used with geotechnical engineering-related materials.

C. Geocomposite Drainage Net (GCN):
Geocomposite Drainage Net (GCN) is composed of one layer of ribbed polyethylene geonet with a nonwoven polypropylene or polyester geotextile, thermally bonded to each side of the geonet.

D. Minimum Average Roll Value (MinARV):
MinARV is the minimum of a series of average roll values representative of the product furnished.

E. Maximum Average Roll Value (MaxARV):
MaxARV is the maximum of a series of average roll values representative of the product furnished.

F. Overlap:
Overlap is the distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver marked or tagged with the following:
1. Manufacturer's name.
2. Product identification.
3. Lot number.
4. Roll number.
5. Roll dimensions.

B. Materials shall be wrapped in original, unopened package during shipment and storage.

C. Unload and store materials with minimum handling.

D. Store materials on pallets such that the rolls or panels are protected from equipment, mud, soil, dust, debris, and direct rays of the sun.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Composite Drainage Net shall be Model TENFLOW 770-2 as manufactured by TENAX® Corporation or approved equal. Should the Contractor submit an alternate product, then transmissivity testing with 1,000 hours at the specified boundary conditions must be submitted prior to material being considered for use on the project.

B. Geonet:
1. Manufactured from domestic polyethylene resin extruded ribs manufactured to form a porous net of uniform pattern with distinct openings.
2. The geonet shall conform to the requirements in Table 02073-1.

Table 02073-1: Geonet Physical Property Requirements

Property	Test Method	Requirement[2]
Tensile strength, lb/ft (minimum)	ASTM D4595	450
Reduction Factor for Compressive Creep @ 2,000 psf after 10,000 hours, (maximum)[1]	ASTM D1621	1.1
Density, g/cm^3 (minimum)	ASTM D1505	0.94
Melt Flow Index, g/10 min. (maximum)	ASTM D1238	1.0
Carbon Black content, %	ASTM D4218	2-3
Thickness, mils (minimum)	ASTM D5199	340

Notes:
[1]. Properties prior to lamination.
[2]The creep reduction factor is determined from 10,000 hour test duration, extrapolated to 30 years and using a compressive load of 2,000 psf. SIM method is acceptable for confirmation only, but is not acceptable for baseline data to determine the creep reduction factor.

C. Nonwoven Geotextile:

1. Pervious sheet of polypropylene or polyester filaments oriented into a stable network so that the filaments retain their relative position with respect to each other.
2. Composed of continuous filaments held together by needle-punching.
3. The edges of the geotextile shall be salvaged or otherwise finished to prevent the other material from pulling away.
4. Geotextile continuous filament process shall allow increased UV resistance and ability to manufacture orange textile for use as visual warning barrier to delineate potential over-excavation of cap.
5. The geotextile shall be high UV resistant, continuous filament, needle punched, nonwoven polypropylene geotextile. The geotextile color shall be orange to serve as a visual warning barrier. The strength retained after 500 hours of UV exposure shall be at least 95% per ASTM G154. The geotextile shall meet the property requirements listed in Table 02073-2

Table 02073-2: Geotextile Physical Property Requirements

Property	Test Method	Units	Value
Color	Orange		
Serviceability Class	Class 2		
AOS (MaxARV)	ASTM D4751	US Sieve (mm)	70 (0.21)
Permittivity (MARV)	ASTM D4491 Falling head	sec^{-1}	0.5
Grab Tensile Strength (MARV)	ASTM D4632	lbs	157
Trapezoid Tear (MARV)	ASTM D4533	lbs	56
Puncture Strength (MARV)	ASTM D4833	lbs	56
CBR Puncture Strength (MARV)	ASTM D6241	lbs	346
UV Resistance @500 Hours (MIN)	ASTM G154	%	95

D. Geocomposite:

1. The geocomposite shall conform to the requirements in Table 02073-3

Table 02073-3: Geocomposite Physical Property Requirements

Property	Test Method	Requirement
Ply Adhesion, lb/in	ASTM F904	0.5
Transmissivity 1,000 psf Load in Soil Boundary Condition and after 100 hours, and gradient: m^2/sec 0.1 0.3	GRI-GC8	 $8.0x10^{-3}$ $4.0x10^{-3}$
Interface Friction Angle between Geomembrane/GCN and GCN/Cover Soil, degrees	ASTM D5321	25 peak 22 residual

2.02 SOURCE QUALITY CONTROL

A. Contractor shall provide Certification of Compliance in accordance with SECTION 01330 – Submittal Procedures, showing test results for all physical properties specified at a minimum frequency of one test per 100,000 square feet.

PART 3 - EXECUTION

3.01 PLACEMENT OF GCN

A. Place and anchor the GCN in the manner at the locations shown in the Drawings and as directed by the Engineer. At or before the time of installation, GCN shall be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. Place GCN with the long dimensions downslope, with panel upslope overlying the panel downslope in a shingle fashion, unless otherwise directed by the Engineer. Install GCN smooth and free of tensions, stress, folds, wrinkles, or creases. GCN panels shall be laid smooth to provide a minimum width of 4 inches of geonet overlap along each joint and 1 foot at the end of rolls. GCN joints shall be tied at 5-foot intervals along edges and 2 foot along end using a method approved by the Engineer. Plastic ties or tying materials shall be of contrasting color to the GCN panels for inspection. Metallic connectors shall not be allowed. Secure and leakproof bags of sand shall be used to secure the GCN during installation. Securing pins shall not be used.

B. Protect GCN at all times during construction from contamination by surface runoff. Remove contaminated GCN and replace with uncontaminated GCN.

C. Should the geotextile on the GCN be damaged during any step of the installation, torn or punctured sections shall be repaired by placing a piece of geotextile which extends at least 6 inches in all directions beyond the damaged area. Geotextile repair patches shall be secured by sewing or bonding as approved by the Engineer.

D. The orientation of GCN panels shall result in approximate alignment of the drainage paths between bottom ribs of the geonet with the drainage paths indicated by the elevations shown.

E. Overlap the excess geotextile at each edge of the geonet panels in a manner that results in a smooth geotextile surface free of wrinkles and openings across the overlapped panels of geonet. Seam the geotextile so that no slack material remains between seams. Acceptable seaming methods shall be in accordance with Section 02072 - Geomembrane.

3.02 PLACEMENT OF MATERIAL ON GCN

A. Place Cover Soils on GCN as specified in Section 02300 - Earthwork. If damage occurs to the GCN during the spreading operation, the overlying material shall be carefully removed from the GCN and the damaged area repaired as specified.

B. To protect the GCN from UV deterioration, protective plastic covering will be placed above the GCN on the slope. This coverage will be removed progressively as fill is placed against the slope. The Contractor shall furnish and install the protective plastic covering.

C. Spread overlying Cover Soils in the direction of GCN overlap.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish all labor, equipment, and materials necessary for excavation, filling/backfilling, compaction, testing, and grading. The Work shall be as shown on the Drawings, the Shop Drawings, and as specified herein. Work includes, but is not limited to the following:
   1. Grading and compacting existing fill to establish subgrade;
   2. Placing, grading, and compacting cap soil layers including the following materials:
      a. Sand;
      b. Cover Soil; and
      c. Plantable Soil.
   3. Borrow Source testing, field testing, and contractor quality control testing:

B. In preparation for excavation, clearing shall occur in accordance with Section 02231 - Clearing and Grubbing

C. Control of surface water run-off during construction shall be in accordance with Section 02370 - Erosion and Sedimentation Control.

D. Removal of larger waste debris including concrete and metal shall occur in accordance with Sections 02110 – Waste Excavation, Removal, and Handling and Section 02120 – Off-Site Transportation and Disposal.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 00330: Existing Conditions.
B. Section 01110: Summary of Work.
C. Section 01330: Submittals Procedures.
D. Section 02110: Waste Excavation, Removal, and Handling
E. Section 02120: Off-Site Transportation and Disposal.
F. Section 02231: Clearing and Grubbing.
G. Section 02240: Dewatering.
H. Section 02370: Erosion and Sedimentation Control.
I. Section 02072: Geomembrane.
J. Section 02073: Geocomposite
K. Section 02074: Geotextile.
L. Section 02921: Seeding and Soil Supplements.

1.03 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The current version/edition of the publication is referenced, unless otherwise noted. The publications are referred to in the text by basic designation only.

B. American Society for Testing and Materials (ASTM):
   1. ASTM C 33 - Standard Specification for Concrete Aggregates;
   2. ASTM C 88 - Standard Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate;

3. ASTM C 127 - Test Method for Specific Gravity and Absorption of Coarse Aggregate;
4. ASTM C 136 - Sieve Analysis of Fine and Coarse Aggregates;
5. ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils;
6. ASTM D 535 - Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine;
7. ASTM D 854 - Test Method for Specific Gravity of Soils;
8. ASTM D 1140 - Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve;
9. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3);
10. ASTM D 2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soils and Rock by Mass;
11. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System);
12. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth);
13. ASTM D 2974 - Standard Test Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils;
14. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock by Nuclear Methods (Shallow Depth);
15. ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction;
16. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils;

C. Standards Specifications for Road and Bridge Construction, 2004, by the Rhode Island State Department of Transportation (RIDOT).

D. "Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases", (Remediation Regulations) by the Rhode Island Department of Environmental Management (RIDEM), Office of Waste Management, as amended February 2004.

E. Quarried Stone for Erosion and Sediment Control, by the National Stone Association, dated 1978.

1.04 DEFINITIONS

A. Satisfactory Soils:

1. Satisfactory Soils shall meet the requirements specified in Part 2 of this Section and shall be used in areas as shown on the Drawings, Shop Drawings, and as approved by the Engineer. In addition, Satisfactory Soils shall satisfy the following conditions:
   a. Satisfactory Soils shall be free of all Unsatisfactory Soils/Materials listed below; and
   b. Satisfactory Soils shall be free of material greater than 6 inches any direction, unless otherwise specified or approved by the Engineer. Furthermore, the maximum particle size shall not exceed one half of the specified maximum lift thickness, unless otherwise specified.

B. Unsatisfactory Soils/Materials:

1. Unsatisfactory Soils/Materials include but are not limited to highly plastic/fat silt

and clay, organic soils, and/or peat (classified as MH, CH, OL, OH, or PT via ASTM D 2487), stumps/brush, trash, refuse, debris, frozen soils, soils containing materials greater than the allowable size (see above), saturated soils, fine-grained soils above their liquid limit at the time of compaction, and soils that are either too wet or too dry to compact.

C. Cohesionless and Cohesive Soils:
   1. Cohesionless soils include gravels, sand-gravel mixtures, sands, and gravelly-sands, classified as GW, GP, SW, or SP by the Unified Soil Classification System (ASTM D 2487).
   2. Cohesive soils include clayey gravels, sand-clay mixtures, clayey sands, clays, and silts, classified as GC, SC, CL, CH, ML, or MH by the Unified Soil Classification System (ASTM D 2487).
   3. Soils classified as GM and SM will be identified as cohesionless only when the "fines" are determined to be non-plastic.
   4. Testing required for the classification of soil shall be in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

D. Percent Compaction:
   1. Degree of compaction (percent compaction) required is expressed as a percentage of the maximum dry density, at the optimum moisture content.
   2. Maximum dry density and optimum moisture content shall be obtained by the test procedure presented in ASTM D 1557, unless otherwise specified.

1.05 QUALITY ASSURANCE

A. Codes and Standards:
   1. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

1.06 SUBMITTALS

Submit to the Engineer for approval (unless otherwise specified) the following in accordance with Section 01340, "Submittals":

A. Borrow Source(s):
   1. The Contractor shall provide the proposed source(s) of borrow materials prior to initiation of work. Any available/previous geotechnical laboratory testing data shall be provided.

C. Contractor's Quality Control Testing Laboratory (QCTL):
   1. The name and qualifications of an independent third-party geotechnical testing laboratory to be used for borrow source testing and field quality control testing shall be submitted within 7 days following notice to proceed.
      a. The Contractor's QCTL shall meet the requirements of ASTM D 3740, at a minimum.

D. Test Reports:
   1. The Contractor's QCTL shall submit 2 copies of the following test reports directly to the Engineer, with at least 1 copy to the Contractor:
      a. All test reports for borrow source materials; and
      b. Field quality control test reports.

1.07 SITE CONDITIONS

A. Known existing site conditions are described in Section 00330 – Existing Conditions.

B. Protection of Persons and Property:
   1. Barricade and mark open excavations occurring as part of this Work in accordance with applicable standards.
   2. Protect structures, utilities, pavements, sidewalks, fences, and other facilities designated to remain from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations and heavy truck/equipment traffic.

PART 2 - PRODUCTS

2.01 REGRADED FILL

A. Location/Use:
   1. Regraded Fill shall be used as necessary, to achieve the subgrade elevations indicated on the Drawings.

B. Regraded Fill shall consist of Satisfactory Soils suitable for embankment construction. It shall be free from frozen materials, perishable rubbish, peat, and other Unsatisfactory Soils/Materials. It shall be of such a nature and character that it can be compacted to the specified density (see Part 3 of this Section).

C. Regraded Fill shall have a maximum nominal particle size of 6 inches or less. Furthermore, the maximum particle size shall not exceed one half of the specified maximum lift thickness, unless otherwise specified.

D. The moisture content shall be sufficient to provide the required compaction and a stable embankment and/or subgrade. In no case shall the moisture content exceed 3% above optimum.

E. Satisfactory Soils obtained from on-site excavations of existing fill and/or subgrade preparations may be re-used on-site as Regraded Fill, as approved by the Engineer.

2.02 CRUSHED STONE

A. Location/Use:
   1. Stone Check Dams.
   2. Construction Entrance.

B. Crushed Stone shall consist course aggregate consisting of 100 percent crushed bedrock. It shall not contain crushed or uncrushed gravel and shall be free soft, friable particles or any Unsatisfactory Soils/Material.

C. Gradation shall meet the requirements of RIDOT Type II Crushed Stone as specified in RIDOT Specification Table 1, Subsection M.01.09 and shown in Table 02300-1.

Table 02300-1: Crushed Stone Gradation Requirements

Sieve Size	Percent Passing
2-1/4"	100%
2"	90 – 100%
1-1/2"	30 - 55%
1-1/4"	0 - 25%
1"	0 - 5 %

2.03 SAND

A. Location/Use:
   1. Slag Area Cap System.

B. As defined in RIDOT Specification Subsection M.01.03 for Pervious Fill.

C. Clean, naturally occurring granular bank run or plant-processed soil materials that shall not contain Unsatisfactory Soil/Materials.

C. Gradation shall generally meet the requirements of RIDOT Type IV as specified in RIDOT Specification Table 1, Subsection M.01.09 with the following exception:
   1. Maximum particle size shall be 1/2 inches.
   2. The modified Type IV gradation in Table 02300-2.

Table 02300-2: Sand Gradation Requirements

Sieve Size	Percent Passing
1/2"	100%
#4	30 - 100%
#200	0-8%

2.04 RIPRAP

A. Location/Use:
   1. Slag Area Cap Toe Detail;
   2. Transition Detail: Upland Cap to Wetland Buffer Cap; and
   3. Typical Drainage Area Cap.

B. As defined in RIDOT Specification M.10.03 shall consist of broken stone produced from sound ledge or large boulders with at least three fractured faces on each particle and be free from shale, organic matter, overburden material, and/or other Unsatisfactory Soil/Materials. Rounded stones are not acceptable except at locations approved by the Engineer.

C. Riprap shall meet the National Stone Association (NSA) gradations for the classifications of riprap (designated by the Modified NSA Numbers) as specified in RIDOT Specification M.10.03 and noted in the Table 02300-3.

Table 02300-3: Riprap Gradation Requirements

NSA Modified No.	Sieve Size		
	100% Passing	0-50% Passing	0-15% Passing
R-3	8"	4"	2"
R-4	14"	7"	4"

2.05 COVER SOIL

A. Location/Use:
   1. Slag Area Cap;
   2. Upland Cap; and
   3. Drainage Area Cap

B. Cover Soil shall consist of Satisfactory Soils suitable for embankment construction. It shall be free from frozen materials, perishable rubbish, peat, and other Unsatisfactory Soils/Materials. It shall be of such a nature and character that it can be compacted to the specified density (see Part 3 of this Section).

C. Cover Soil shall have a maximum nominal particle size of 3 inches or less. Furthermore, the maximum particle size shall not exceed one half of the specified maximum lift thickness, unless otherwise specified. Acceptable materials will be classified as GM, GC, SW, or SP as determined by ASTM D2487.

D. The moisture content shall be sufficient to provide the required compaction and a stable embankment and/or subgrade. In no case shall the moisture content exceed 3% above optimum, which shall be determined in accordance with ASTM D 1557.

E. Cover Soil shall meet the Rhode Island Industrial/Commercial Direct Exposure Criteria for Volatile Organic Compounds (VOCs), Semi-Volatile Compounds (SVOCs), Total Metals (RCRA 18), Total Petroleum Hydrocarbons (TPH) as compared to Table 1 of the RIDEM "Remediation Regulations".

2.07 PLANTABLE SOIL

A. As defined in Section M.18.02 of the RIDOT Specifications.

B. Loose, friable topsoil, free of refuse, brush, stumps, roots, rocks, cobbles, stones, noxious weeds, litter and any other materials that are longer than 1 inch in any dimension and which will prevent the formation of a suitable seed bed.

C. Organic matter shall not constitute less than 4 percent or more than 20 percent as determined by loss-on-ignition testing of oven dried samples.

D. A pH between 5.5 and 7.5.

E. Plantable Soil shall meet the Rhode Island Industrial/Commercial Direct Exposure Criteria for Volatile Organic Compounds (VOCs), Semi-Volatile Compounds (SVOCs), Total Metals (RCRA 18), Total Petroleum Hydrocarbons (TPH) as compared to Table 1 of the RIDEM "Remediation Regulations".

2.08 BORROW SOURCE TESTING

A. Borrow source testing, including geotechnical characterization requirements, shall be conducted on all soil materials proposed for construction. Minimum third-party geotechnical laboratory testing requirements and frequency for materials are listed as follows:

1. Crushed Stone:

Test	Methodology[1]	Frequency[2]
Sieve Analysis	ASTM C 136	1 test/source/material

2. Sand:

Test	Methodology[1]	Frequency[2]
Particle-Size Analysis (to #200 Seive)	ASTM D 422	1 test/source/material
Modified Proctor	ASTM D 1557	1 test/source/material

3. Riprap:

Test	Methodology[1]	Frequency[2]
Sieve Analysis	ASTM C 136	1 test/source/material

5. Cover Soil

Test	Methodology[1]	Frequency[2]
Particle-Size Analysis (to #200 Seive)	ASTM D 422	1 test/500 cy
Modified Proctor	ASTM D 1557	1 test/source/material
VOCs	EPA 8250B	1 test/500 cy
SVOCs	EPA 8270C	1 test/500 cy
TPH	EPA 8100M	1 test/500 cy
RCRA Metals (total only)	EPA 6010B	1 test/500 cy

6. Plantable Soil

Test	Methodology[1]	Frequency[2]
Particle-Size Analysis (to #200 Seive)	ASTM D 422	1 test/500 cy
Organic Content	ASTM D 2974	1 test/500 cy
pH	ASTM D 4972	1 test/500 cy
VOCs	EPA 8250B	1 test/500 cy
SVOCs	EPA 8270C	1 test/500 cy
TPH	EPA 8100M	1 test/500 cy
RCRA Metals (total only)	EPA 6010B	1 test/500 cy

Borrow Source Testing Notes:

1. Other testing methods may be considered acceptable, based on prior approval of the Engineer.
2. Testing frequency shall be as listed, at any change in borrow source, or at any discernable change in material delivered to the site (as determined by the Engineer).

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions under which excavating, filling, and grading are to be performed and notify the Engineer, in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3.02 EXCAVATION DEWATERING

A. General:

1. Perform dewatering as necessary for the control and collection of ground and surface water entering trenches and/or excavations.
2. Perform dewatering as necessary for provide a safe working environment.
3. See Section 02240 - Dewatering for additional information.

3.03 STABILITY OF EXCAVATIONS

A. General:

1. Slope sides of excavations to comply with applicable codes and ordinances.
    a. Shore and brace excavations where sloping is not possible because of space restrictions or stability of material excavated.
2. Maintain excavations in a safe condition until completion of backfilling, or longer if specified or directed by the Engineer.

B. Shoring, Sheeting, and Bracing:
1. Utilize where necessary to meet safety requirements and/or as shown on the Drawings.
    a. Establish requirements for trench shoring and bracing to comply with codes and ordinances of authorities having jurisdiction.
2. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.

3.04 COLD WEATHER PROTECTION

A. Protect exposed subgrade surfaces against freezing when atmospheric temperature is less than 35°F.

B. Fill materials shall not be placed atop frozen subgrade surfaces.

3.05 EXCAVATION

A. General:
1. Excavation consists of removal of material encountered when establishing required subgrade.
2. During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times.

B. Subgrade Excavation:
1. Any large, concrete or metal debris encountered during excavation shall be removed from the Site as described in Section 02221 – Select Site Demolition.
2. Establish grades within a maximum 33.33 percent (3 horizontal (H) to 1 vertical (V)) and a minimum 5.00 percent (20H to 1V).
3. Conform to grades within a tolerance of one inch deviation over 50 feet of slope. This relates to an allowable minimum slope of 4.83 percent (20.69H to 1V) and an allowable maximum slope of 33.51 percent (2.98H to 1V).

3.06 SUBGRADE PREPARATION

A. General:
1. Remove vegetation, debris, Unsatisfactory Soils/Materials, obstructions, and deleterious materials from subgrade surfaces prior to placement of fills.
2. Bench, plow, strip, scarify, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

B. Regraded Fill Placement
1. Regraded Fill soil shall be obtained from cut areas within the limit of disturbance
2. Regraded Fill shall be placed in areas where fill is required to achieve subgrade elevations.
3. Regraded Fill shall be placed in compacted lifts no greater than 12 inches in depth.
4. Compaction of Regraded Fill shall be as specified is Sub-Part 3.11

1. Prior to placing Regraded Fill the surface shall be relatively smooth/even, free of loose soil, ponded water, and debris. Any loose, soft, wet, frozen, or otherwise unsuitable/unsatisfactory soils or materials observed should either be re-compacted or undercut to a suitable subgrade, as approved by the Engineer.
2. Any undercut/excavated material should be replaced/backfilled with Regraded Fill or Sand, as approved by the Engineer.
    a. Fill materials shall be placed and compacted as specified herein.
3. Prior to placing Regraded Fill the exposed subgrade shall be benched, plowed, or scarified such that fill material will bond with existing subgrade surface.
    a. Limit extent of disturbance, as indicated on the Construction Drawings and/or approved by the Engineer.

3.07 HANDLING AND TEMPORARY ON-SITE STORAGE OF EXCAVATED MATERIALS

A. General:
1. During daily excavation activities, locate and retain excavated soils/materials away from the edge of excavations.
    a. Temporary/daily stockpiles shall be maintained a sufficient distance from the top of the riverbank to prevent loading of the slope and to provide for stability of the slope.

B. Satisfactory Soils:
1. Satisfactory Soils obtained from on-site excavations and/or subgrade preparations shall be re-used as Subgrade Fill, and used insofar as practical for rough site grading and backfill, as specified herein.
    a. Satisfactory Soils and/or Regraded Fill shall have a maximum nominal particle size of 6 inches. Furthermore, the maximum particle size shall not exceed ½ of the specified maximum lift thickness, unless otherwise specified.
2. Excess amounts of Satisfactory Soils shall be transported to the designated Waste Staging and Storage Area as shown on the Drawings, and as approved by Owner and the Engineer.
    a. Stockpiles shall be constructed in accordance with Section 02110 - Waste Excavation, Removal, and Handling.
    b. Soils suspected to be hazardous waste based on visual examination shall be segregated from those suspected to be non-hazardous.
        1) Final determination of hazardous versus non-hazardous shall be based on sampling, analysis, and characterization.

C. Unsatisfactory Soils/Materials:
1. Unsatisfactory Soils/Materials obtained from on-site excavations and/or subgrade preparations that can be improved or modified (i.e. thawed, screened, and/or moisture-conditioned) to meet the definition of Satisfactory Soils may be re-used as Subgrade Fill, as approved by the Engineer.
2. Unsatisfactory Soils/Materials that cannot be improved or modified to meet the definition of Satisfactory Soils shall be transported to the designated Waste Staging and Storage Area as shown on the Drawings, and as approved by Owner and the Engineer.
    a. Stockpiles shall be constructed in accordance with Section 02110 - Waste Excavation, Removal, and Handling.

b. Soils suspected to be hazardous waste based on visual examination shall be segregated from those suspected to be non-hazardous.
   1) Final determination of hazardous versus non-hazardous shall be based on sampling, analysis, and characterization.

3.08 SAMPLING, ANALYSIS, AND CHARACTERIZATION

A. Excess Satisfactory Soils:
   1. Stockpiles of excess Satisfactory Soils shall be sampled, analyzed, and characterized as specified in Section 02110 – Waste Excavation, Removal, and Handling.

B. Unsatisfactory Soils/Materials:
   1. Stockpiles of excess Unsatisfactory Soils/Materials shall be sampled, analyzed, and characterized as specified in Section 02110 – Waste Excavation, Removal, and Handling.

3.09 TRANSPORTATION AND DISPOSAL

A. Excess Satisfactory Soils:
   1. Transportation and/or disposal shall be in accordance with Section 02120 – Off-Site Transportation and Disposal.

B. Unsatisfactory Soils/Materials:
   1. Transportation and/or disposal shall be in accordance with Section 02120 – Off-Site Transportation and Disposal.".

3.10 PLACEMENT OF FILL/BACKFILL MATERIALS

A. General:
   1. Place specified fill/backfill materials in lifts as specified herein as required to achieve specified subgrade elevations.
   2. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
   3. Backfill excavations as promptly as work permits, but not until completion of the following:
      a. Acceptance by Engineer of construction below finish grade.
      b. Inspection, testing, approval, and recording locations of underground utilities.
      c. Removal of trash and debris.

B. Fill/Backfill Placement:
   1. Place fill/backfill materials in layers not more than 12 inches (prior to compaction) for material to be compacted by heavy compaction equipment (i.e. vibratory roller), unless otherwise specified.
   2. Place fill/backfill materials in layers not more than 8 inches (prior to compaction) for material to be compacted by hand-operated tampers or hydraulic equipment, unless otherwise specified.
   3. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to required percentage of maximum dry density (Sub-Part 3.11).
   4. Place fill/backfill materials evenly around/adjacent to structures, to the required elevations.

a. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

5. Do not backfill anchor trenches until authorized by the Engineer.
   a. Use care in backfilling to avoid damage or displacement of the geosynthetics.

3.11 COMPACTION

A. General:
   1. Provide soil compaction during construction as necessary to achieve minimum percent/degree of compaction, as specified herein.
   2. Maximum dry density and optimum moisture content shall be determined in accordance with ASTM D 1557 (or Engineer-approved equivalent).

B. Percent Compaction Requirements:
   1. Foundations and/or Pre-Cast Structures:
      a. Fill/backfill materials placed beneath or adjacent to foundations or pre-cast structures shall be compacted to at least 95% of maximum dry density, unless otherwise specified or approved by the Engineer.
   2. Pavement Areas:
      a. Fill/backfill materials placed beneath areas to be surfaced with asphaltic concrete pavement shall be compacted to at least 95% of maximum dry density, unless otherwise specified or approved by the Engineer.
   3. Cap Areas:
      a. Fill/backfill materials shall be compacted to at least 90% of maximum dry density, unless otherwise specified or approved by the Engineer.
   4. Pipe/Conduit Trenches:
      a. Compact pipe/conduit bedding (Sand) and each layer of backfill (Sand) to six (6) inches over the pipe to at least 90% of maximum dry density.
      b. Backfill placed above 6 inches over the pipe shall be compacted in accordance with the applicable surface treatment, as shown on the Drawings and as specified above.

C. Moisture Control:
   1. Where the subgrade or a layer of fill/backfill must be moisture-conditioned before compaction, uniformly apply water to the surface, in proper quantities to prevent free water appearing on surface during or subsequent to compaction operations.
   2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
   3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled as specified herein or spread and allowed to dry. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory level.

3.12 FINAL GRADING

A. General:
   1. The Contractor shall uniformly grade areas within the Limits of Disturbance. Smooth finished surface within specified tolerances, with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

2. Establish grades within a maximum 33.33 percent (3 horizontal (H) to 1 vertical (V)) and a minimum 5.00 percent (20H to 1V). Select areas at Cap Transitions and upslope of the existing Stormwater Detention Basin outfall may be as steep as 50 percent (2H:1V), however, the extent of the areas shall be minimized.
3. Conform to grades within a tolerance of one inch deviation over 50 feet of slope. This relates to an allowable minimum slope of 4.83 percent (20.69H to 1V) and an allowable maximum slope of 33.51 percent (2.98H to 1V). For the 50 percent (2H:1V) slope areas, a maximum slope of 50.17 percent (1.99H to 1V) is allowable.

3.13 VEGETATION STABILIZATION

A. Refer to Section 02921 – Seeding and Soil Supplements.
B. Refer to Section 02370 – Erosion and Sedimentation Control.

3.14 FIELD QUALITY CONTROL TESTING

A. Quality Control Testing During Construction:
1. Allow testing service to examine and test subgrade surfaces and fill/backfill layers. Before further construction work is performed, test results meeting the requirements of Sub-Part 3.11 of this Section shall be obtained.
2. Perform field density tests in accordance with ASTM D2922 (nuclear method), or other Engineer approved methods, as applicable.
   a. Foundations and/or Pre-Cast Structures:
      1) For each layer of fill/backfill placed, conduct 1 compaction test for every 100 linear feet of foundation/structure, but in no case less than 3 tests
      2) Exception: 1 test is acceptable for each layer of backfill around pre-cast below-grade vault structures.
   b. Pavement Areas:
      1) For each layer of fill/backfill placed, conduct at least 1 compaction test for every 1000 square feet, but in no case less than 3 tests per lift.
   c. Cap Areas:
      1) For each layer of fill placed, conduct at least 1 compaction test for every 8,000 square feet, but in no case less than 3 tests per lift.
      2) For every 8,000 square feet of cover soils placed, conduct at least 1 thickness test. 90% of fill thickness tests shall be within 10% of specified thickness and no test shall be less than 80% of thickness. Additional fill shall be placed in areas that do not meet minimum thickness requirements.
   d. Pipe/Conduit Trenches:
      1) For each layer of fill placed, conduct at least 1 compaction test for every 100 linear feet of trench.
   e. Anchor Trenches:
      1) For each layer of fill placed, conduct at least 1 compaction test for every 100 linear feet of trench.
3. If in opinion of Engineer, based on testing service reports and inspection, subgrade soils or fill/backfill materials which have been placed are below specified density,

the Contractor shall provide additional compaction and testing at no additional expense to the Owner.

3.15 MAINTENANCE

A. Protection of Graded Areas:

1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas:

1. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

END OF SECTION